



THE UNIVERSITY OF
NEW MEXICO



NMFMA Fall 2018 QGIS Workshop

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Part A. Introduction to QGIS

1. QGIS

- QGIS is a free and open source cross-platform (Windows, Mac OS, Linux, BSD, and Android) Desktop Geographic Information System (GIS)
- QGIS can help users create, edit, visualize, analyze, and publish geospatial data
- QGIS integrates with other open source GIS packages, including but not limited to PostGIS, GRASS GIS, and MapServer
- QGIS supports shapefiles, coverages, personal geodatabases (only feature class), many raster formats, and many other formats

2. QGIS vs. ArcGIS

- QGIS – free and open source software, more stable, less analysis tools, multi-platform
- ArcGIS – commercial software, less stable, more analysis tools, single-platform

3. Start to Learn QGIS

- Graser, A. 2016. *Learning QGIS*, 3rd ed. Packt Publishing, Birmingham, UK.
- Mastering QGIS, Menke, K., Smith, R. Jr., Pirelli, L., and Van Hoesen, J. *Mastering QGIS*, 2nd ed. Packt Publishing, Birmingham, UK.
- Graser, A., Mearns, B., Mandel, A., Ferrero, V. O., and Bruy A. *QGIS: Becoming a GIS Power User*. Packt Publishing, Birmingham, UK.
- Website
 - QGIS Workshop <http://maps.cga.harvard.edu/qgis/>
 - QGIS Tutorials and Tips <http://qgistutorials.com>
- Online Education
 - Udemy Introduction to GIS <https://www.udemy.com/gis-for-everyone/>
 - Udemy Learnt to use QGIS <https://www.udemy.com/draft/149366/>

Part B. Getting Started with QGIS

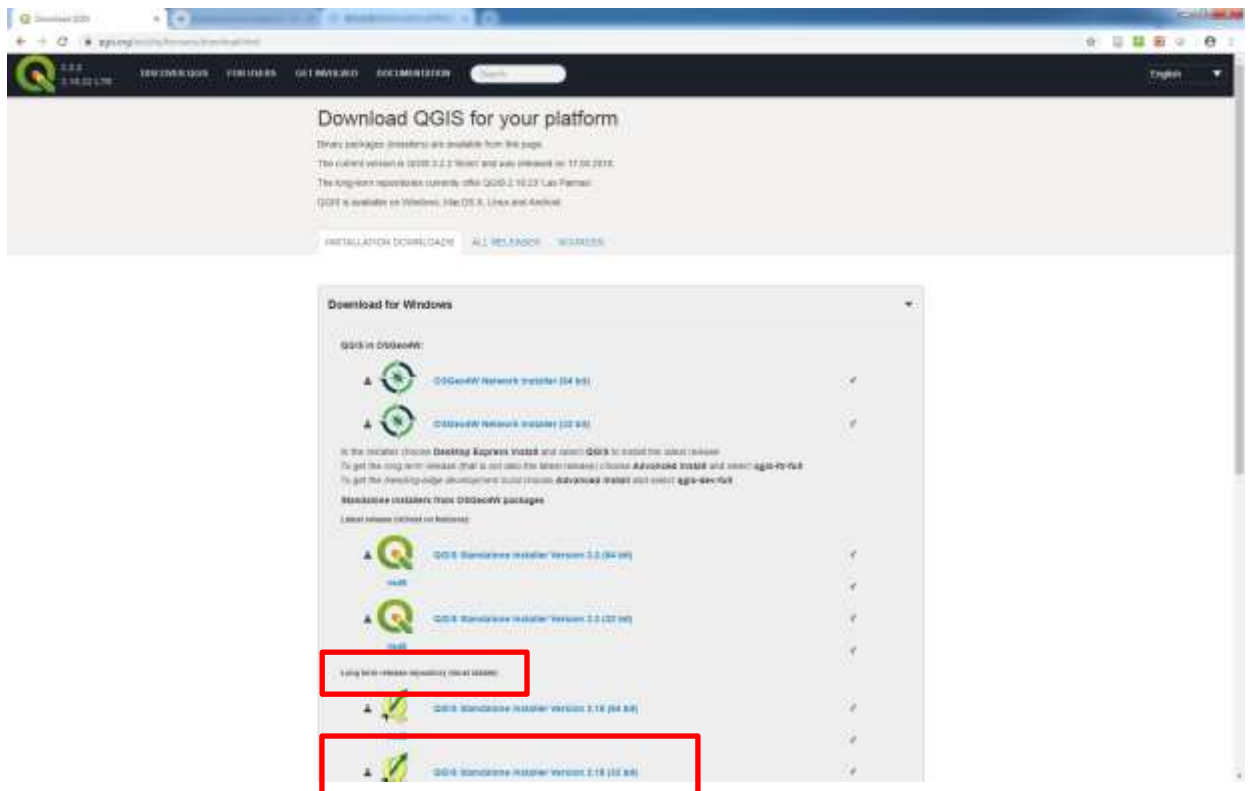
1. Download QGIS

(1) Go to www.qgis.com.

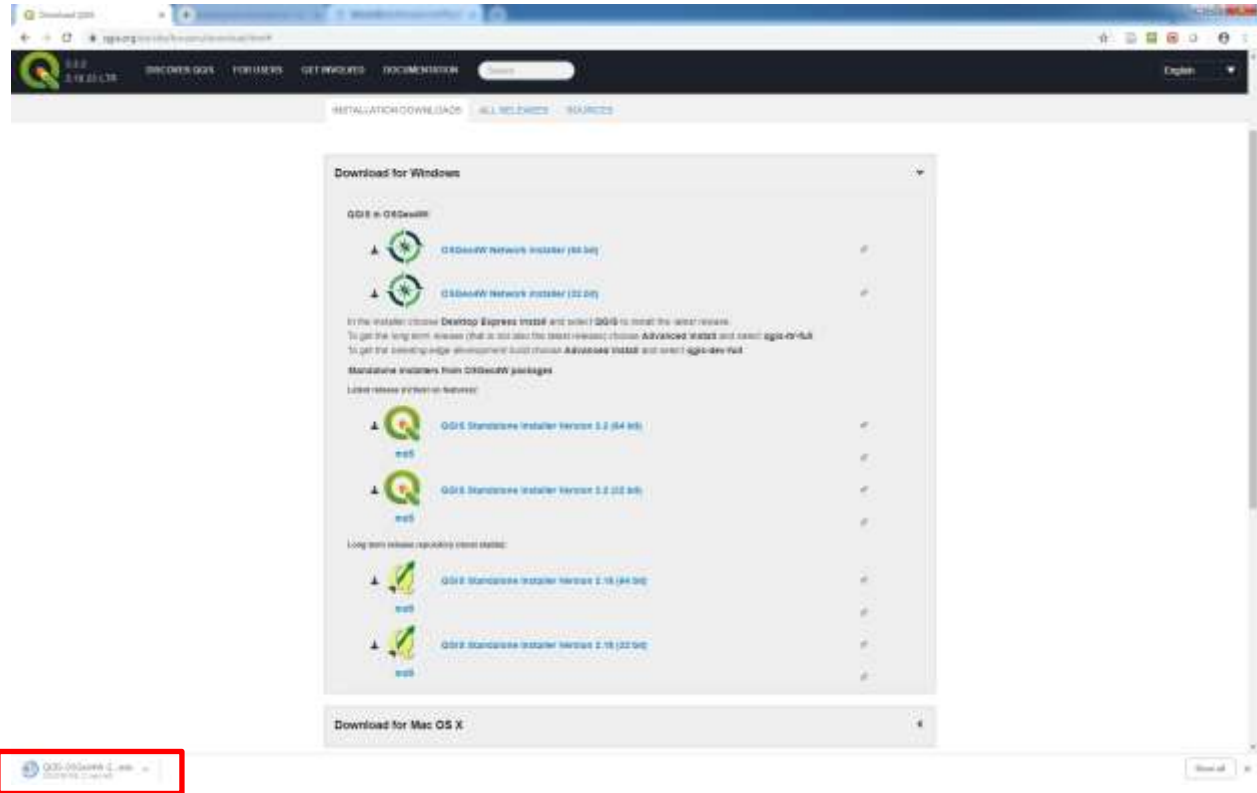
(2) You will see a webpage looks like this; click “Download Now” to start the download page.



(3) Select the latest version that is compatible with your operating systems to download; preferably 64-bit; the long term release version is the most stable one for your choice.



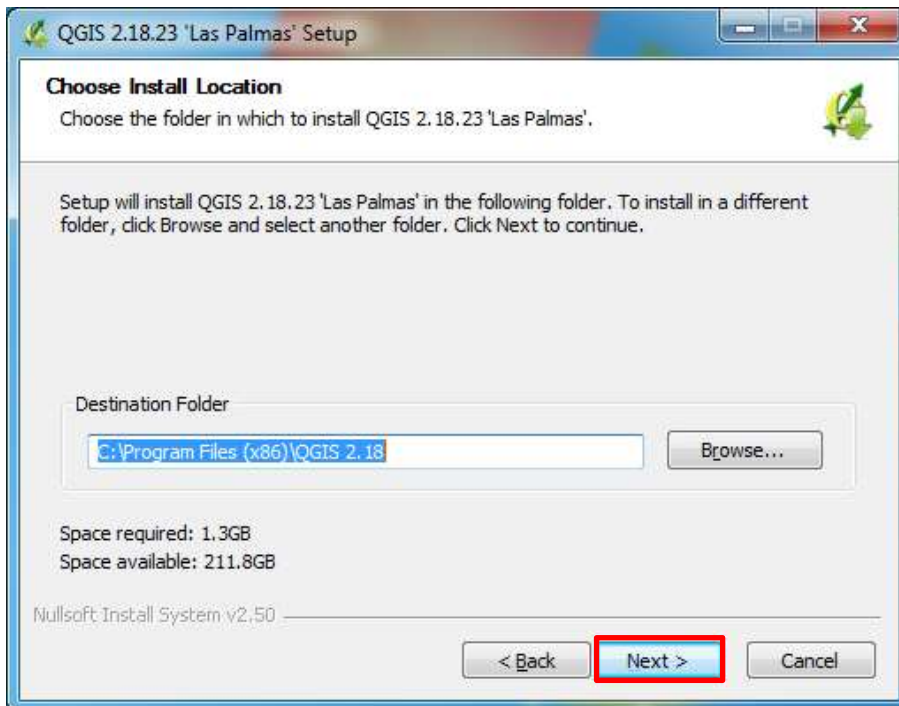
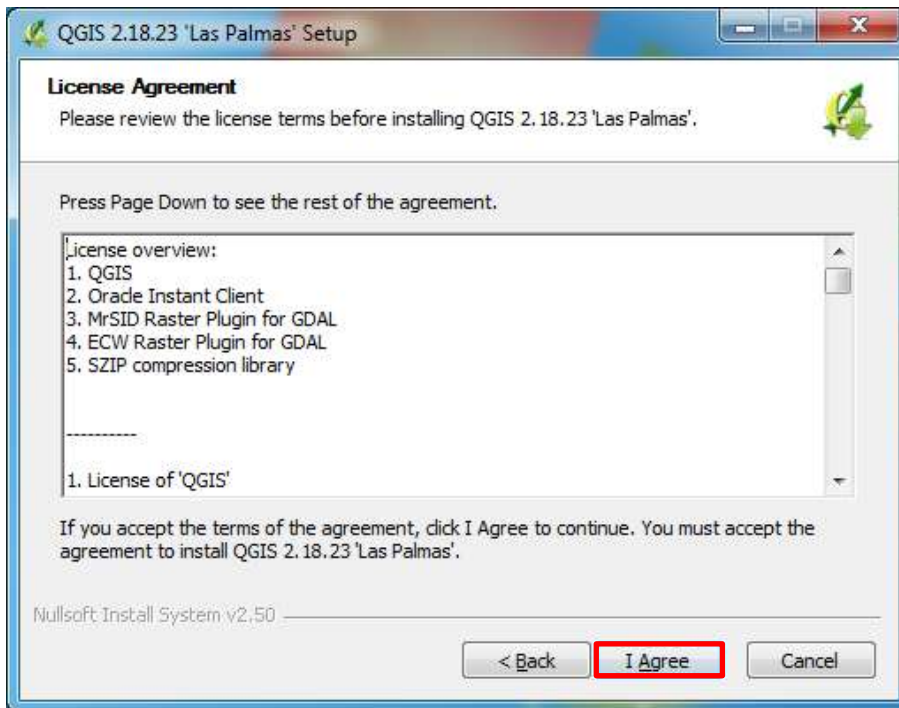
(4) Click QGIS Standalone Installer Version 2.18 (64 bit) and the web browser should be able to automatically download the installer.

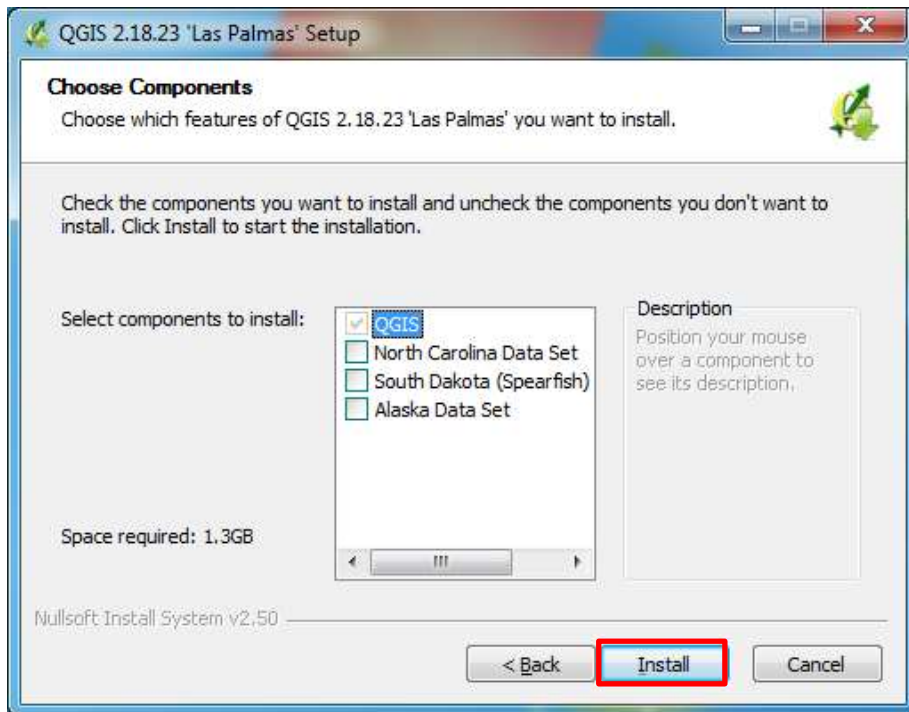


2. Install QGIS

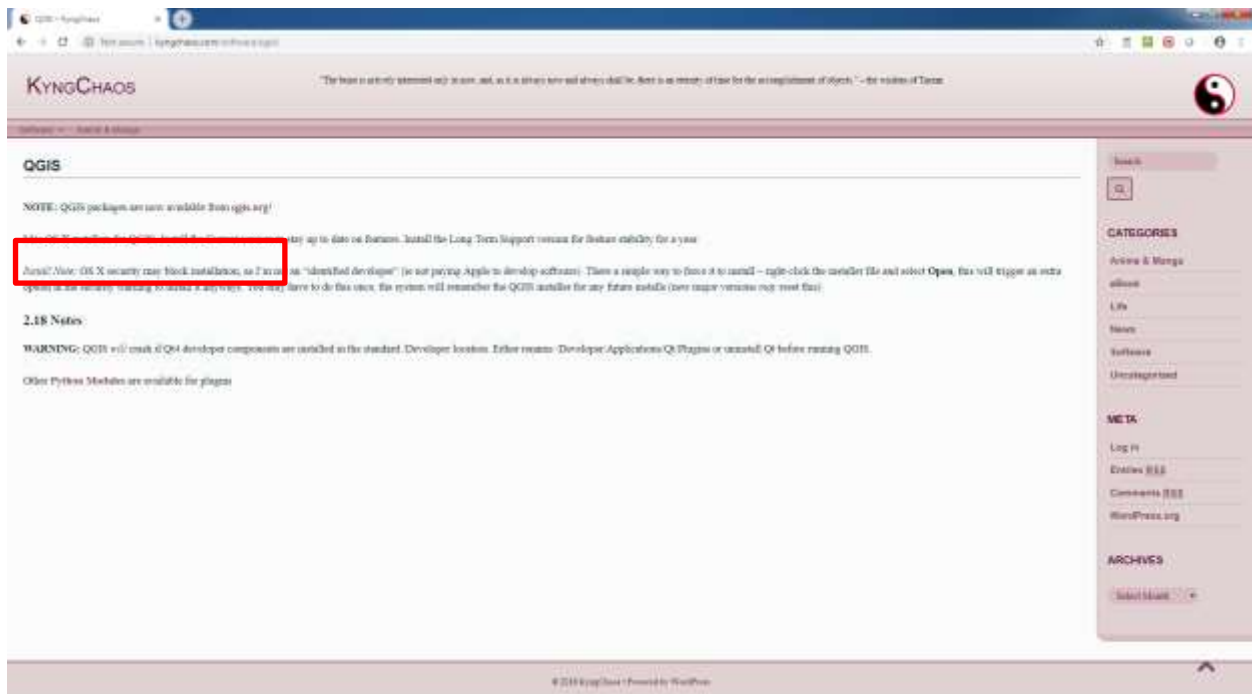
(1) Double click the installer you just downloaded; QGIS Setup Wizard should show up, and click Next to start the installation process; you will see the License Agreement, Installation Location, and Components to Install, etc.







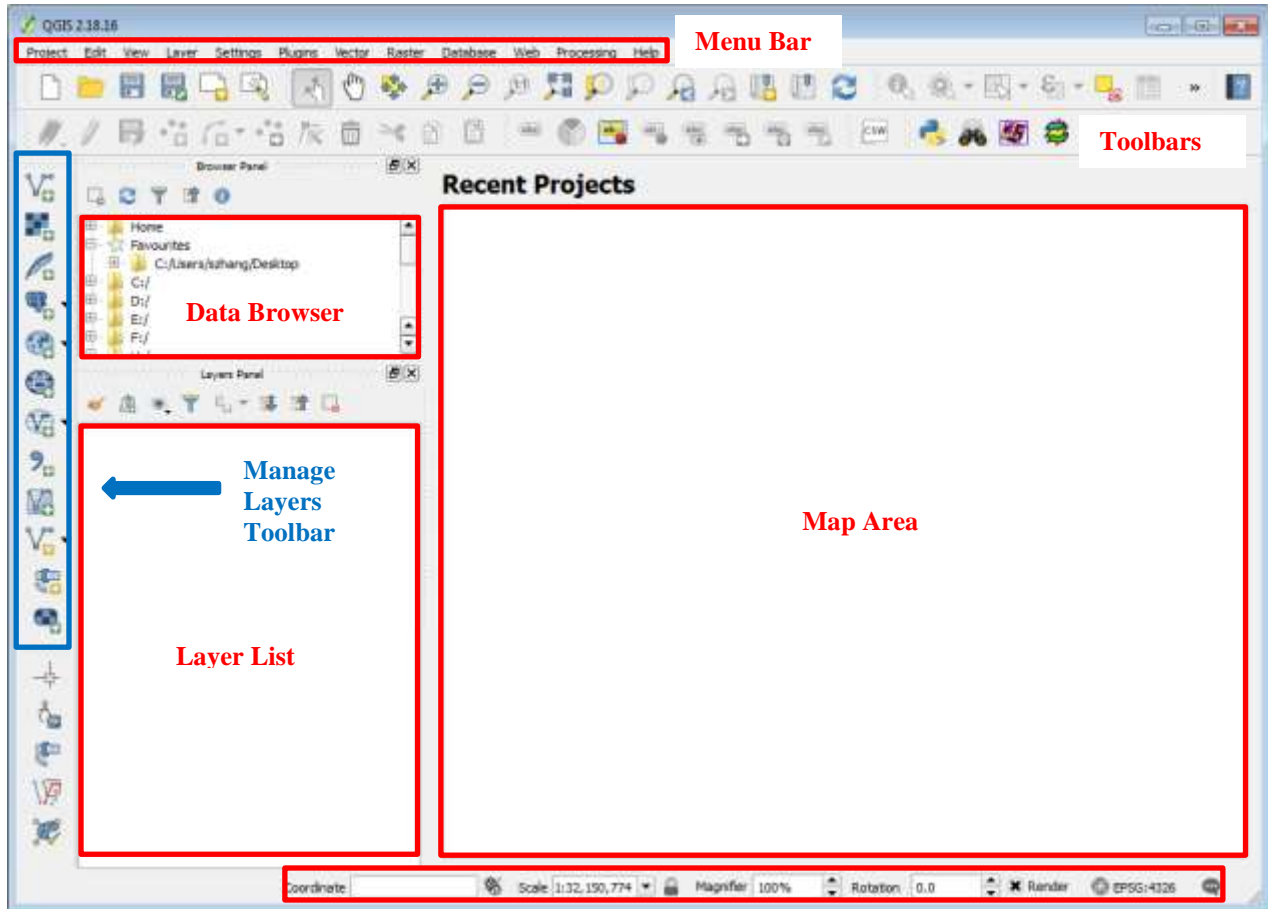
Note: if you are using Mac OS X, click Download for Mac OS X, and then click You can download the installation file (.dmg file) and install it directly. In the past, you have to the QGIS download page <http://www.kyngchaos.com/software/qgis> to do.



Note: for Linux please use the following command line
 sudo add-apt-repository http://qgis.org/debian
 sudo apt-key adv --keyserver keyserver.ubuntu.com --recv-key CAEB3DC3BDF7FB45
 sudo apt update
 sudo apt install qgis

3. The QGIS Interface and Installing Plugins

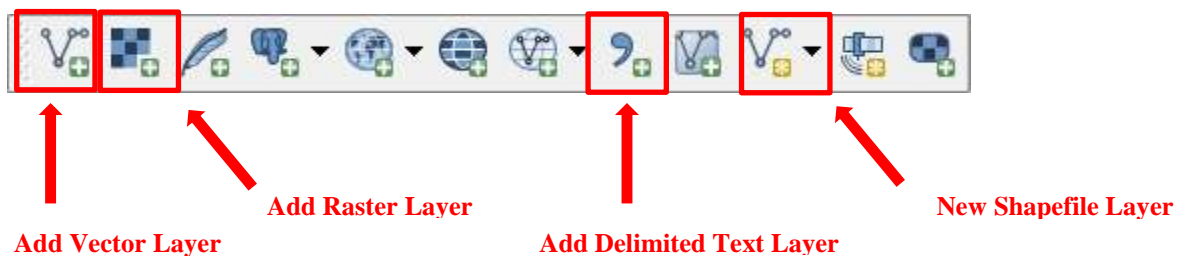
(1) Start QGIS Desktop 2.18



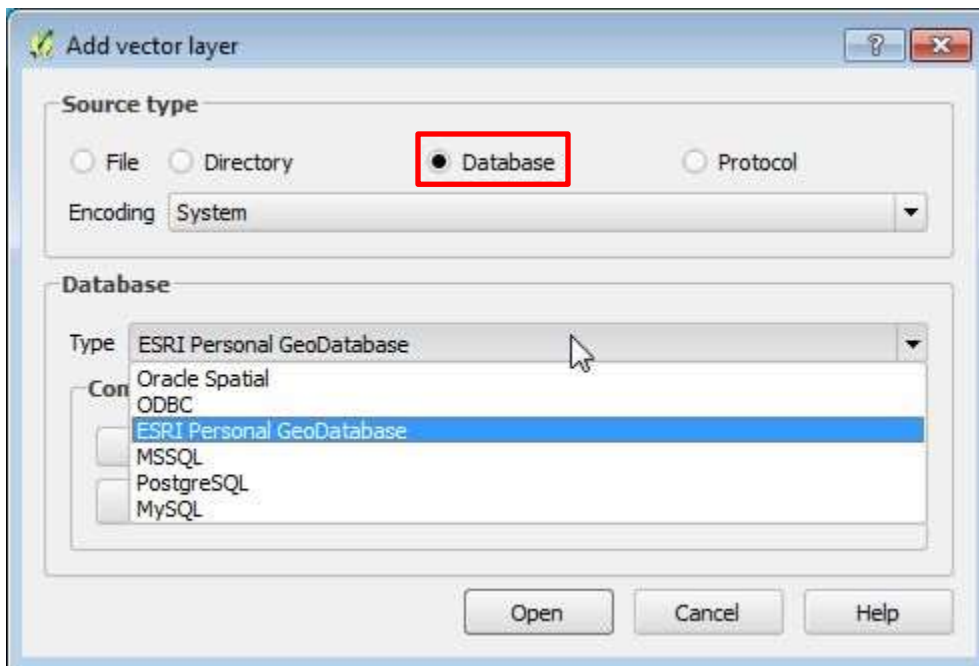
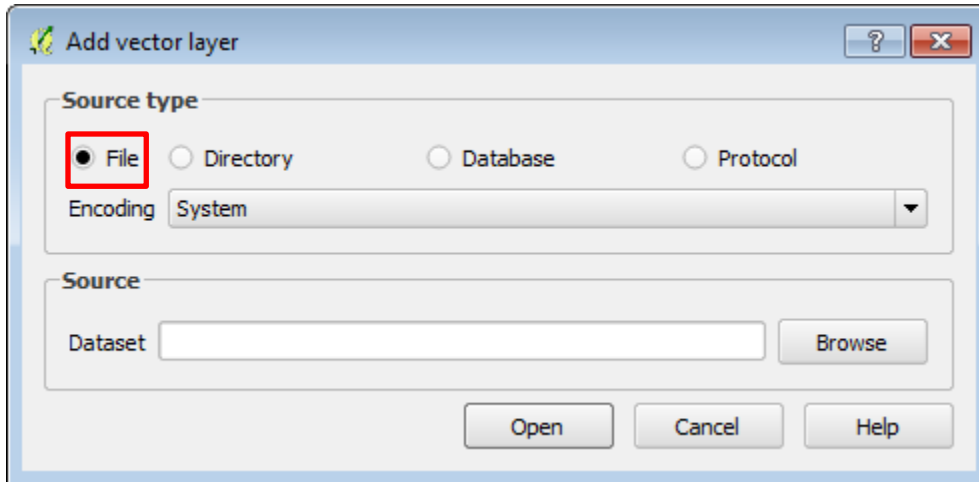
(2) You can move and dock any of the toolbars to a new location

Status Bar

(3) You can add data by using the “Manage Layers Toolbar” or by dragging and dropping the correct file (.shp file, .tiff file, .img file, .bmp file, .csv file, etc.) to the Map Area. When using the “Manage Layers Toolbar”, browse to the location of the input data folder for inserting. Spatialite layers, PostGIS layers, WMS/WFS/WCS layers, Virtual layers, Oracle GeoRaster layers can also be added by using the “Manage Layers Toolbar”.



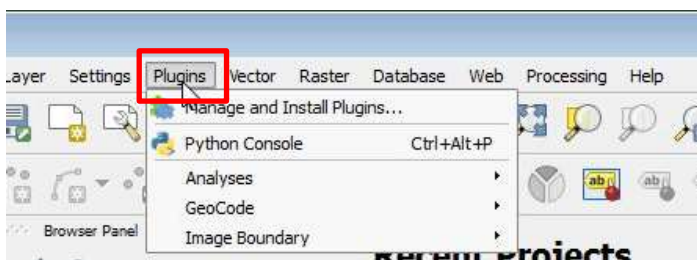
(4) Add vector layer; select Source type as File for shapefiles; or select Source type as Database for ESRI Personal Geodatabase or other types of databases.



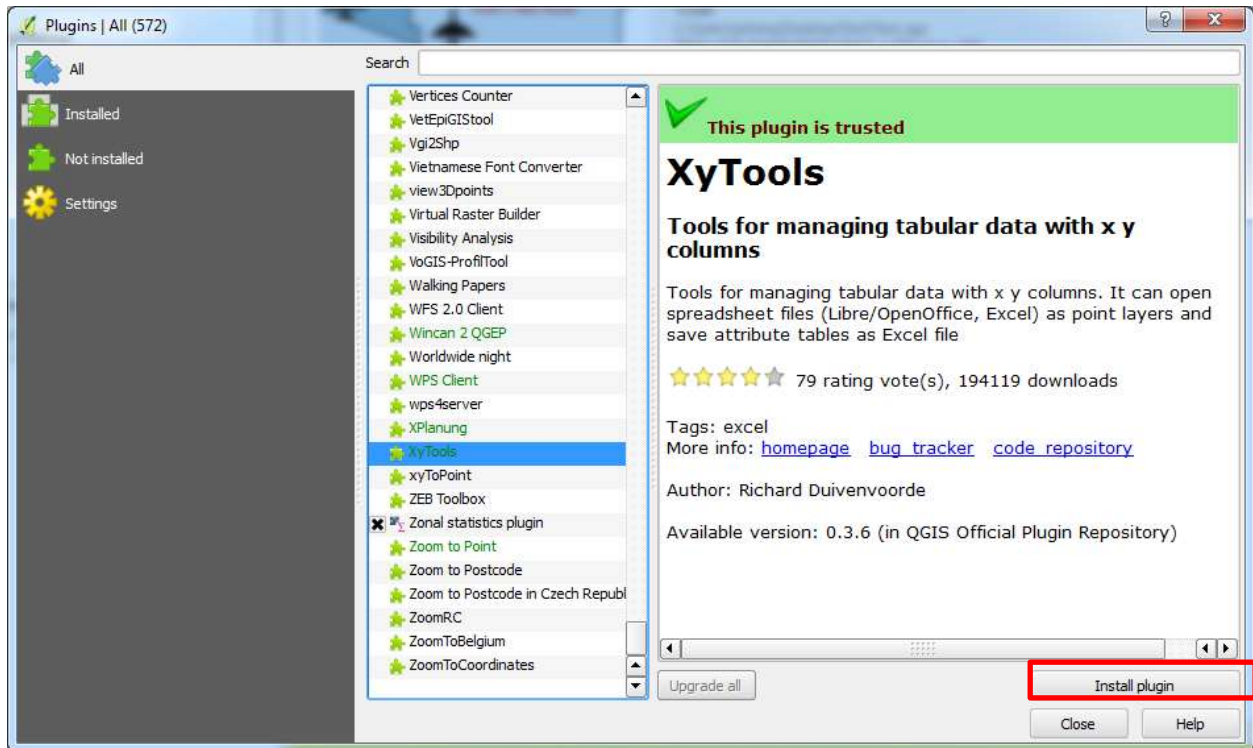
4. Installing Plugins

Many default tools come with QGIS installation. QGIS also has “Plugins” available to help the users with base maps and geoprocessing tools. One of the great benefits of QGIS is the active communities who support it by developing plugins that extend the application’s functionality.

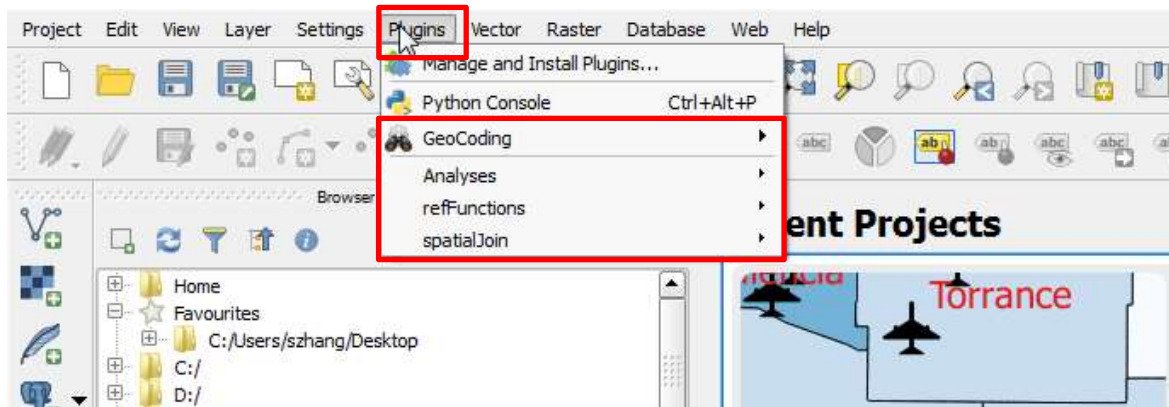
(1) Click the “Plugins” in the Menu Bar and then go to Manage and Install Plugins



(2) One example is provided to show how to install plugins. In the Plugins dialogue, under the All Plugins, search for XyTools Plugin, and install it.



(3) Installed plugins could be located in different places. For example, the installed XyTools Plugin is located under Vector menu in the Menu Bar. Most of the installed plugins will be located under Plugins menu in the Menu Bar.



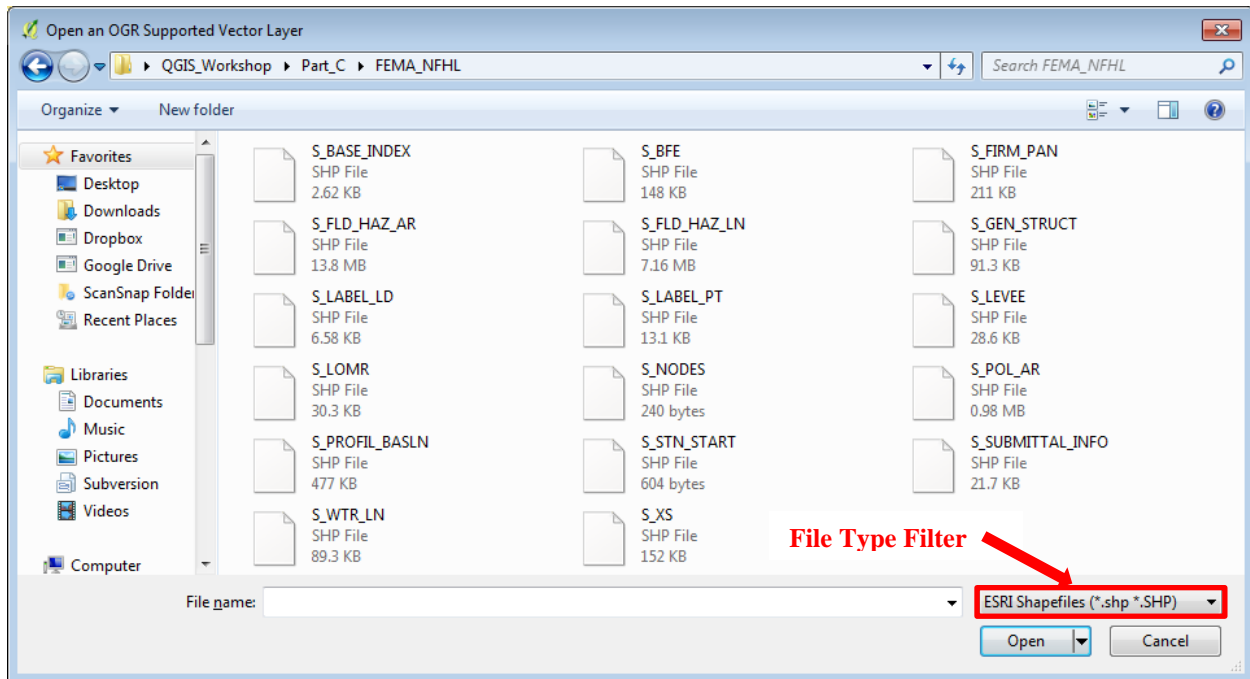
(4) Some great plugins that you should consider OpenLayer Plugins, Zonal Statistics, Heatmap, Table Manager, GeoCoding, and SpatialJoin, etc. There are many other available plugins within QGIS that you can explore on your own time. For ESRI ArcMap users, you will discover that many of the QGIS tools have the same logic and functionality as ArcMap.

Part C. Working with Vector Data

1. Adding Vector Data

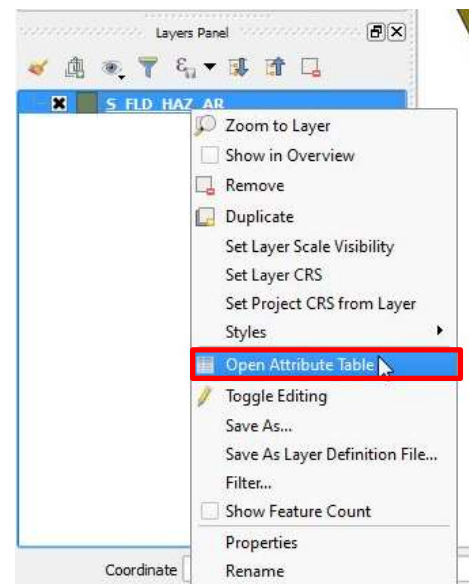
- (1) Open QGIS Desktop application.
 - (2) Navigate to the folder of QGIS_Workshop >>> Part_C >>> FEMA_NFHL.
 - (3) Click on the S_FLD_HAZ_AR.shp and drag and drop it into your map area; you can also use the Add Vector Layer tool to add the layer; another option is using the Browser Panel to add data.
- Note: To quickly locate .shp files, use the file type filter.

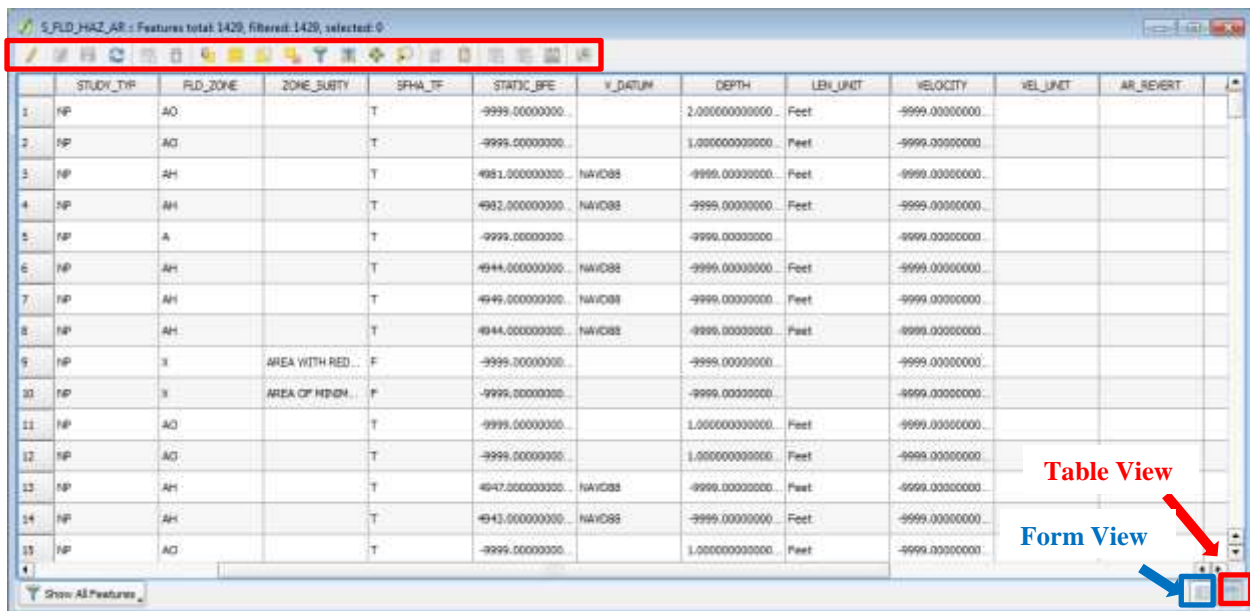
QGIS does not have one Add Data button, but rather many different buttons depending on your data type. This is a notable difference between ArcMap and QGIS.




2. Attribute Table

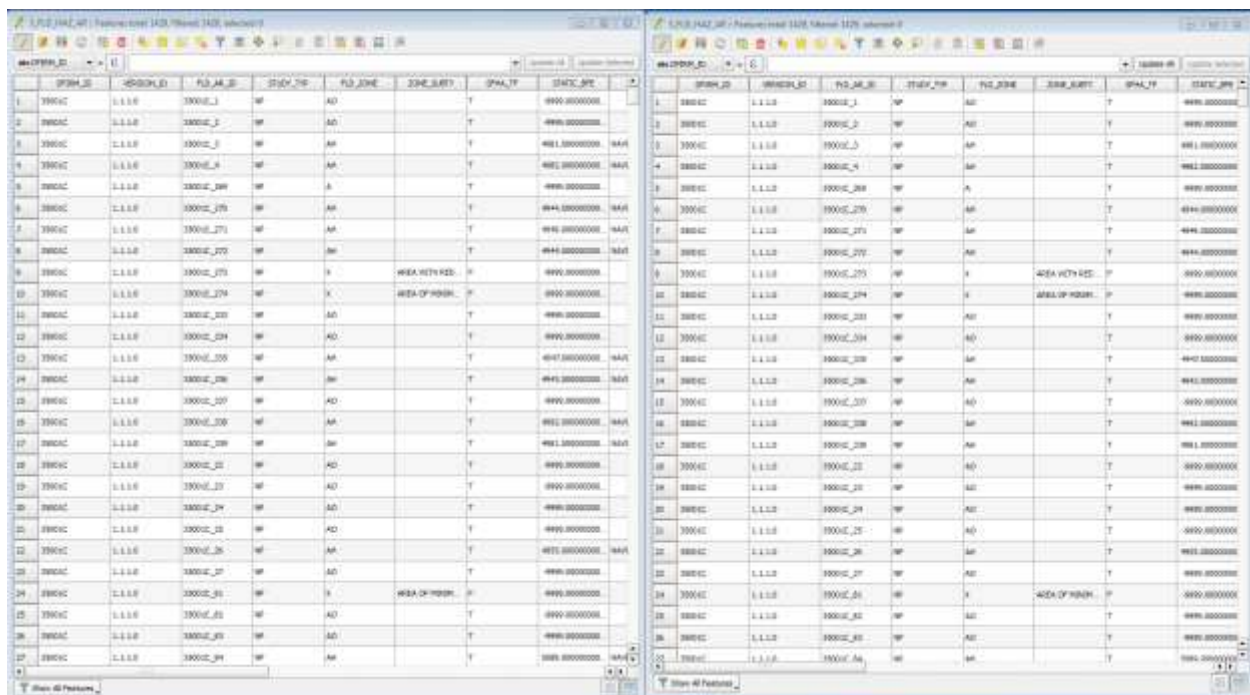
- (1) Right-click on the S_FLD_HAZ_AR layer in the Layers Panel.
- (2) Left-click on Open Attribute Table.
- (3) The organization of the attribute table is similar to ArcMap.
- (4) Unlike ArcMap, there are not FID and Shape fields.
- (5) In the attribute table, users can edit attributes, add features or delete features, select features, invert selection, deselect features, zoom map to the select row, move selection to the top, copy and paste selected features, create new fields, delete fields, and use field calculator (see below).





Note: In order to edit attributes, add or delete features, and create or delete fields, users need to click the  button to toggle editing mode; to exit editing mode, left-click on the same button. Users can also right-click on the layer and then left-click toggling editing to exit.

(6) Unlike ArcMap, users can open the same attribute table as many times as they want.



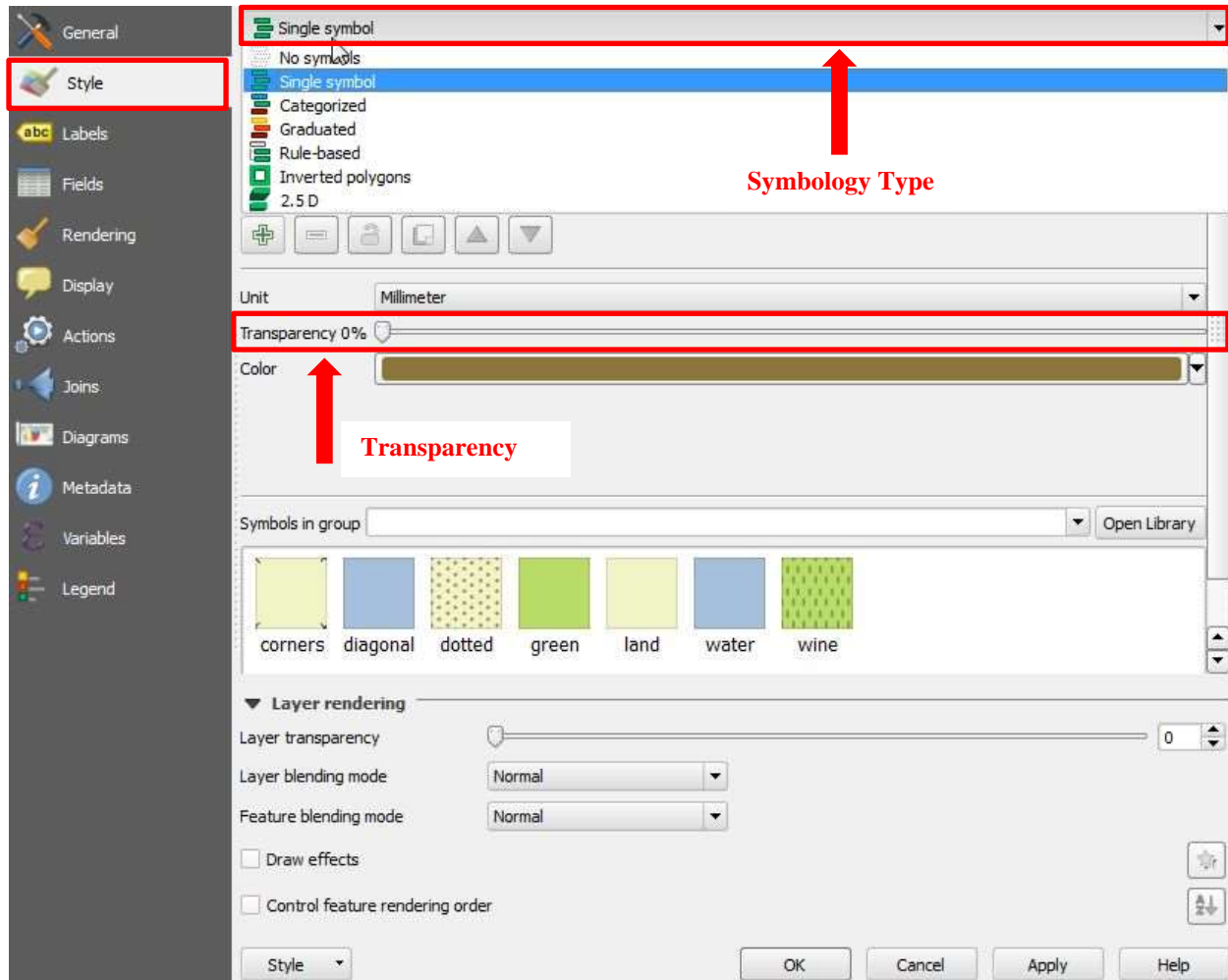
(7) Users can also sort a field by right-click on the field name and then select Sort. Another simple way is left-click on the field name then it will automatically sort descending or ascending.

(8) To see the summary statistics of a field, use the “Basic statistics for numerical (or text) fields” tool in Vector >>> Analysis Tools, users can also use the Statist plugin for the same function.

(9) To rearrange the order of the fields, users need to install the Table Manager plugin.

3. Styling Vector Data

(1) Double-click on the S_FLD_HAZ_AR within the Layers Panel to bring up the layer's property dialogue. The default tab is Style.



(2) Many symbology options are available, including

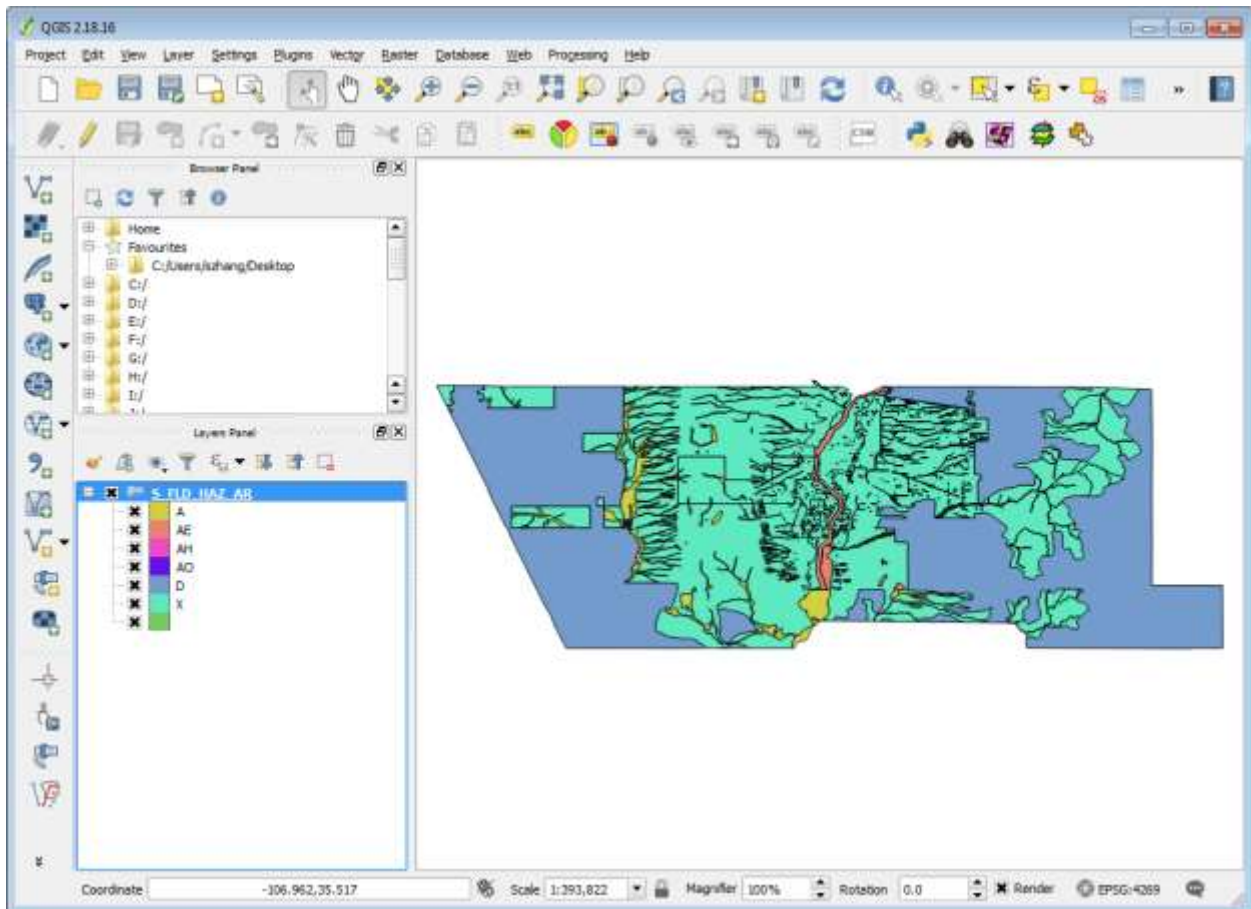
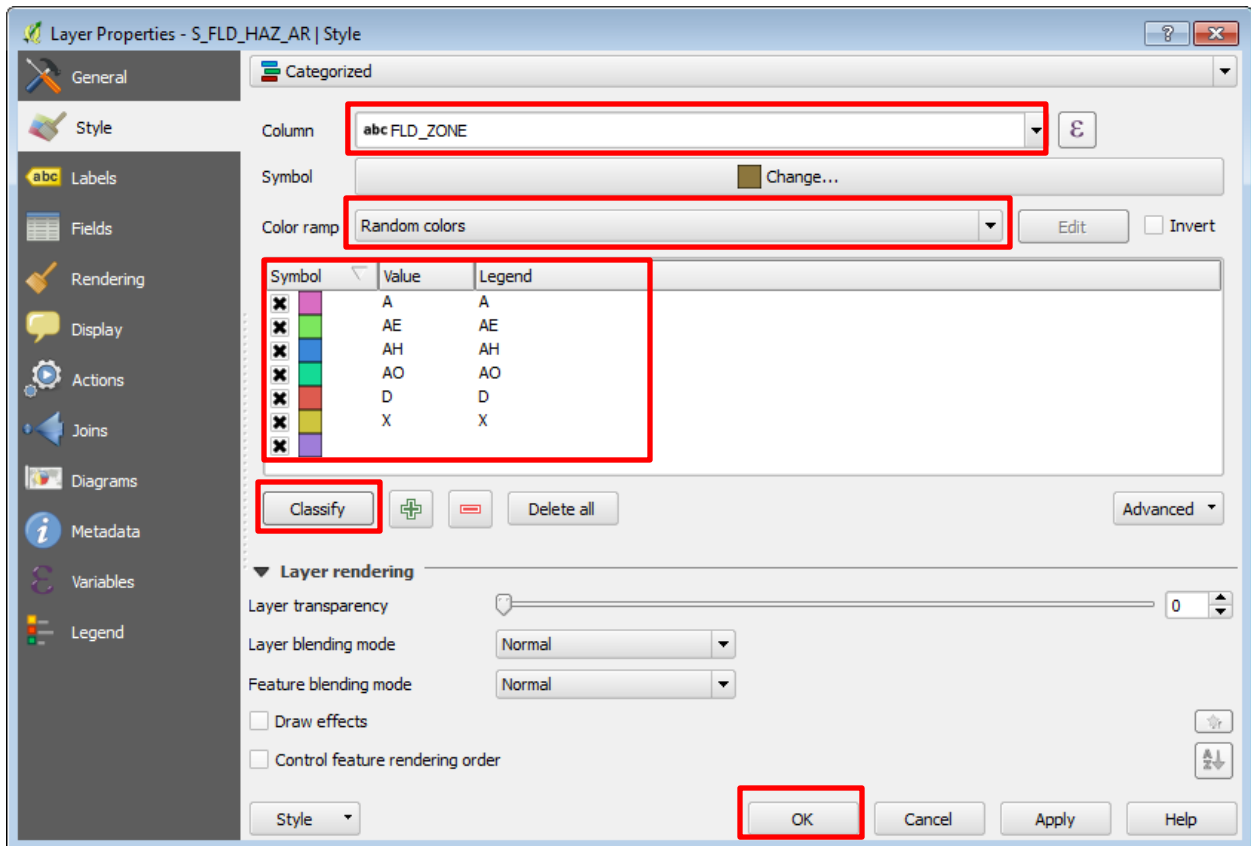
- Single symbol
- Categorized
- Graduated
- Rule-based
- Inverted polygons
- 2.5D.


For this workshop, we will use Categorized. Change the Style from Single Symbol to Categorized.

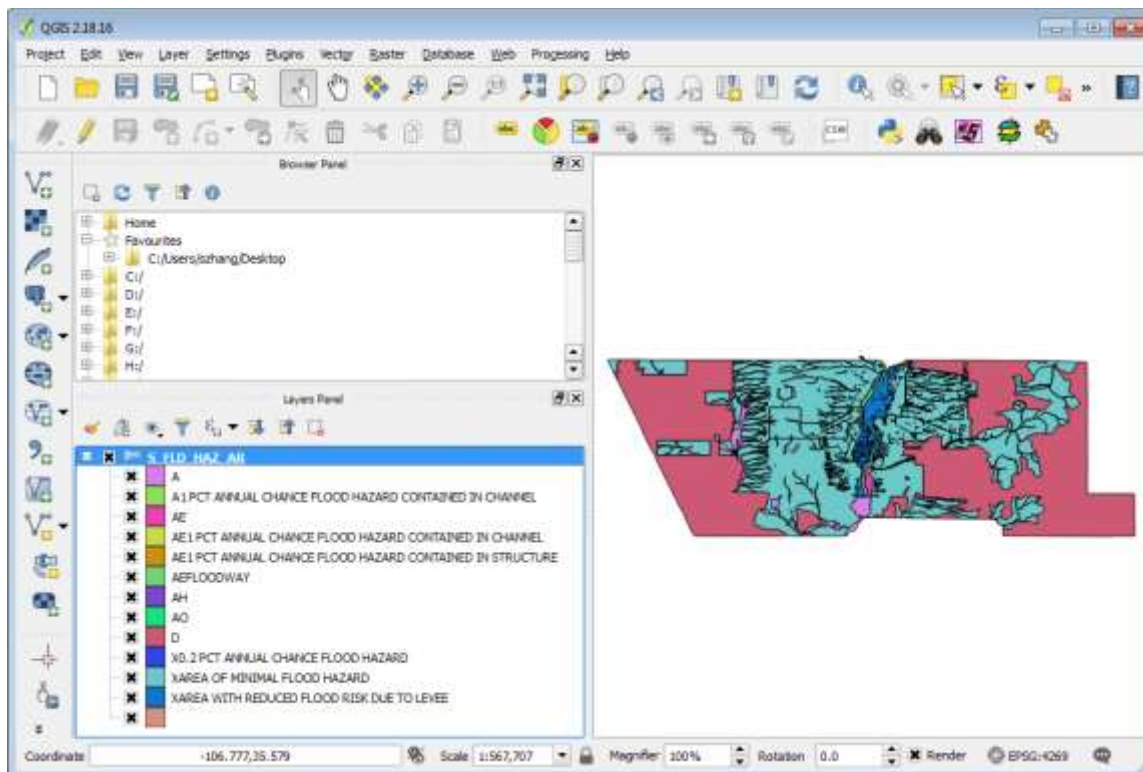
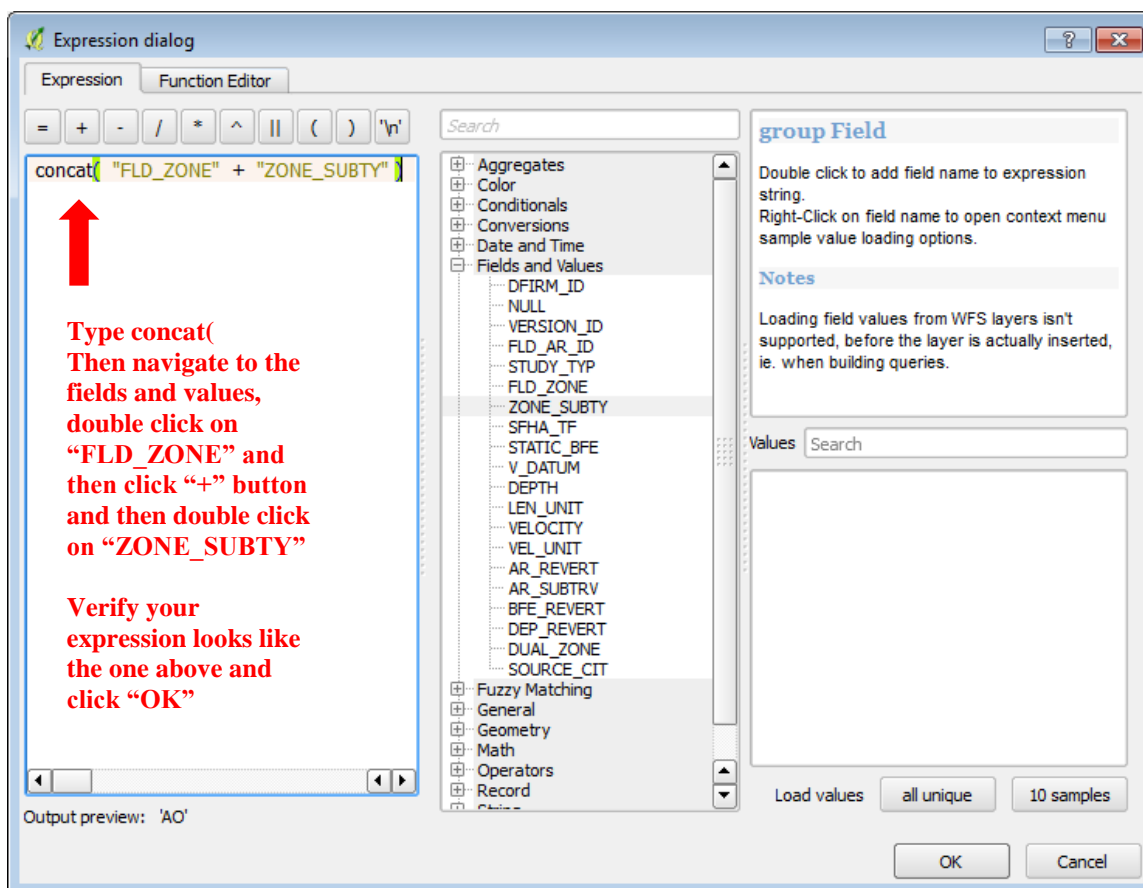
(3) Select FLD_ZONE for Column.

(4) Select Random colors for Color ramp.

(5) Left-click on Classify. The symbols for different categories will display. Click OK.

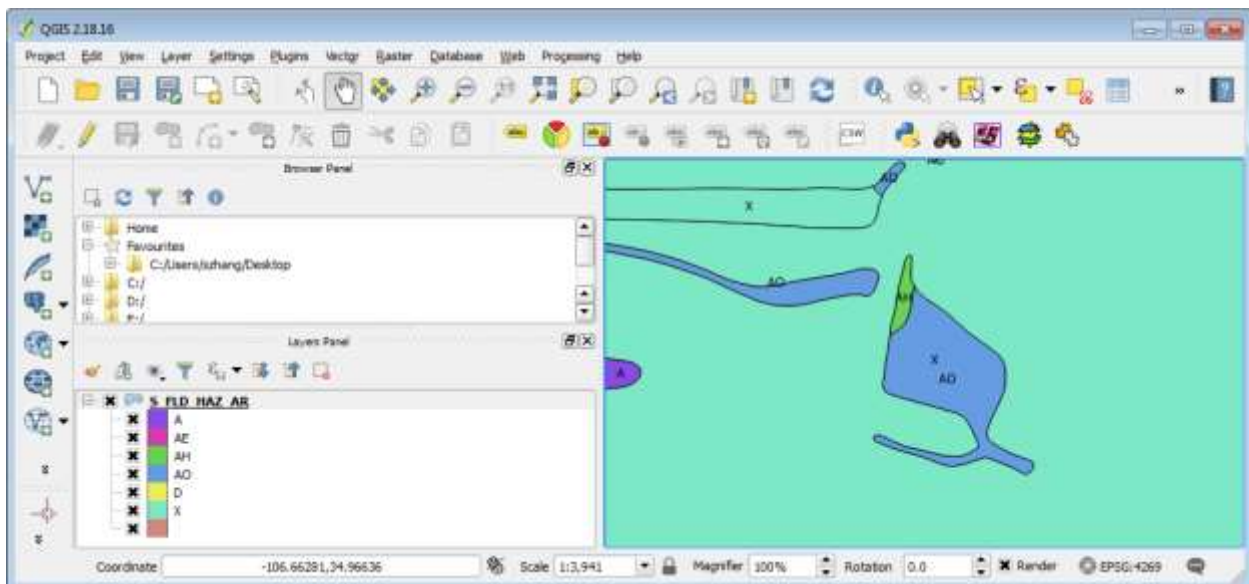
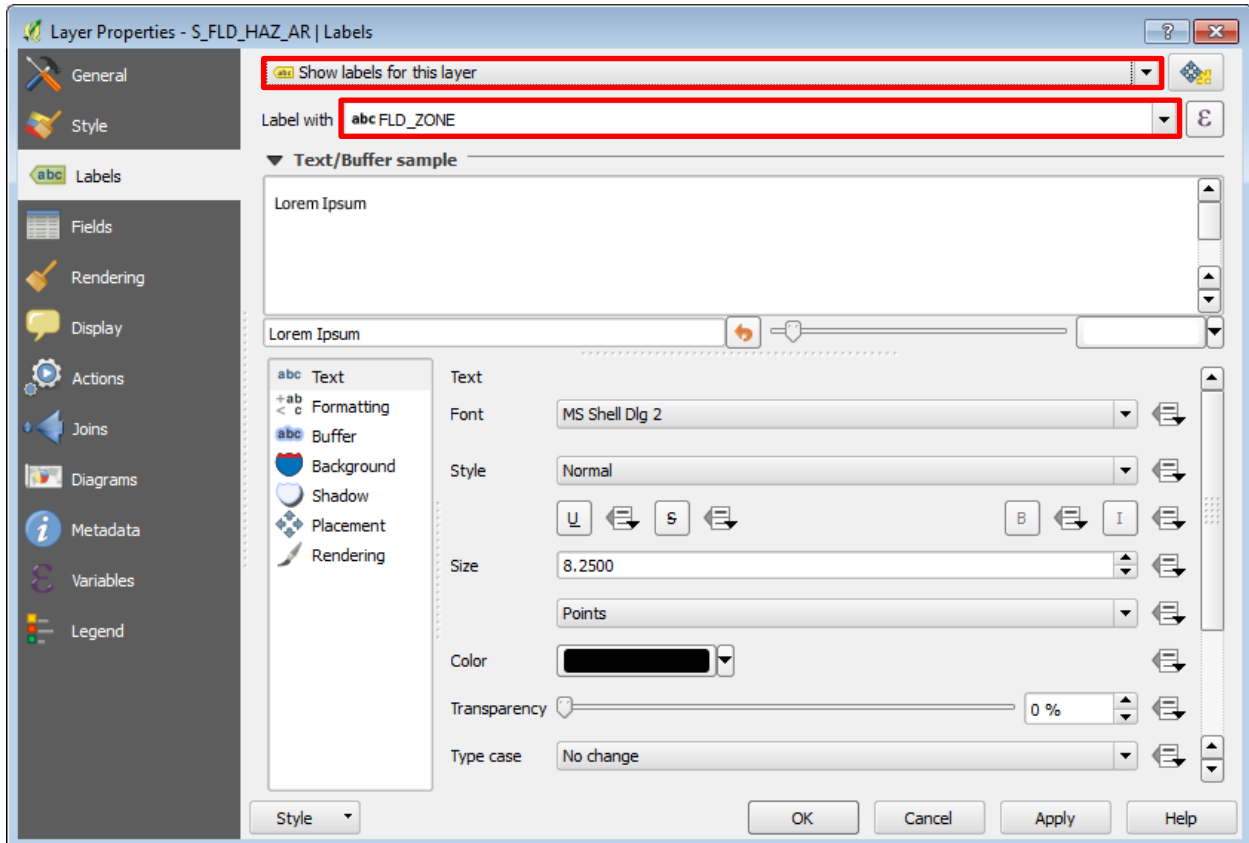


(6) QGIS can also concatenate two fields (strings) for symbolization. Click the  button at the end of the Column row to start Expression dialog. Repeat previous steps for symbolization.



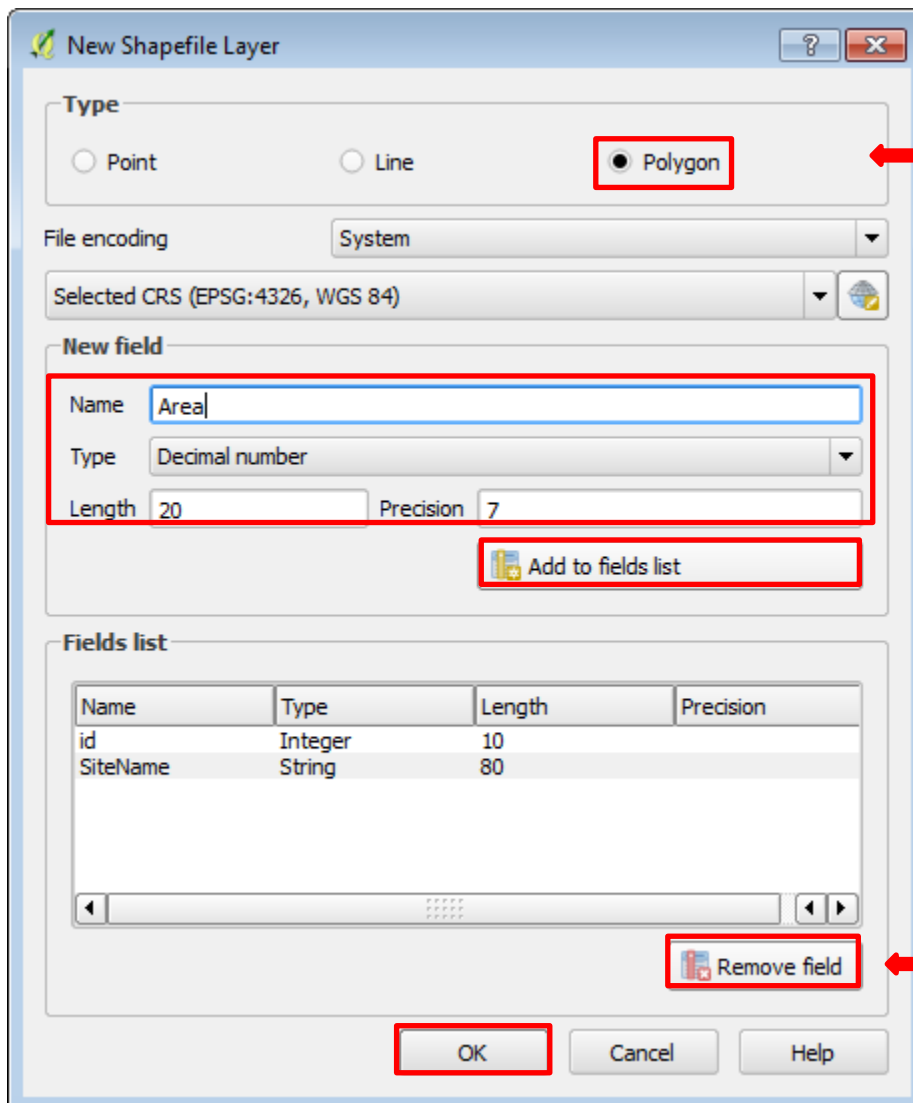
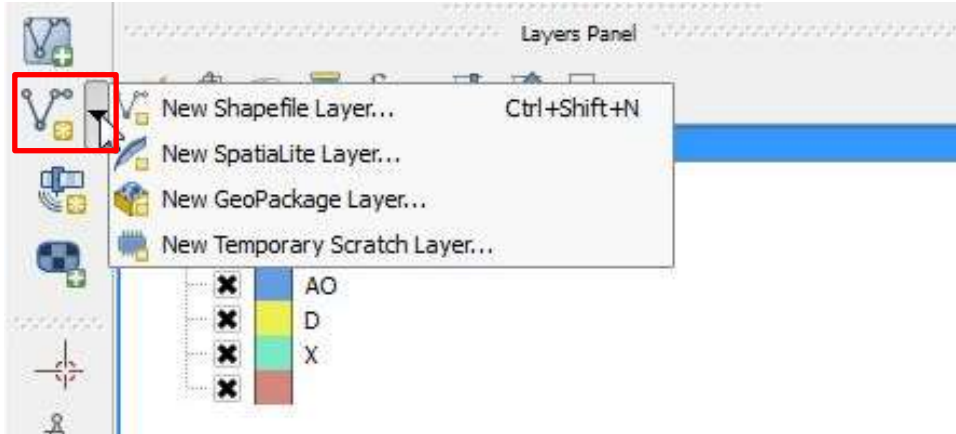
4. Labeling Vector Data

- (1) Double-click on the S_FLD_HAZ_AR within the Layers Panel to bring up the layer's property dialogue. Select Labels.
- (2) Select "Show labels for this layer."
- (3) Label with "FLD_ZONE."



5. Creating New Vector Layers

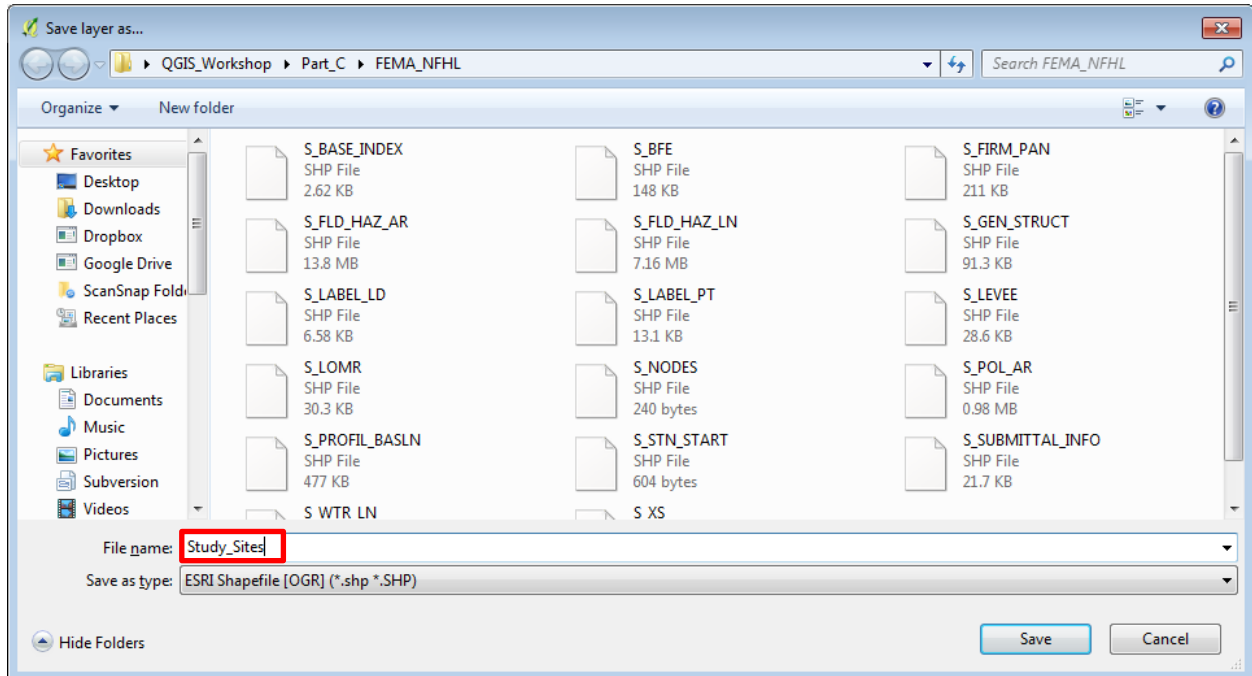
(1) Click the New Shapefile Layer button; make sure the current selection is New Shapefile Layer because this tool can also be used to create New SpatialLite Layer, New GeoPackage Layer, and New Temporary Scratch Layer. The New Shapefile Layer dialogue should display. Fill in the Name for the New Field, Type, and other information. Click Add to fields list. Click OK.



Select the type for the new shapefile.

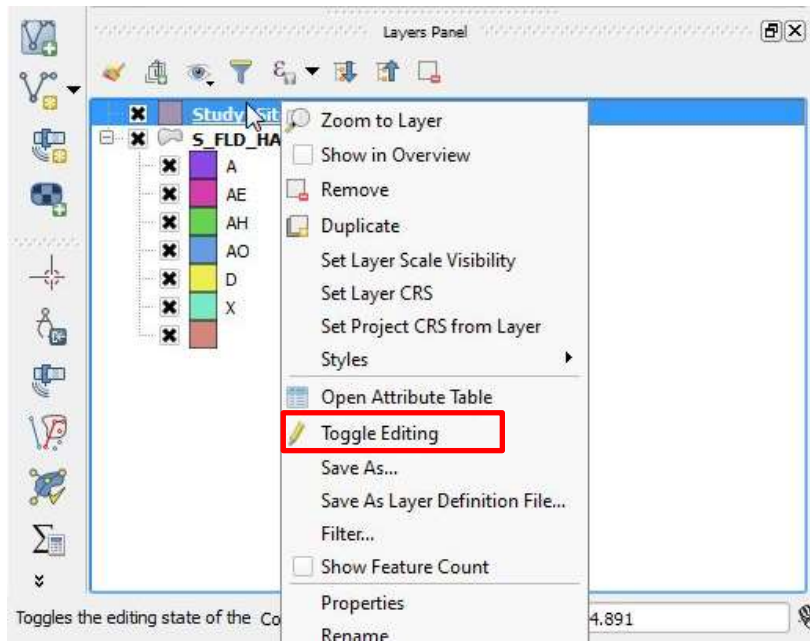
This can be used to remove fields.

(6) The Save layer as dialogue will display. Type in Study_Sites as the layer name. Make sure the layer will be saved in QGIS_Workshop >>> Part_C >>> FEMA_NFHL folder.

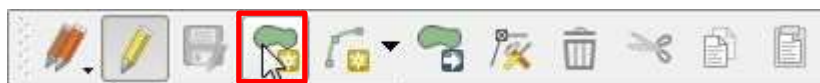


(7) The Study_Sites layer will be automatically added to your Layers Panel.

(8) Right-click on the Study_Sites layer and then click on Toggle Editing.



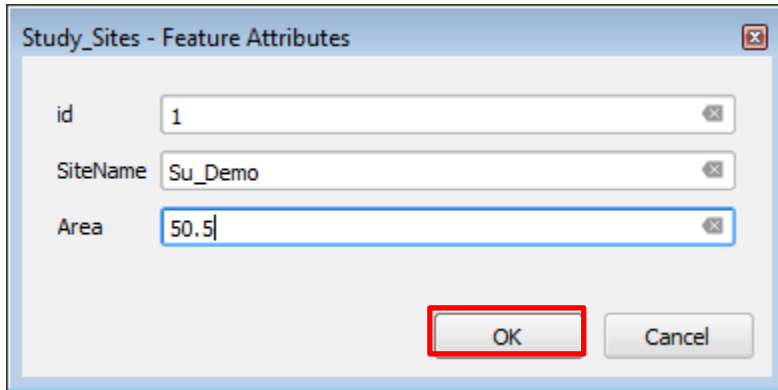
(9) Click on Add Feature button in the Digitizing Toolbar.



(10) Click on the Mapping Area to create a polygon, when done, right-click.

(11) The Feature Attributes dialogue will display.

(12) Type in the attributes value. For the Area field, just type in a random number for now. Click OK to finish the first feature.

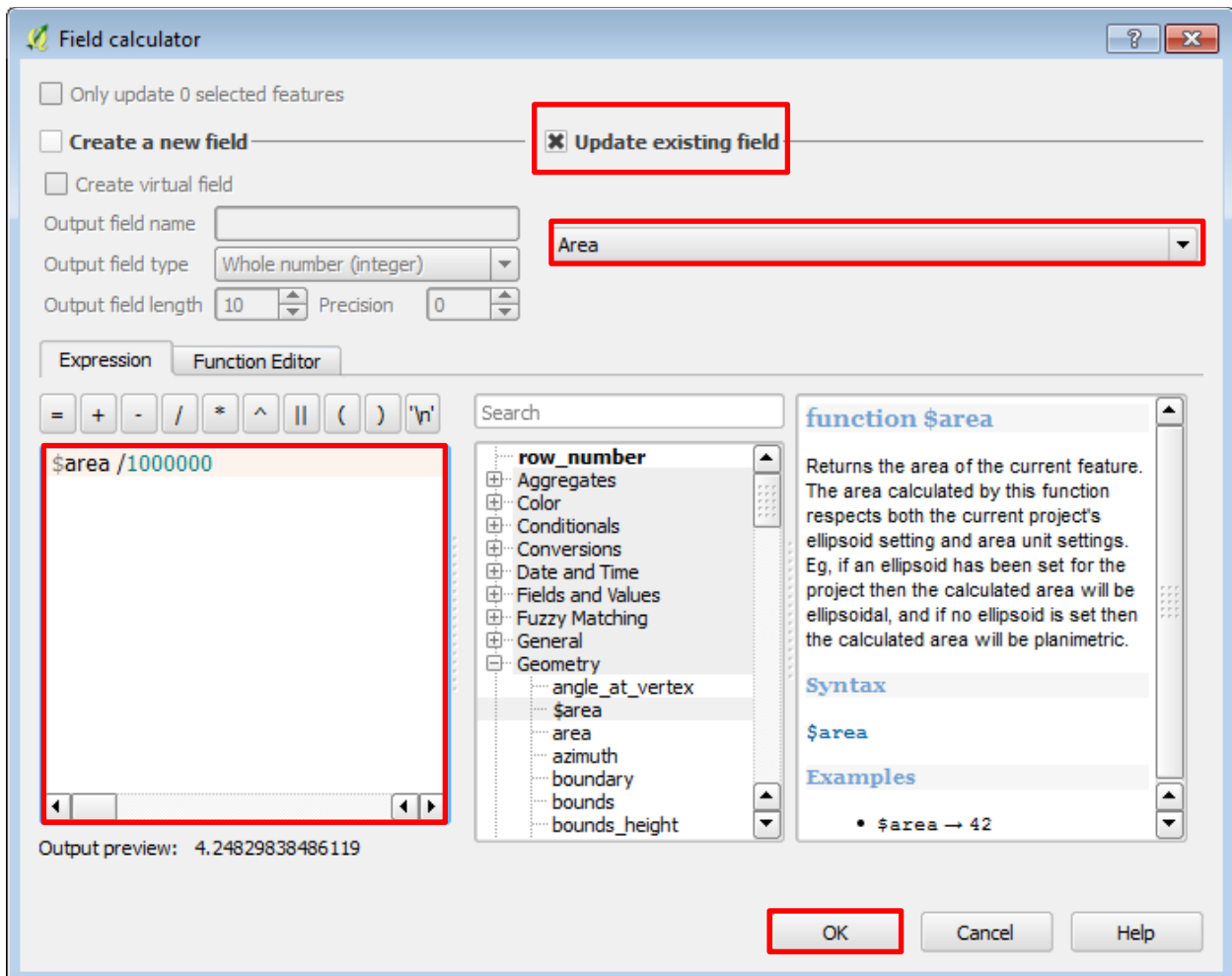


(13) To calculate the real area for the feature you just create, you need to update the existing area field. To do this, you need to set your current project's coordinate system to a projected coordinate system; otherwise it will give you a "arcsec" value for area.

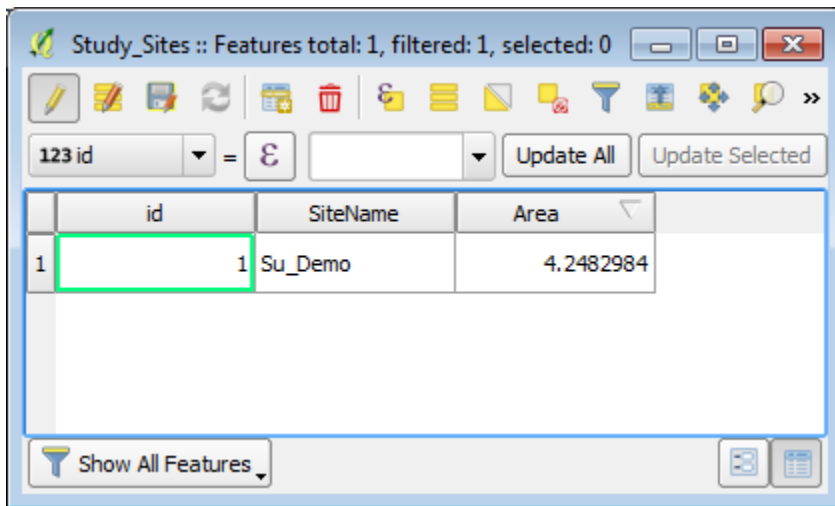
(14) Go to Project >>> Project Properties >>> CRS >>> select NAD 83 UTM zone 13 N.

(15) Open the attribute table of the feature, and then click "Open field calculator" button.

(16) Select "Update existing field", and then select \$area. Click OK.



(17) Your attribute table should look like this. Notice that the area's unit is km².



(18) When done, click the “Save Layer Edits” button in the Digitizing Toolbar.

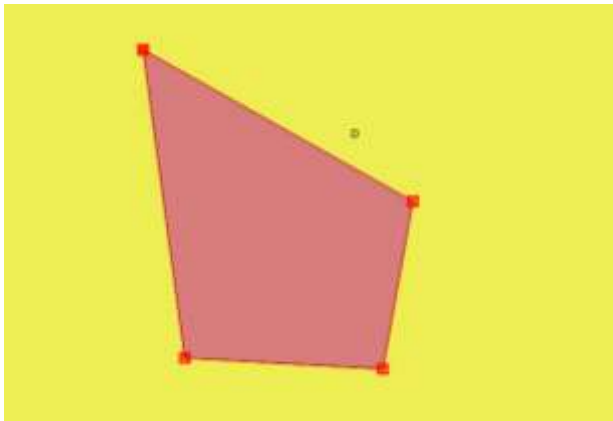


6. Editing Features

(1) In editing mode, click the “Node Tool” button in the Digitizing Toolbar.



(2) Click on the nodes of your feature of interest to start editing.



(3) When done, click the “Node Tool” button again to stopping editing.

(4) Click the “Save Layer Edits” button to save your edits.

(5) Like ArcMap, your area geometry value will not be updated automatically. You need to recalculate it after you make changes.

7. Data Query Based on Attributes

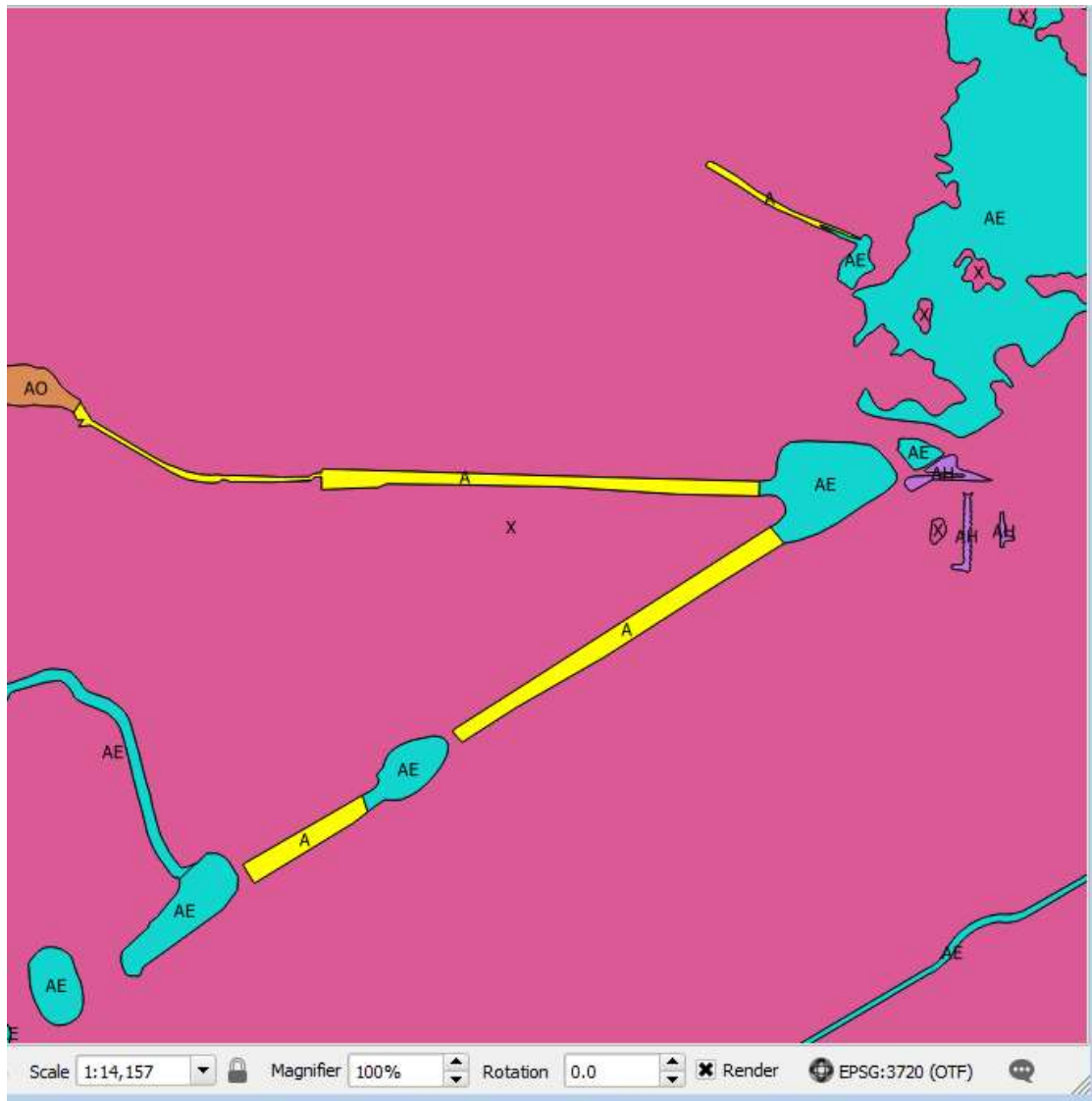
- (1) Open the attribute table of the S_FLD_HAZ_AR layer.
- (2) Click on the “Select features using an expression.”

	DFIRM_ID	VERSION_ID	FLD_AR_ID	STUDY_TYP	FLD_ZONE	ZONE_SUBTY	SFHA_TF
1	35001C	1.1.1.0	35001C_1	NP	AO		T
2	35001C	1.1.1.0	35001C_2	NP	AO		T
3	35001C	1.1.1.0	35001C_3	NP	AH		T
4	35001C	1.1.1.0	35001C_4	NP	AH		T
5	35001C	1.1.1.0	35001C_269	NP	A		T
6	35001C	1.1.1.0	35001C_270	NP	AH		T
7	35001C	1.1.1.0	35001C_271	NP	AH		T

- (3) In the Select by expression dialogue, building the query expression.

Four options, including Select, Add to selection, Remove from selection, and Select from selection

- (4) Browse the Fields and Values to select the FLD_ZONE, double-click on it.
- (5) Click the “=” sign under “Expression.”
- (6) Click “all unique” next to “Load Values.”
- (8) Click on Select
- (9) Go to the mapping area and users can see selected features will be highlighted in yellow color.



8. Data Query Based on Location

(1) Go to Vector (in the Menu Bar) >>> Spatial Query

Note: at least two vector layers are required for this tool.

(2) The Spatial Query dialogue will display.

(3) Select S_FLD_HAZ_AR for “Select source features from.”

(4) Select Intersects for “Where the feature.”

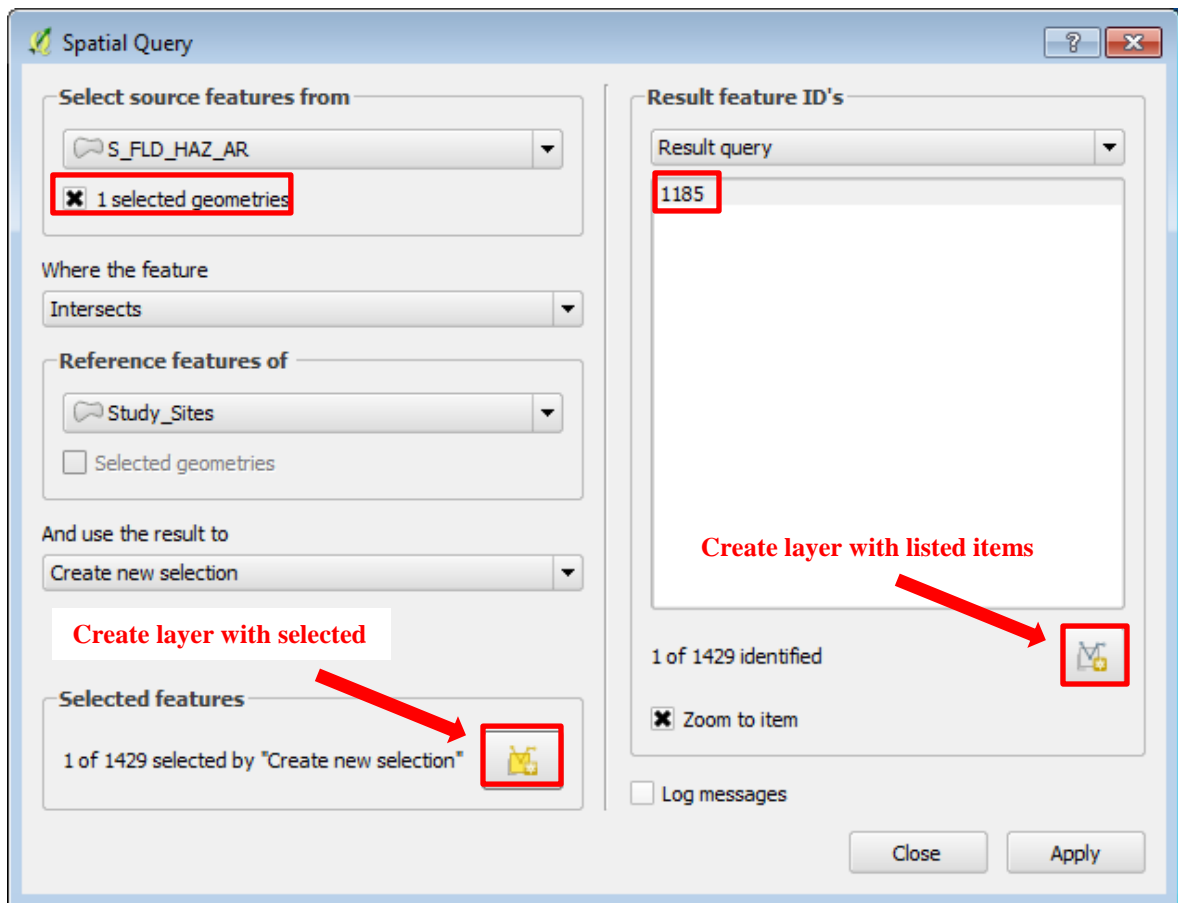
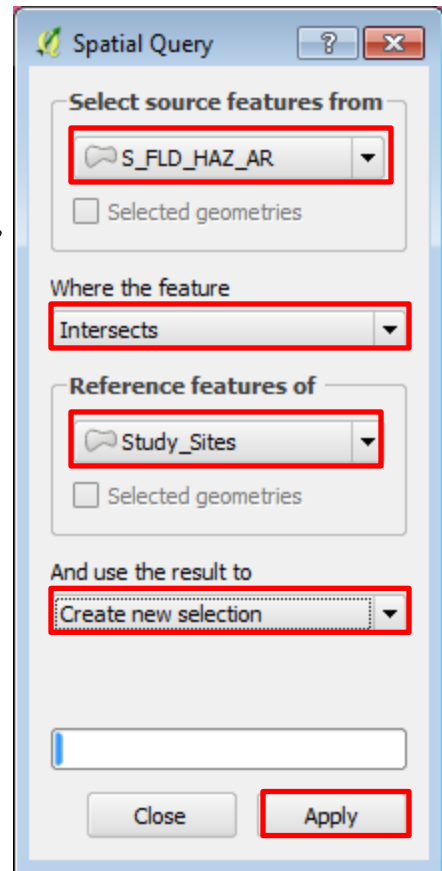
(5) Select Study_Sites for “Reference features of.”

Select Create new selection for “And use the result to.”

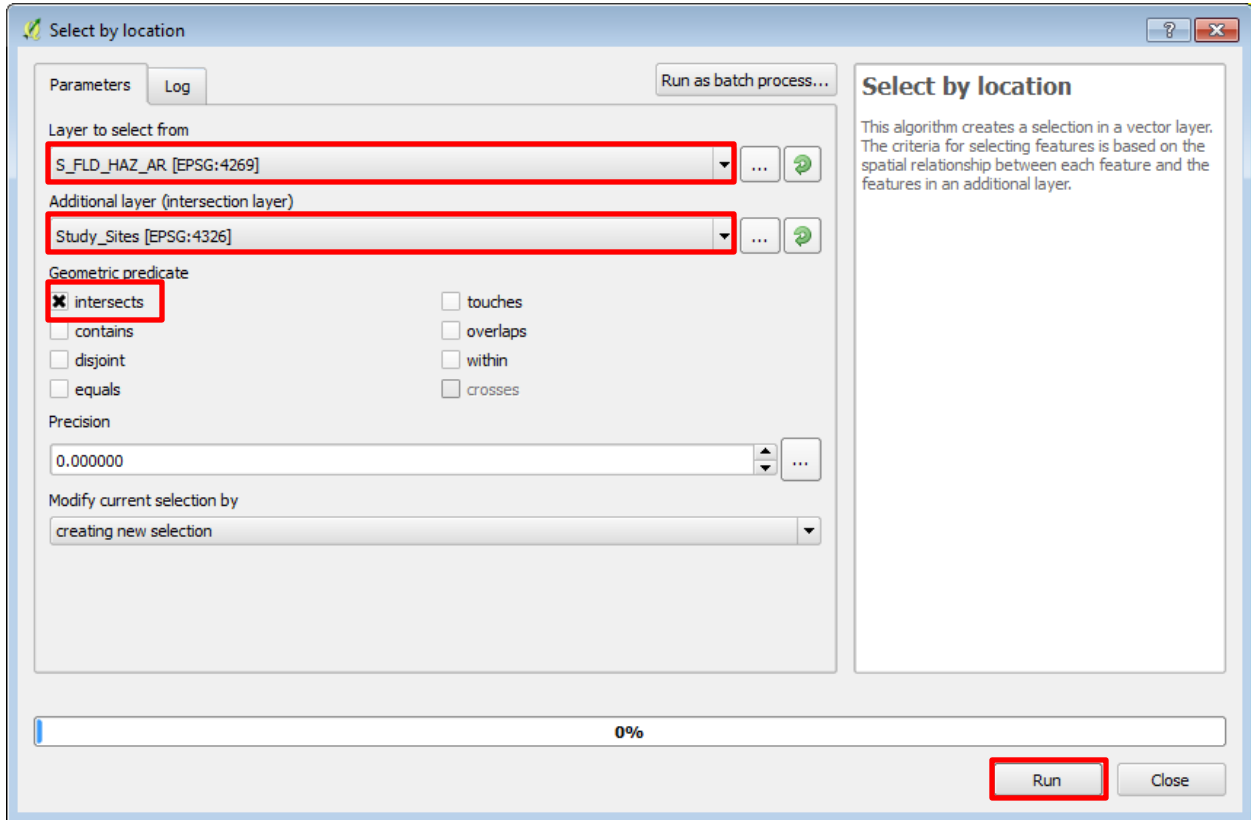
(6) Click Apply.

(7) In the result dialogue, select “Zoom to item” to see the selected feature.

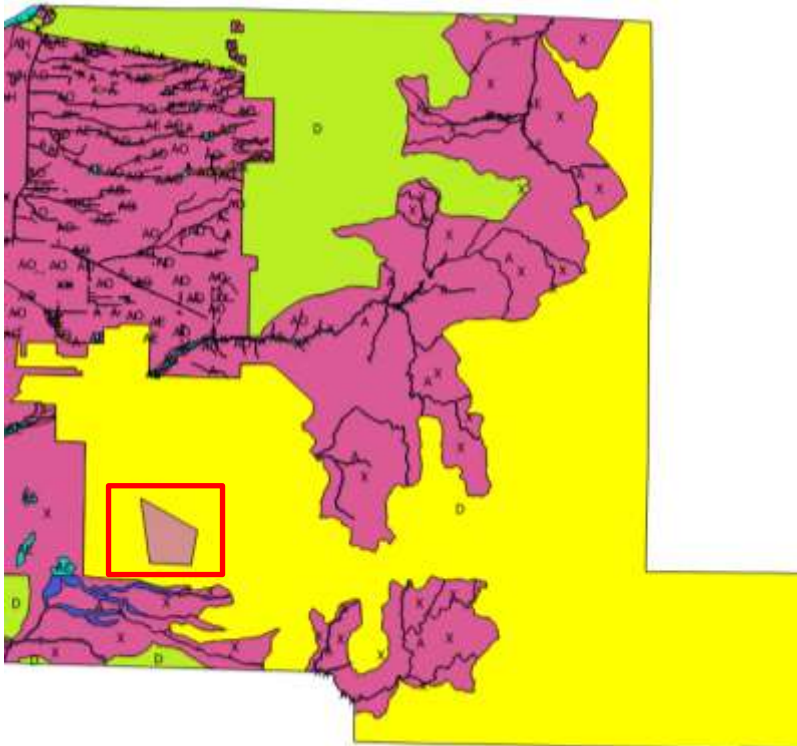
(8) Users can also click on “Create layer with selected” or “Create layer with listed items” to create a feature layer.



(9) Another tool to do spatial query based on location is Vector >>> Research Tools >>> Select by Location.



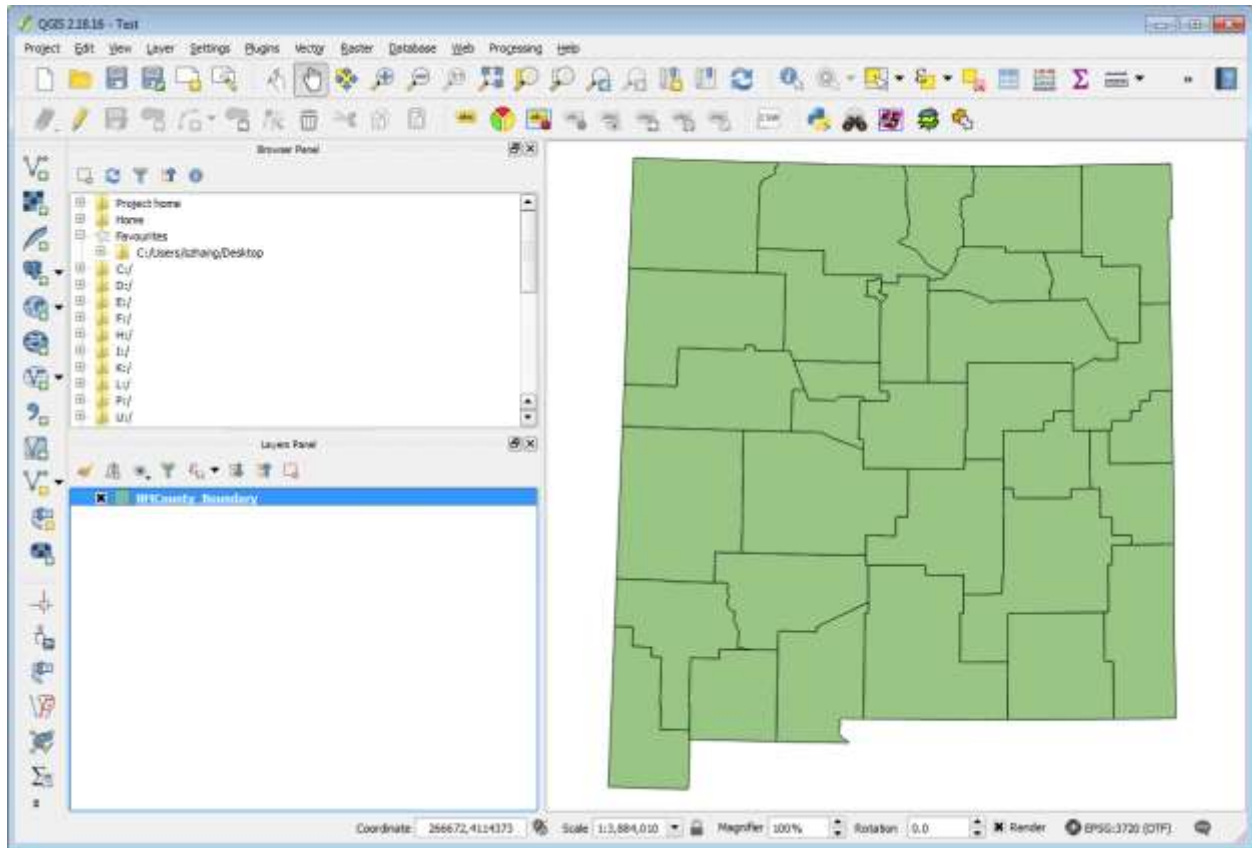
Note: when using this tool, make sure the two layers have the same coordinate system.



9. Table Join

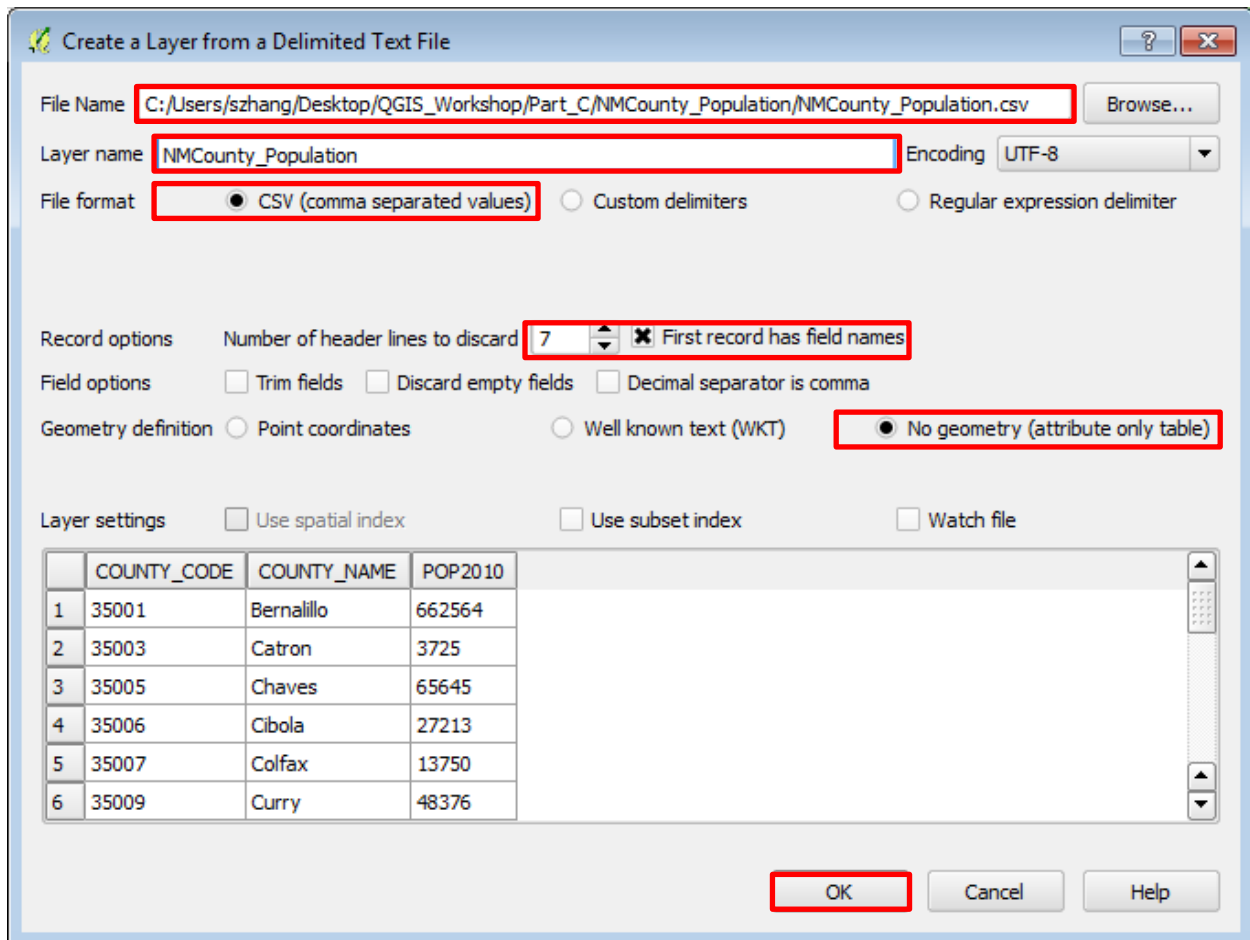
Sometimes a single shapefile does not include all the information you want, which makes “Table Join” to be necessary and useful. Table Join is typically used to append the fields of one table to another through an attribute or field common to both feature layers/tables.

(1) Add the NMCounty_Boundary shapefile located in QGIS_Workshop >>> Part_C >>> NMCounty_Boundary folder.

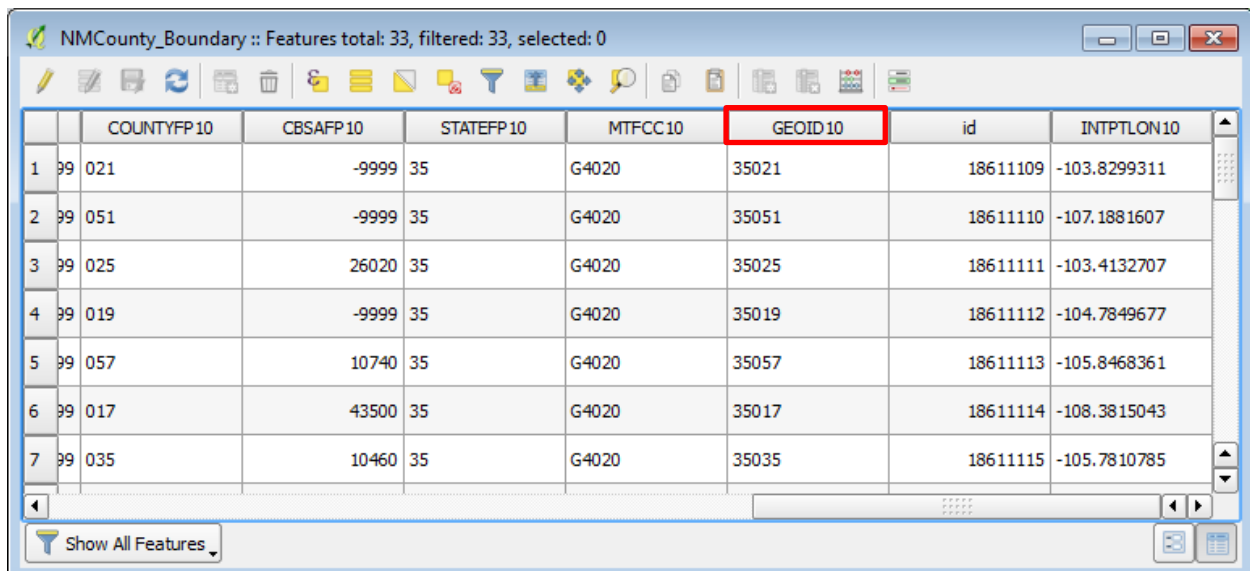


(2) Add the NMCounty_Population file located in QGIS_Workshop >>> Part_C >>> NMCounty_Population folder. Click “Add Delimited Text Layer” button. In the “Create a Layer from a Delimited Text File” dialogue, browse to the location of the .csv file. Provide a layer name, select CSV for file format, select 7 for Number of header lines to discard, check on First record has field names, and then select No geometry. Click OK.



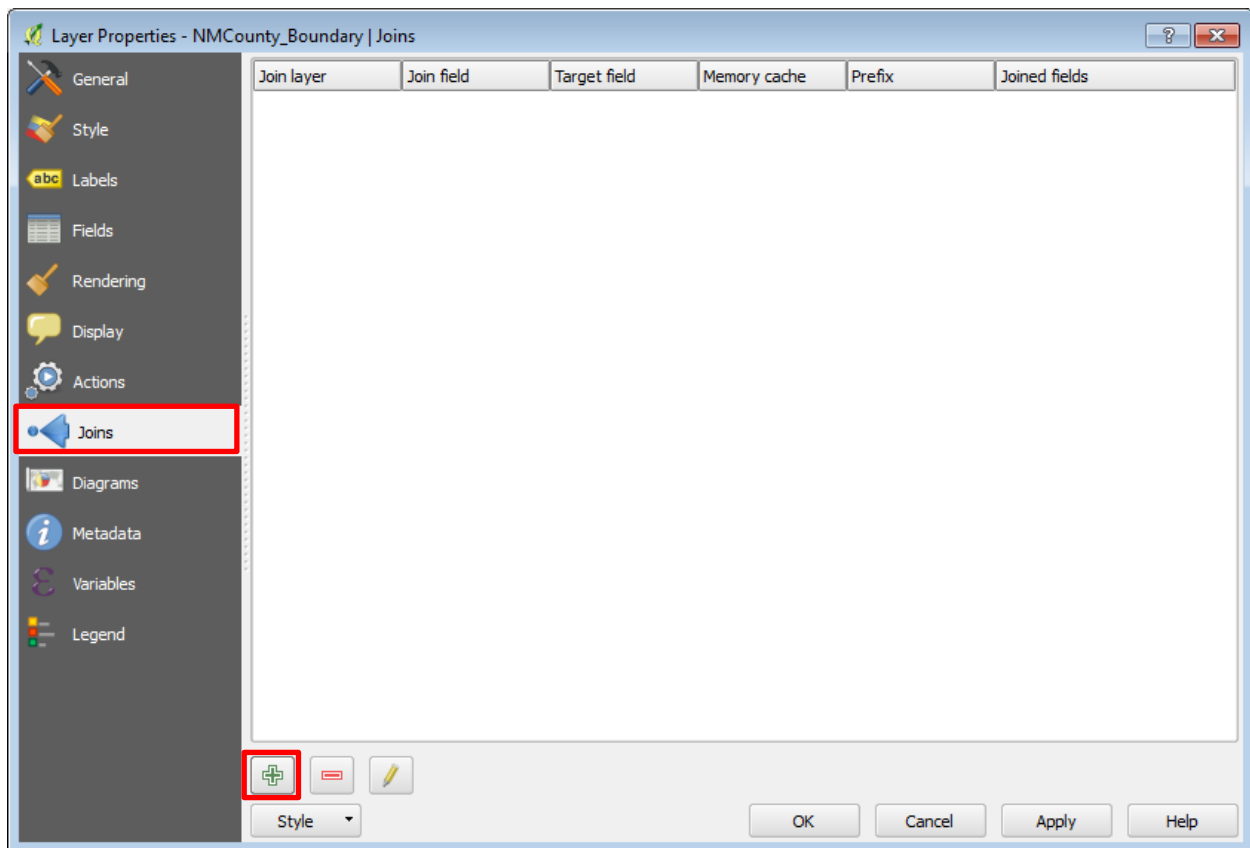


(3) Right-click on the NMCounty_Boundary layer and then left-click on Open Attribute Table. Browse the table and find the unique IDs for each county (GEOID10).

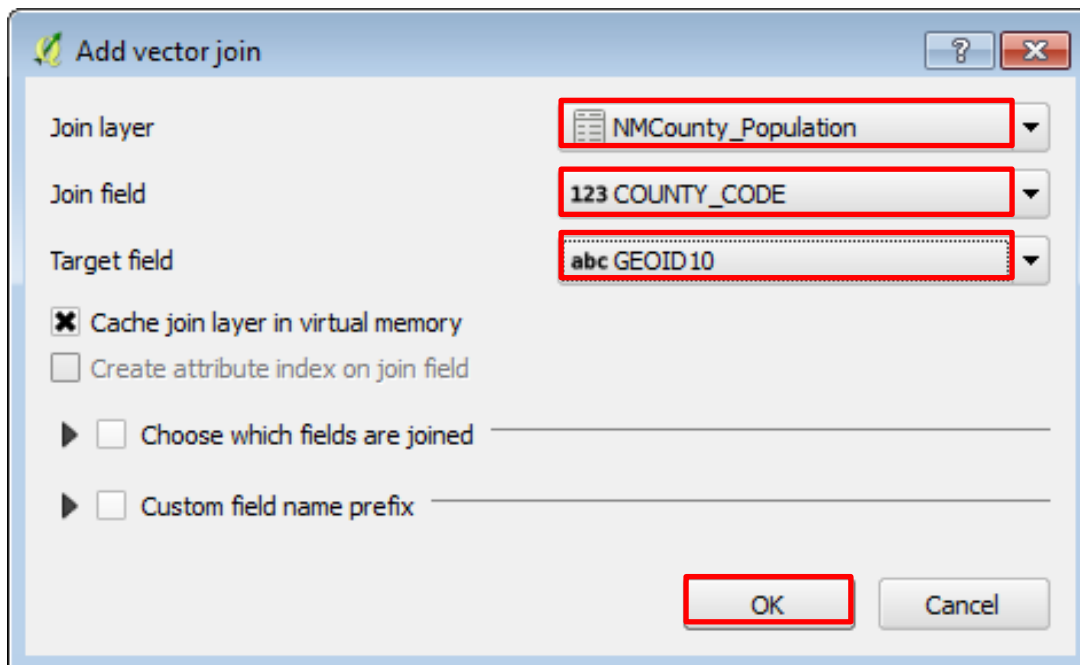


(4) Close the attribute table.

(5) Right-click on the NMCounty_Boundary layer and then left-click on Properties. Click Joins on the Layer Properties dialogue. Then click on the Green Plus (+) sign.

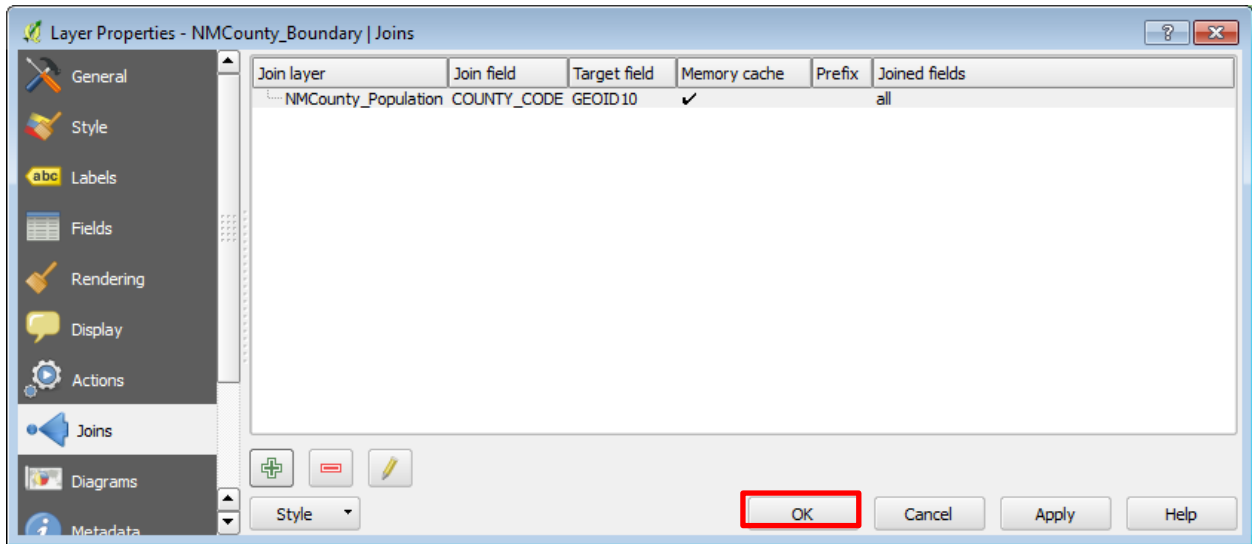


(6) In the “Add vector join” dialogue, select NMCounty_Population for “Join layer”, select COUNTY_CODE for “Join field”, and select GEOID10 for Target field.



(7) Click OK.

(8) In the Layer Properties dialogue, it should show that the layer is appropriately joined. Click Ok to close the dialogue.



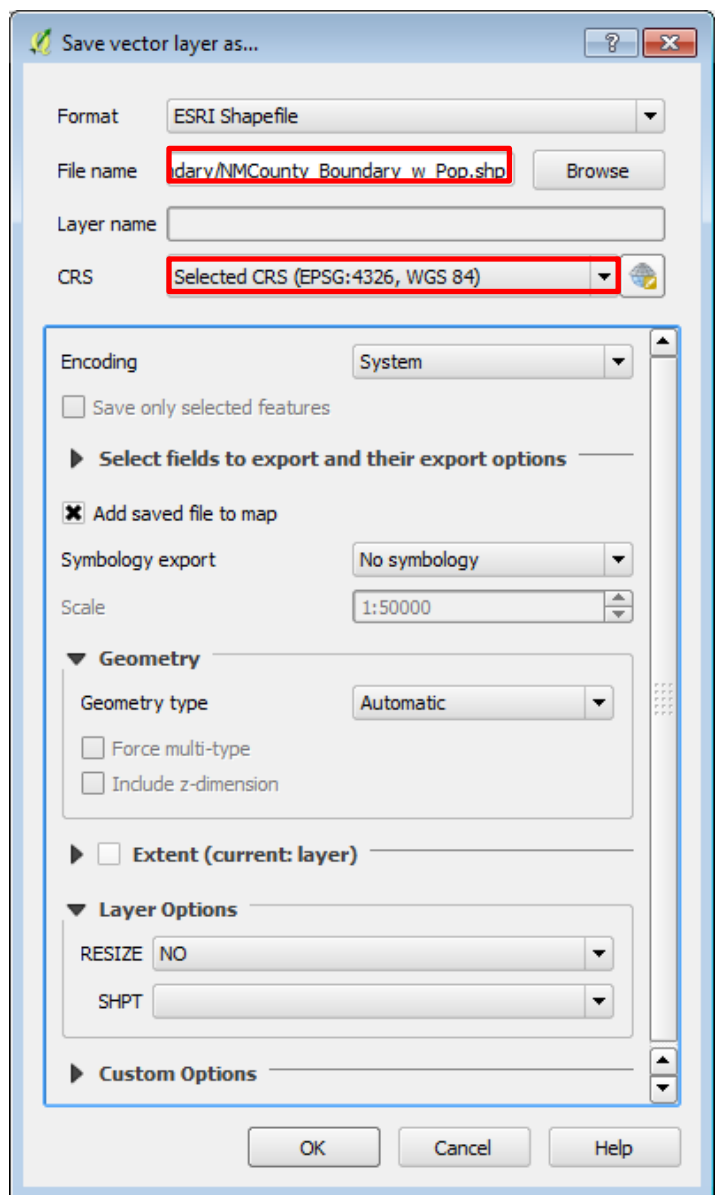
(9) Open the attribute table of the NMCounty_Boundary layer again.

(10) You can see that the two fields in the population layer are joined with the boundary layer.

(11) Right-click on the boundary layer and click on “Save As” to permanently save the joined layer (as ArcMap).

10. Vector Data Analysis

QGIS provide many tools to conduct vector analysis, and many more tools can be found by using the Plugins. Go to Vector or Plugins in the Menu Bar to find these tools. All of these tools have the similar function as ArcMap’s tools and the uses of them are very straightforward.



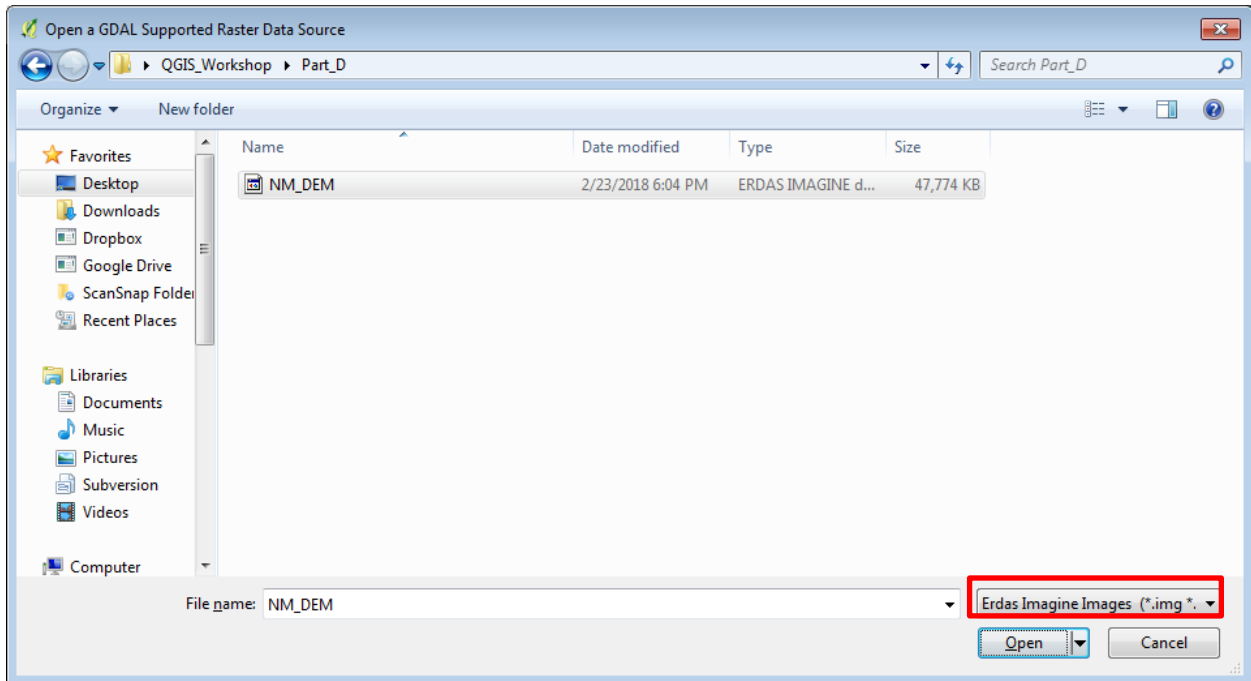
Part D. Working with Raster Data

1. Adding Raster Data

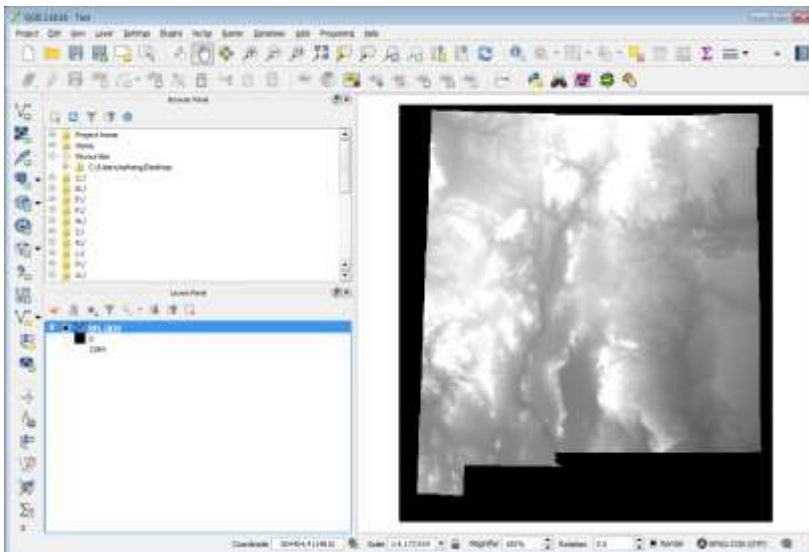
(1) Click “Add Raster Layer” button in the “Manage Layers Toolbar.”



(2) In the “Open a GDAL Supported Raster Data Source” dialogue, navigate to QGIS_Workshop >>> Part_D folder to locate the NM_DEM file (.img) file. Similar to Add Vector Layer tool, users can use the file type filter to quickly locate the .img file.

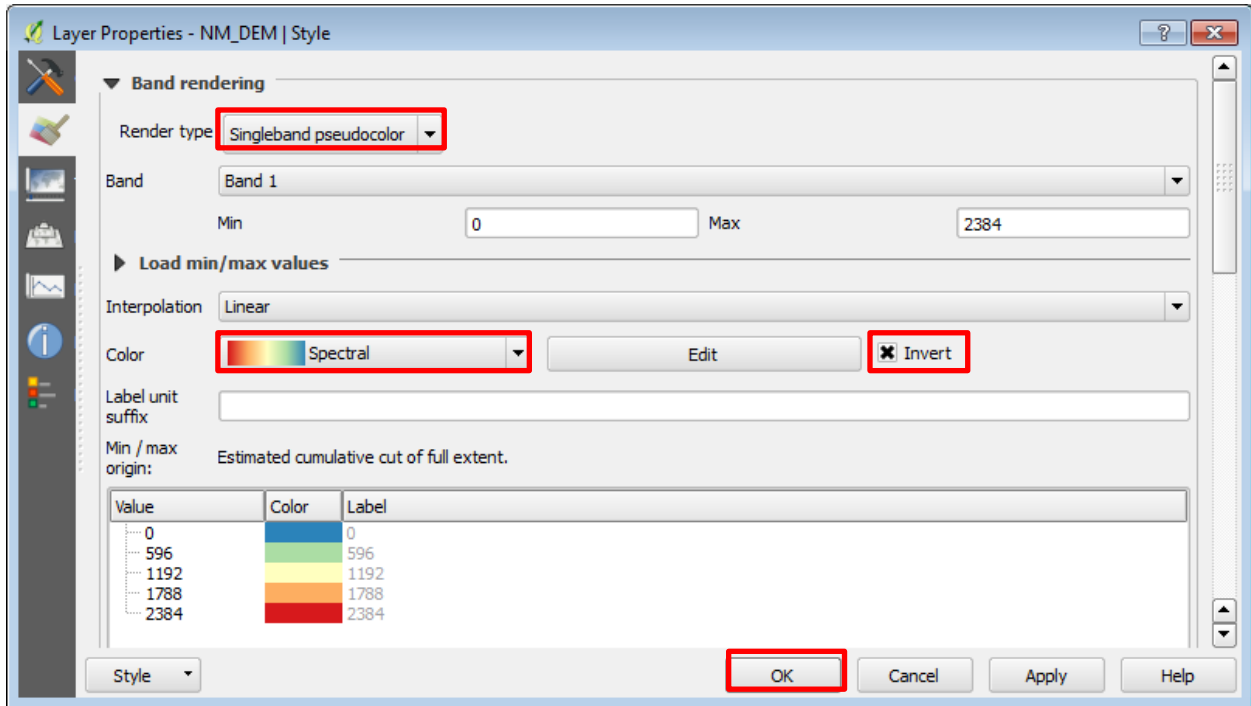


(3) Click Open to open the New Mexico DEM file.

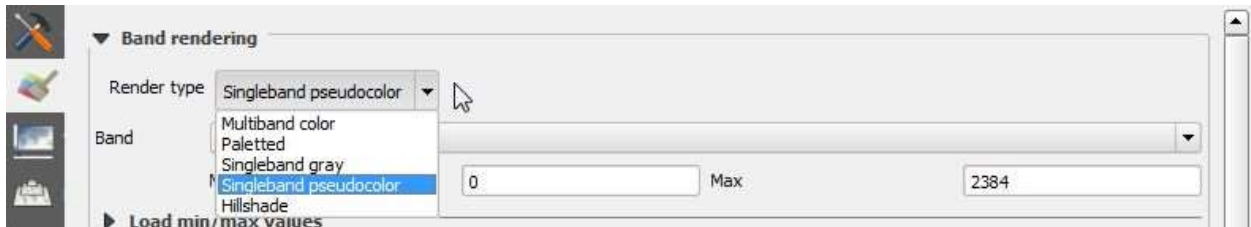


2. Styling Raster Data

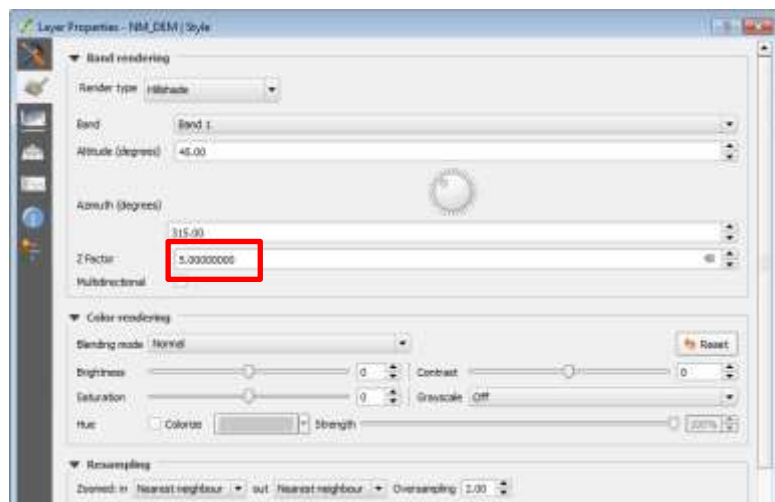
- (1) Right-click on the NM_DEM layer in the Layers Panel.
- (2) In the Layers Properties dialogue, click on the Style tab. Change the “Render type” to Singleband pseudocolor. Select Spectral for “Color”, and check on Invert. Click OK.

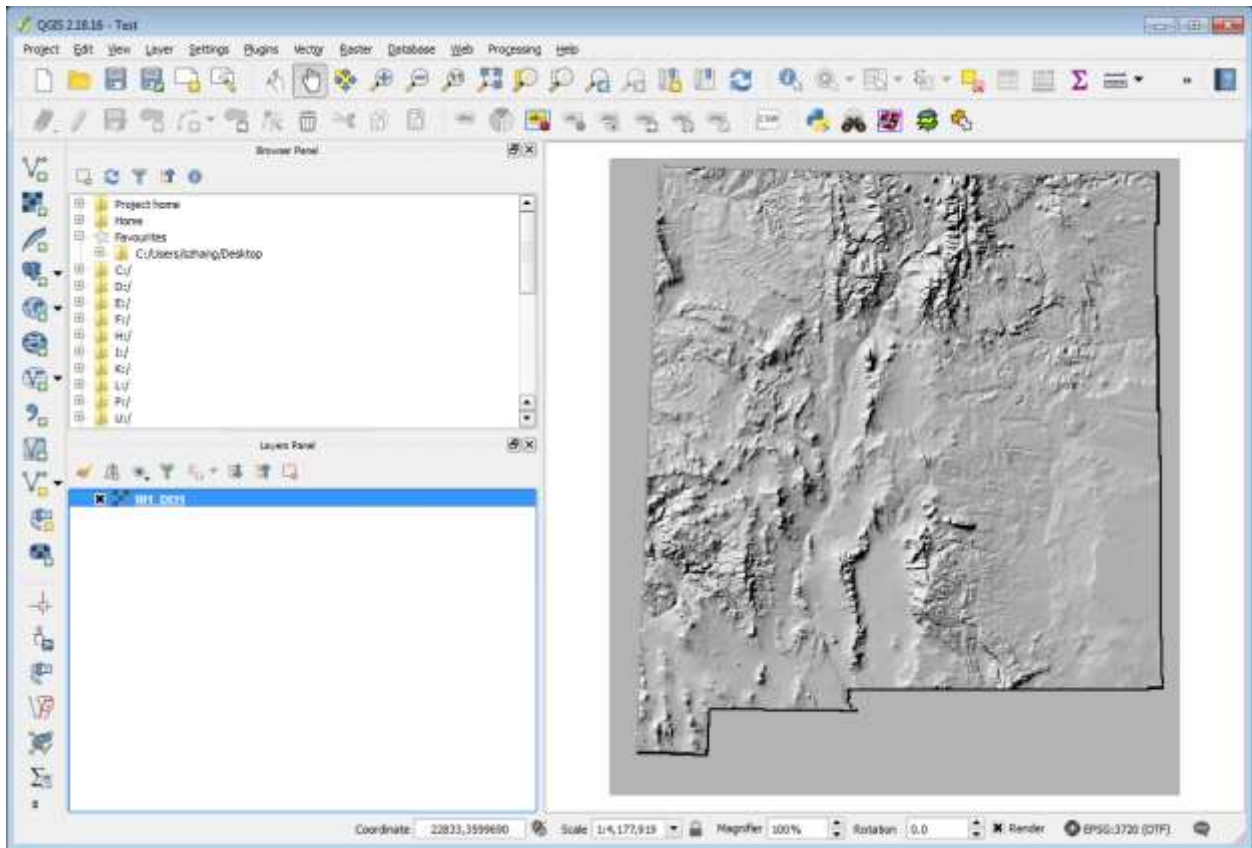
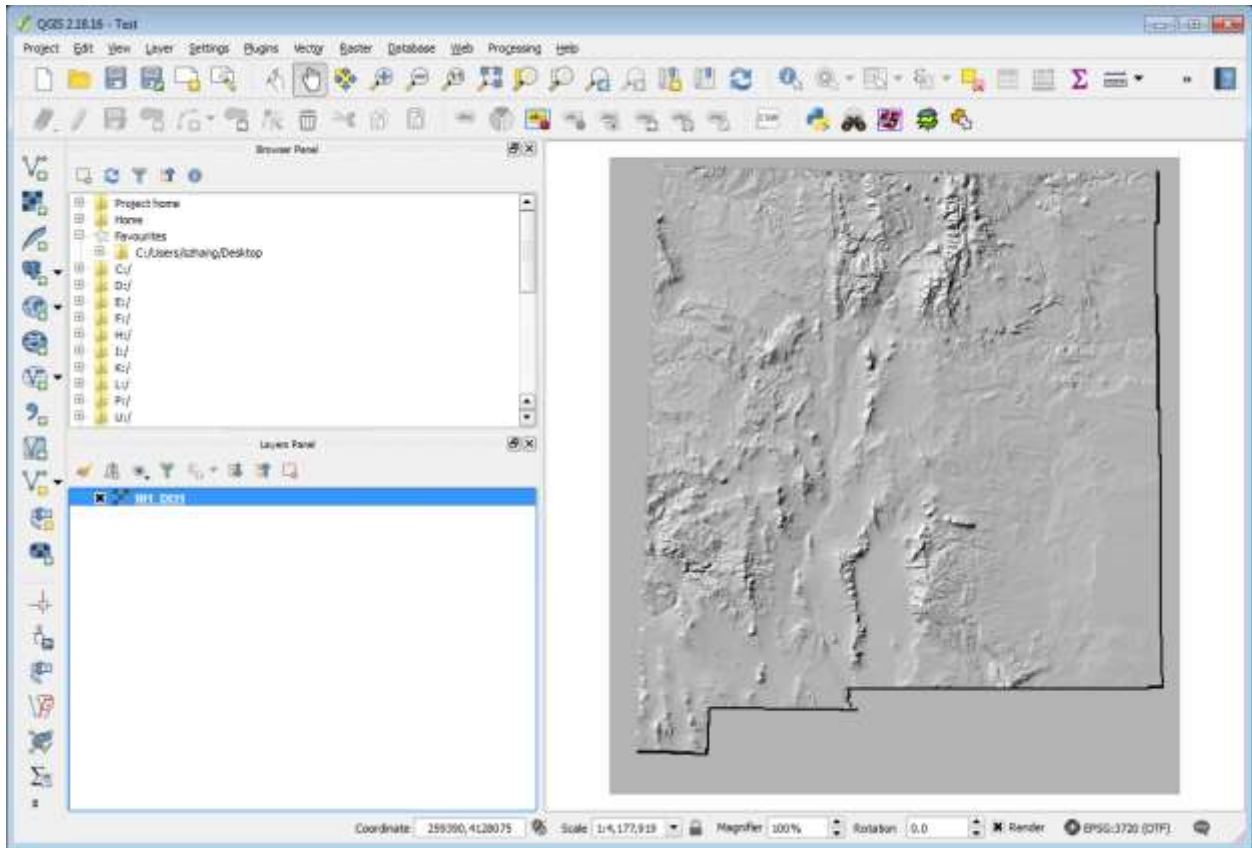


- (4) Many other render types can be selected, including the followings.



- (5) Users can also create a hillshade from the DEM by selecting Hillshade for “Render type.” Change the Z factor to 5 or 10 or even larger to exaggerate the elevation difference.

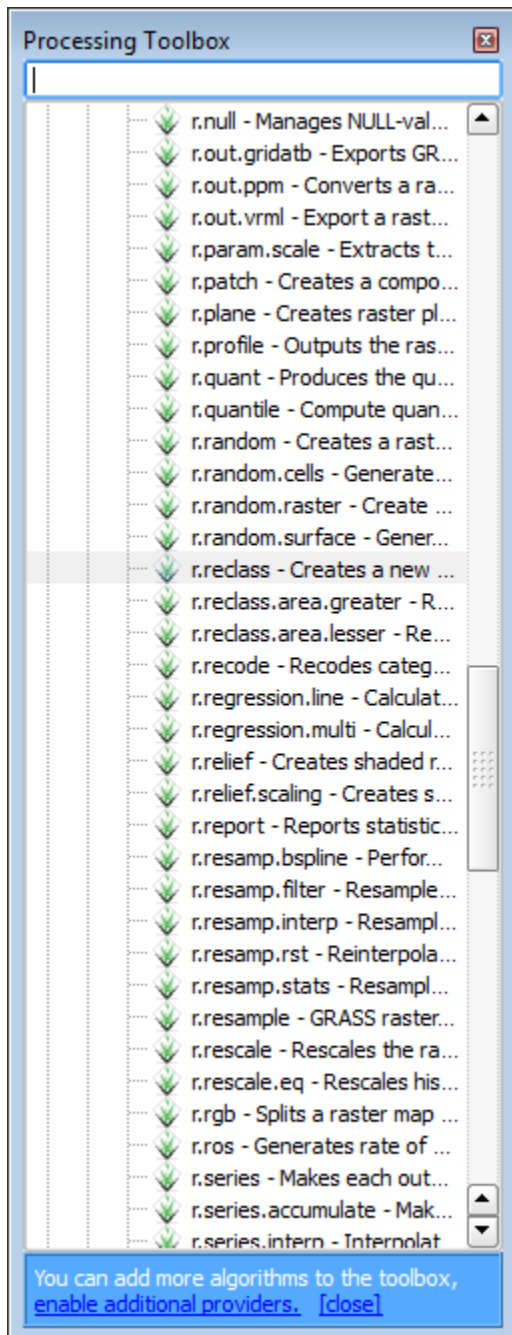




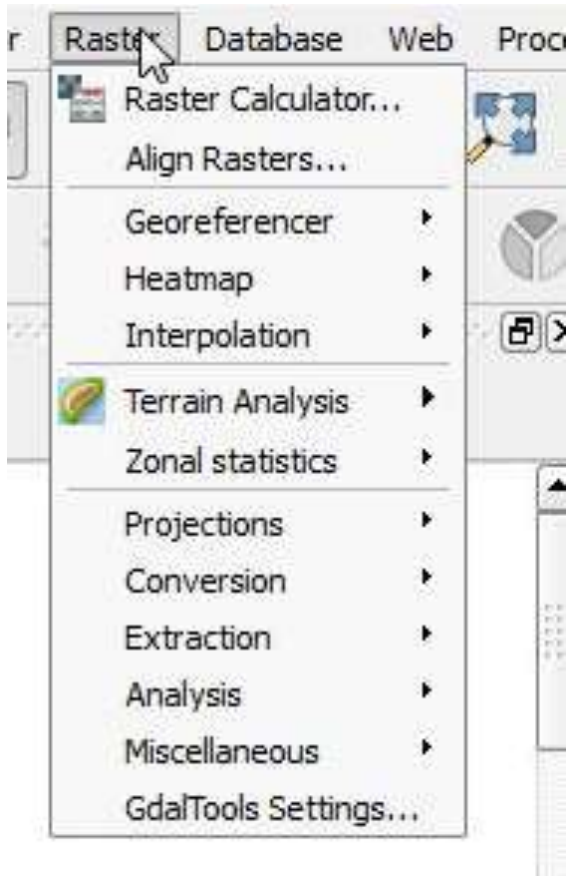
2. Raster Data Analysis

(1) QGIS provide many tools to conduct raster analysis, and many more tools can be found by using the Plugins. Go to Raster or Plugins in the Menu Bar to find these tools. All of these tools have the similar function as ArcMap's tools and the uses of them are very straightforward.

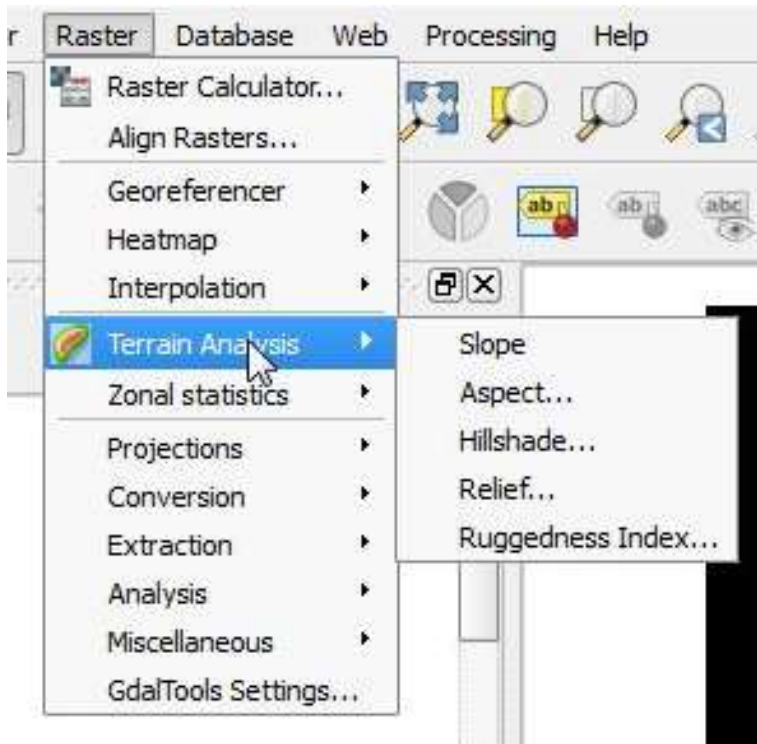
Note: Reclassifying rasters has to use the GRASS r-reclass tool, which can be found Processing >>> Toolbox >>> GRASS GIS >>> Raster



(2) Some of the common tools include the followings:

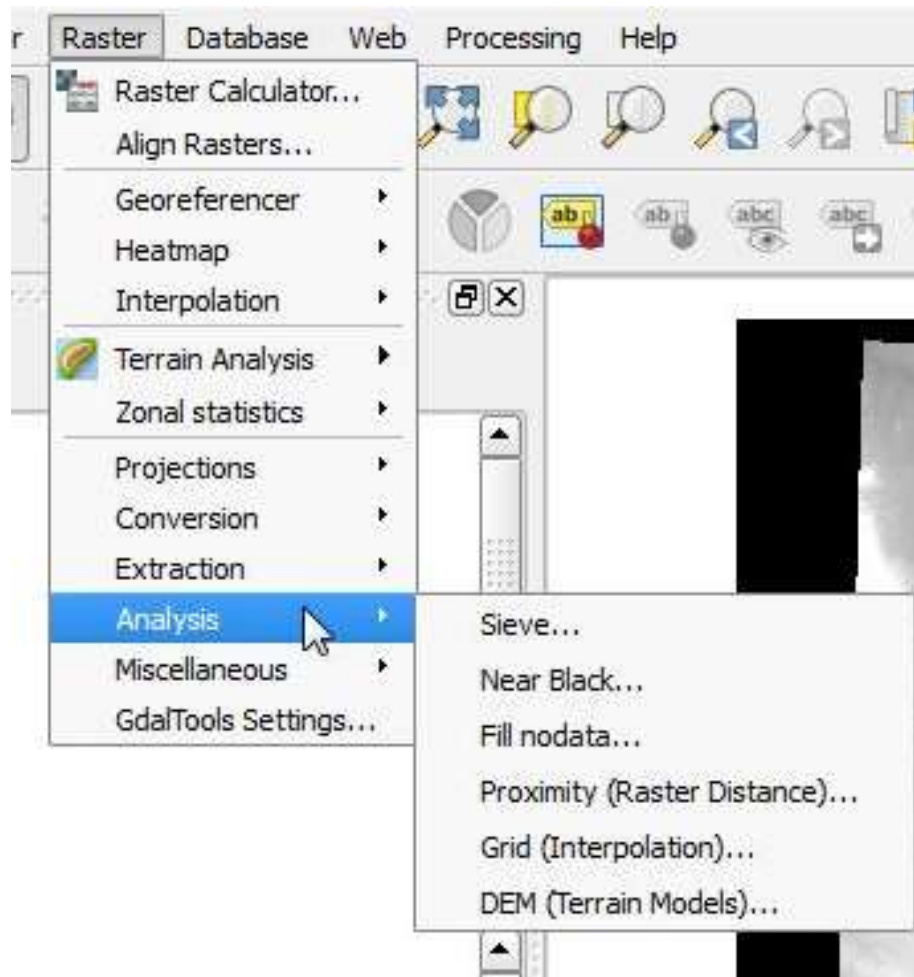


(3) Terrain Analysis is very useful, and it includes the following tools:

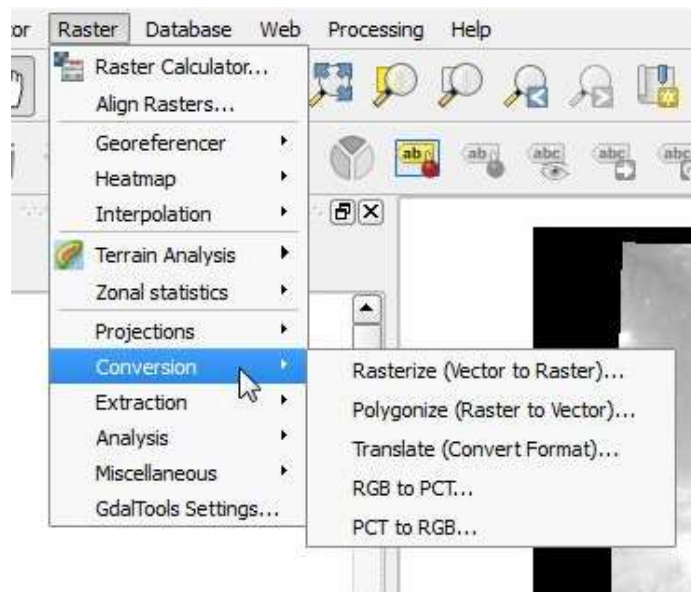


(4) The Georeferencer tool can be used to georeference images.

(5) Analysis tools can be used to do the followings:

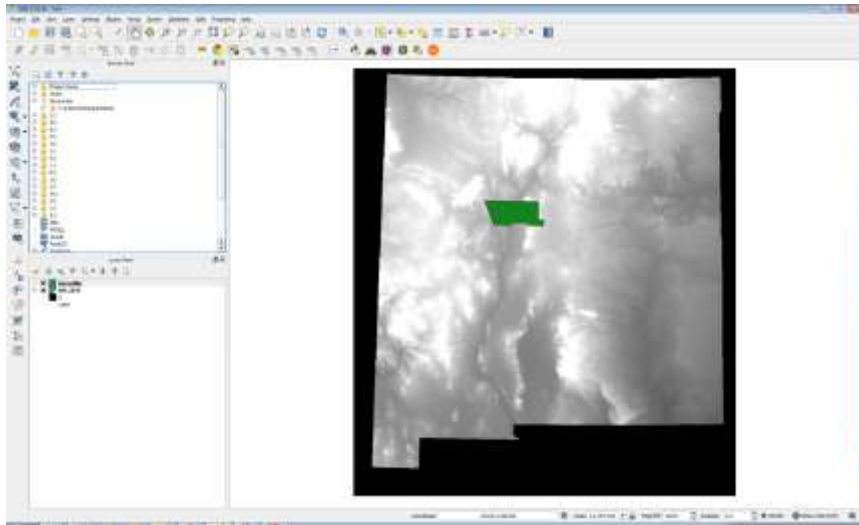


(6) Interpolation and Heatmap are plugins. Raster calculator, Zonal statistics, Conversion, Extraction, and Projections are also very useful tools.

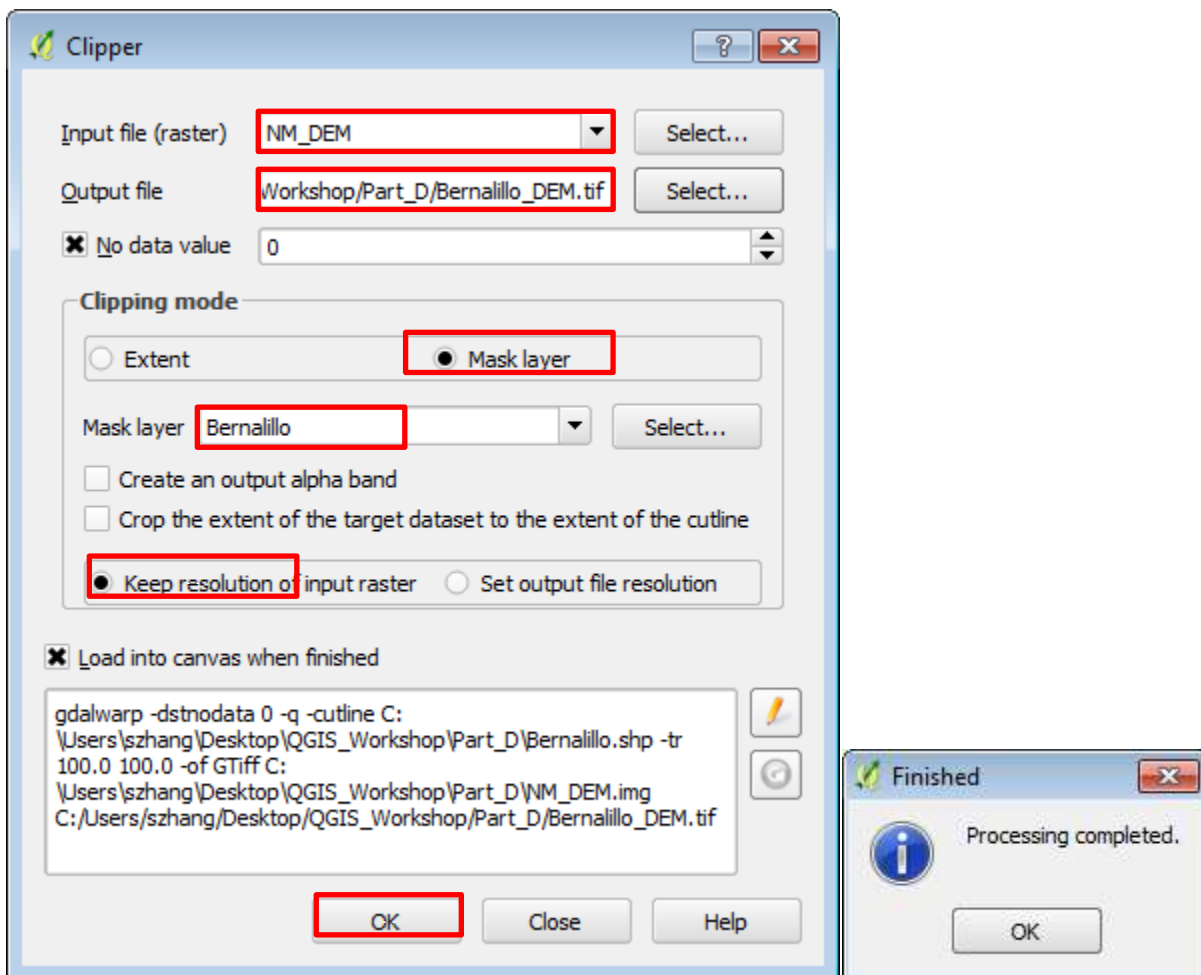


(7) As an example to use these tools, we are going to explore the Clipper tool.

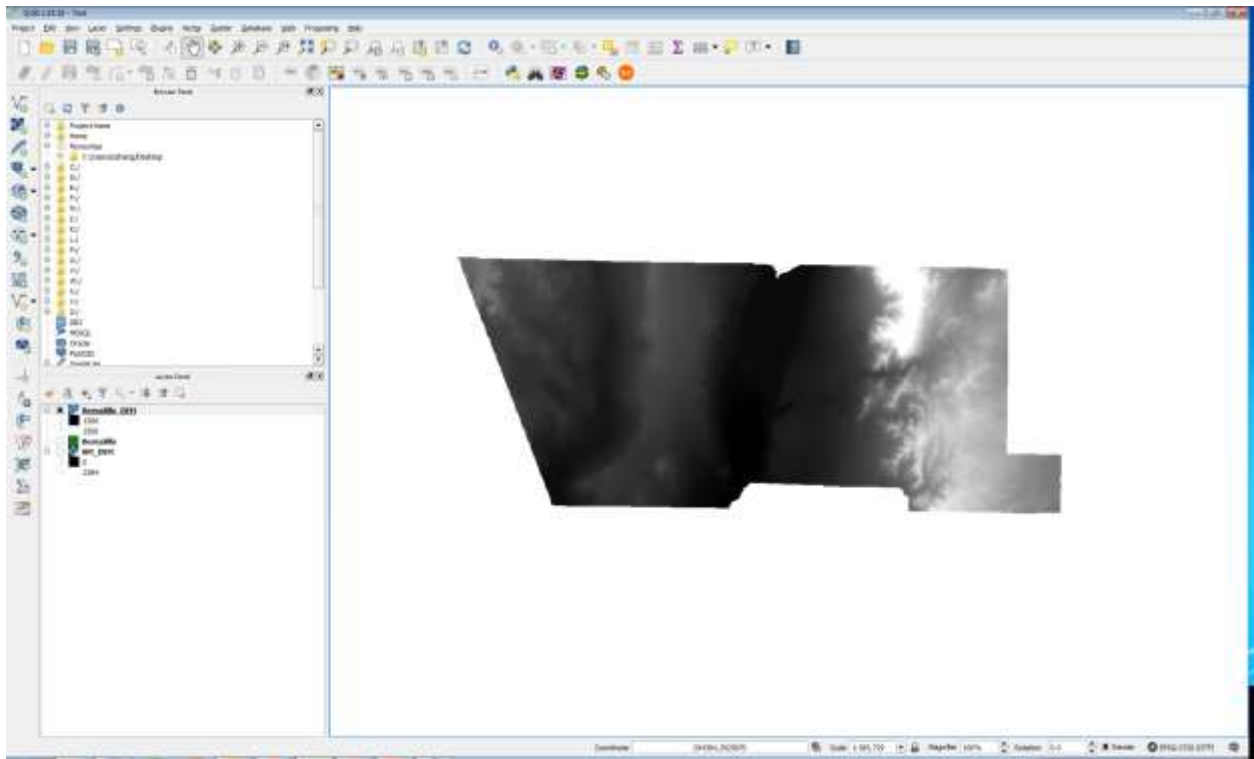
(8) Add the Bernalillo layer in the QGIS_Workshop >>> Part_D folder.



(9) Go to Raster >>> Extraction >>> Clipper

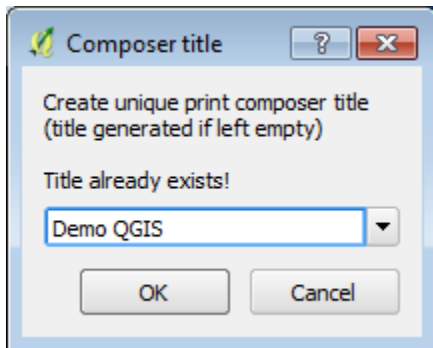


Note: QGIS 2.18.16 has a bug that leads to this tool not working appropriately for .img file. It should be resolved in the future version.

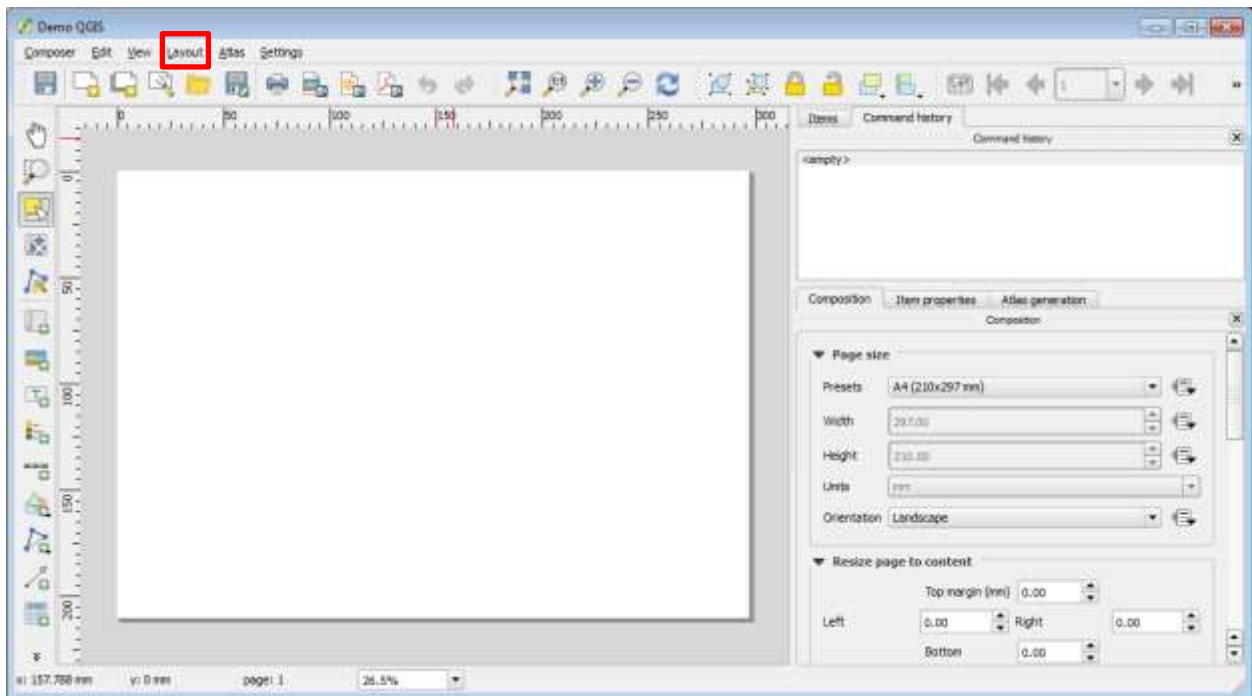


Part E Creating Maps

1. Add the layers in QGIS_Workshop >>> Part_E folder.
2. Table Join population data to county boundary data. Use Graduated for symbolization.
3. Click Project
4. Click on New Print Composer
5. Type in a name for your composer.



6. The composition panel should display, Click Layout and then click Add map.



7. Use mouse pointer to select the area on the canvas of the composer for adding the map.
8. Click Layout and then click add Scale bar, Add Legend, and Add Image (for North Arrow)
10. Click Layout and then click Add Shape and then click Add Rectangular to add neatline.

9. Click Composer and then click Export as Image.

