Academia International College

Tribhuvan University

Institute of Science and Technology

Lab Report

On

"Geographic information system"

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Labs

Lab 1: Introduction to QGIS

1.1. Objectives

- Introduce QGIS software.
- Install QGIS and review its interface

1.2. Theory

QGIS

QGIS (Quantum GIS) is a free and open-source geographic information system (GIS) software that allows users to create, edit, visualize, analyze, and publish geospatial information.

Features

i. Versatility: Supports various vector, raster, and database formats.
ii. Plugins: Extensive plugin architecture for customization and extending functionality.
iii. Interoperability: Compatible with other GIS software and data formats.
iv. Data Analysis: Offers a wide range of spatial analysis tools.
v. Mapping: Capable of creating high-quality maps with advanced cartographic features.

Pros

→ Free and open-source.
→ Cross-platform compatibility.
→ Extensive functionality and customization options.
→ Active development and community support.
→ Scalable for both small and large projects.

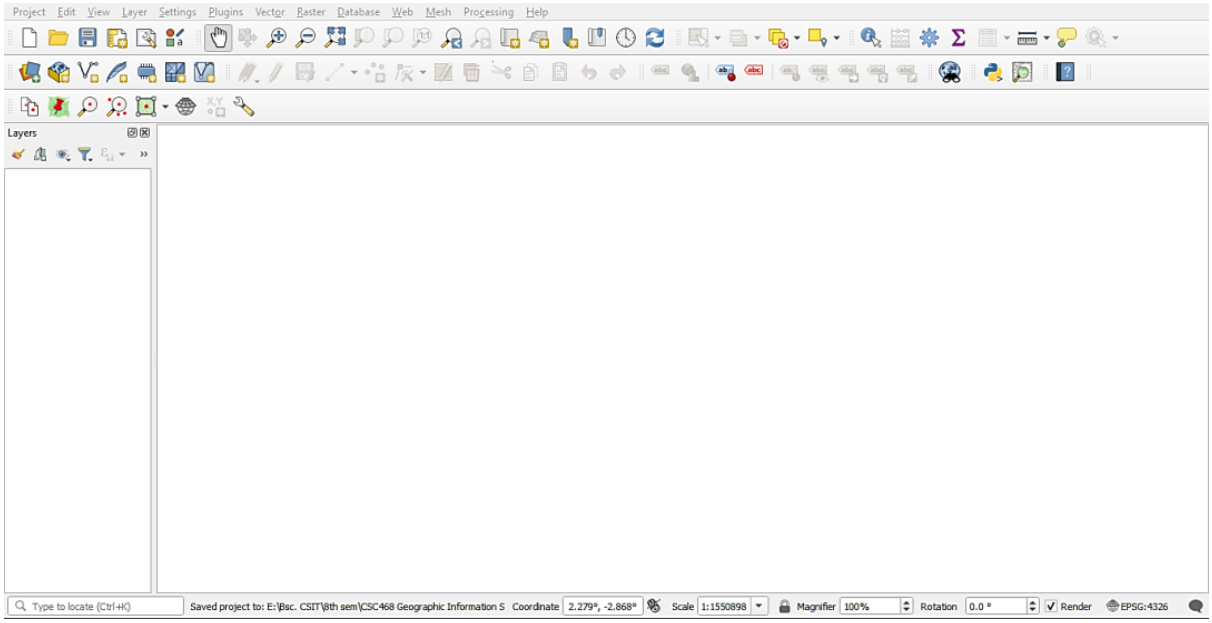
Cons

→ Steeper learning curve compared to some commercial GIS software.
→ Occasional stability issues, especially with complex operations or large datasets.
→ Limited technical support compared to commercial alternatives.

Output

1. Loading QGIS software after installation.

2. Interface of QGIS software.



Lab 2: Creating and Managing Vector Data

2.1. Objectives

- Adding vector layer (do for Gwarko city)
- Setting properties and formatting

2.2. Theory

Layer

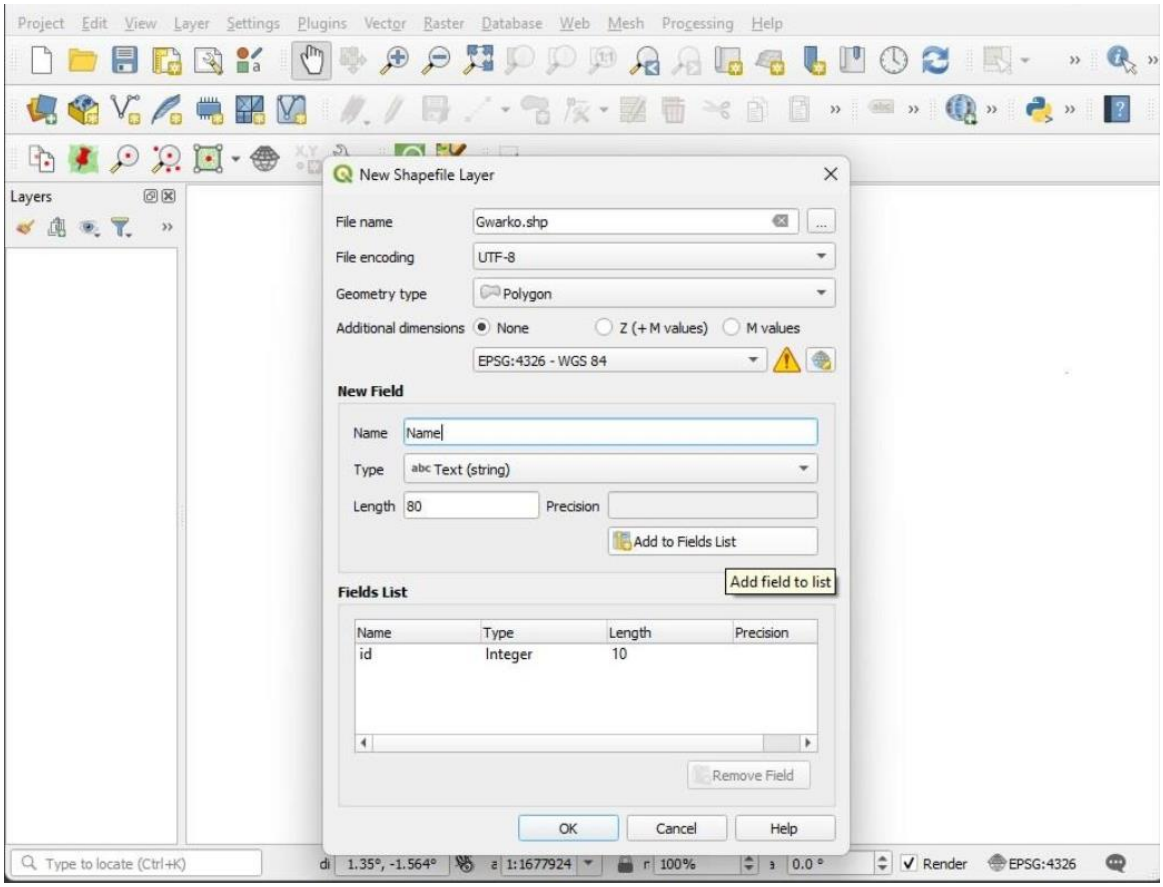
→ A layer is a fundamental component used to display and work with geographic data.
→ Layer can represent various types of data, including vector data and raster data.
→ Each layer in QGIS is associated with a specific dataset, which can be stored in various formats such as shapefiles, GeoJSON, or spatial databases like PostgreSQL.

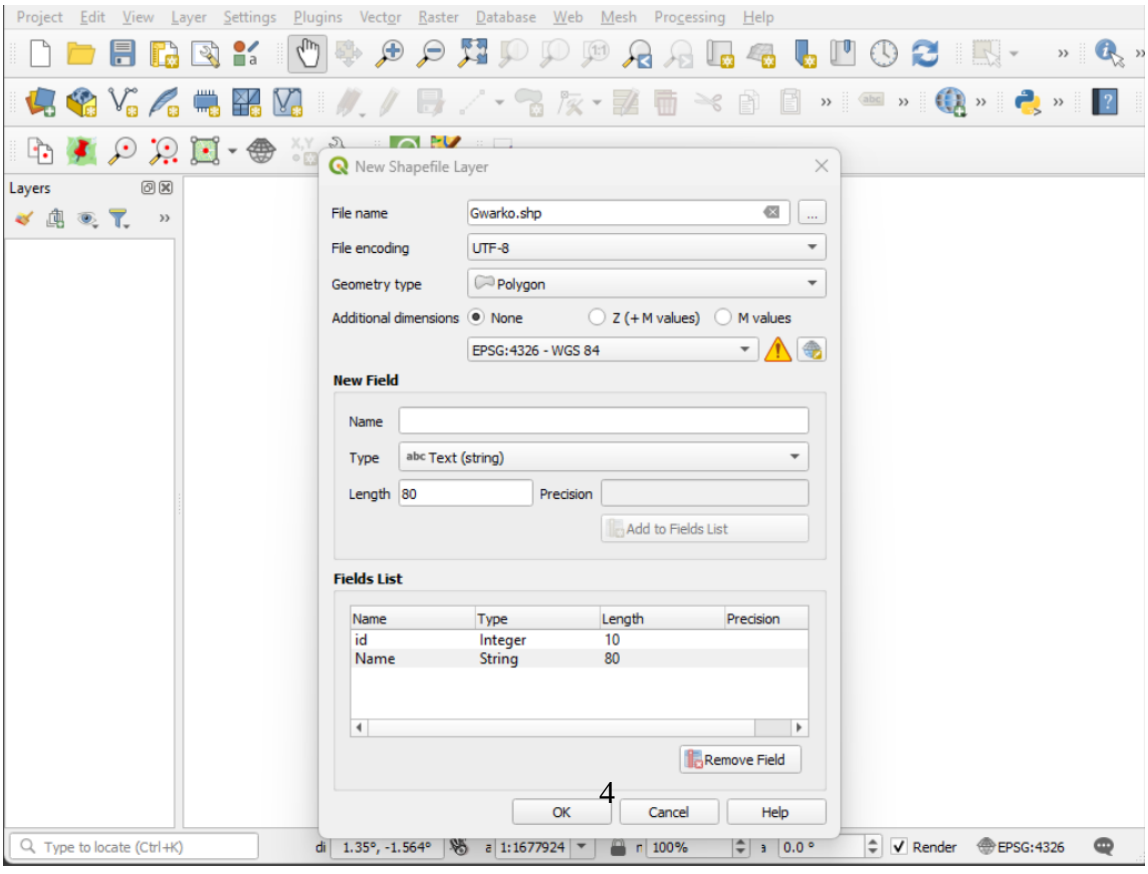
Steps to Create a New Shapefile Layer

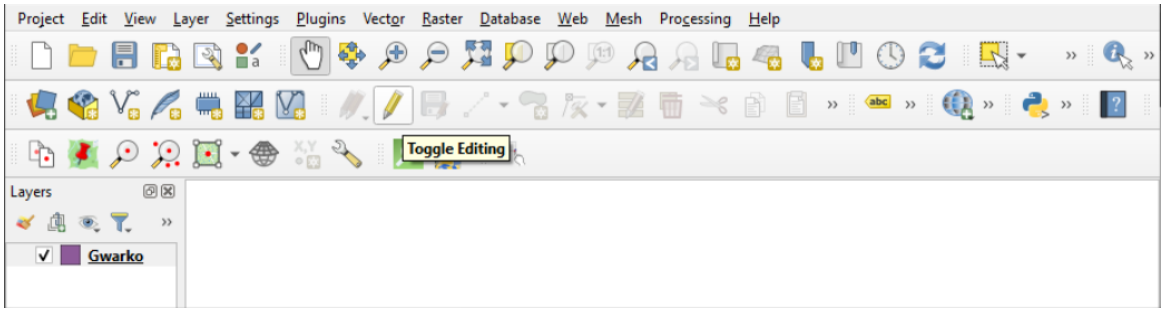
1. Launch the QGIS software.
2. In the menu bar, click on the "Layer" → Create Layer → New Shapefile Layer.
3. Choose the type of geometry for your layer.
4. Select the appropriate CRS (Coordinate Reference System) for your data.
5. Define the attributes (fields) for your layer, including their names and data types.
6. Enter a name for your shapefile and choose the directory where you want to save it.
7. Click the pencil icon to add, modify, or delete features as needed.

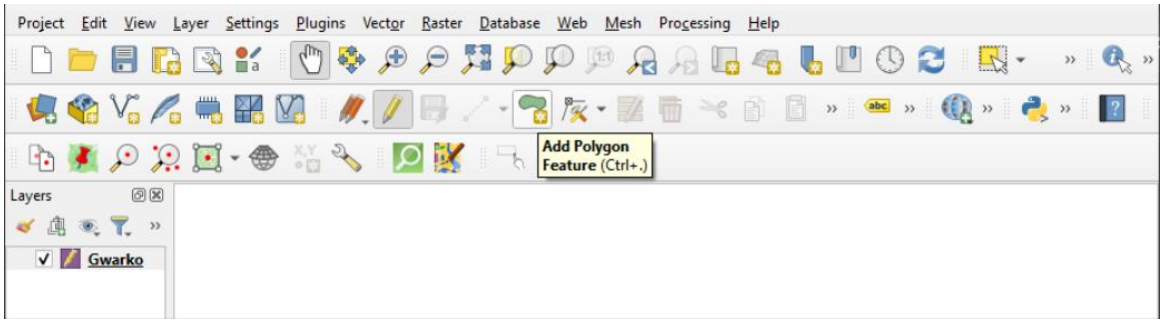
2.3. Output

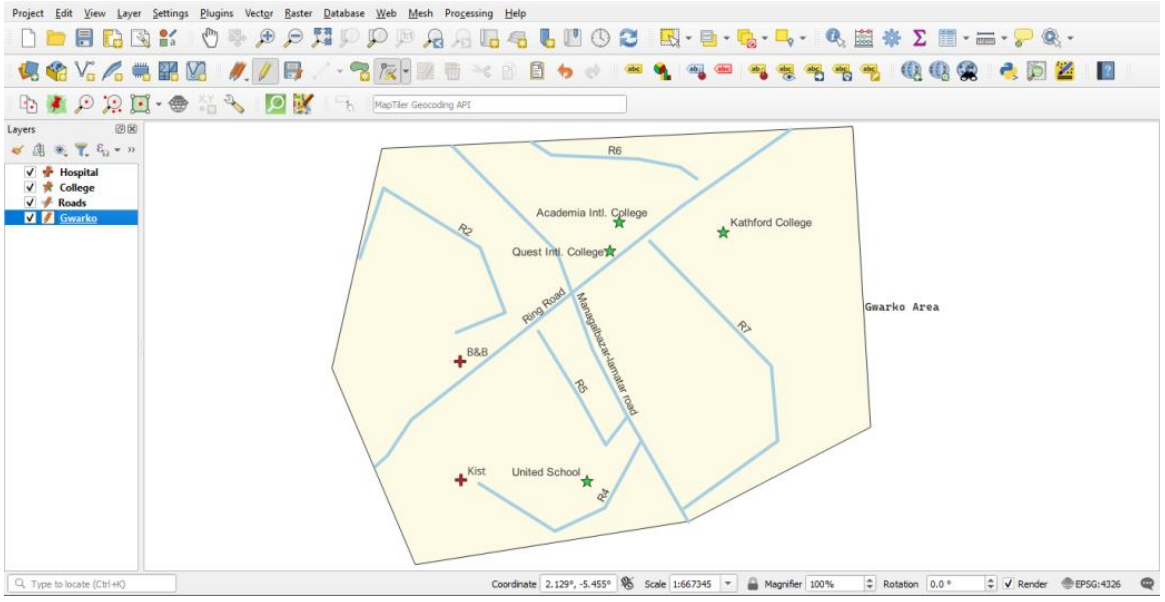
1. Creating new shapefile layer


Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Layers
New Shapefile Layer
File name
Gwarko.shp
File encoding
UTF-8
Geometry type
Polygon
Additional dimensions
None
Z (+M values)
M values
EPSG:4326 - WGS 84
New Field
Name
Name
Type
abc Text (string)
Length
80
Precision
Add to Fields List
Add field to list
Fields List
Name
Type
Length
Precision
id
Integer
10
Remove Field
OK
Cancel
Help
Type to locate (Ctrl+K)
1.35°, -1.564°
1:1677924
100%
0.0 °
Render
EPSG:4326


Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Layers
New Shapefile Layer
File name
Gwarko.shp
File encoding
UTF-8
Geometry type
Polygon
Additional dimensions
None
Z (+M values)
M values
EPSG:4326 - WGS 84
New Field
Name
Type
abc Text (string)
Length
80
Precision
Add to Fields List
Fields List
Name
Type
Length
Precision
id
Integer
10
Name
String
80
Remove Field
OK
Cancel
Help
Type to locate (Ctrl+K)
1.35°, -1.564°
1:1677924
100%
0.0 °
Render
EPSG:4326


Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Toggle Editing
Layers
Gwarko


Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Add Polygon Feature (Ctrl+.)
Layers
Gwarko


Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
MapTiler Geocoding API
Layers
Hospital
College
Roads
Gwarko
R6
Academia Intl. College
Kathford College
R2
Quest Intl. College
Ring Road
Managalbazar-Jamatar road
R7
Gwarko Area
B&B
R5
Kist
United School
R4
Type to locate (Ctrl+K)
Coordinate 2.129°, -5.455°
Scale 1:667345
Magnifier 100%
Rotation 0.0 °
Render
EPSG:4326

Lab 3: Calculating Area Statistics of Vector Data

3.1. Objectives

- Load the map of Nepal as vector map and calculate the area of gaunpalika or municipality

3.2. Theory

Vector Layers

A vector layer in QGIS is a type of data representation used to store geographic features like points, lines, or polygons, using vector data. It can contain points, lines, or polygons, each defined by coordinates and attributes. It is essential for handling spatial data in GIS projects, allowing users to visualize, analyze, and manipulate geographical information.

Steps for adding vector layer and calculating the area of gaunpalika or municipality

1. Launch the QGIS software.
2. Go to the "Layer" menu in the menu bar.
3. Select "Add Layer" → "Add Vector Layer" or simply use the "Add Vector Layer" button in the toolbar.
4. Browse to the location of your vector data file.
5. Select the file and click "Open" to add it to the map canvas.
6. After adding the vector layer, right-click on the layer name in the Layers panel and select "Open Attribute Table".
7. Click on the "Field Calculator" button located within the "Attribute Table" window.
    - Create a new field, name it appropriately, and specify its data type.
    - In the expression box, type `$area` to calculate the area of each polygon feature.
    - Click "OK" to apply the changes.
8. Once the area field is added, the area values will be automatically calculated for each district polygon.

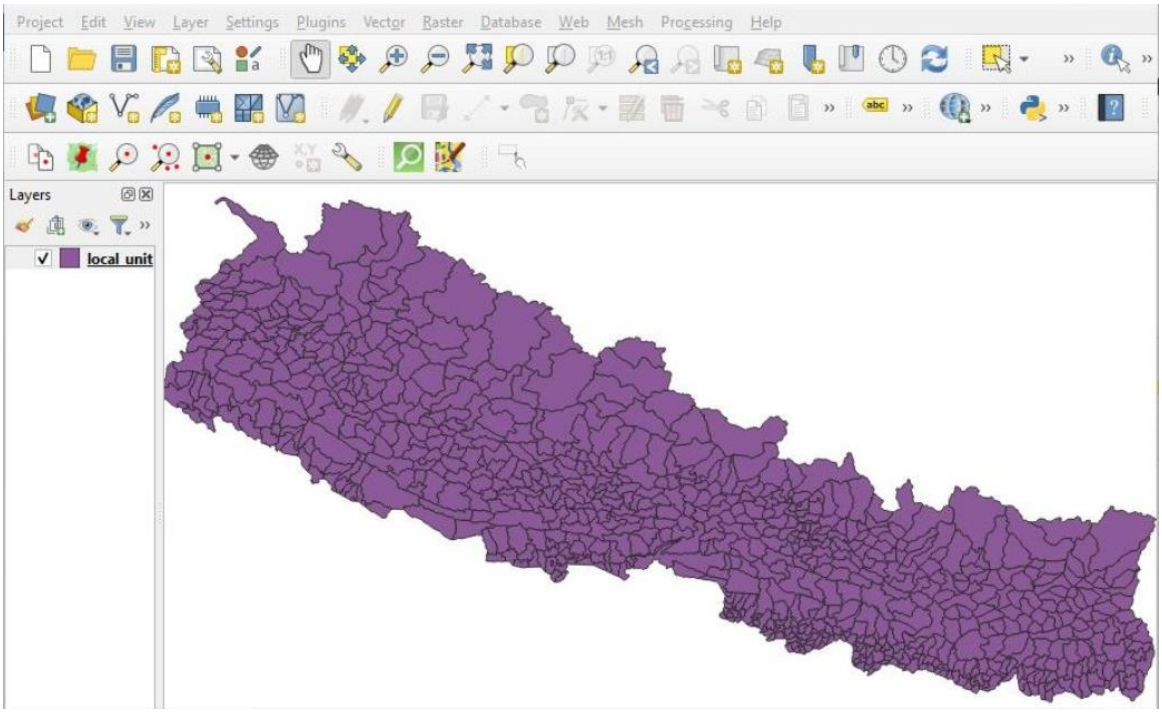
Steps to calculate basic statistics

In QGIS, you can calculate basic statistics for fields, which helps to quickly calculate and analyze basic descriptive statistics for attribute fields within vector layers. This tool helps to quickly figure out some key facts and figures about the categories in your map, making it easier to understand and work with your data. Here's how to use it:

1. Navigate to the "Vector" menu and select "Analysis Tools".
2. Choose the submenu "Basic Statistics for Fields".
3. Select the layer containing the attribute table you want to analyze.
4. Choose the specific field for which you want to calculate basic statistics.
5. Browse to the destination where you want to save the results.
6. Press "Run".

3.3. Output

1. Added a vector layer *local_unit.shp* - Map of Nepal.

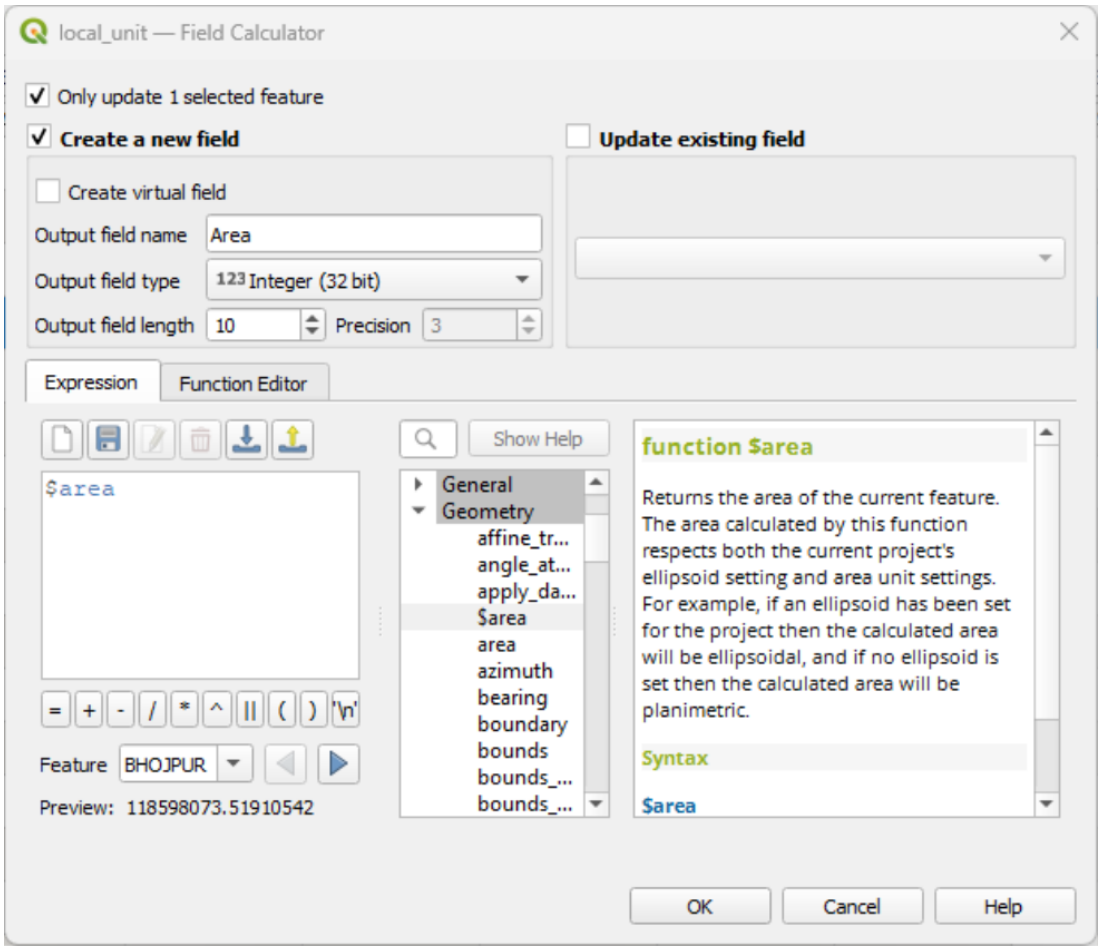


2. Attribute Table of the vector layer.

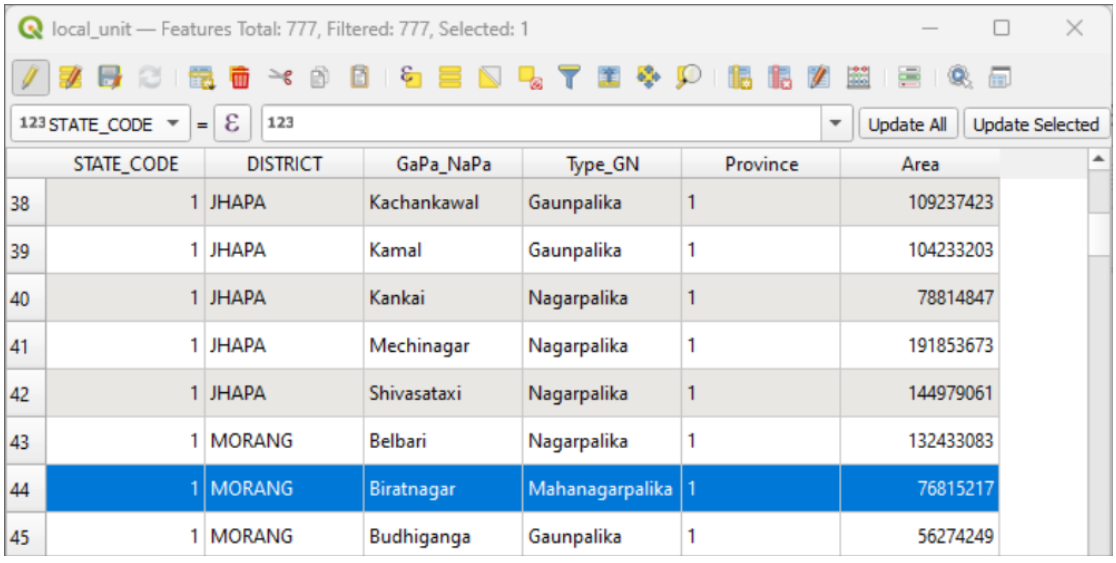
local_unit — Features Total: 777, Filtered: 777, Selected: 0

	STATE_CODE	DISTRICT	GaPa_NaPa	Type_GN	Province
34	1	JHAPA	Gauradhaha	Nagarpalika	1
35	1	JHAPA	Gauriganj	Gaunpalika	1
36	1	JHAPA	Haldibari	Gaunpalika	1
37	1	JHAPA	Jhapa	Gaunpalika	1
38	1	JHAPA	Kachankawal	Gaunpalika	1
39	1	JHAPA	Kamal	Gaunpalika	1
40	1	JHAPA	Kankai	Nagarpalika	1
41	1	JHAPA	Mechinagar	Nagarpalika	1
42	1	JHAPA	Shivasataxi	Nagarpalika	1
43	1	MORANG	Belbari	Nagarpalika	1
44	1	MORANG	Biratnagar	Mahanagarpalika	1
45	1	MORANG	Budhiganga	Gaunpalika	1
46	1	MORANG	Dhanpalthan	Gaunpalika	1

3. Using 'Field Calculator' to create and add a new filed to the attribute table.

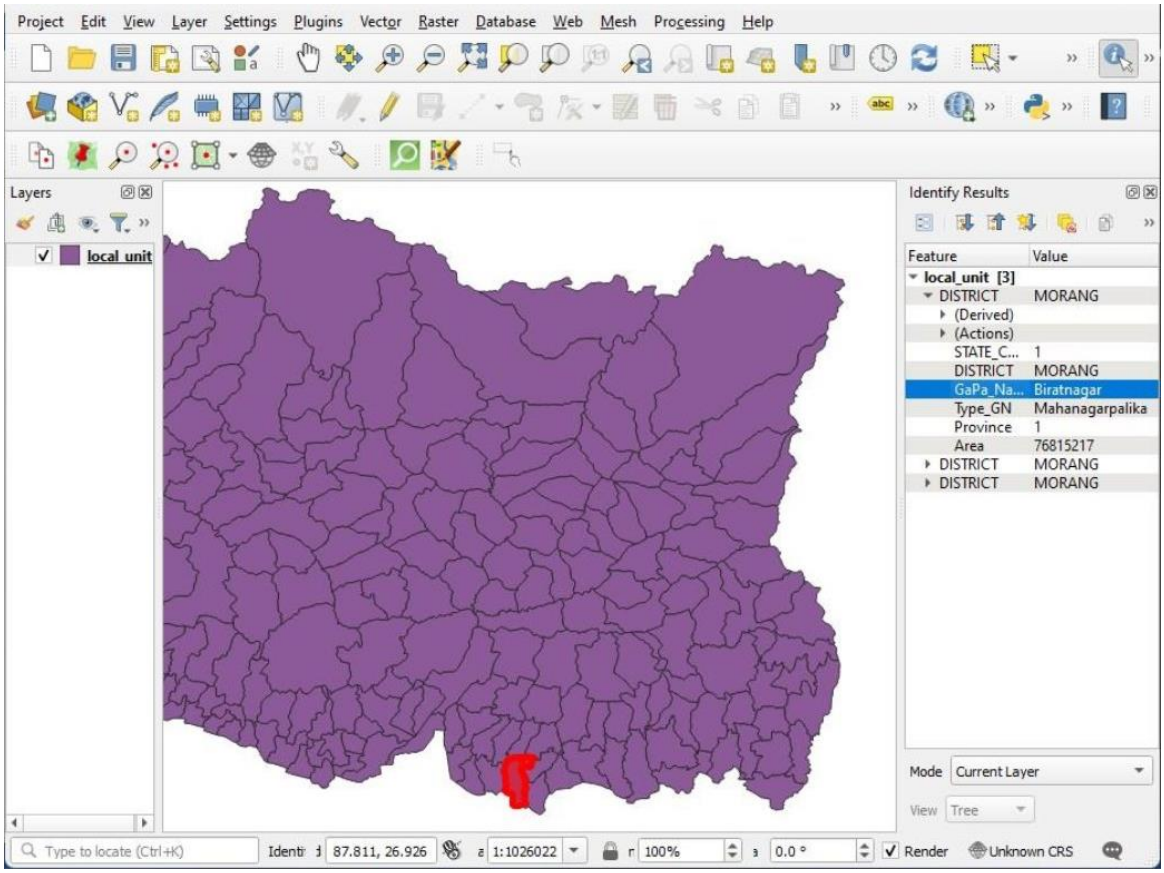


4. 'Area' field successfully added in the Attribute Table.

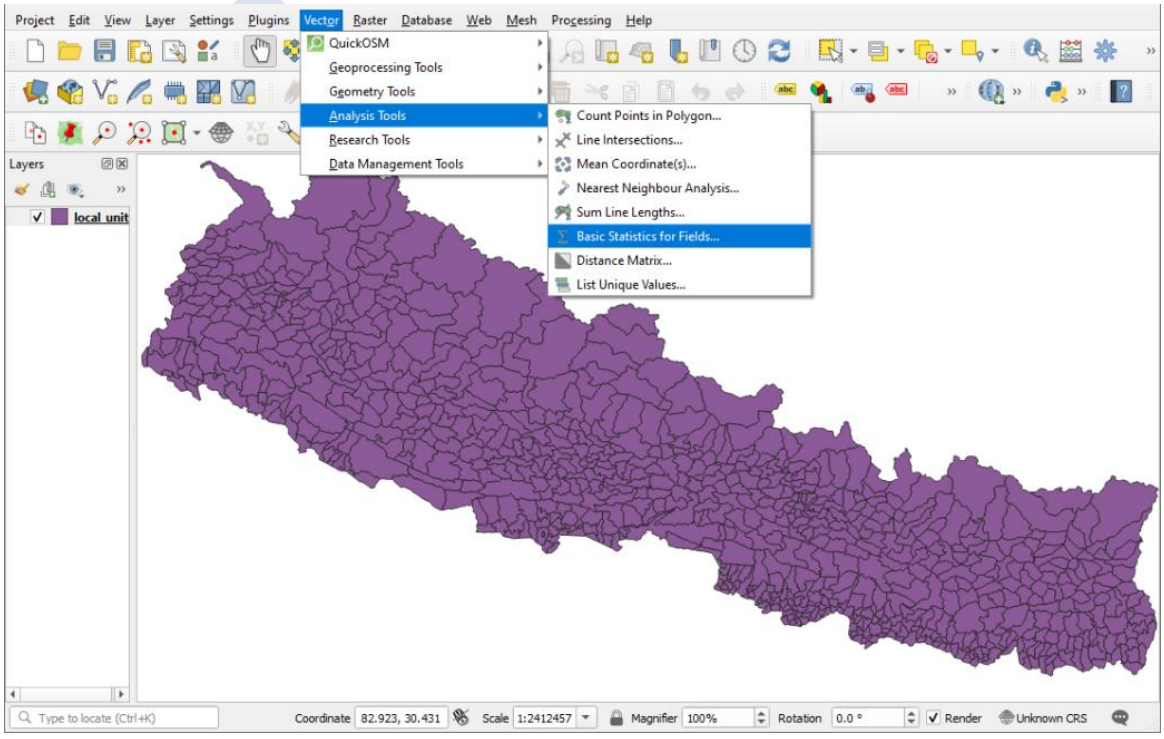


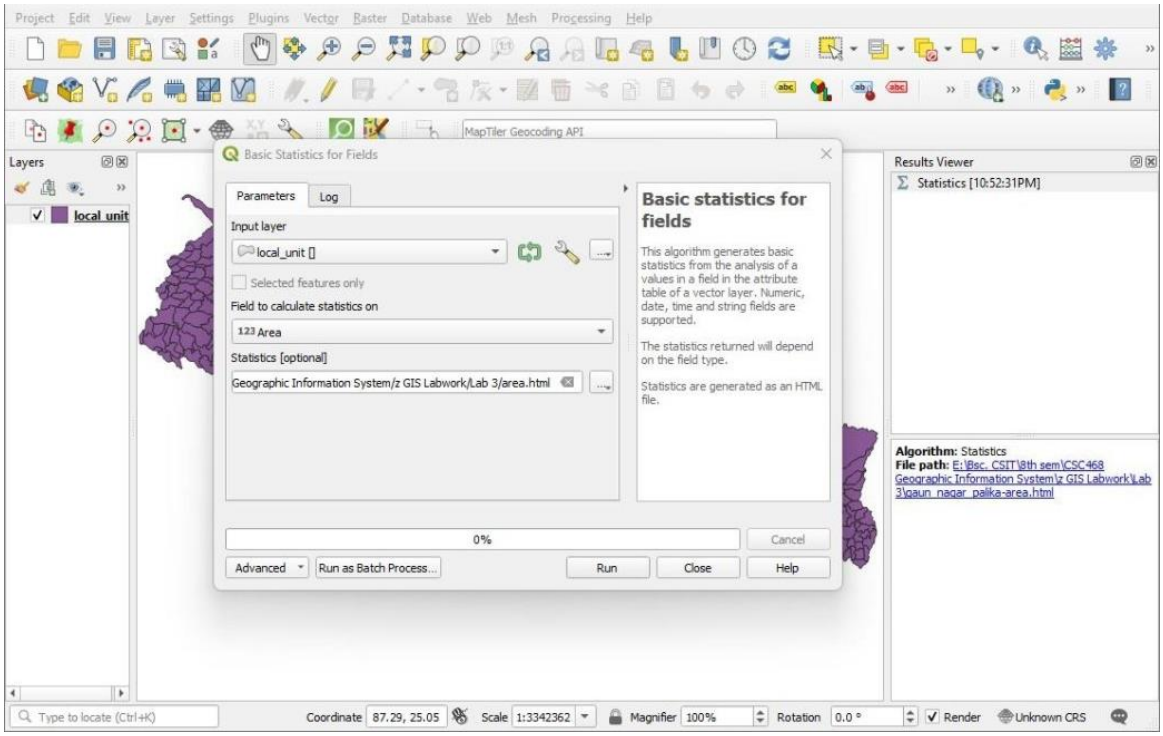
	STATE_CODE	DISTRICT	GaPa_NaPa	Type_GN	Province	Area
38	1	JHAPA	Kachankawal	Gaunpalika	1	109237423
39	1	JHAPA	Kamal	Gaunpalika	1	104233203
40	1	JHAPA	Kankai	Nagarpalika	1	78814847
41	1	JHAPA	Mechinagar	Nagarpalika	1	191853673
42	1	JHAPA	Shivasataxi	Nagarpalika	1	144979061
43	1	MORANG	Belbari	Nagarpalika	1	132433083
44	1	MORANG	Biratnagar	Mahanagarpalika	1	76815217
45	1	MORANG	Budhiganga	Gaunpalika	1	56274249

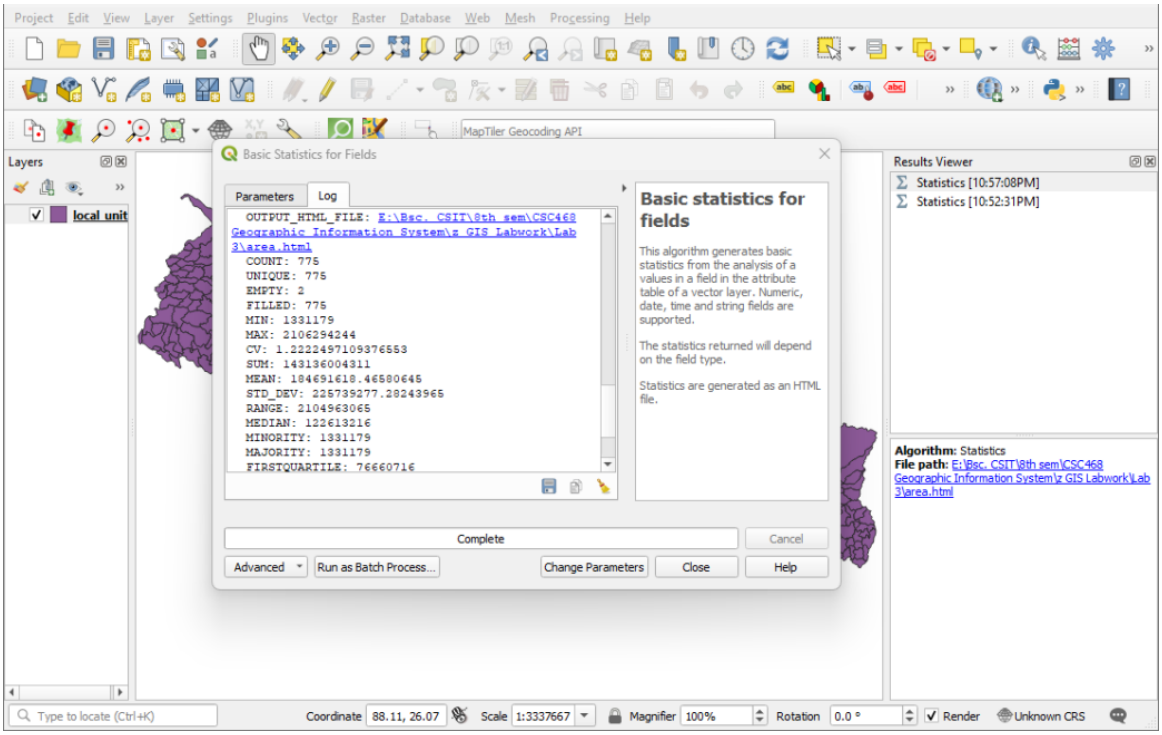
5.



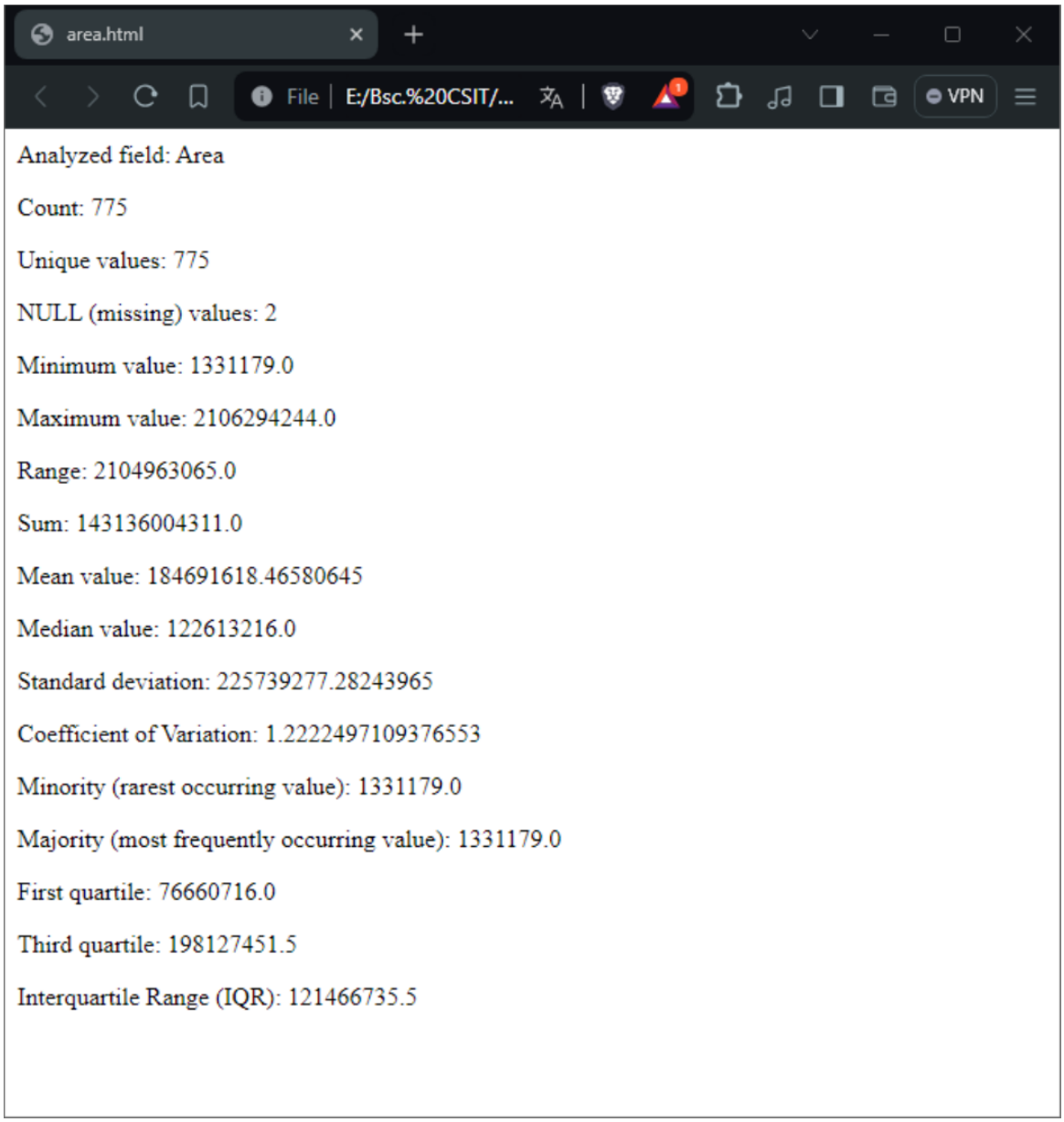
6. Calculating basic statistics for Area field.




Basic Statistics for Fields
Parameters
Log
Input layer
local_unit []
Selected features only
Field to calculate statistics on
123 Area
Statistics [optional]
Geographic Information System/z GIS Labwork/Lab 3/area.html
Basic statistics for fields
This algorithm generates basic statistics from the analysis of a values in a field in the attribute table of a vector layer. Numeric, date, time and string fields are supported.
The statistics returned will depend on the field type.
Statistics are generated as an HTML file.
0%
Cancel
Advanced
Run as Batch Process...
Run
Close
Help
Results Viewer
Statistics [10:52:31PM]
Algorithm: Statistics
File path: E:\Bsc. CSIT\8th sem\CSC468 Geographic Information System\z GIS Labwork\Lab 3\gaun_nagar_palika-area.html
Layers
local_unit
MapTiler Geocoding API
Coordinate 87.29, 25.05
Scale 1:3342362
Magnifier 100%
Rotation 0.0 °
Render
Unknown CRS


Basic Statistics for Fields
Parameters
Log
OUTPUT_HTML_FILE: E:\Bsc. CSIT\8th sem\CSC468 Geographic Information System\z GIS Labwork\Lab 3\area.html
COUNT: 775
UNIQUE: 775
EMPTY: 2
FILLED: 775
MIN: 1331179
MAX: 2106294244
CV: 1.2222497109376553
SUM: 143136004311
MEAN: 184691618.46580645
STD_DEV: 225739277.28243965
RANGE: 2104963065
MEDIAN: 122613216
MINORITY: 1331179
MAJORITY: 1331179
FIRSTQUARTILE: 76660716
Basic statistics for fields
This algorithm generates basic statistics from the analysis of a values in a field in the attribute table of a vector layer. Numeric, date, time and string fields are supported.
The statistics returned will depend on the field type.
Statistics are generated as an HTML file.
Complete
Cancel
Advanced
Run as Batch Process...
Change Parameters
Close
Help
Results Viewer
Statistics [10:57:08PM]
Statistics [10:52:31PM]
Algorithm: Statistics
File path: E:\Bsc. CSIT\8th sem\CSC468 Geographic Information System\z GIS Labwork\Lab 3\area.html
Layers
local_unit
MapTiler Geocoding API
Coordinate 88.11, 26.07
Scale 1:3337667
Magnifier 100%
Rotation 0.0 °
Render
Unknown CRS

7. Output HTML file generated after calculating field statistics on area.



Lab 4: Exploring and Managing Raster Layer

4.1. Objectives

- Adding raster layer, and setting properties and formatting it.
- ADD two raster layer file (population of world in 1990 and 2000) then calculate change in population in 10 years also do the formatting.

4.2. Theory

Raster Layer

A raster layer refers to a digital image or map composed of a grid of cells or pixels, each cell containing a value representing a certain attribute. Raster layers are commonly used to represent continuous phenomena across a geographic area, such as terrain, vegetation, or satellite imagery.

A raster layer is a grid-based representation of imagery or gridded data, like satellite images or elevation models. It is used for tasks such as land cover analysis, terrain modeling, and environmental monitoring, offering tools for visualization and analysis within the software. The grid of cells contains values representing certain attributes.

Raster Calculation

Raster calculation is the process of performing mathematical operations on raster data layers in QGIS. It enables users to derive new information, conduct spatial modeling, and make informed decisions based on spatial data.

Steps to add Raster Layers in QGIS

Ensure you have the raster dataset you want to add saved in a compatible format.

1. Launch the QGIS software.
2. Go to the "Layer" menu in the menu bar then select "Add Layer" → Add Raster Layer.
3. In the "Data Source Manager" window that appears, navigate to the location of your raster dataset.
4. Select the raster file you want to add from the file browser and click "Open".
5. The raster layer will appear in the "Layers Panel" on the left side of the QGIS interface, and the layer will be displayed in the main map canvas.

Raster Calculation

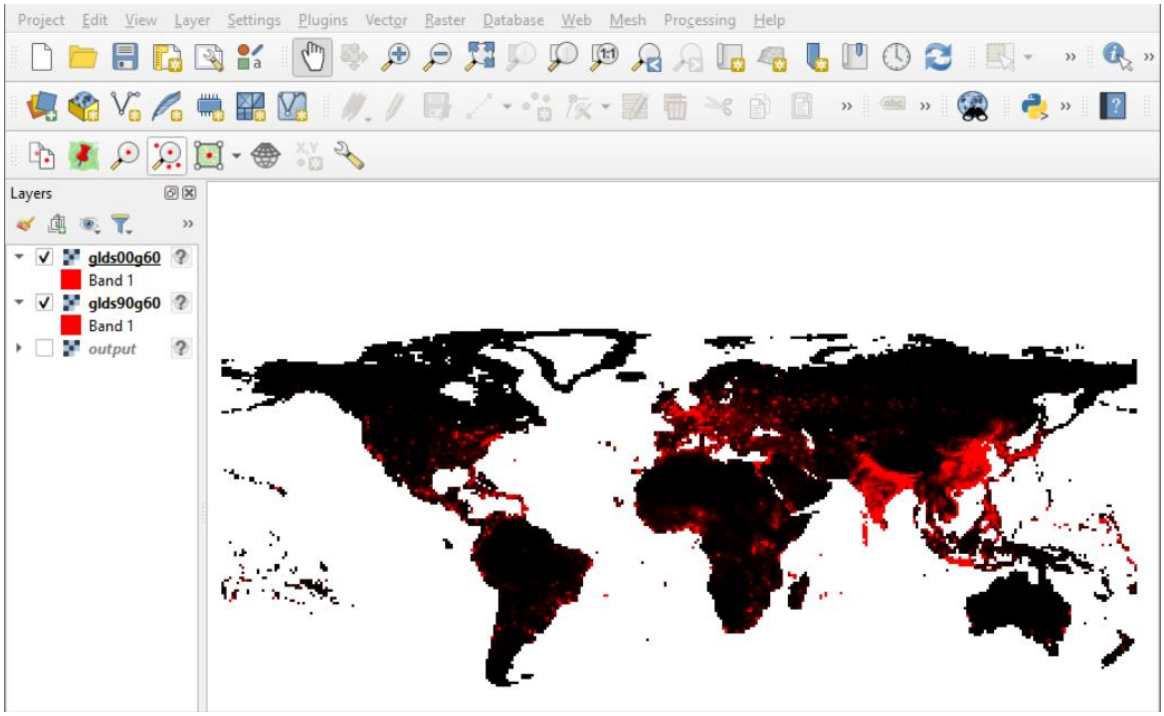
Raster calculation involves performing mathematical operations on raster layers to derive new information or analyze relationships between variables. This process allows users to generate new raster layers based on the values of one or more input raster layers.

Steps to Perform Raster Calculation

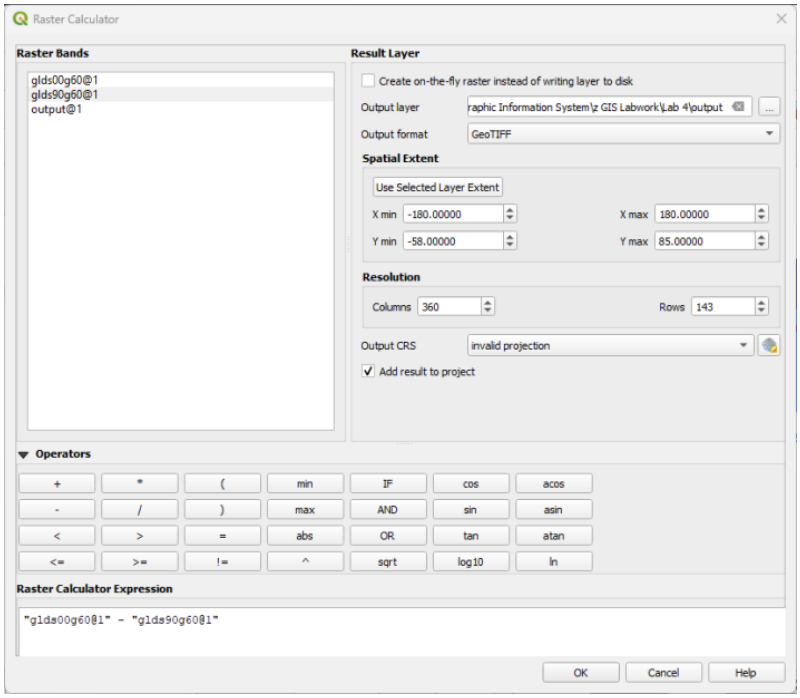
1. Launch the QGIS software on your computer.
2. Ensure that the raster layers are loaded using the steps outlined earlier.
3. Go to the "Raster" menu in the menu bar at the top of the QGIS interface and select "Raster Calculator".
4. Define a mathematical expression that specifies the desired calculation.
5. Specify the name and location for the output raster layer that will be created as a result of the calculation.
6. Once the expression is defined, click the "OK" button to execute the calculation.
7. After the calculation is completed, the output raster layer will be added to the QGIS project. You can visualize the result, adjust its symbology, and perform further analysis as needed.

4.3. Output

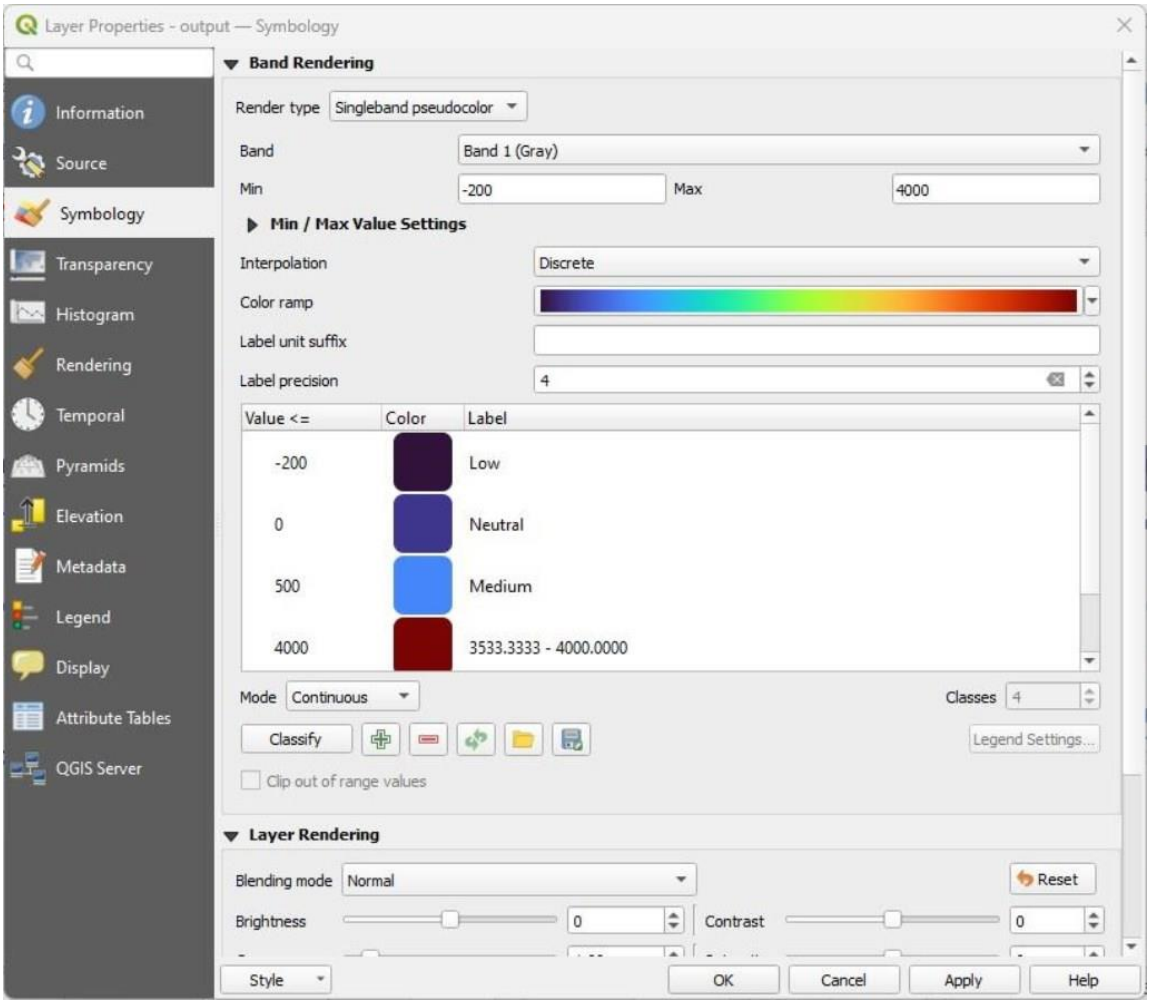
1. Added two raster layers *(.asc files)* representing the world population in 1990 and 2000.



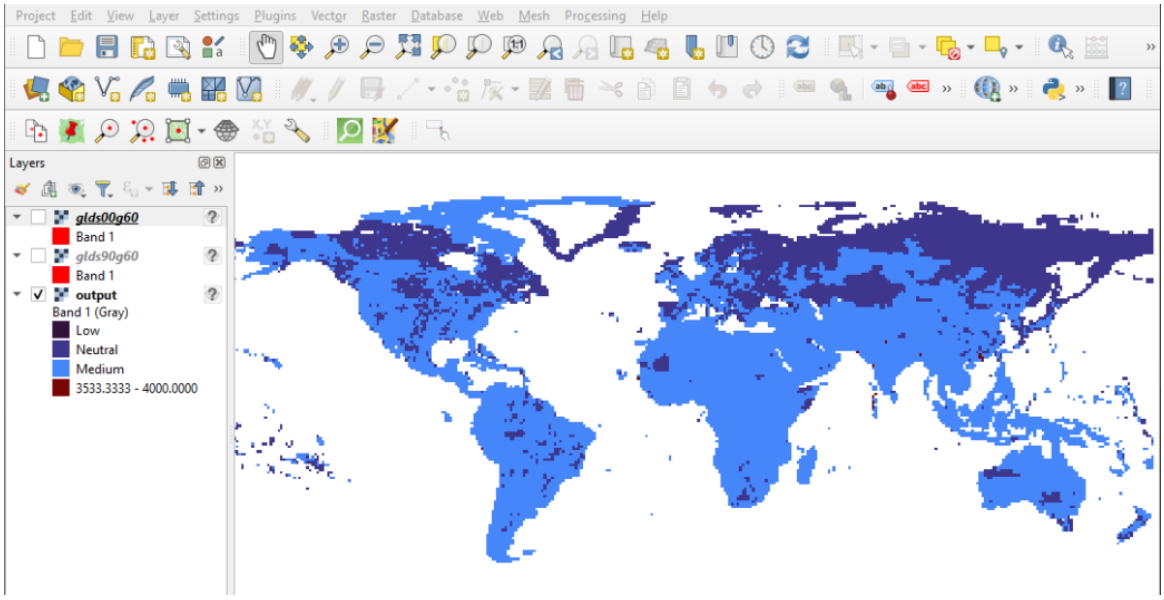
2. Using 'Raster Calculator' to calculate the change in population between 1990 and 2000.


Raster Calculator
Raster Bands
glds00g60@1
glds90g60@1
output@1
Result Layer
Create on-the-fly raster instead of writing layer to disk
Output layer
raphic Information System\z GIS Labwork\Lab 4\output
Output format
GeoTIFF
Spatial Extent
Use Selected Layer Extent
X min -180.00000
X max 180.00000
Y min -58.00000
Y max 85.00000
Resolution
Columns 360
Rows 143
Output CRS
invalid projection
Add result to project
Operators
+ * (min IF cos acos
- /) max AND sin asin
< > = abs OR tan atan
<= >= != ^ sqrt log10 ln
Raster Calculator Expression
"glds00g60@1" - "glds90g60@1"
OK
Cancel
Help

3. Setting/formatting properties of the resultant layer representing change in population.



4. Resultant Output:



Lab 5: Importing Spreadsheets or CSV files

5.1. Objectives

- Import and work with CSV files and other tabular data in a GIS project.

5.2. Theory

CSV File

A Comma Separated Values (CSV) file is a plain text file that stores data by delimiting data entries with commas. It is used to store tabular data, where each line represents a row, and each value within a row is separated by a comma. CSV files are often used when data needs to be compatible with different programs.

CSV file is commonly used for storing and exchanging data between different software applications, as it is simple and widely supported. CSV files are often used for tasks such as data import/export, data manipulation, and data analysis.

Delimited Text Layer

A delimited text layer refers to a vector layer created from tabular data stored in a delimited text file, such as a CSV file. This type of layer allows us to visualize and analyze point, line, or polygon features based on the geographic coordinates and attributes provided in the text file. Delimited text layers are useful for importing and displaying non-spatial data in a GIS environment.

In delimited text layer, values are separated by a delimiter such as a comma, tab, semicolon, or space. This text file could be in CSV format or any other delimited format.

Steps to Use Delimited Text Layer

1. In QGIS, go to the "Layer" menu in the menu bar.
2. Select "Add Layer" → Add Delimited Text Layer.
3. Browse to the location of your delimited text file.
4. QGIS will automatically detect the delimiter used in the text file. You may need to adjust the settings if necessary, such as choosing the correct coordinate reference system and specifying which columns contain the latitude and longitude values.
5. Once you have specified the parameters, click "Add" to create the delimited text layer in the QGIS project.
6. The delimited text layer will be added to the Layers Panel.

Plugins

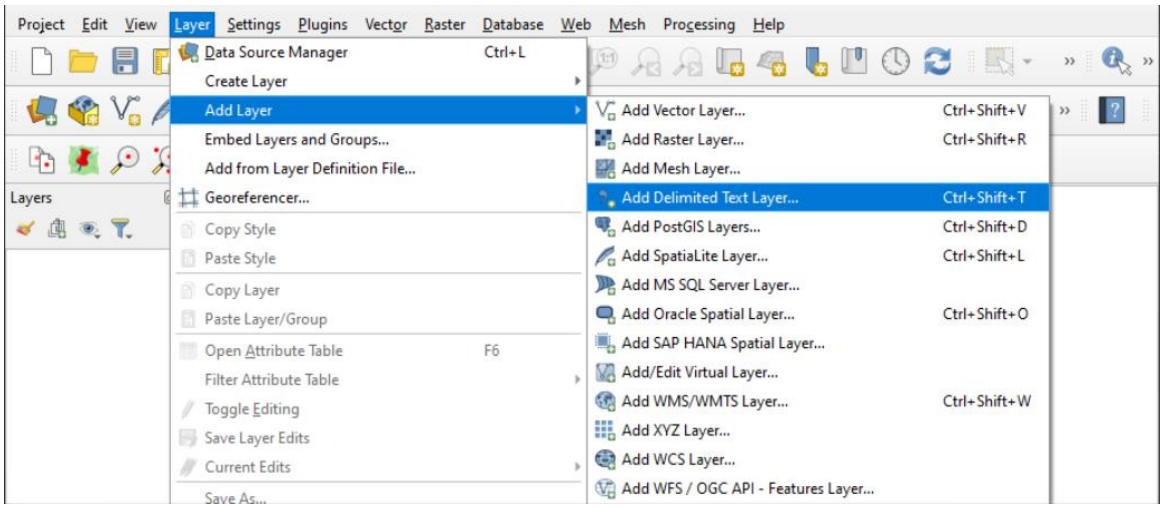
Plugins are additional tools or functionalities that extend the capabilities of the software beyond its core features. Plugins are developed by independent organizations and developers. The QGIS organization does not take any responsibility for them.

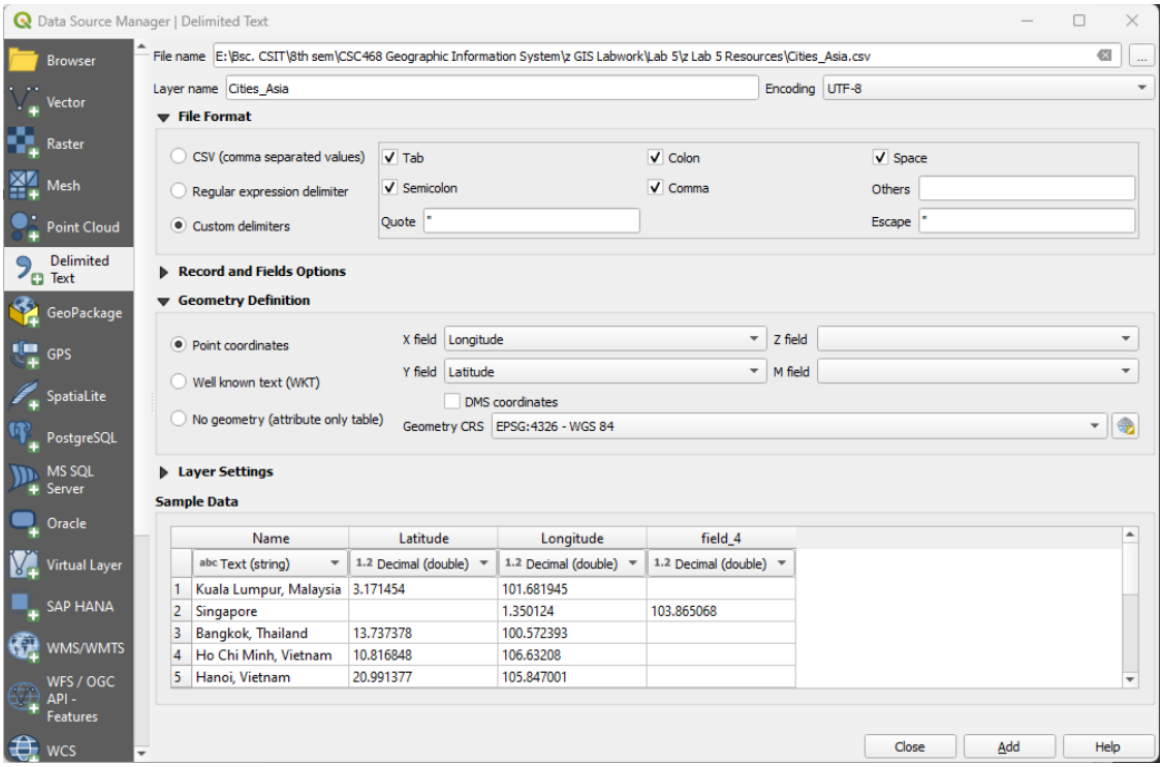
Steps to Use Plugins

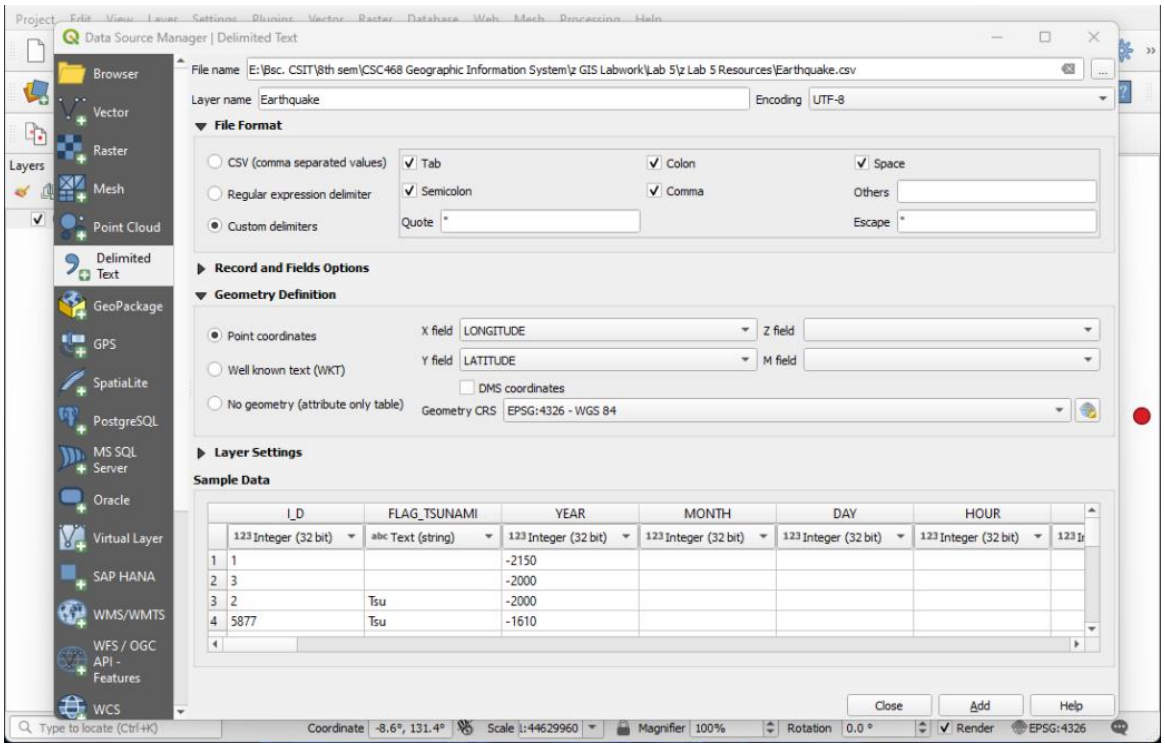
1. Go to the "Plugins" menu in QGIS.
2. Browse through the list of available plugins.
3. Search for the plugin you want to install and press "Install".

5.3. Output

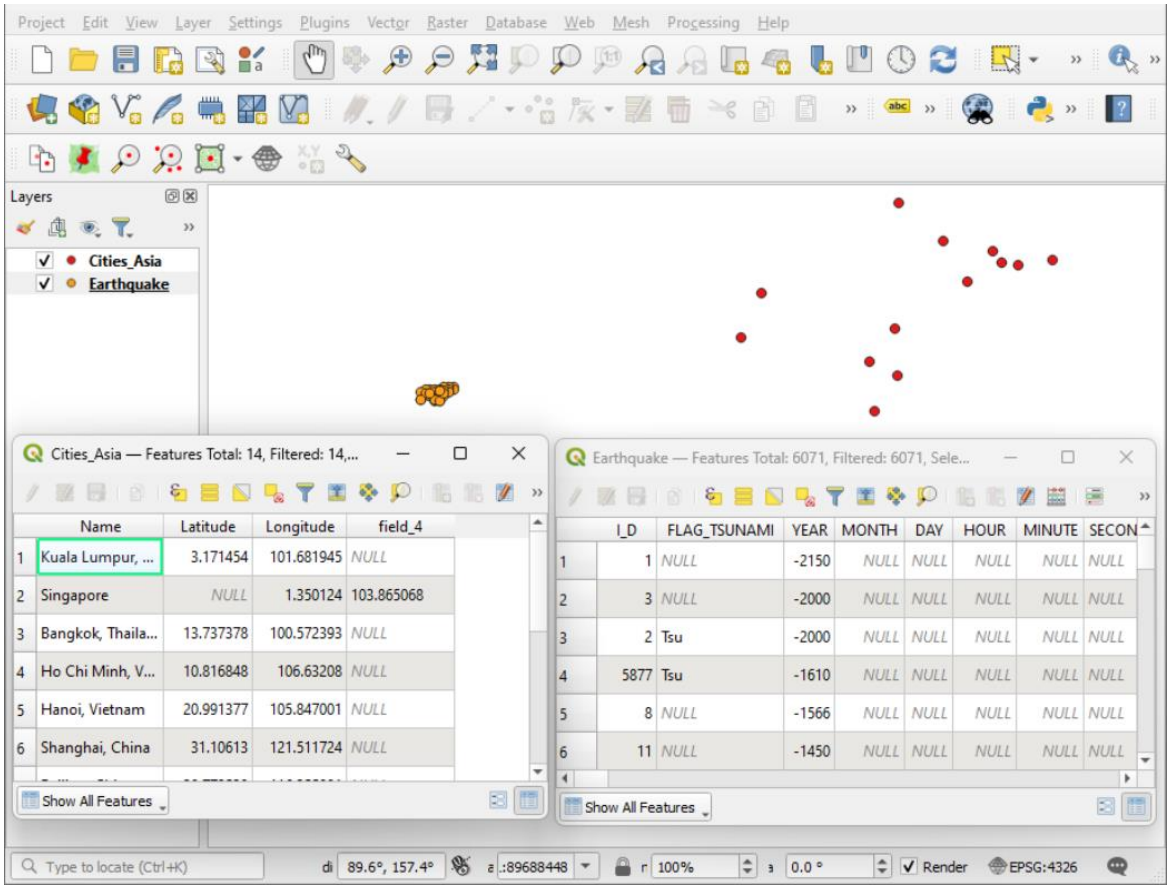
1. Add required delimited text layer *(Cities_Asia.csv & Earthquake.csv).*



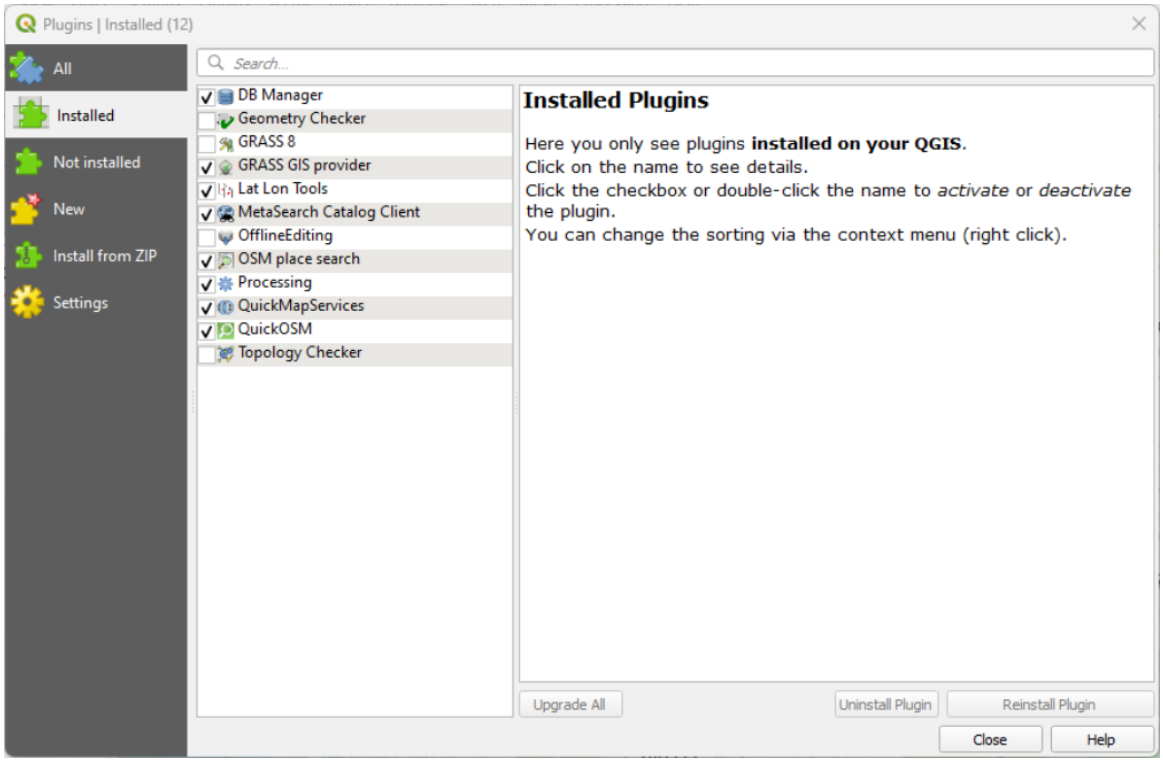




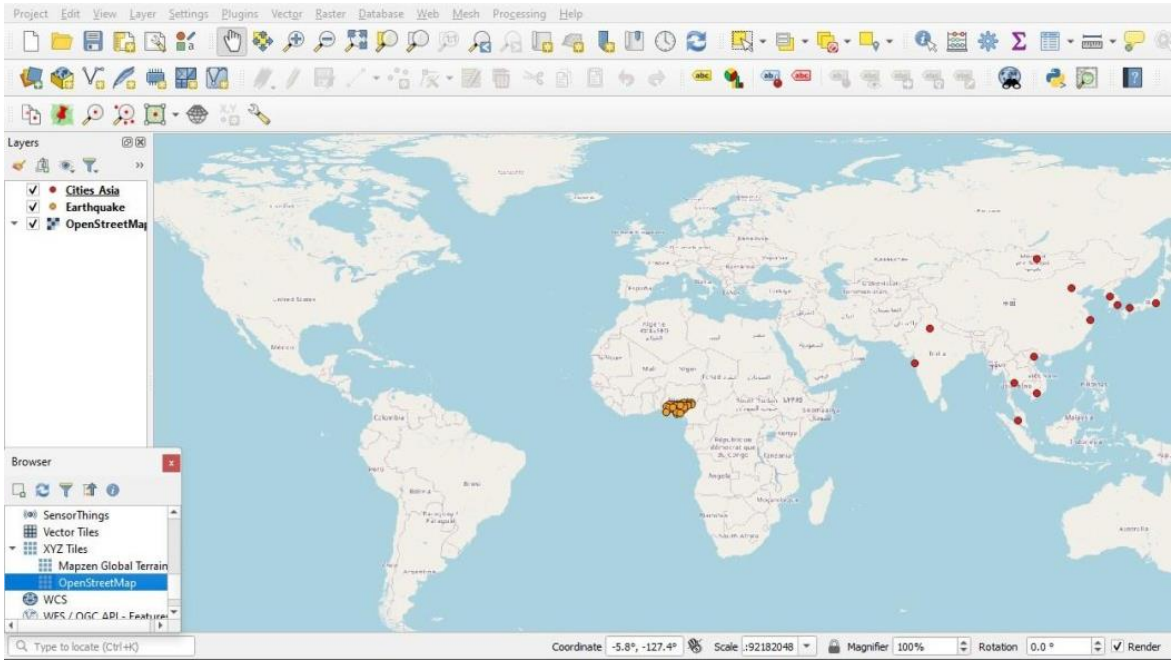
2. Delimited text layers with their attribute table.



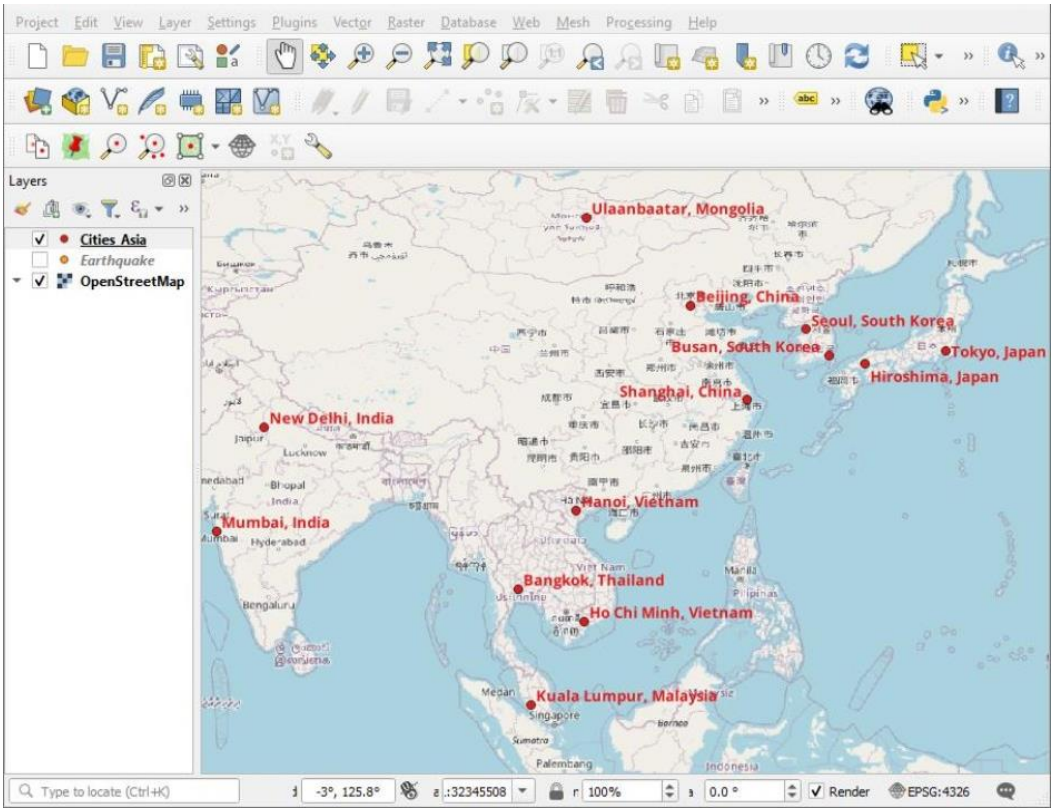
3. Install required plugin for OMS.



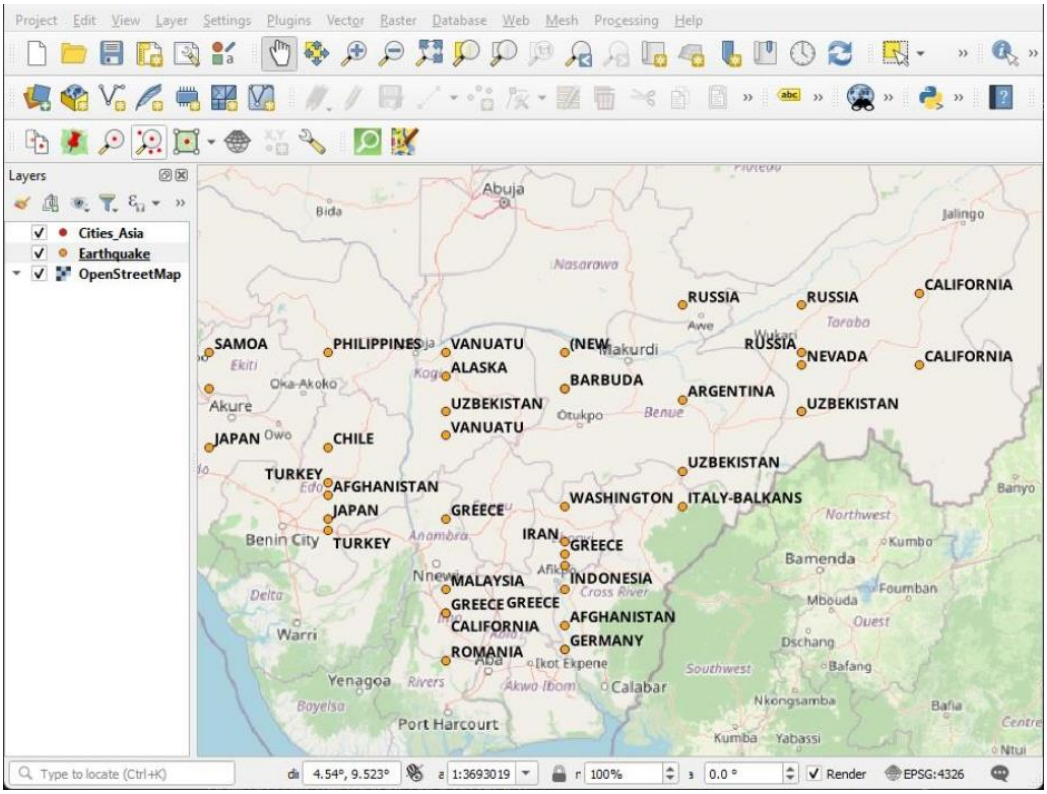
4. Added OpenStreetMap (OSM) data using XYZ Tiles.



5. Showing city points



6. Showing earthquake points



Lab 6: Creating Map

6.1. Objectives

- Learn how to create map compositions using the Print Layout functionality.
- Add and arrange map elements, then export the final layout as a PDF or image file.

6.2. Theory

Print Layout

→ The Print Layout functionality in QGIS allows users to create professional-quality map compositions for printing or exporting.

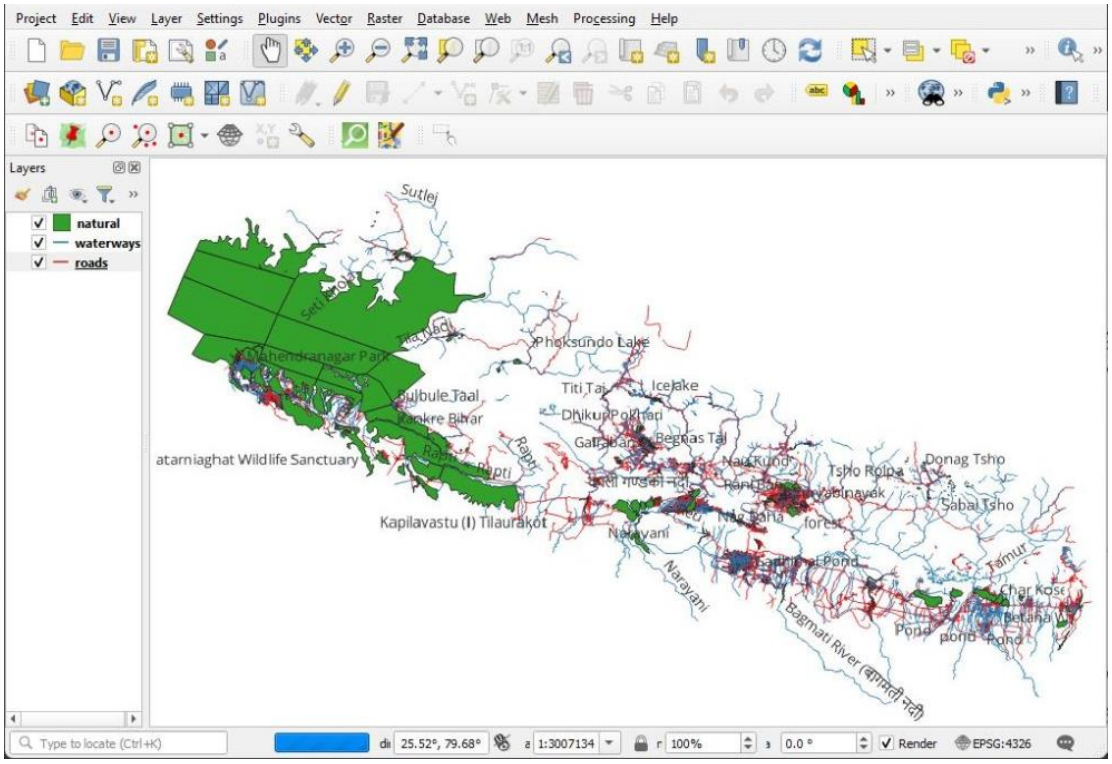
→ It provides a versatile environment for arranging map elements such as maps, legends, scale bars, north arrows, and text labels into a single document.

Steps to Use Print Layouts in QGIS

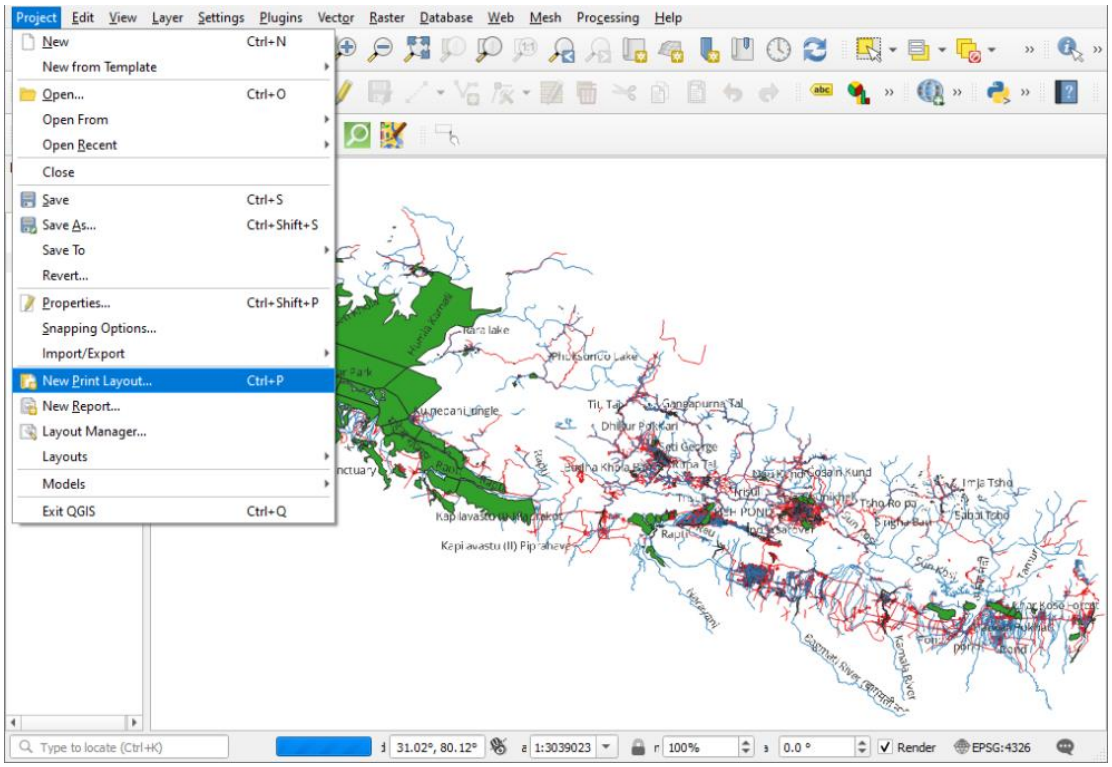
1. Go to the "Project" menu in the menu bar and select "New Print Layout" or click the "New Print Layout" button on the toolbar. This opens the Print Layout Manager.
2. To add a map to the layout, click the "Add Map" button in the toolbar or drag the map item from the Layout toolbox onto the canvas. Resize and reposition the map as desired.
3. Use the Layout toolbox to add additional map elements such as legends, scale bars, labels, and images. Drag these items onto the canvas and customize their properties using the Item Properties panel.
4. Arrange the map elements on the canvas and adjust their styles.
5. Once the layout is finalized, go to the "Layout" menu and select "Export as PDF" or "Export as Image" to save the layout as a PDF file or image file.

6.3. Output

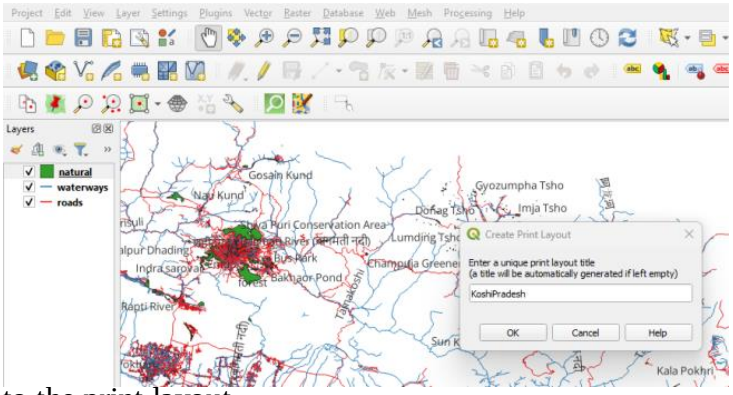
1. Added three vector layers: *natural.shp*, *waterways.shp* and *roads.shp*.



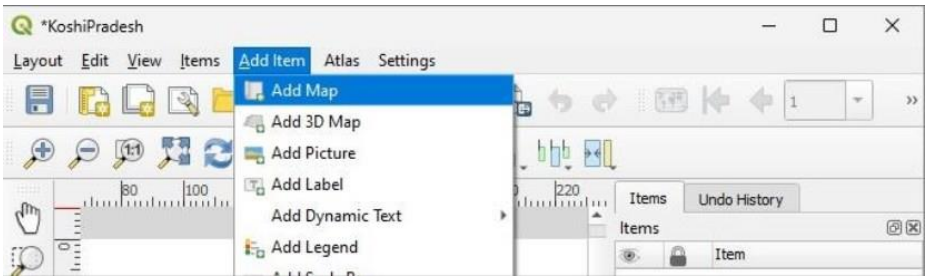
2. Creating new print layout.



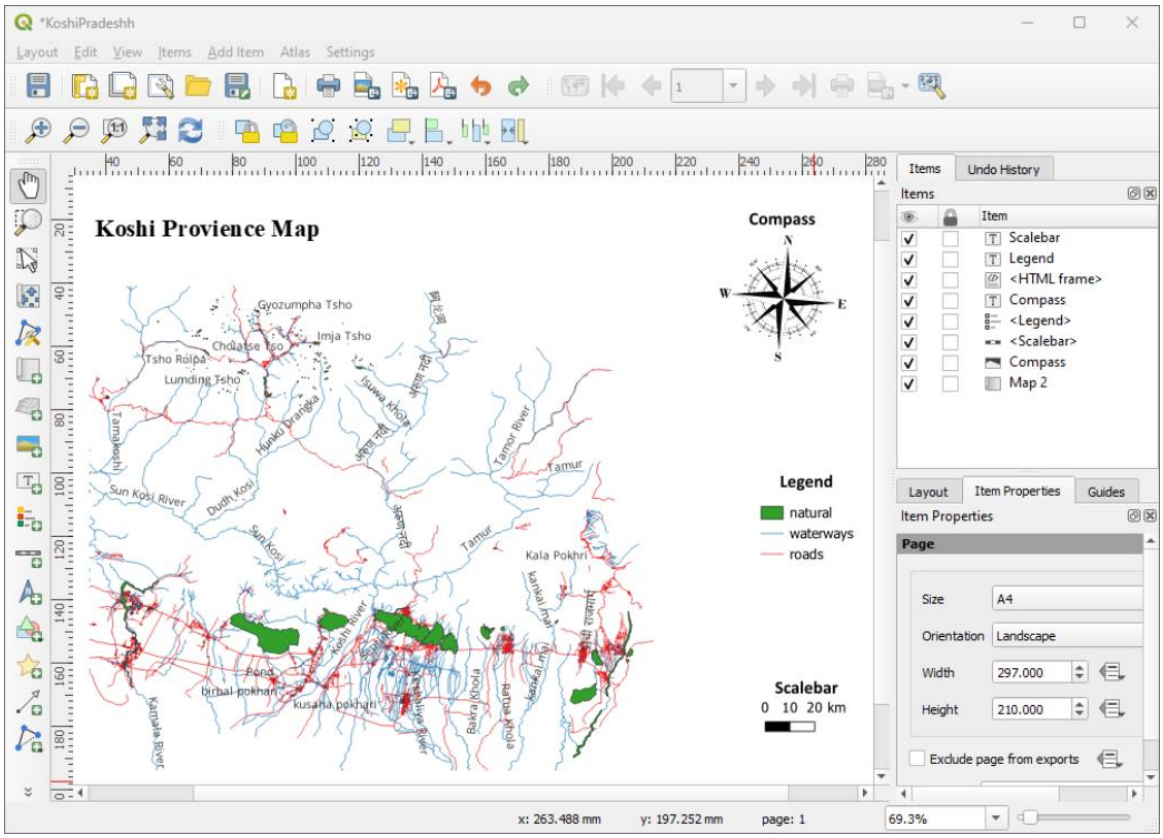
3. .



4. Adding map to the print layout.



5. Map of Koshi Province with appropriate map decorations and layout items.



Lab 7: Projection

7.1. Objectives

- Understand the importance of projections in GIS.
- Learn how to transform geographic data from one Coordinate Reference System (CRS) to another in QGIS.

7.2. Theory

Projections

→ Projections refer to the process of transforming geographic data from one Coordinate Reference System (CRS) to another.

→ It is important because different GIS datasets may be in different CRSs, and when overlaying or analyzing them, they need to be in the same CRS to ensure accurate results.

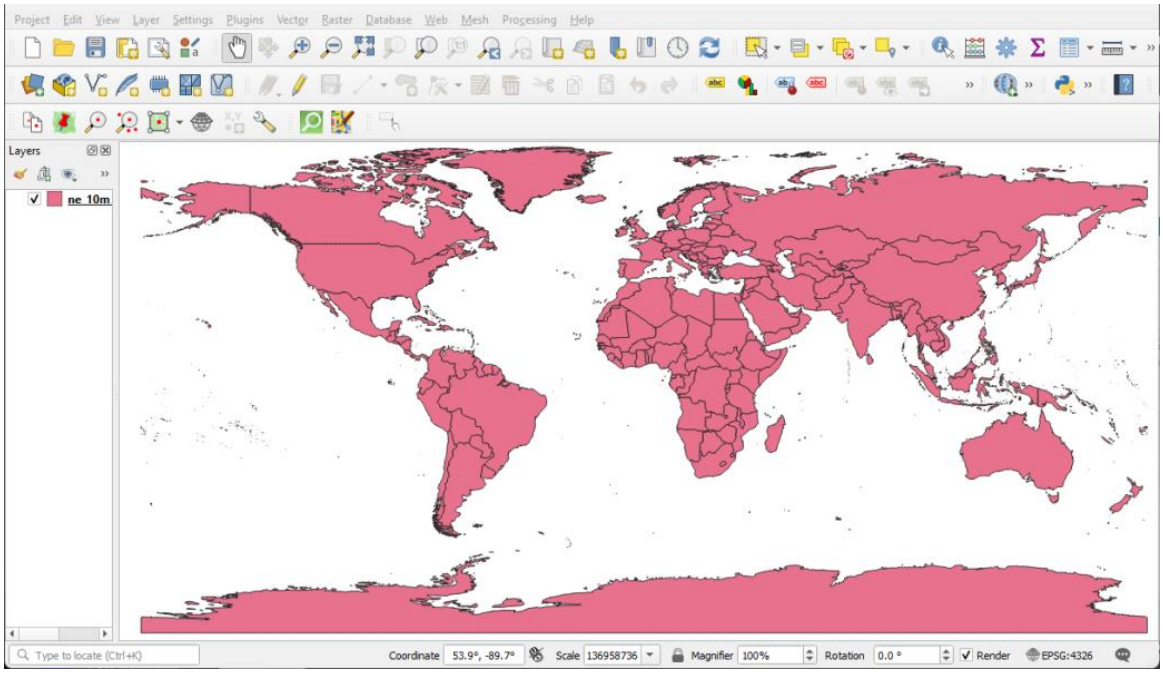
→ There are various types of projections, each with different properties and distortions. QGIS supports multiple projections, allowing users to work with spatial data in different coordinate systems based on their needs.

Steps to Project Data in QGIS:

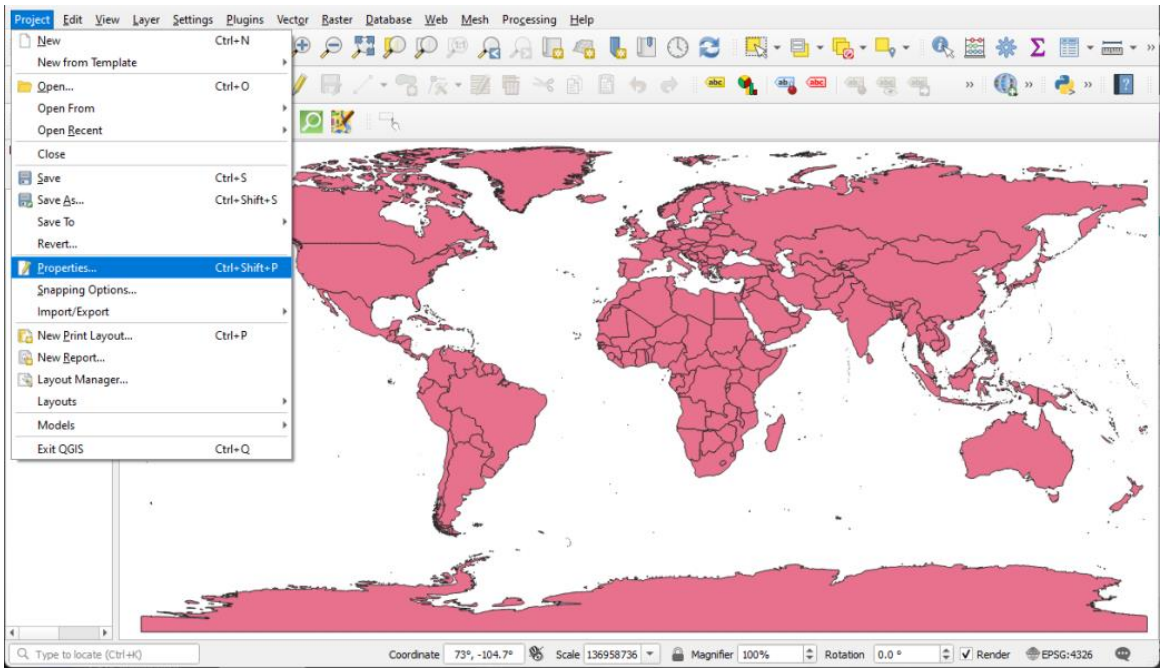
1. Launch the QGIS application on your computer.
2. Add the layers you want to project into QGIS.
3. Go to the "Project" menu in the menu bar and select "Properties". Here, you can see the CRS of the layer.
4. Set the CRS you want to project to.
5. Apply the changes and save the project.

7.3. Output

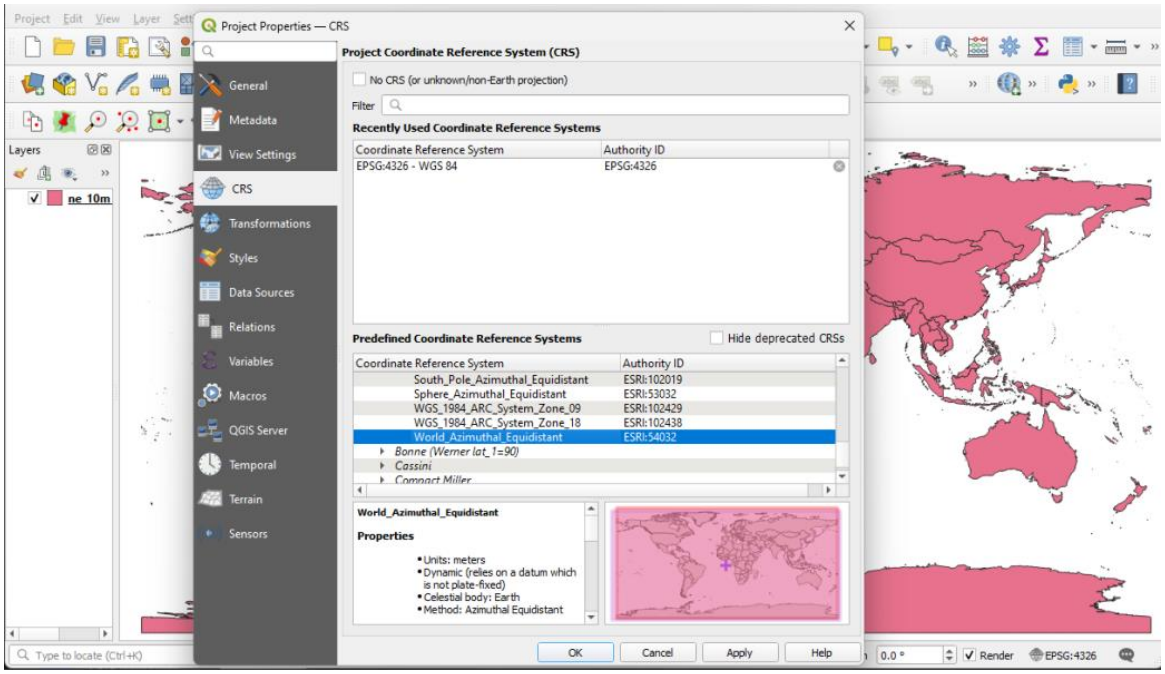
1. Added a vector layer *ne_10m_admin_0_countries.shp* file; Before projection



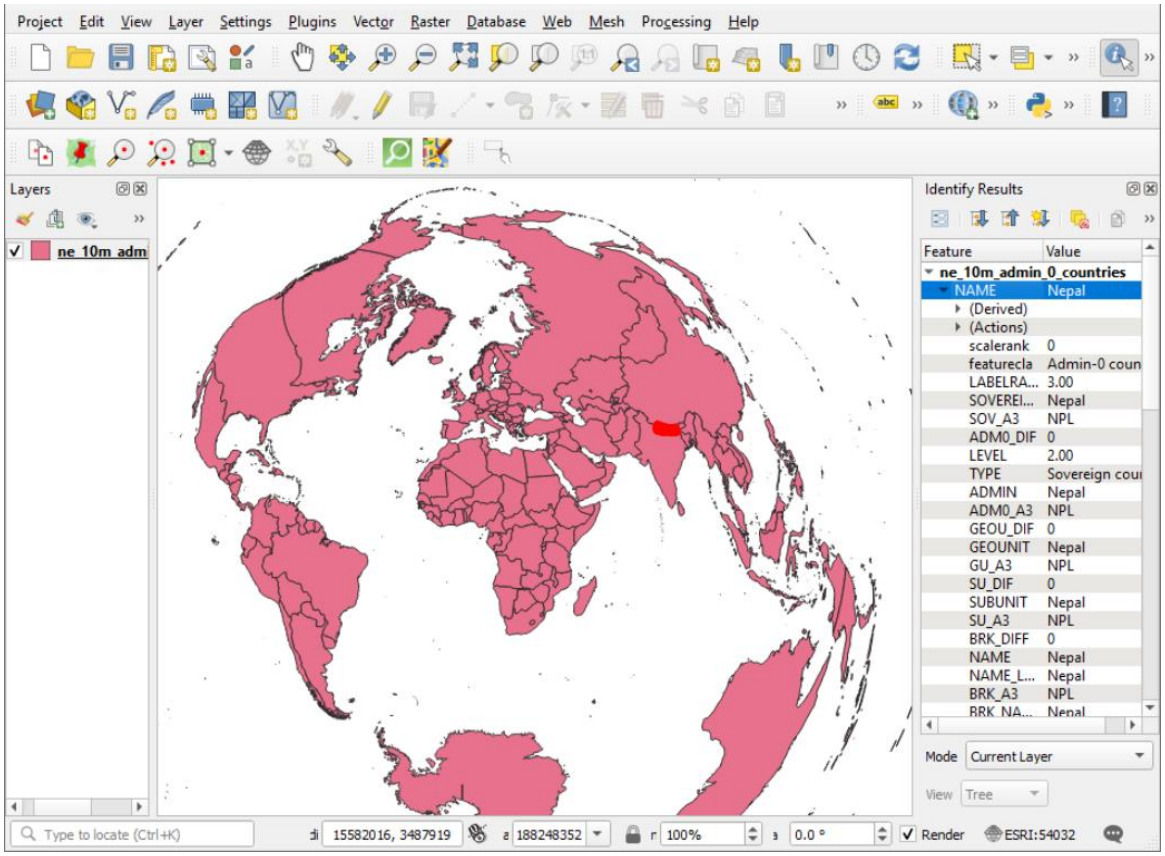
2.



3. Selecting appropriate projection from CRS.



4. Resultant output after Projection:



Lab 8: Nearest neighbor Analysis

8.1. Objectives

- Learn about Nearest Neighbor Analysis and its application in GIS.
- Understand the steps involved in performing Nearest Neighbor Analysis in QGIS, including loading layers, removing null values, and calculating distances to the nearest hub.

8.2. Theory

Nearest Neighbor Analysis

Nearest Neighbor analysis is a spatial analysis technique used in GIS to identify the closest features to each feature in a dataset. This analysis is particularly useful for understanding spatial patterns, clustering, and relationships within a dataset.

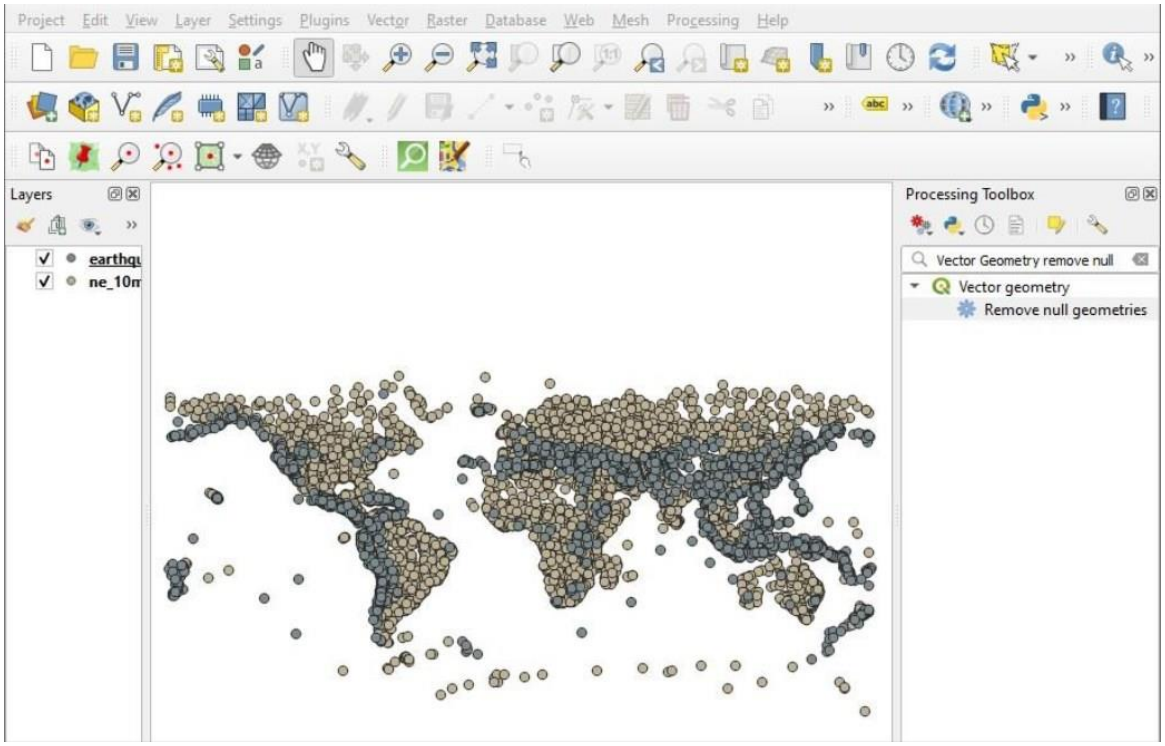
Steps to Perform Nearest Neighbor Analysis:

1. Load the input layer and the reference layer into QGIS.
    i. Add Vector Layer → *(ne_10m_populated_places_simple.shp)*.
    ii. Add Delimited Text Layer by keep the settings as custom → *(earthquakes_2021_11_25_14_31_59_+0530.tsv)*
2. Remove Null Values:
    i. Go to 'Processing' *(in the processing toolbox)* → Toolbox → Vector Geometry → Remove Null Geometry.
    ii. Specify the layer to remove null geometries *(earthquakes_2021_11_25_14_31_59_+0530.tsv)*.
    iii. Give the layer a name.
    iv. Allocate a file location to save the layer.
    v. A non-null geometry layer will be added. You can now remove the original earthquake layer.
3. Perform Distance to Nearest Hub:
    i. Search for "Distance to Nearest Hub" in the processing toolbox.
    ii. Select the source point layer *(eq-non-null geometry)*.
    iii. Select the destination hub *(ne_10m_populated_places_simple.shp)*.
    iv. Select the "Hub layer name attribute" → *abc: name*. (if default value is left then it will display number instead of name.)
    v. Choose the "Measurement unit" → *Kilometers*.
    vi. In hub distance, allocate a file location and name *(NearestHubDistance)* to save the result.
    vii. Click 'Run'.
    viii. A new layer will be added displaying the distance to the nearest hub.

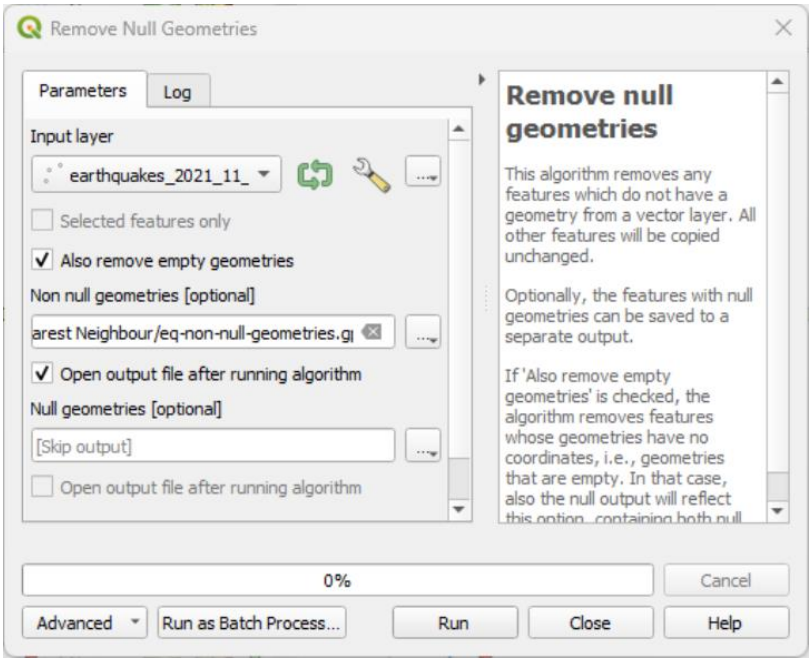
By following these steps, you can perform a Nearest Neighbor analysis using QGIS software to identify spatial relationships within your dataset.

8.3. Output

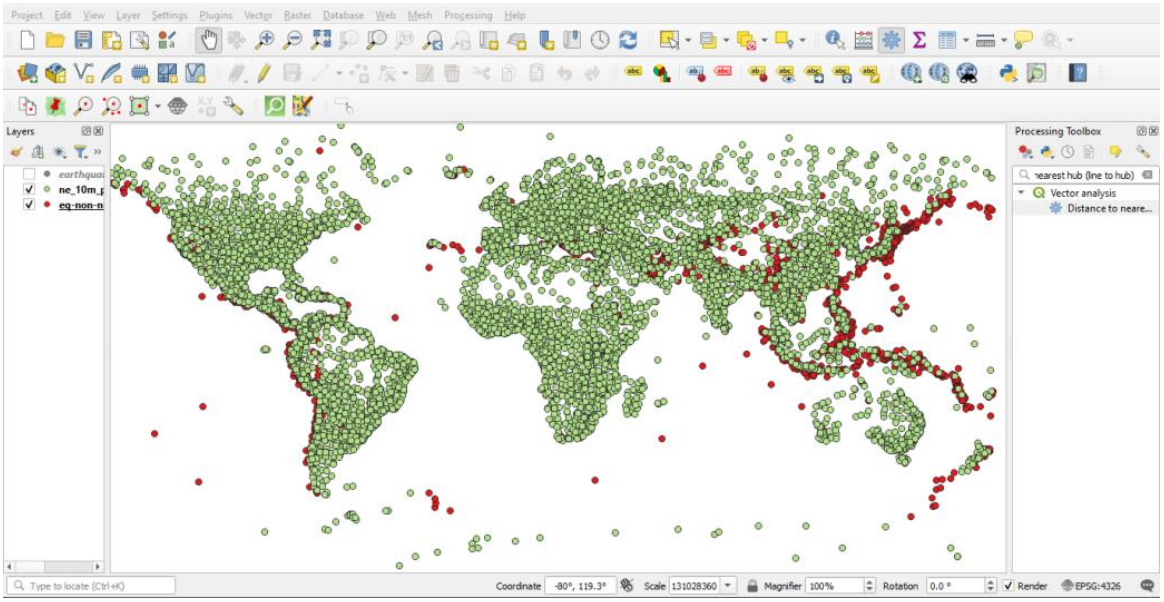
1. Added a vector and a delimited text layer: *ne_10m_populated.shp and earthquakes.tsv*.



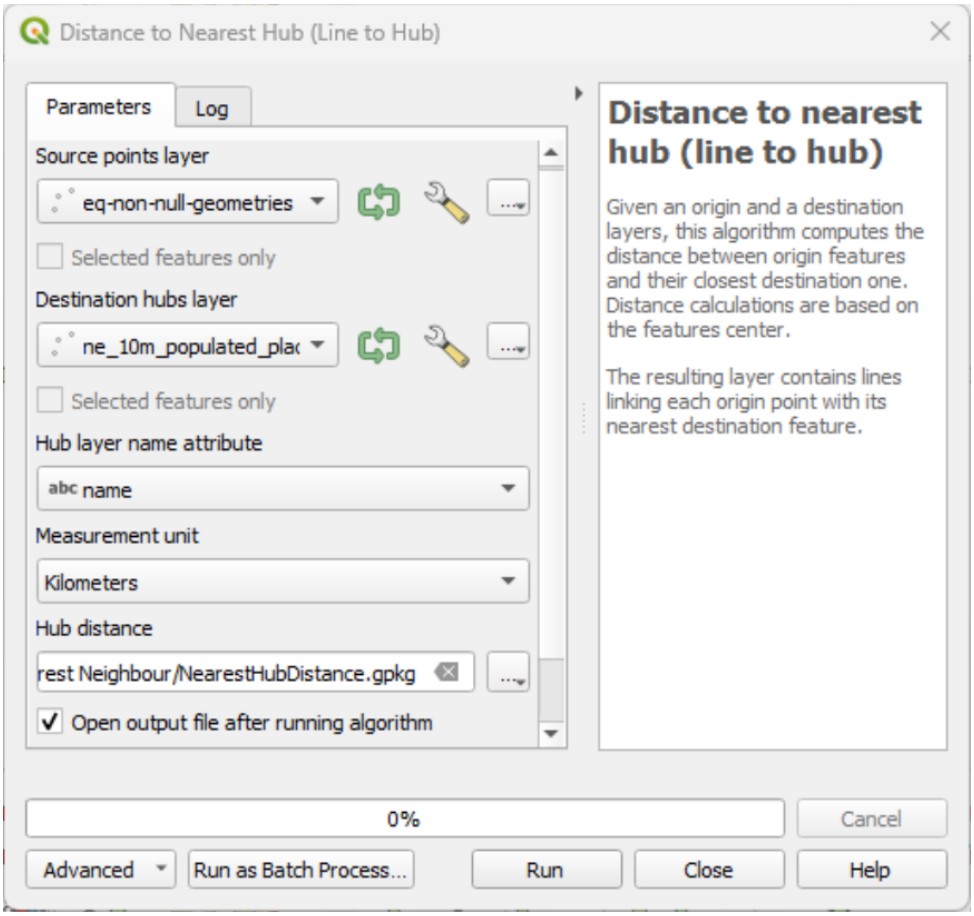
2. Removing the null values.



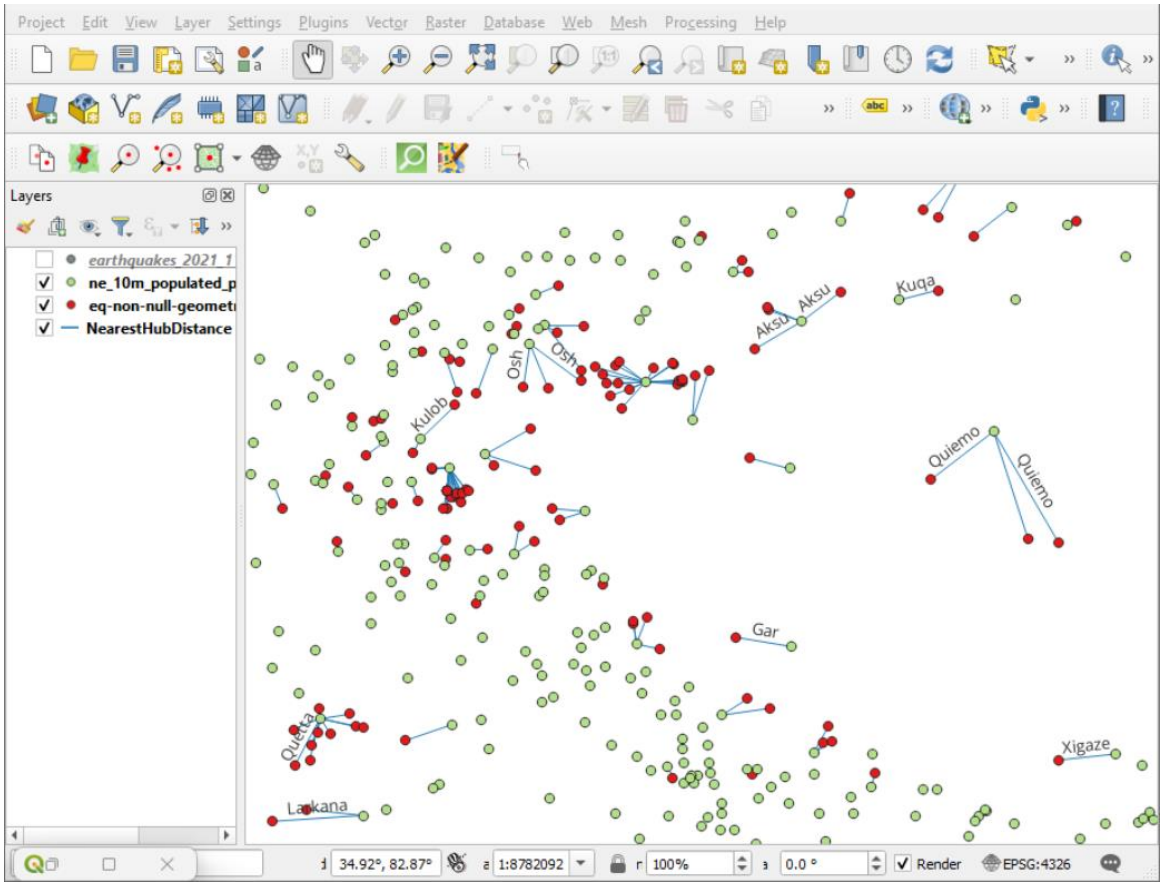
3. Selecting only those layers with non-null data.



4. Calculating distance to nearest hub (line to hub).



5. Resultant Output:



Lab 9: Spatial joins

9.1. Objectives

- Learn how to perform Spatial Join and Point in Polygon Analysis in GIS.
- Understand the steps involved in combining attributes based on spatial relationships and conducting spatial analysis.
- Gain proficiency in loading vector layers, setting parameters, and interpreting analysis results in QGIS.

9.2. Theory

Spatial Join

Spatial joins are used to combine attributes from one layer to another based on their spatial relationship.

Spatial joins are a GIS operation used to combine information from two spatial datasets based on their spatial relationships. In a spatial join, attributes from one dataset are appended to another dataset based on the spatial relationship between their geometries (points, lines, or polygons).

Steps to Perform Spatial Join:

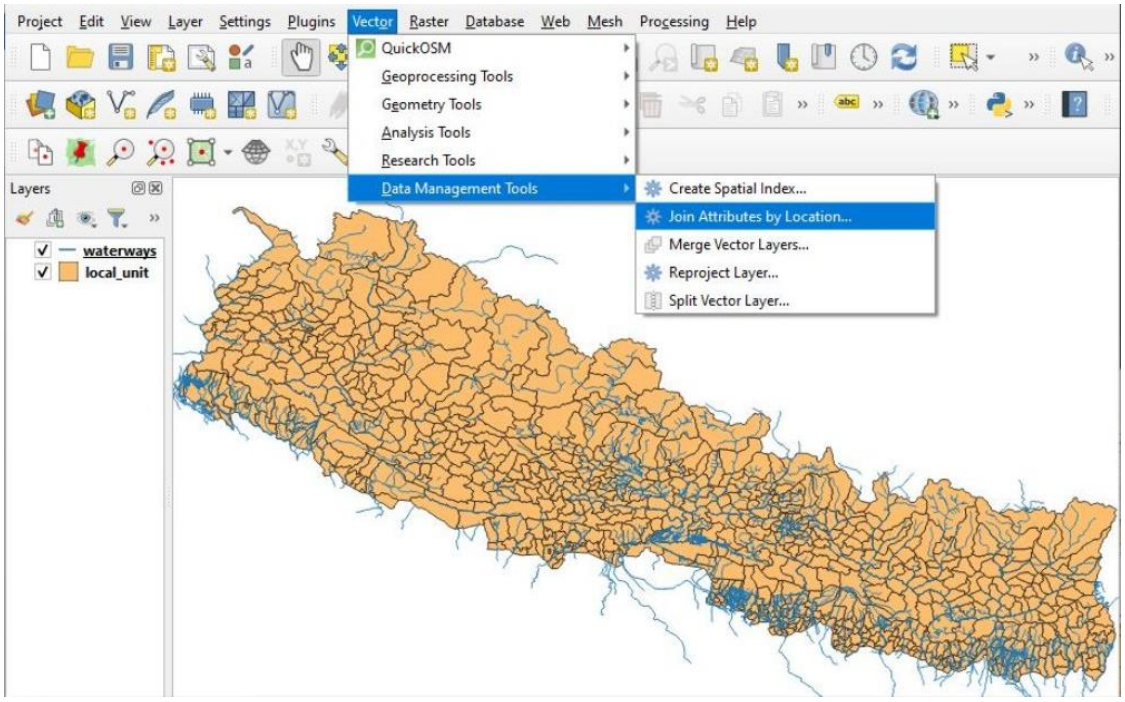
1. Load the vector layers *(local_unit.shp* & *waterways.shp)* in your GIS software.
2. Go to the Processing Toolbox, search for "Join Attributes by Location" and click it. OR, navigate to 'Vector' in the menu bar → Data Management Tools → Join Attributes by Location.
3. Set the following parameters:
    i. Join features in: *local_unit*
    ii. Features to add: intersect
    iii. By comparing to: *waterways*
    iv. Fields to add: all
    v. Join type: one to one *(type of spatial relationship)*
    vi. Provide a name *(joined)* and location for the joined layer to save.
    vii. Click 'Run'.
4. The output will be a new layer containing attributes from both layers based on the specified spatial relationship.
5. Display only the joined layer.
6. Right-click on the joined layer and select `Show Labels`.
7. The names of rivers will be displayed.

Steps to Perform Point in Polygon Analysis:

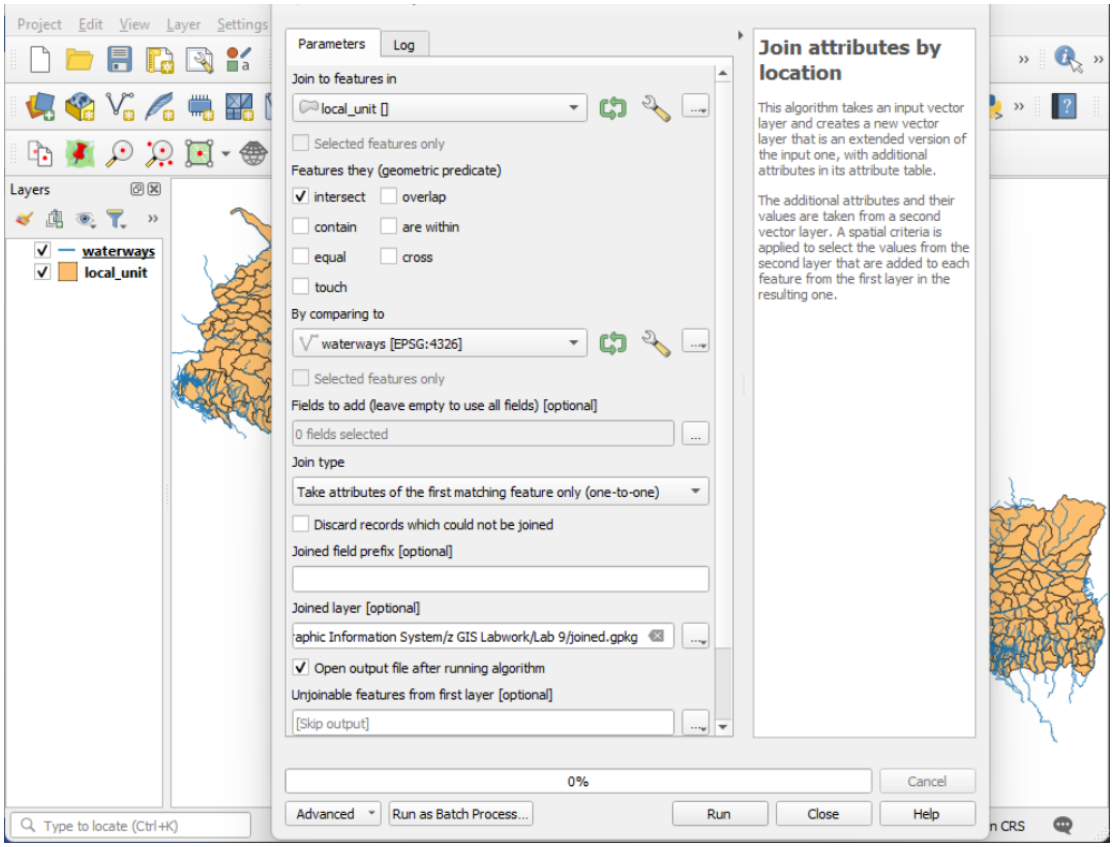
1. Load the required vector layer *(ne_10m_admin_0_countries.shp)* and delimited text layer *(earthquakes_2021_11_25_14_31_59_+0530.tsv)*.
2. Go to the Processing Toolbox, search for "Count Points in Polygon" and click it. OR, navigate to 'Vector' in the menu bar → Analysis Tools → Count Points in Polygon.
3. Set the required parameters:
    i. Polygons: *ne_10m_admin_0_countries*
    ii. Points: *earthquakes_2021_11_25_14_31_59_+0530*
    iii. Provide a name *(countpoints)* and location for the output layer to save.
    iv. Click 'Run'.
4. A new count layer will be created.
5. To locate Nepal's data, zoom in to Nepal and select it.

9.3. Output

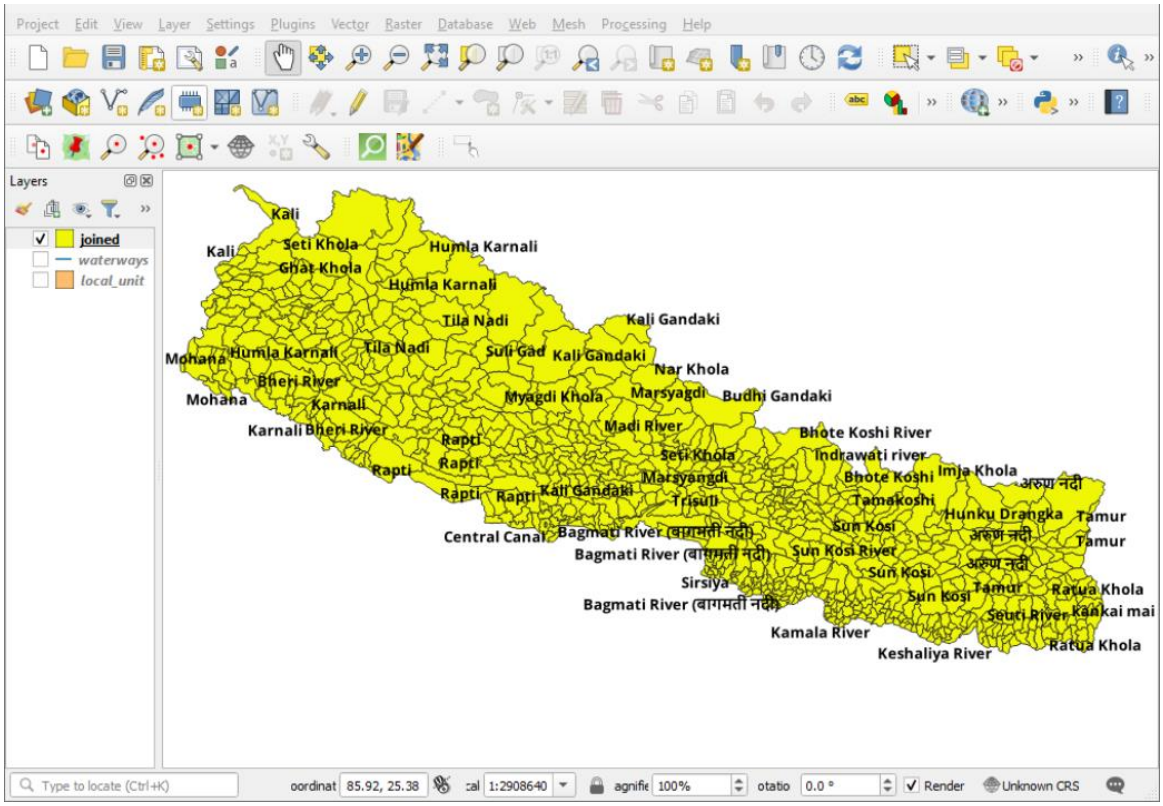
1. Added two vector layers: *local_unit.shp* and *waterways.shp*. (Before joining attributes)



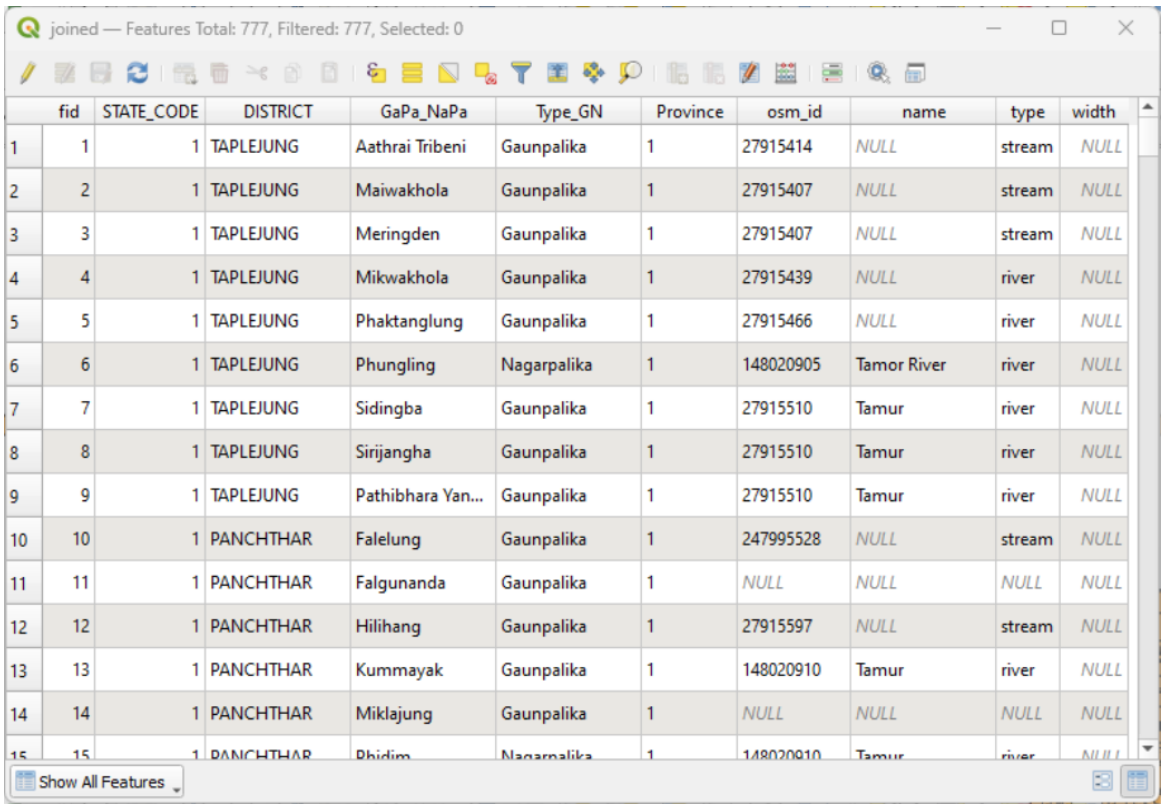
2. Joining Attributes by Location.



3. Resultant Output:



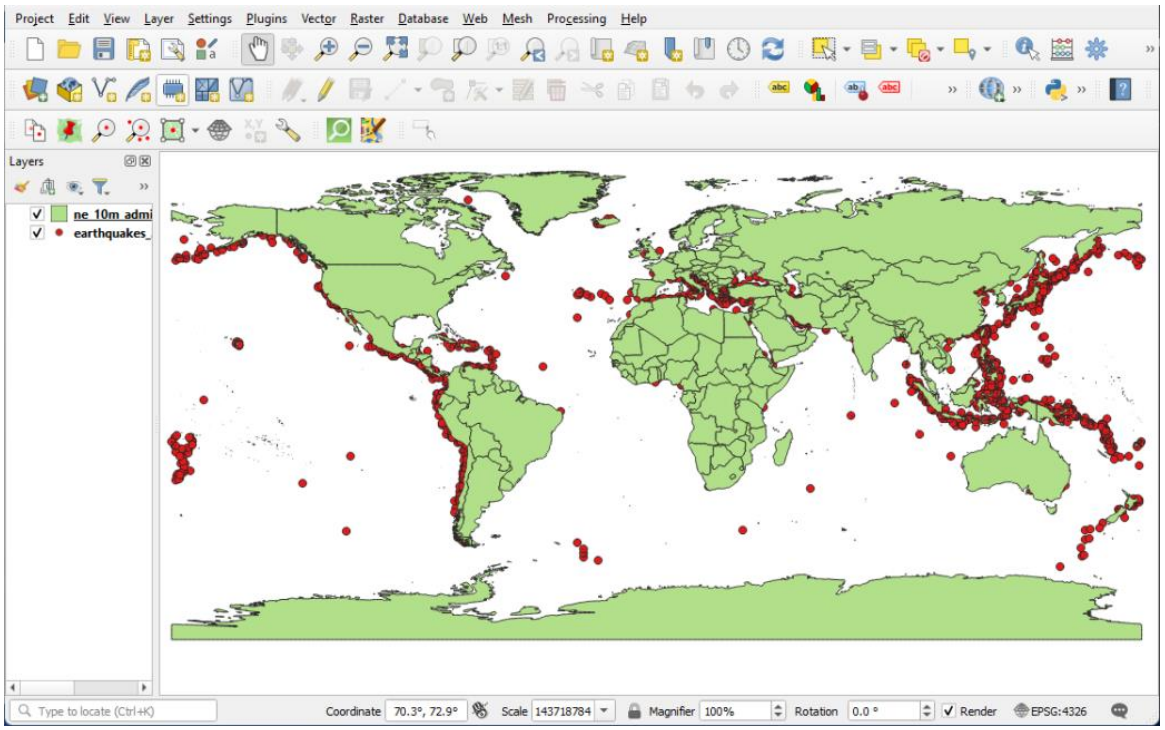
4. Attribute table of joined layer.



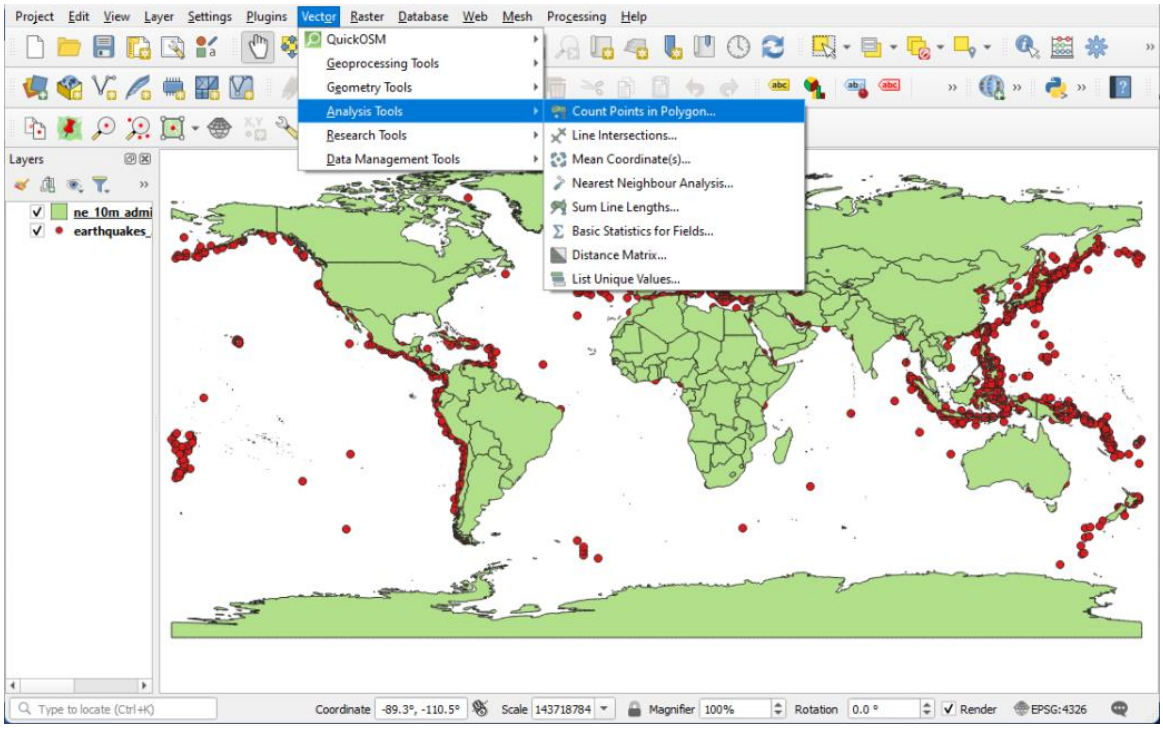
	fid	STATE_CODE	DISTRICT	GaPa_NaPa	Type_GN	Province	osm_id	name	type	width
1	1	1	TAPLEJUNG	Aathrai Tribeni	Gaunpalika	1	27915414	NULL	stream	NULL
2	2	1	TAPLEJUNG	Maiwakhola	Gaunpalika	1	27915407	NULL	stream	NULL
3	3	1	TAPLEJUNG	Meringden	Gaunpalika	1	27915407	NULL	stream	NULL
4	4	1	TAPLEJUNG	Mikwakhola	Gaunpalika	1	27915439	NULL	river	NULL
5	5	1	TAPLEJUNG	Phaktanglung	Gaunpalika	1	27915466	NULL	river	NULL
6	6	1	TAPLEJUNG	Phungling	Nagarpalika	1	148020905	Tamor River	river	NULL
7	7	1	TAPLEJUNG	Sidingba	Gaunpalika	1	27915510	Tamur	river	NULL
8	8	1	TAPLEJUNG	Sirijangha	Gaunpalika	1	27915510	Tamur	river	NULL
9	9	1	TAPLEJUNG	Pathibhara Yan...	Gaunpalika	1	27915510	Tamur	river	NULL
10	10	1	PANCHTHAR	Falelung	Gaunpalika	1	247995528	NULL	stream	NULL
11	11	1	PANCHTHAR	Falgunanda	Gaunpalika	1	NULL	NULL	NULL	NULL
12	12	1	PANCHTHAR	Hilihang	Gaunpalika	1	27915597	NULL	stream	NULL
13	13	1	PANCHTHAR	Kummayak	Gaunpalika	1	148020910	Tamur	river	NULL
14	14	1	PANCHTHAR	Miklajung	Gaunpalika	1	NULL	NULL	NULL	NULL
15	15	1	PANCHTHAR	Phidim	Nagarpalika	1	148020910	Tamur	river	NULL

9.4. Output

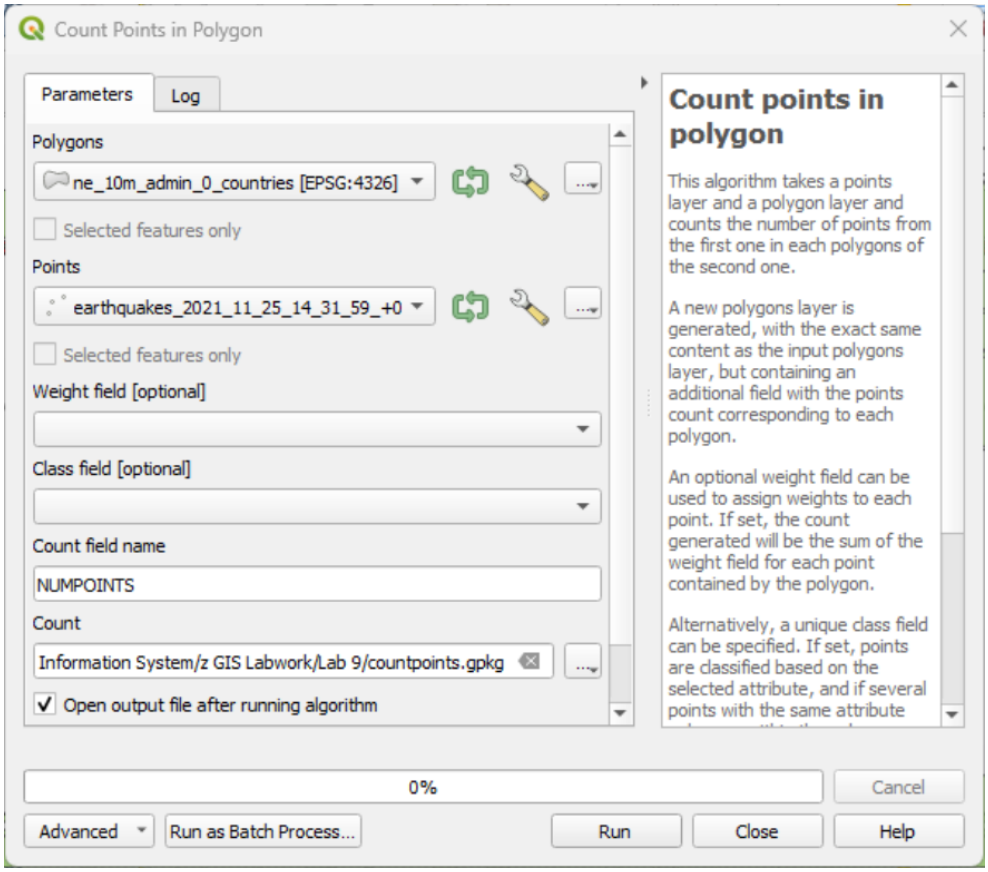
1. Loaded a vector and delimited text layer *ne_10m_admin_countries.shp earthquake.tsv*.



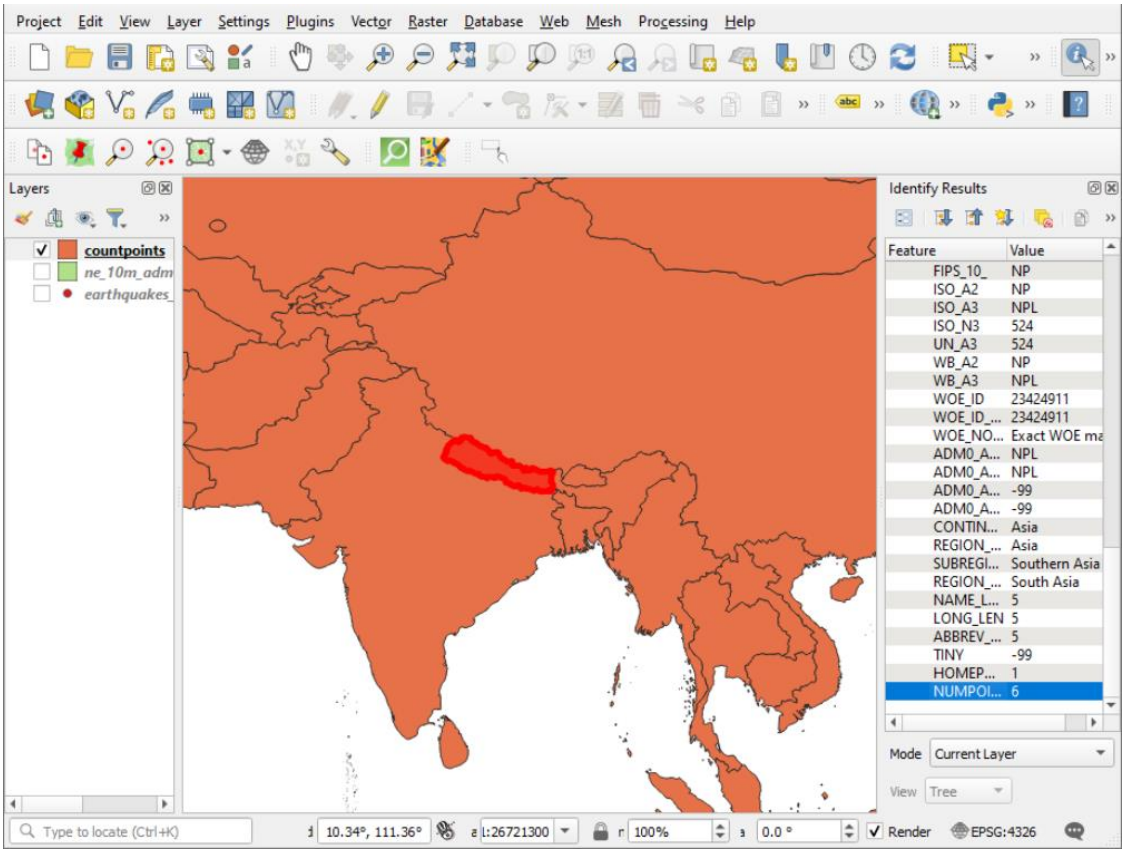
2.



3. Count the number of points in polygon.



4. Resultant Output: Showing number of points in Nepal.



Lab 10: Python in QGIS (PyQGIS)

10.1. Objectives

- I

10.2. Theory

Python in QGIS (PyQGIS)

→ PyQGIS refers to the use of the Python programming language to extend the functionality of QGIS.
→ Python scripting allows users to automate tasks, customize workflows, and perform advanced spatial analysis within the QGIS environment.

Spatial Data:

→ It refers to data that is associated with specific geographic locations or positions on the Earth's surface.
→ It includes information about the shape, size, location, and attributes of spatial features such as points, lines, and polygons.

Data Processing:

→ It involves the manipulation, transformation, and analysis of spatial data to extract meaningful information.

Python Scripting:

→ It involves writing and executing Python code to automate tasks, perform calculations, and manipulate data within the QGIS environment.
→ Open QGIS and go to "Plugins" → "Python Console" to access the Python scripting environment.
→ By utilizing Python scripting in QGIS, users can enhance their workflows and perform complex spatial analyses efficiently.

Python Console:

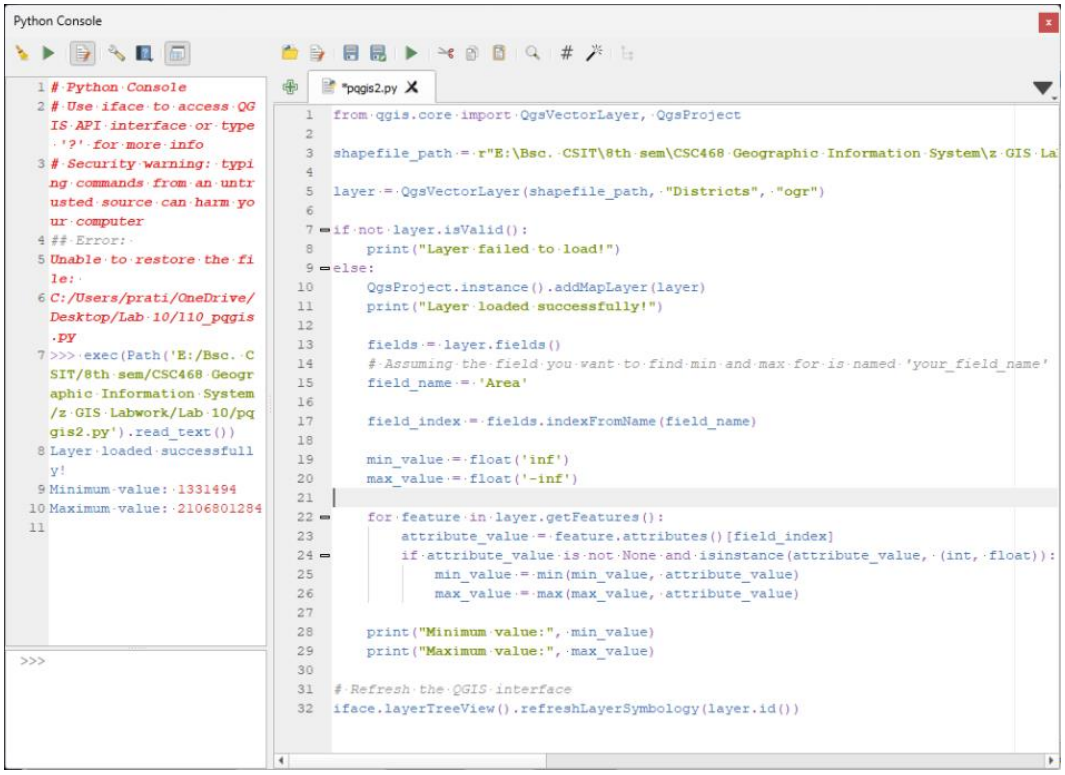
→ The QGIS Python Console is an interactive shell for executing Python commands.
→ It also has a Python file editor that allows you to edit and save your Python scripts.
→ Both the console and editor are based on the PyQScintilla2 package.

Find and display the maximum and minimum area using python.

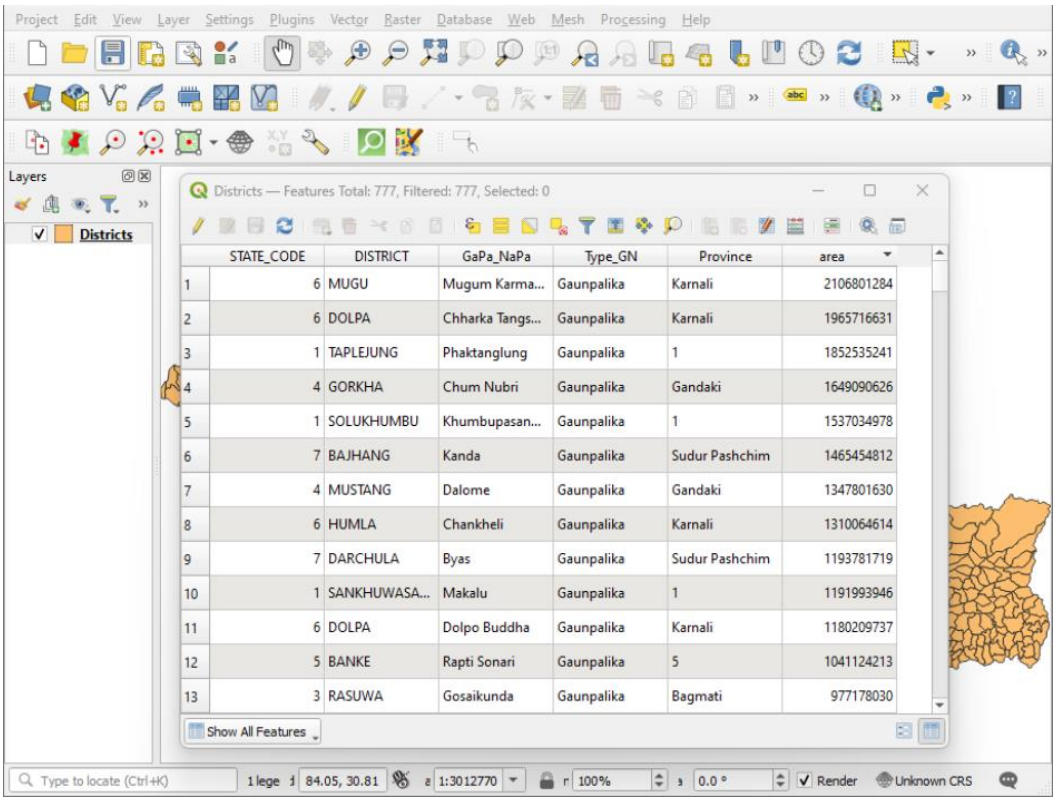
```
# Import necessary modules from PyQGIS
from qgis.core import QgsVectorLayer, QgsProject

# Define the path to your shapefile
shapefile_path =
r"C:\Users\prati\OneDrive\Desktop\shape_files_of_districts_in_nepal.shp"

# Load the shapefile
layer = QgsVectorLayer(shapefile_path, "Layer Name", "ogr")

# Check if the layer was loaded successfully
if not layer.isValid():
    print("Layer failed to load!")
else:
    # Add the layer to the QGIS project
    QgsProject.instance().addMapLayer(layer)
    print("Layer loaded successfully!")

    # Get the fields in the layer
    fields = layer.fields()
    # Assuming the field you want to find min and max for is named 'your_field_name'
    field_name = 'Area'

    # Get index of the field
    field_index = fields.indexFromName(field_name)

    # Initialize variables for min and max values
    min_value = float('inf')
    max_value = float('-inf')

    # Iterate over features to find min and max values
    for feature in layer.getFeatures():
        # Get the attribute value of the field
        attribute_value = feature.attributes()[field_index]
        # Check if the value is numeric
        if attribute_value is not None and isinstance(attribute_value, (int, float)):
            min_value = min(min_value, attribute_value)
            max_value = max(max_value, attribute_value)

    # Print the min and max values
    print("Minimum value:", min_value)
    print("Maximum value:", max_value)

# Refresh the QGIS interface
iface.layerTreeView().refreshLayerSymbology(layer.id())
```

10.3. Output

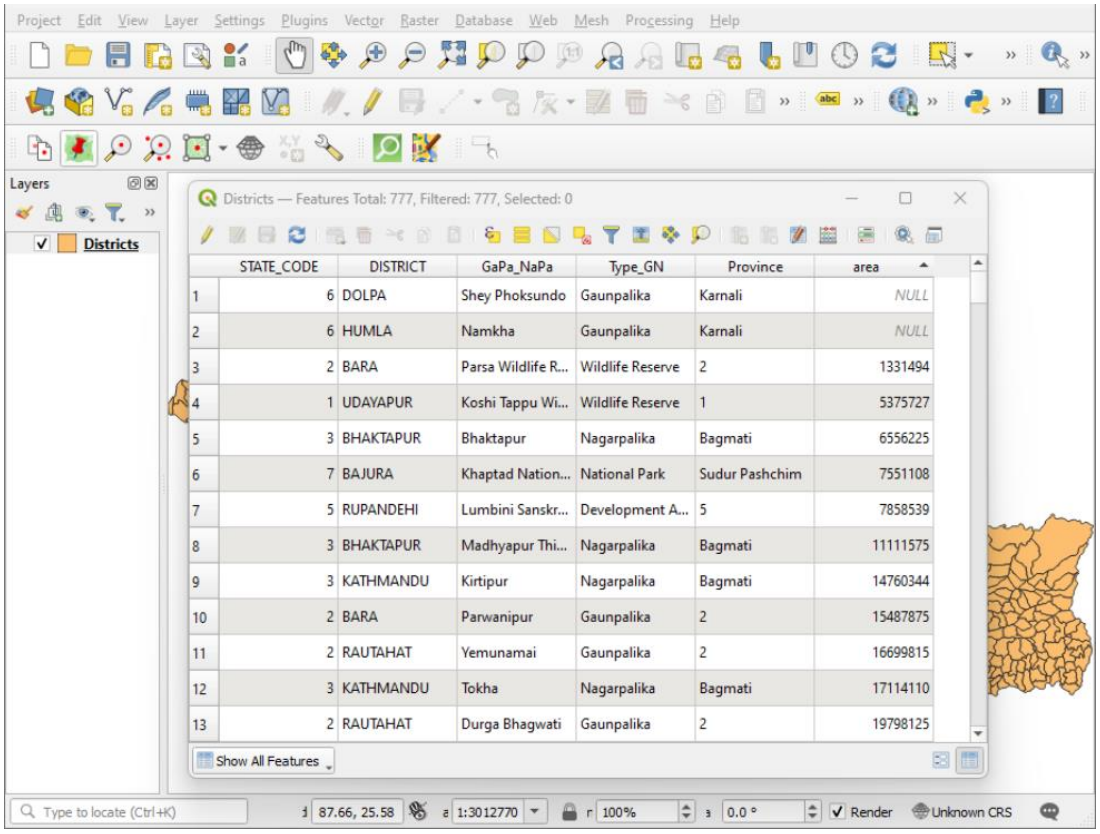
1. Python code and output in Python Console of QGIS.



2. Attribute Table: Displaying area field from maximum to minimum values.



3. Attribute Table: Displaying area field from minimum to maximum values



	STATE_CODE	DISTRICT	GaPa_NaPa	Type_GN	Province	area
1	6	DOLPA	Shey Phoksundo	Gaunpalika	Karnali	NULL
2	6	HUMLA	Namkha	Gaunpalika	Karnali	NULL
3	2	BARA	Parsa Wildlife R...	Wildlife Reserve	2	1331494
4	1	UDAYAPUR	Koshi Tappu Wi...	Wildlife Reserve	1	5375727
5	3	BHAKTAPUR	Bhaktapur	Nagarpalika	Bagmati	6556225
6	7	BAJURA	Khaptad Nation...	National Park	Sudur Pashchim	7551108
7	5	RUPANDEHI	Lumbini Sanskr...	Development A...	5	7858539
8	3	BHAKTAPUR	Madhyapur Thi...	Nagarpalika	Bagmati	11111575
9	3	KATHMANDU	Kirtipur	Nagarpalika	Bagmati	14760344
10	2	BARA	Parwanipur	Gaunpalika	2	15487875
11	2	RAUTAHAT	Yemunamai	Gaunpalika	2	16699815
12	3	KATHMANDU	Tokha	Nagarpalika	Bagmati	17114110
13	2	RAUTAHAT	Durga Bhagwati	Gaunpalika	2	19798125

Lab 11: Sampling raster data using points

11.1. Objectives

- Learn how to sample raster data using points in QGIS.
- Perform zonal statistics analysis to calculate statistics within specified zones.
- Adjust layer properties for zonal statistics visualization, including symbology and labeling.

11.2. Theory

Raster data provides a representation of the world as a regular grid, divided into an array of cells where each cell has an associated value.

Zonal statistics are useful for comparing zones and assessing trends over time across various geographical regions. They provide a convenient way to monitor progress.

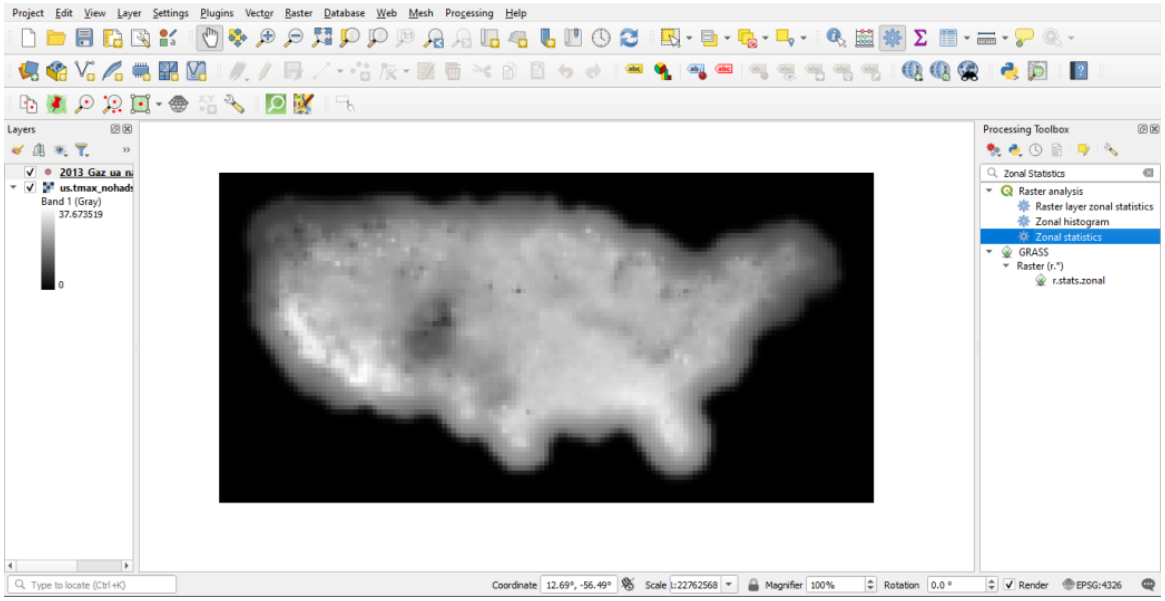
Performing Zonal Statistics:

1. Load the required raster layer *(us.tmax_nohads_ll_20140525_float.tif)*.
2. Load the required delimited text layer *(2013_Gaz_ua_national.txt)* containing point coordinates.
    i. In the Point Coordinates section:
        • Set "X Field" to 'INTPTLAT'.
        • Set "Y Field" to 'INTPTLONG'.
    ii. Add the layer.
3. Go to 'Processing' → Processing Toolbox, and search for "Zonal Statistics" and click it.
4. In the Zonal Statistics tool:
    i. Browse and select the appropriate shapefile (*tl_2018_us_county.shp*).
    ii. Set "Statistics to calculate" to 'Mean'.
    iii. Give a name and location for the output file *(zonal statistics)* to save the layer.
    iv. Click 'Run'.
5. The output will be a new layer containing statistical information calculated within specified zones. In this case, since the statistics to calculate is set to **Mean**, the output will provide the mean value of the raster data within each zone defined by the shapefile (tl_2018_us_county.shp). This means that for each zone (county), the output will include the average value of the raster data.
6. Adjust Layer Properties for the crated layer.
    i. Right-click on the "Zonal Statistics" layer and go to `Properties`.
    ii. Go to the 'Label' tab and set the labeling mode to 'Single Label'.
    iii. Go to the `Symbology` tab, choose 'Graduated', and set 'Value' to the output field from zonal statistics (here, "*outputmean*").
    iv. Click 'Classify'.

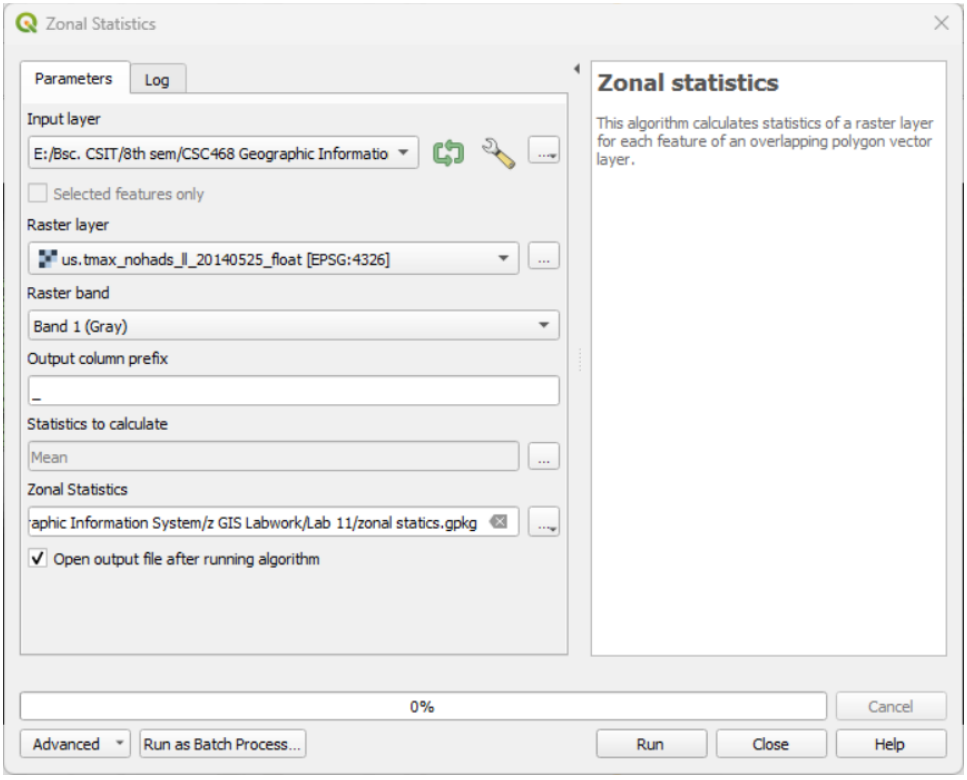
v. Click 'Apply' and then 'OK'.

11.3. Output

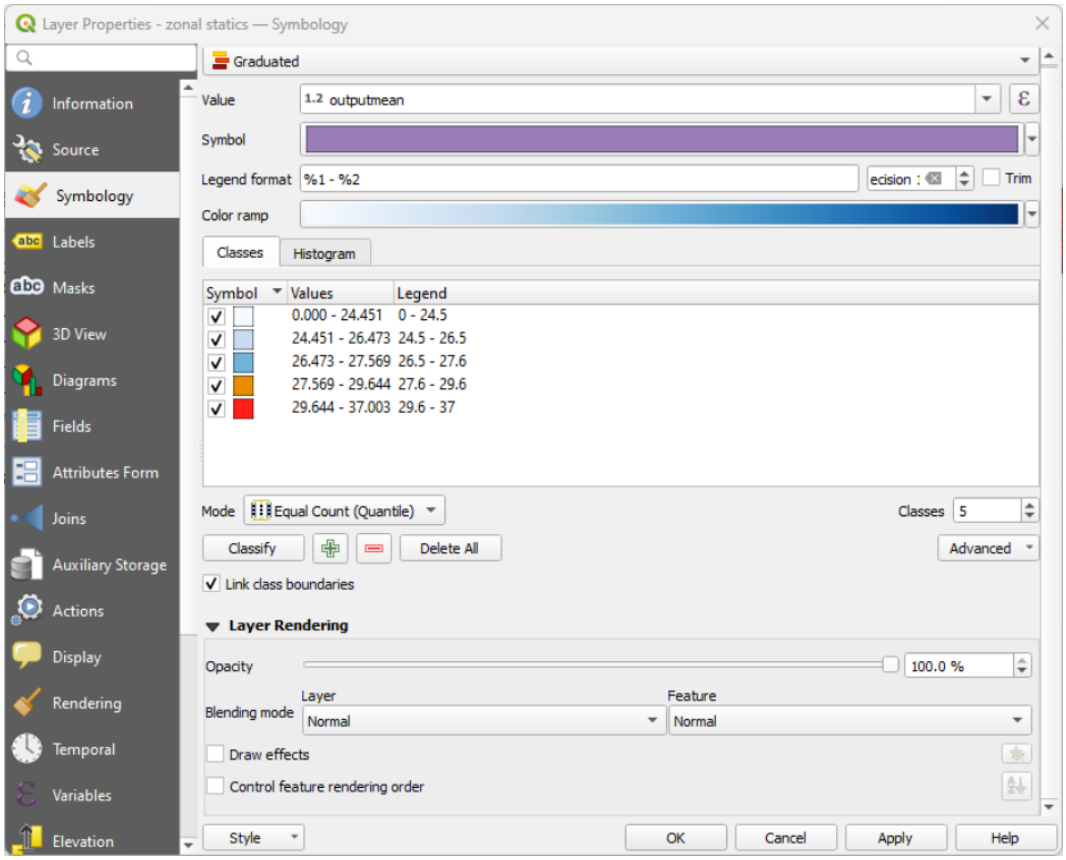
1. Added raster and delimited text layer: *us.tmax_nohads_ll_20140525_float.tif* and *2013_Gaz_ua_national.txt*.



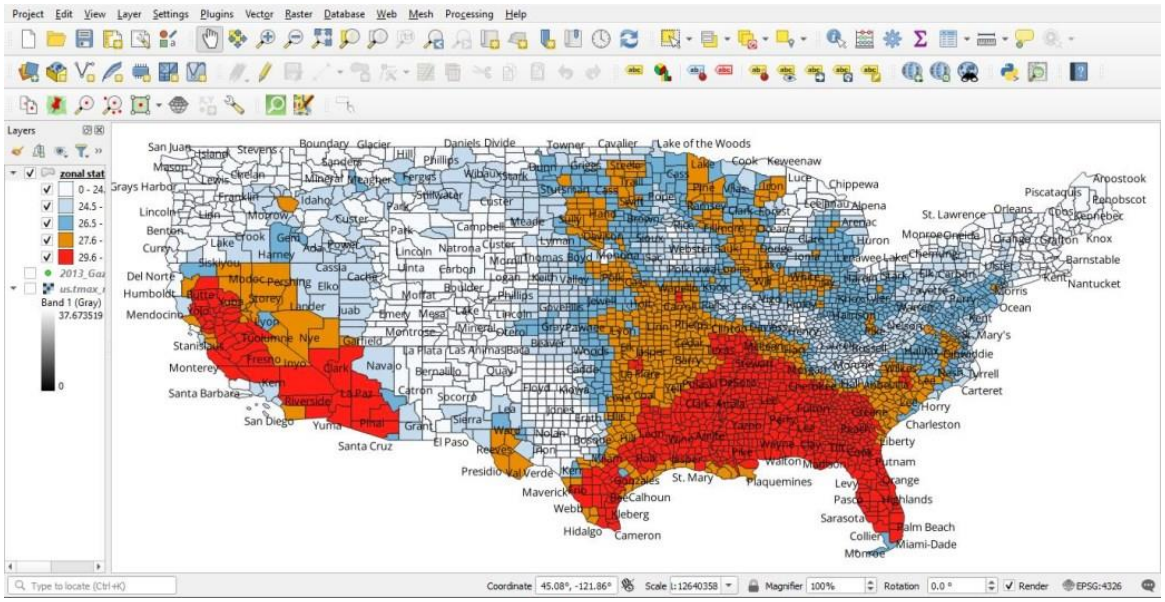
2. Calculating zonal statistics of raster layer.



3. .



4. Resultant Output:



Lab 12: USGS Earth Explorer

12.1. Objectives

- Learn how to search, download, and manage geographic datasets from the USGS Earth Explorer.
- Learn techniques for merging multiple raster datasets into a single comprehensive file.

12.2. Theory

USGS Earth Explorer

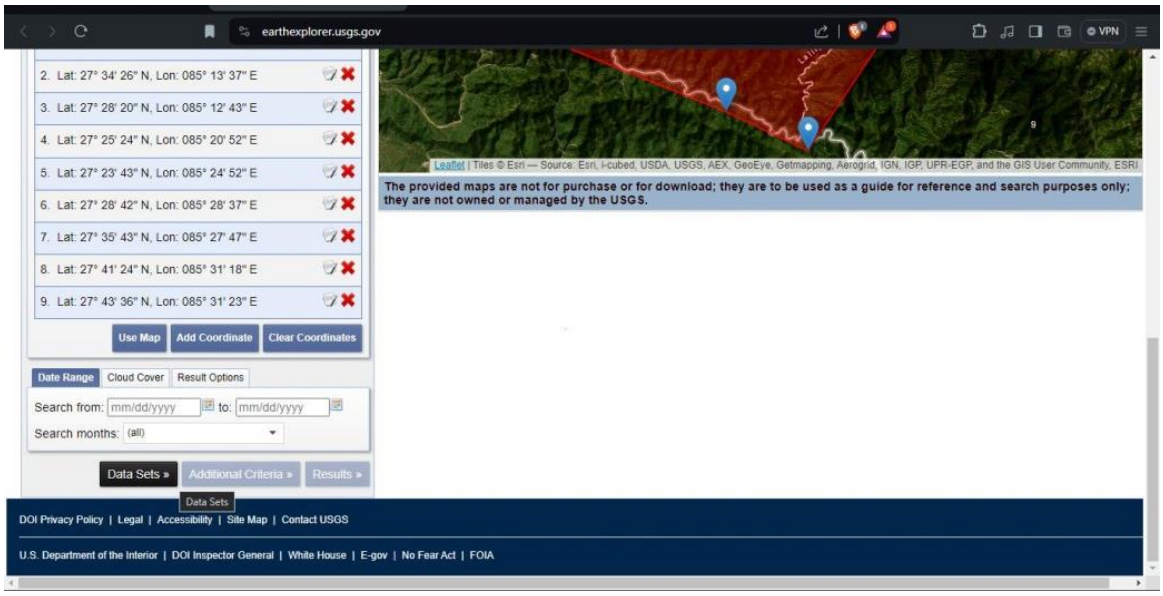
The USGS Earth Explorer is a web-based application that allows users to search, download, and view geographic datasets, including satellite imagery, aerial photographs, and topographic maps. It is widely used by researchers, scientists, and GIS professionals for various applications such as environmental monitoring, land use planning, and disaster management.

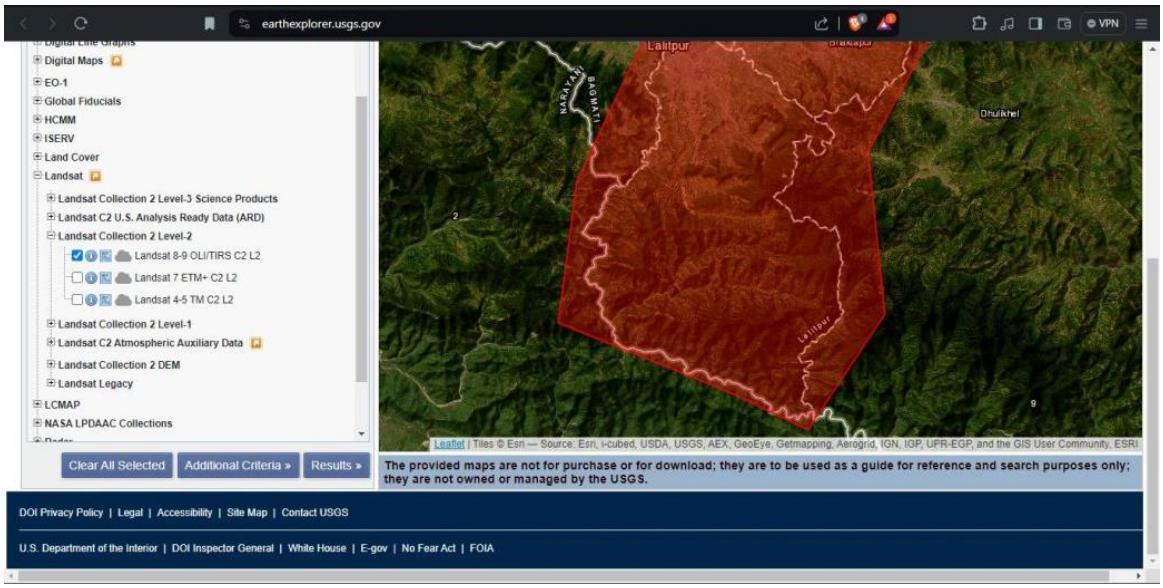
Steps to Merge:

1. Visit the USGS Earth Explorer website.
2. Register your account and then login to the website.
3. Select the area of a particular country or city that you want to merge.
4. Go to the "Data Sets" tab and click on "Landsat → Landsat Collection 2 Level-2 → Landsat 8-9 OLI/TIRS C2 L2."
5. Click on the "Results."
6. Download at least four datasets that appear as results in 'TIF' format.
7. Open QGIS software.
8. Go to Layer → Add Layer → Add Raster Layer.
9. Add all the downloaded data.
10. Go to Raster → Miscellaneous → Merge.
11. Save the file, and you will get the merged data.

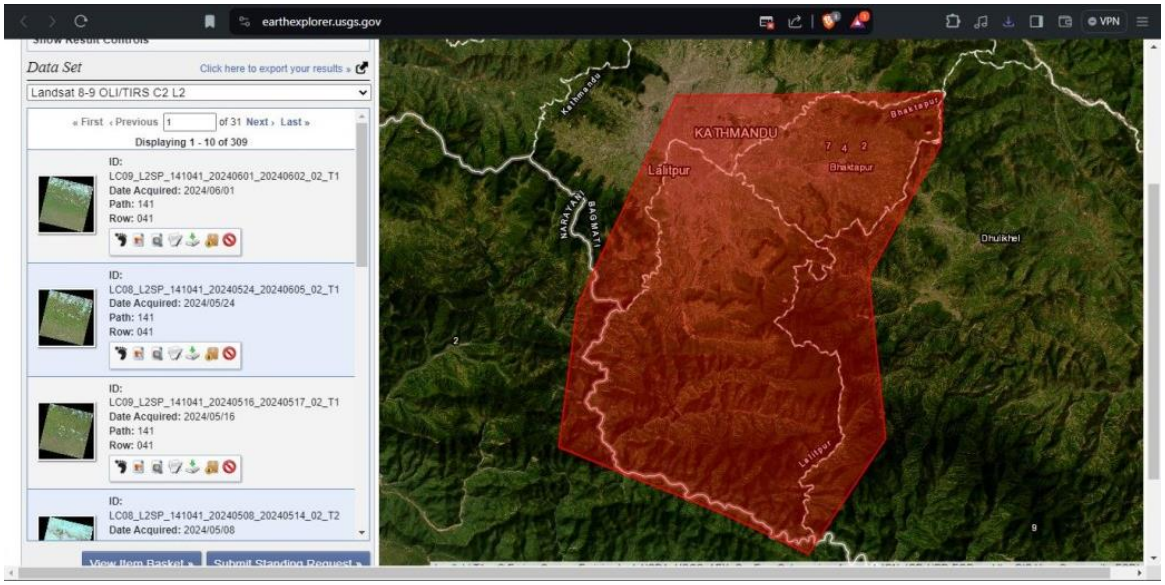
12.3. Output

1. Select any geographical area.

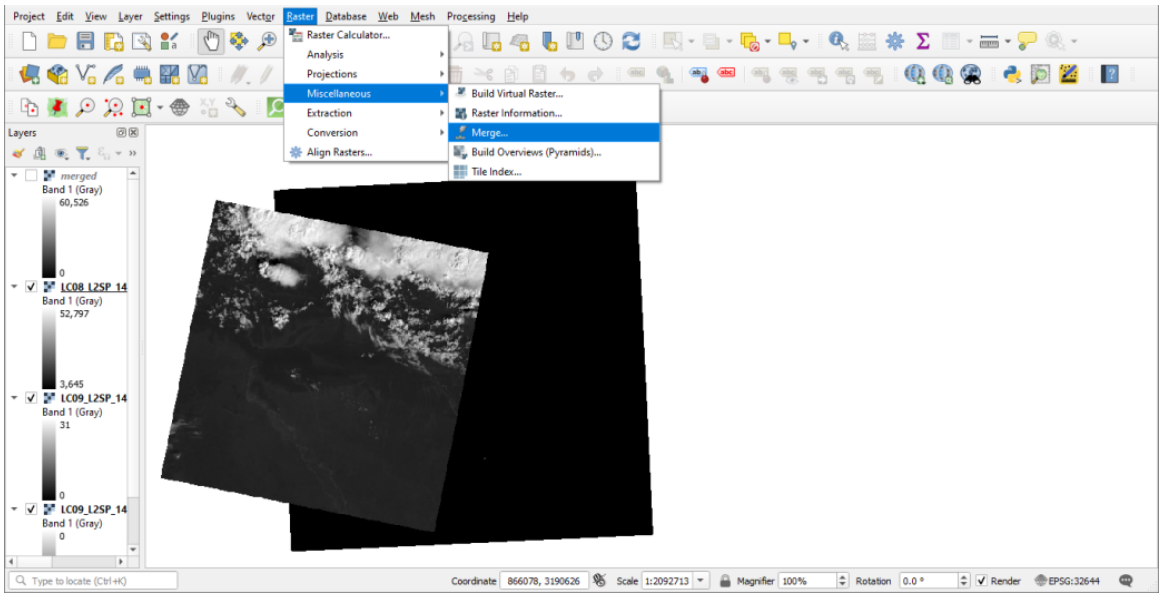




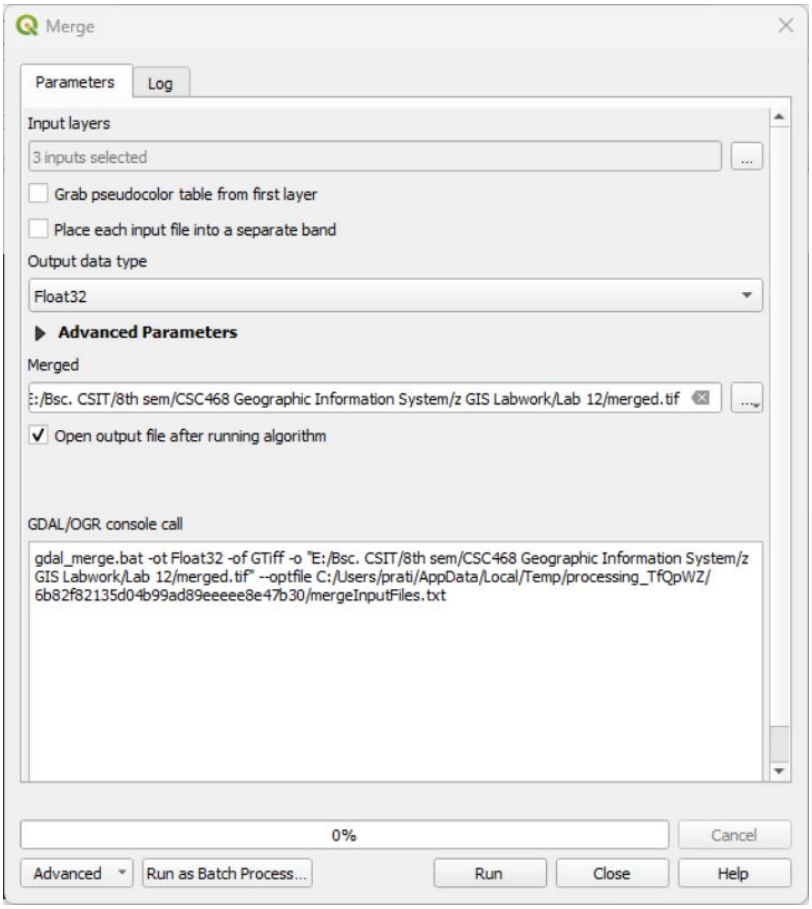
2. Download the required dataset.

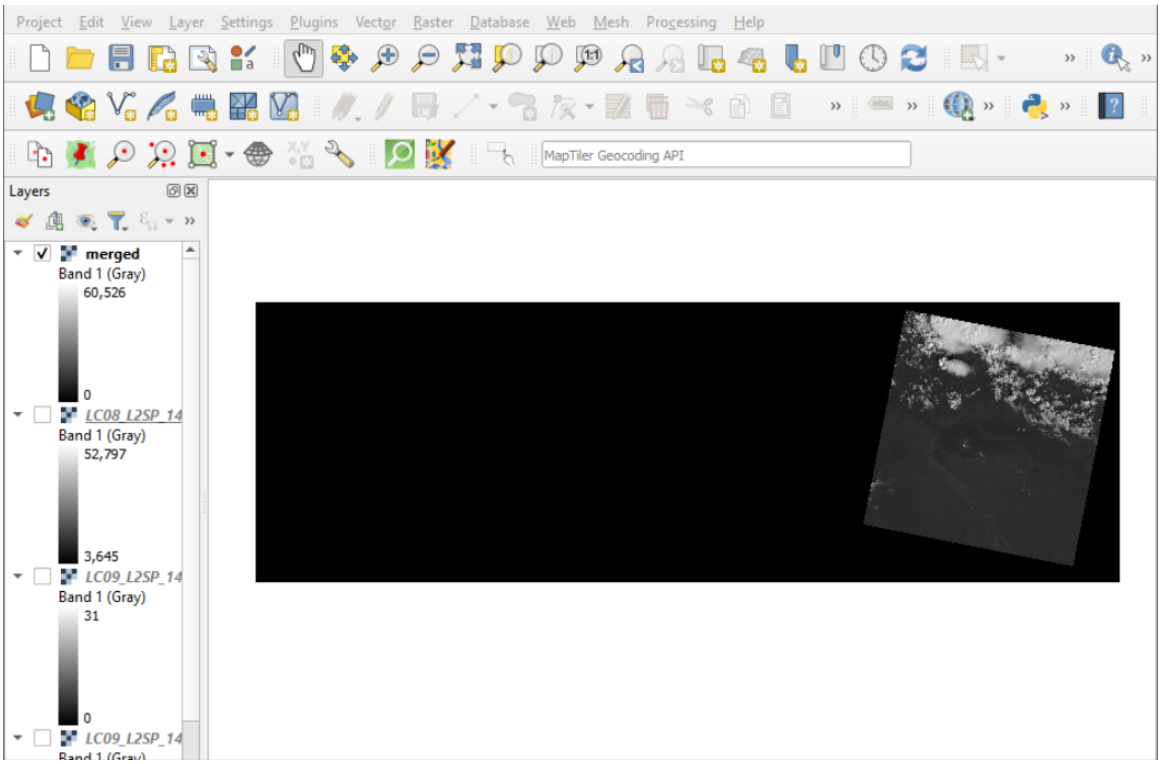


3. Load the raster layers.



4. Merge the raster layers.





Lab 13: Interpolating point Data

13.1. Objectives

- Perform TIN interpolation on point data to create a continuous surface in QGIS.
- Clip the interpolated raster to a specified boundary.
- Generate and customize contour lines from the clipped raster.

13.2. Theory

By following the below steps, you will successfully interpolate point data, clip the resulting raster by a mask layer, and generate contour lines with appropriate properties in QGIS.

Spatial Interpolation

Spatial interpolation is a method used in geographic information systems (GIS) to estimate unknown values at specific locations based on known values at surrounding locations. The primary goal of spatial interpolation is to create a continuous surface from discrete point data, allowing for better visualization, analysis, and decision-making.

Methods of Interpolation

1. Inverse Distance Weighting (IDW)
2. Triangular Irregular Network (TIN)

TIN

The Triangular Irregular Network (TIN) method creates a surface of contiguous, non-overlapping triangles from known data points using Delaunay triangulation, ensuring nearly equilateral triangles. It is ideal for irregularly spaced data and is commonly used in terrain modeling. TIN preserves exact data points and handles irregular spacing well, but it can be computationally intensive for large datasets.

Perform TIN Interpolation:

1. Load the required vector layers. *(Islands_2004_550_stpl83, Boundary_2004_550_stpl83* and *Arlington_Soundings_2007_stpl83)*
2. For TIN Interpolation, open the Processing Toolbox and search for "TIN Interpolation".
3. In the TIN Interpolation tool set the parameters:
    i. Vector layer: 'Arlington' and Interpolation attribute: 'Elevation' then click on add button. Do the same for 'Islands' layer.
    ii. Interpolation: linear
    iii. Extent: Calculate from layer → Boundary.
    iv. Pixel size Y: 5.
    v. Interpolated: Provide a file name and save the output.

vi. Click `Run`.

4. The interpolation will be generated. Customize the properties if needed.

Clip Raster by Mask Layer

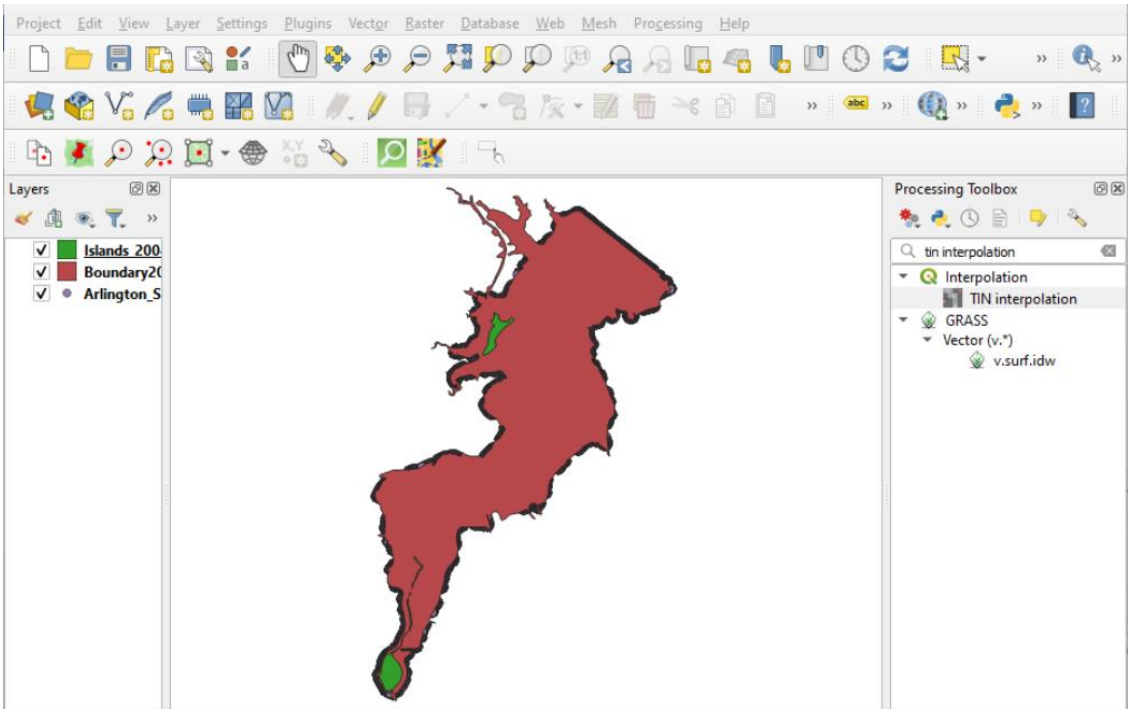
1. For Clipping Raster by Mask Layer, open the Processing Toolbox, and search for "Clip Raster by Mask Layer".
2. Set the parameters:
    a. Input layer: Select the interpolated raster layer.
    b. Mask layer: Select *'Boundary'*.
    c. Provide a location and name to the file to save the output.
    d. Click 'Run'.
3. The clipped raster will be generated. Customize the properties if needed.

Generate Contours

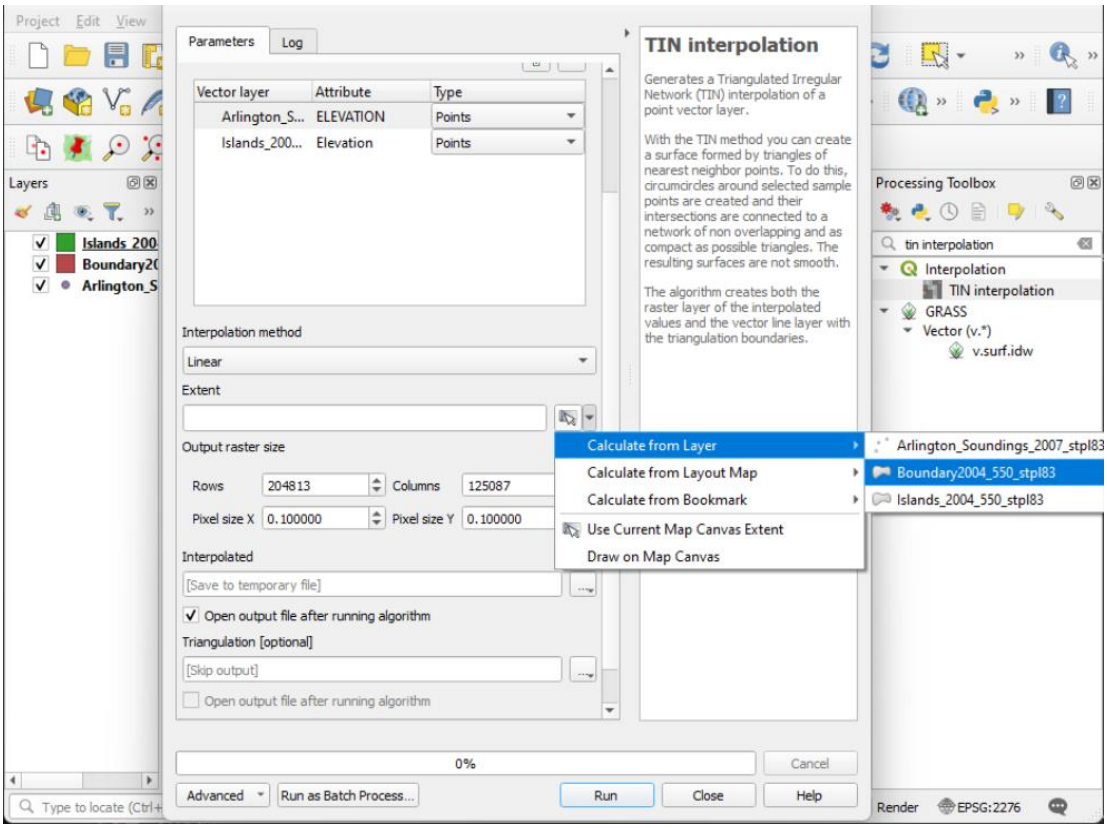
1. For generating contours, open the Processing Toolbox and search for "Contour" (Raster Extraction Contour).
2. Set the parameters:
    a. Input: Select the clipped raster layer.
    b. Band number: Use the default band number.
    c. Interval between contour lines: 10
    d. Provide a location and name to the file to save the output.
    e. Click 'Run'.
3. The contour lines layer will be generated.
4. Customize the layer properties:
    a. Label: Single
    b. Value: Set to the *elevation file name*.
    c. Placement: Curved
    d. Click 'Apply'.

13.3. Output

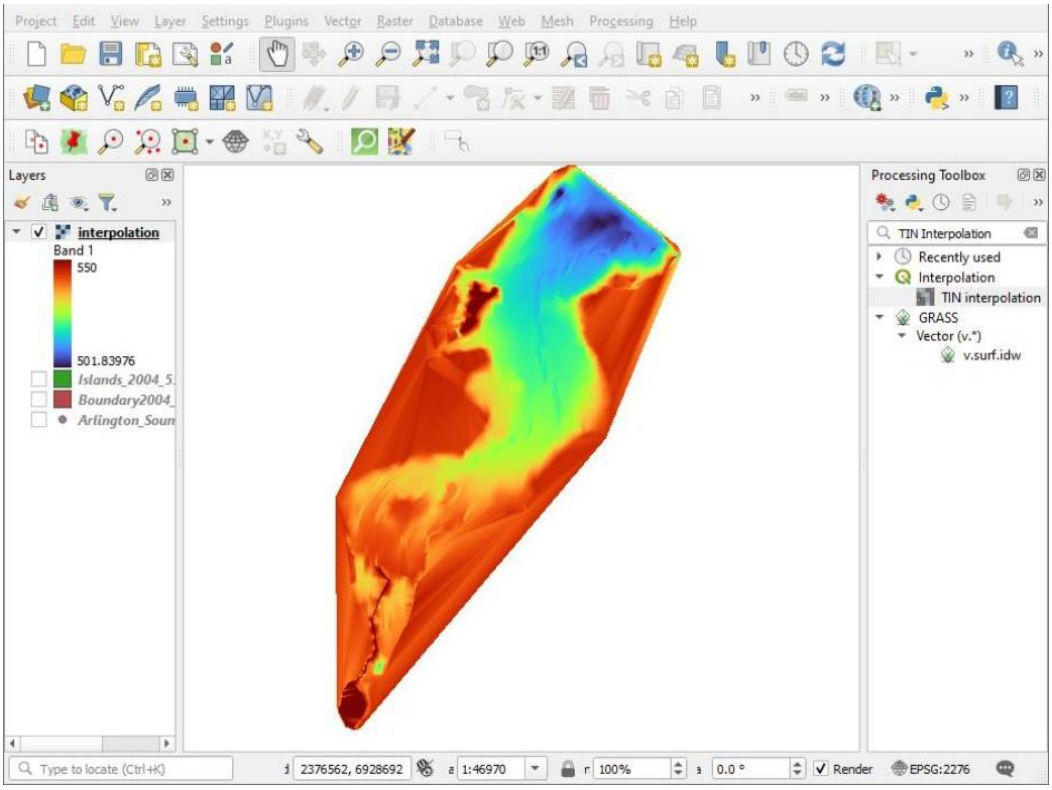
1. Loaded respective vector layers (.*shp* files).



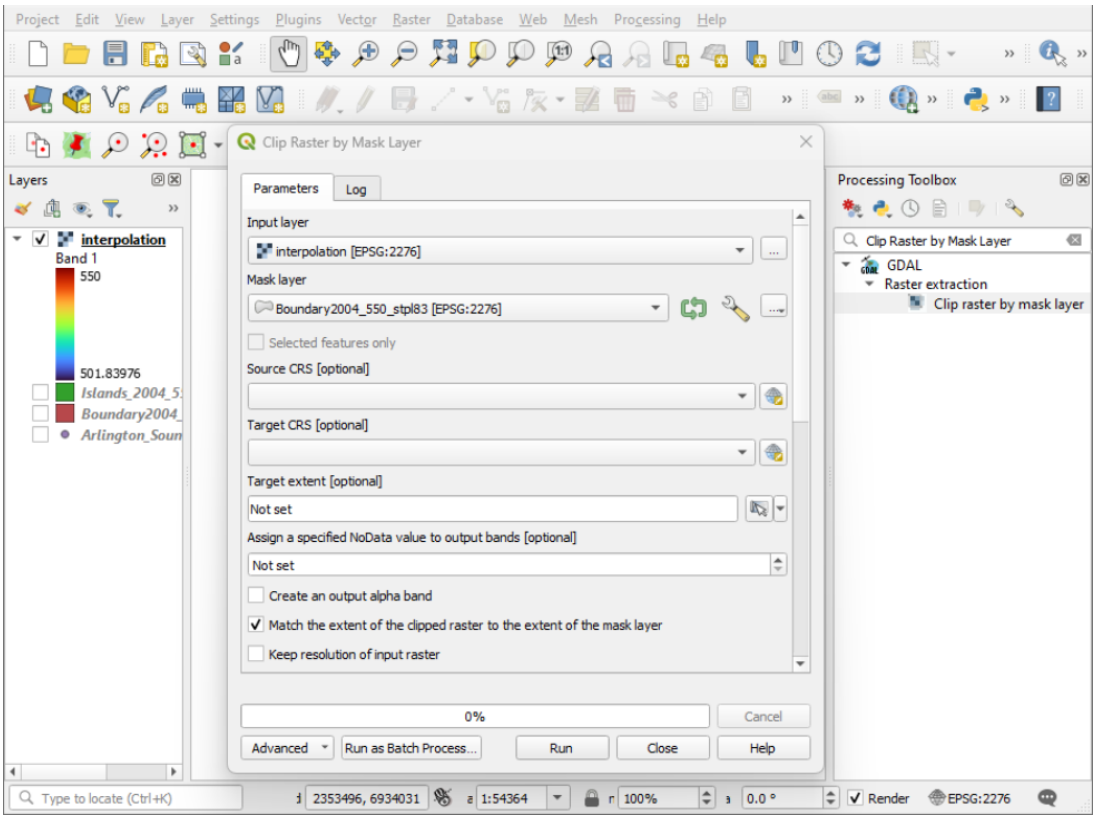
2. Performing TIN Interpolation.



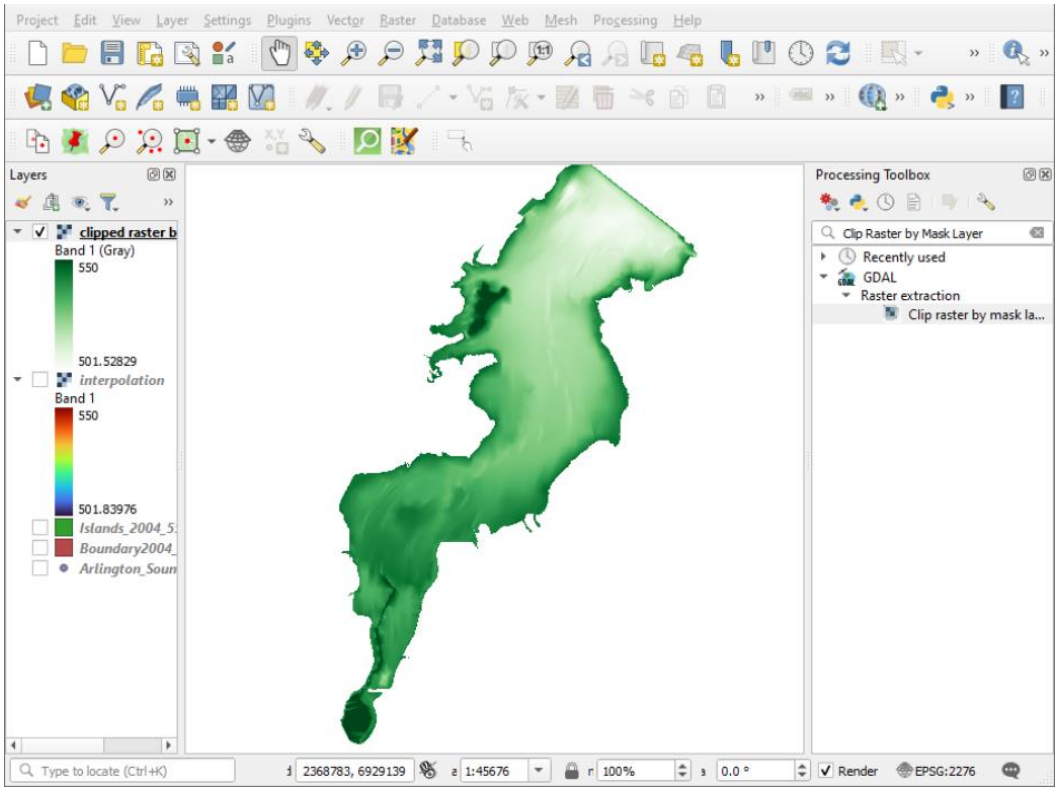
3. Interpolated Layer:



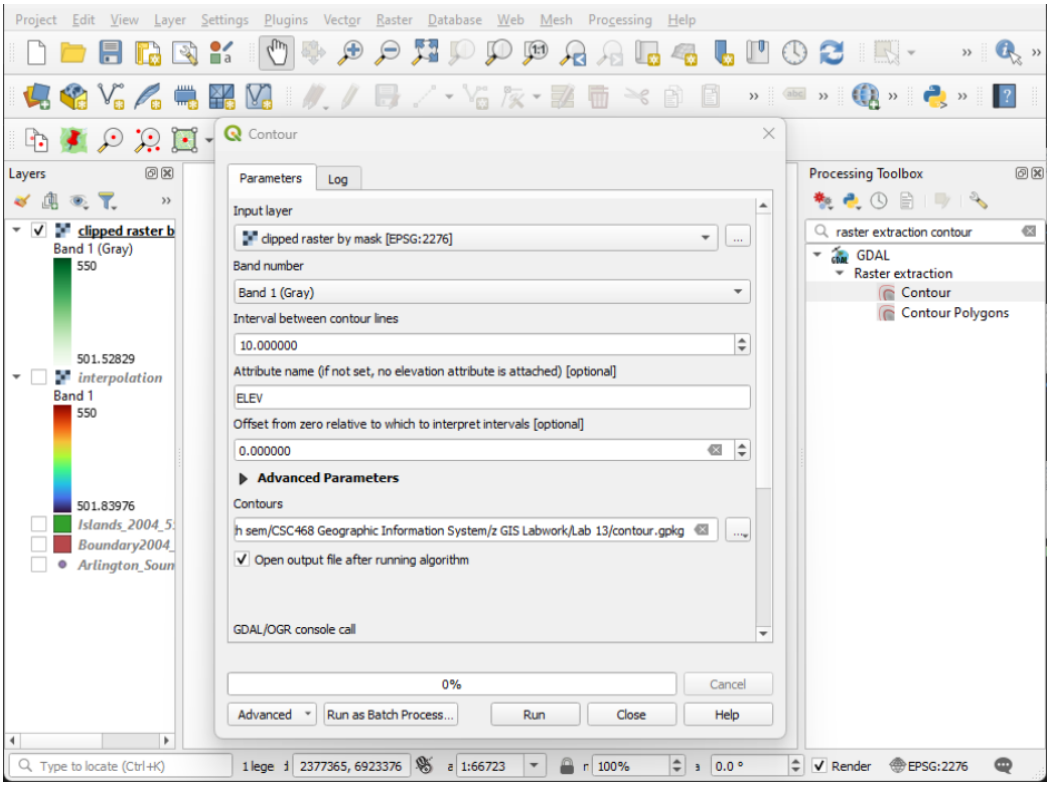
4. Clipping interpolated raster layer by mask.



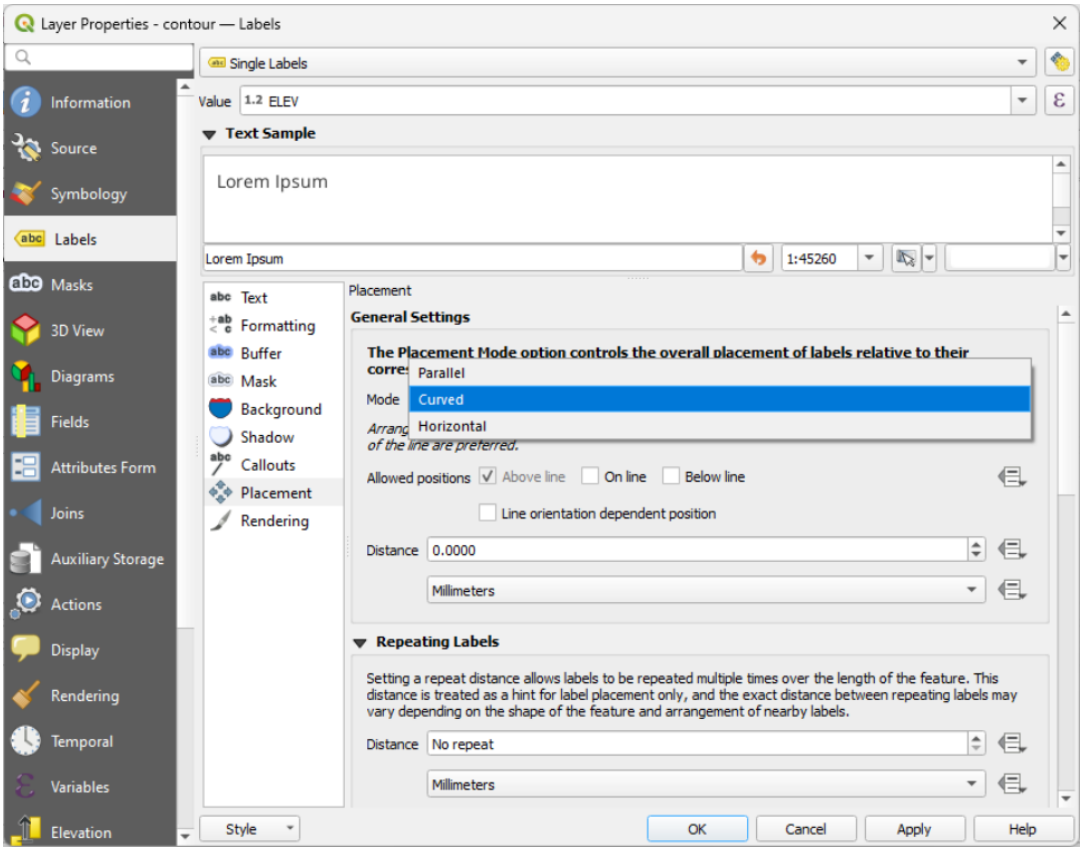
5. Clipped raster layer:



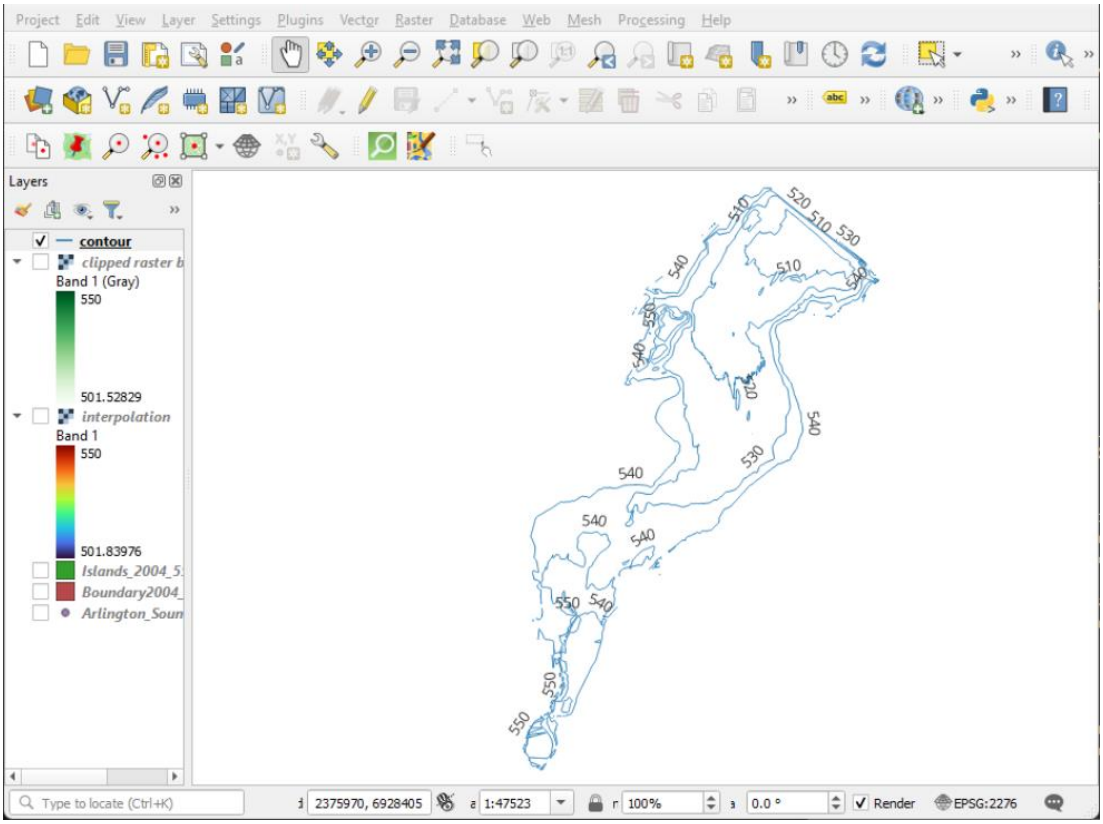
6. Generating Contour Lines:



7. Customizing Contour Properties:



8. Resultant Contour Lines:



Lab 14: Batch processing using processing framework

14.1. Objectives

- Learn to dissolve vector layers based on a specified attribute field.
- Practice exporting selected features from a vector layer.
- Perform batch processing of vector overlay operations to clip multiple layers efficiently.

14.2. Theory

Batch Processing

Batch processing in GIS refers to the automation of repetitive geoprocessing tasks across multiple datasets. Instead of manually applying a geoprocessing tool to each dataset individually, batch processing allows users to define the operation once and apply it to all datasets in a single execution. This approach significantly enhances efficiency and ensures consistency across processed data.

By following the given below steps, you will efficiently use batch processing to perform dissolve and clip operations on multiple layers, and customize the resulting layers in QGIS.

Steps to Dissolve layer:

1. Load the vector layer *(ne_10m_admin_0_countries.shp)*.
2. For dissolving layer, open the Processing Toolbox and search for " Dissolve". OR, in the menu bar, go to 'Vector' → Geoprocessing Tools → 'Dissolve'.
3. In the Dissolve tool set the parameters:
    i. Input layer: *ne_10m_admin_0_countries.shp*.
    ii. Dissolve field: Continent.
    iii. Click 'Run'.

Steps to Export Selected Features:

1. Use the "Select features by" icon on the toolbar.
2. Select the desired features.
3. Right-click on the layer and choose 'Export' → Save Selected Features As.
    i. Provide a location and name to the file to save the output.
    ii. Click 'OK'.

Steps for Batch Processing with Vector Overlay:

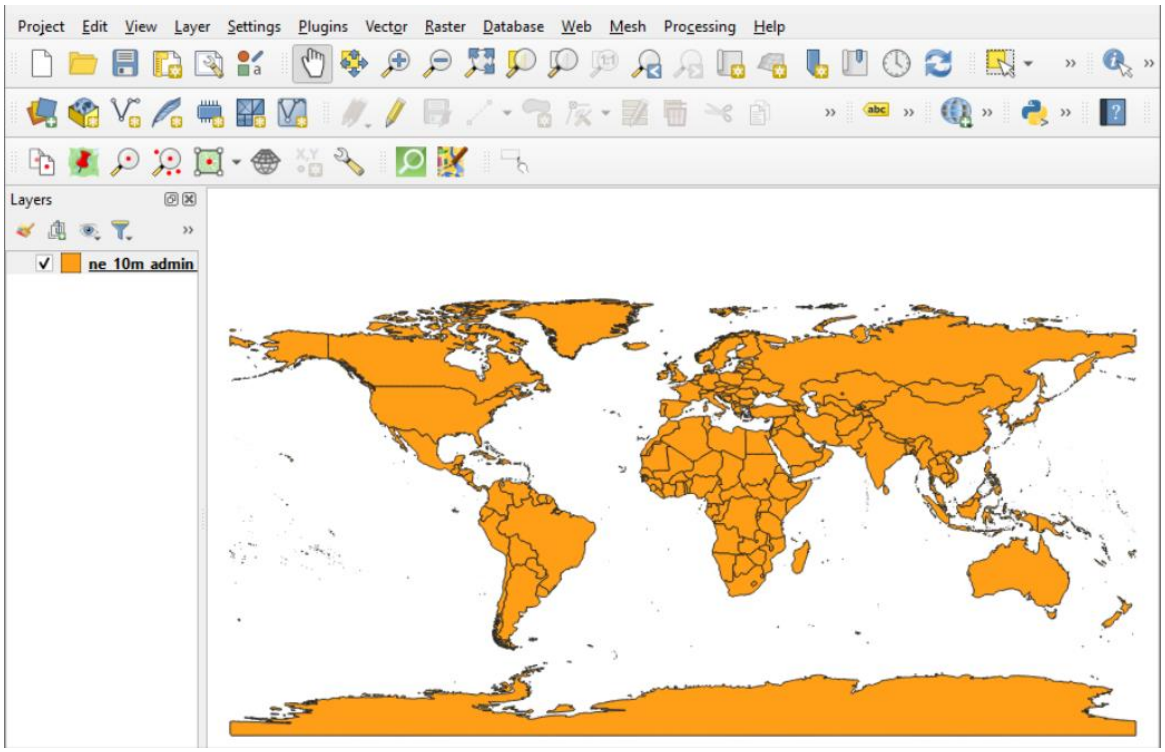
1. Open the Processing Toolbox and search for "Vector overlay".
2. Find and right-click on "Clip" → Execute as batch process.
3. In the batch processing dialog, set:

i. Input layer: Browse and select the shapefiles for *'airports'*, *'ports'*, and *'railways'*.
ii. Overlay layer: Select the newly created layer from the dissolve operation using "select feature".
iii. Clipped: Browse and select the file location to save each clipped output.

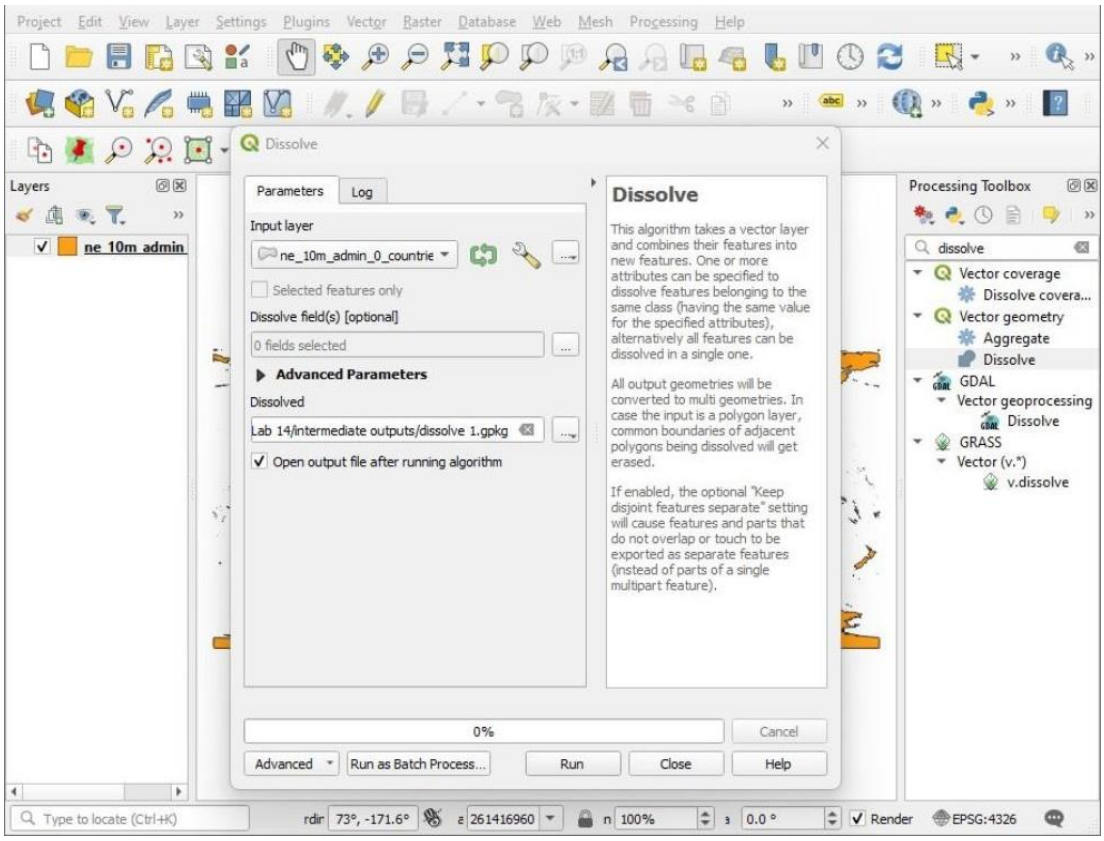
4. In the Autofill menu:
   i. Set Autofill mode: Fill with parameter values
   ii. Check on 'Load layer on completion'.
   iii. Click 'Run'.
5. Once the batch process is complete, you can customize the properties of the newly created layers.
6. To show labels on layers:
   i. Right-clicking on a respective layer.
   ii. Go to 'Properties' → Labels.
   iii. Set 'Label' → Single Labels.
   iv. Choose the appropriate field for the label.
   v. Click 'Apply' and 'OK'.

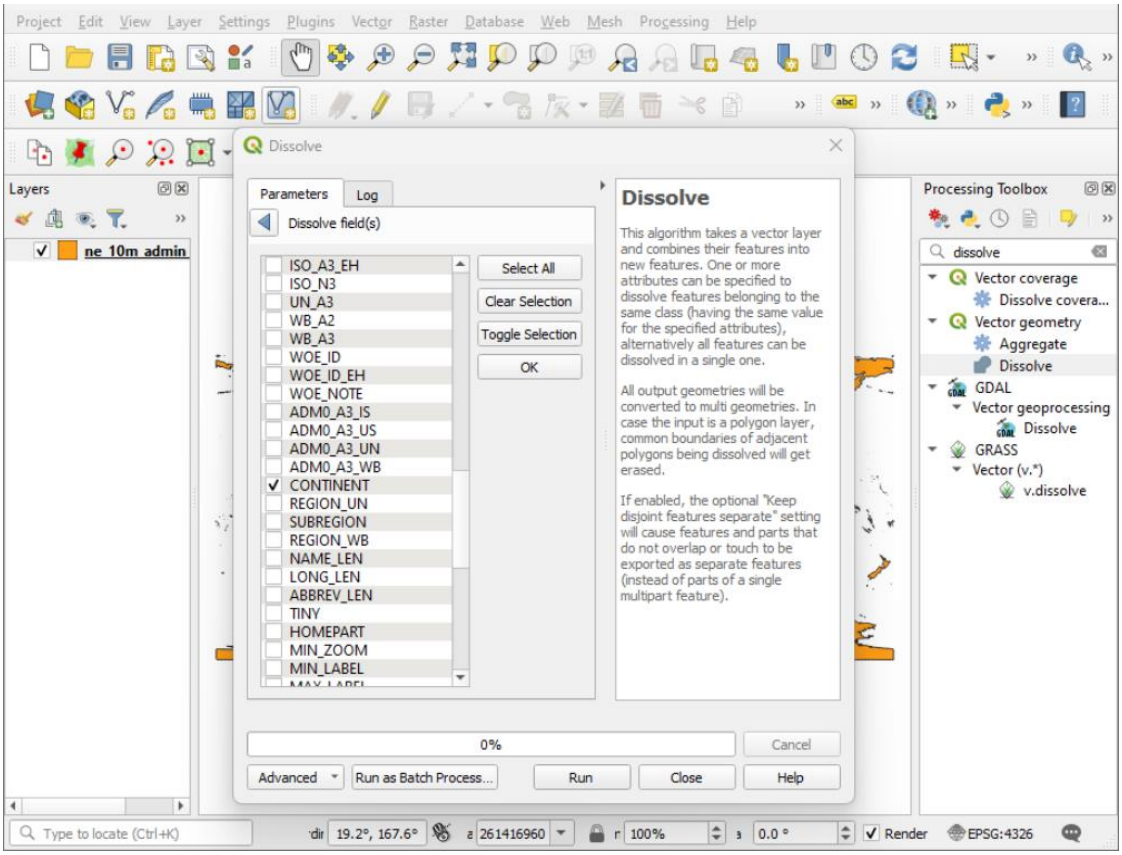
14.3. Output

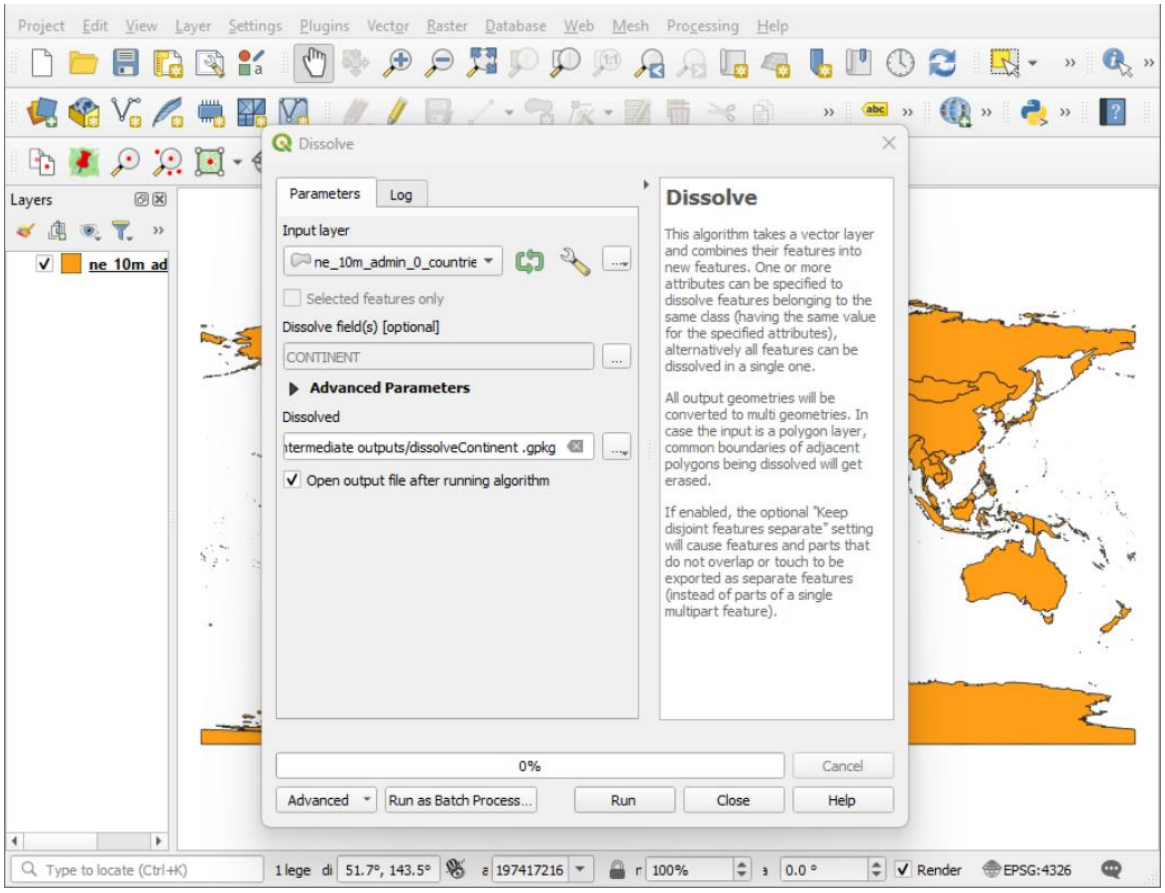
1. Loaded the vector layer `*ne_10m_admin_0_countries.shp*`.



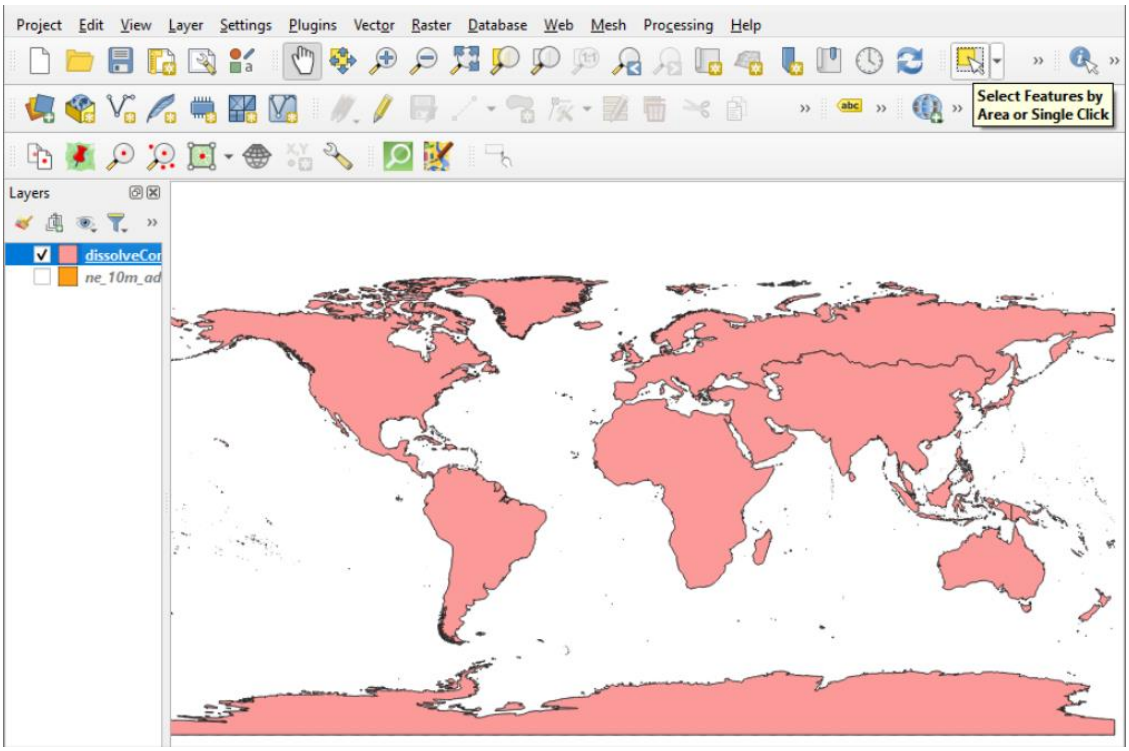
2. Dissolving continent field from the vector layer.



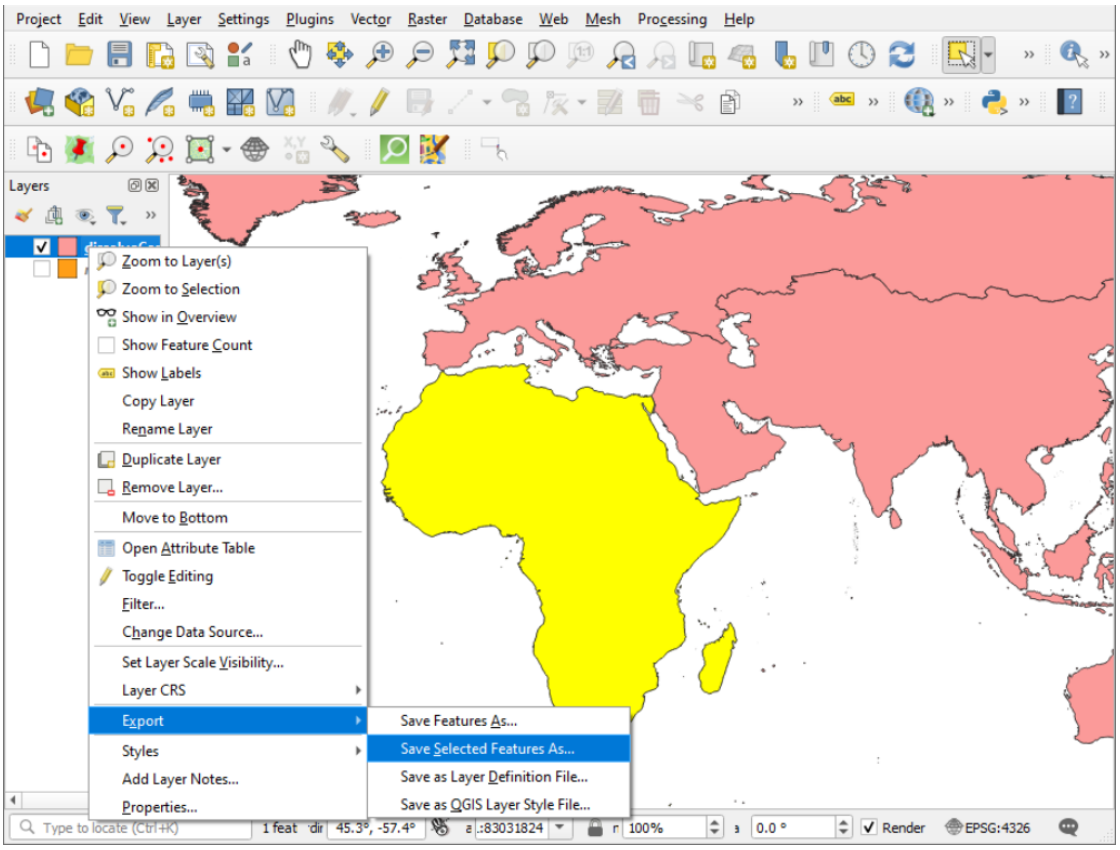




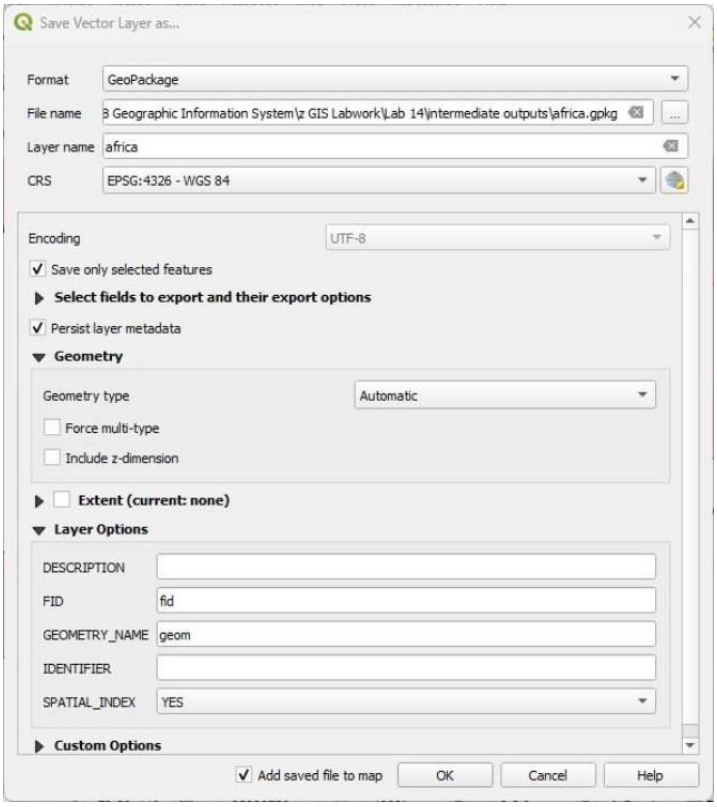
3. Layer generated after dissolving continent field.



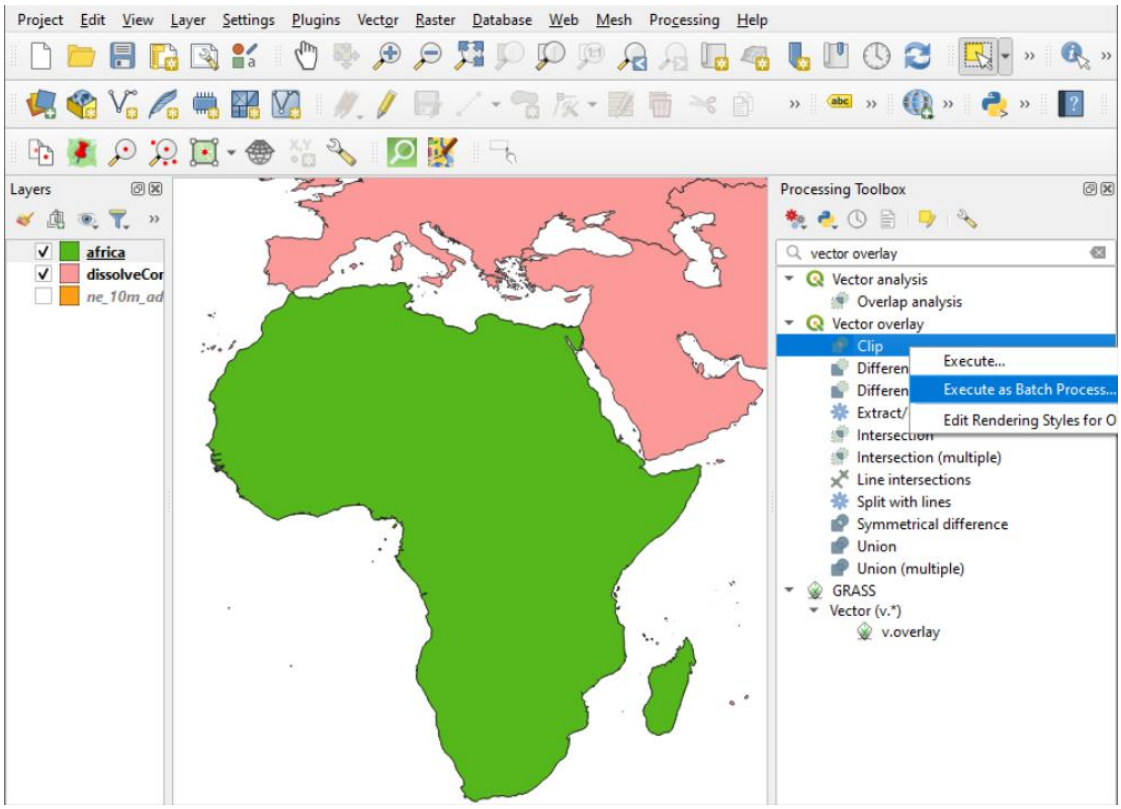
4. Exporting selected feature: Africa continent.



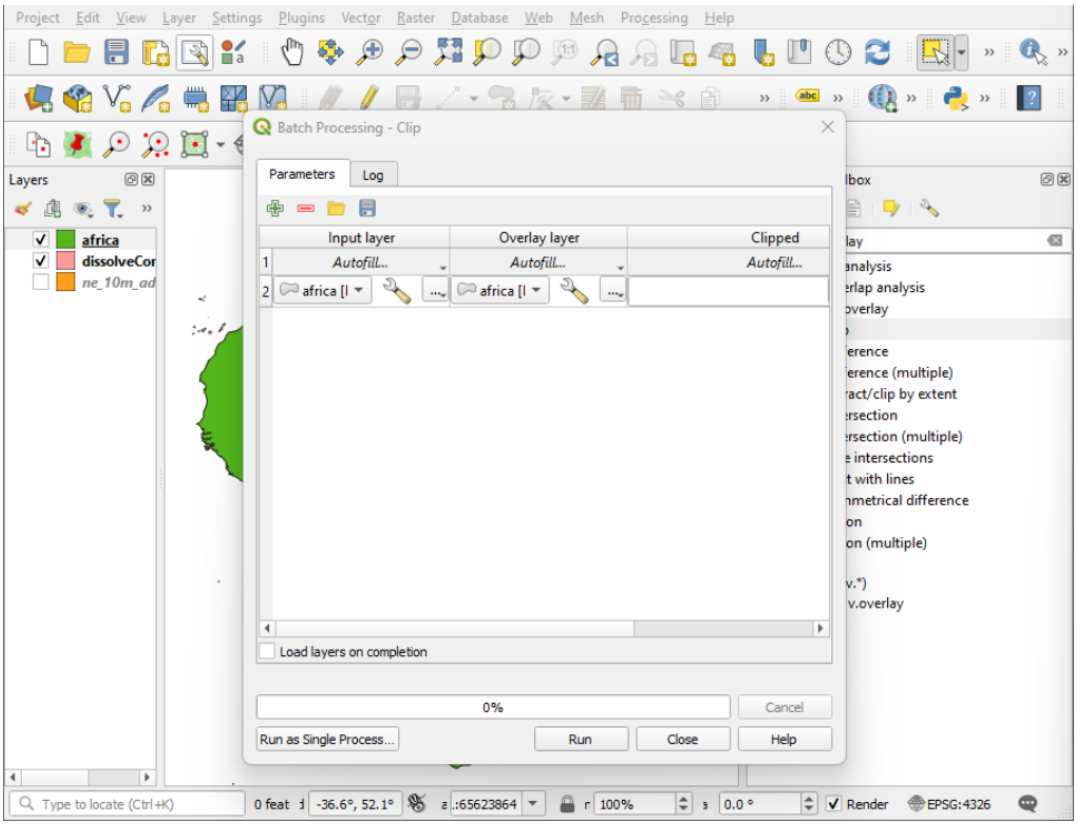
5. Saving the selected feature to be exported as a vector layer.

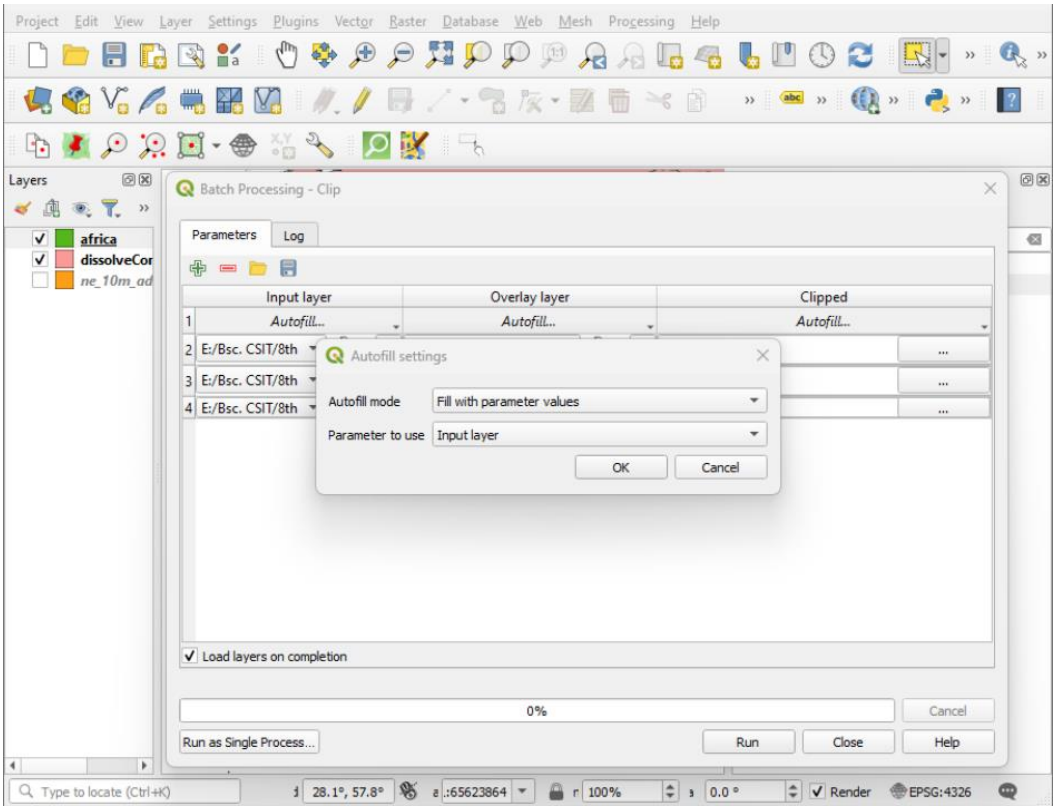


6. A new vector layer named *'africa'* has been added to the project.



7. Vector Overlay Clip Operations on Multiple Layers (Batch Processing).





8. Resultant clipped layers: