

## 0.1 Overview

In this session, we will have an overview of GIS, including the most popular used open source GIS platform QGIS, the basic and most common vector and raster file types, and zonal statistics analysis. The tools and techniques used in this lesson will be used in all following lessons, and these materials should be helpful as reference in the future. Note you can either use the paperspace online environments or, if you have a laptop with sufficient memory and power, install QGIS locally. Note that later assignments may require more memory and computation than you have available on your laptop; in those cases you can instead move to cloud environments.

## 0.2 QGIS

To open QGIS, double click on the QGIS icon in your Paperspace desktop.

Once QGIS is launched you should see a window similar to the one below.

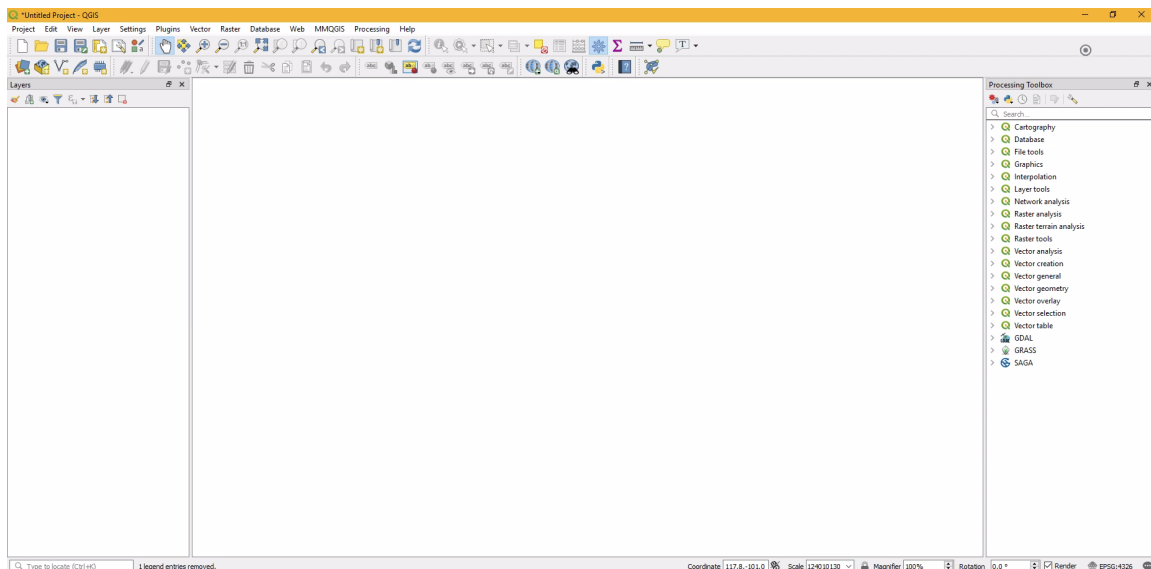


Figure 1: Screenshot of QGIS interface

There are several main elements to the QGIS interface:

1. The **toolbars** along the top include the most often used tools for loading and working with spatial data. If the tools are not visible in a toolbar, you can find them from the menus.
2. The **layer list** on the left side will populate with your spatial data layers as you add them.
3. The **processing toolbox** on the right shows the list of all available algorithms grouped in different blocks.
4. The **status bar** along the bottom shows you information about the current map view.
5. The **map canvas** in the center is where your spatial data will be visualized.

There are a wide variety of geospatial tools, functions, and analysis procedures available through the core QGIS library, however, some GIS processes have yet to be integrated into QGIS. Fortunately,

there is an increasingly large population of developers and users who are contributing to QGIS's functionality by developing plugins (searchable using the *Plugins* menu). All plugins used in this tutorial have been pre-installed and activated for you.

More on QGIS can be found at <https://qgis.org/>.

### 0.3 Loading and Exploring Data

In this section we will explore several datasets which represent the types of data you might want to include in a Geospatial Impact Evaluation (GIE), and basic processing steps needed to prepare data for a GIE. The Nigeria State boundaries will represent the unit of analysis for the GIE, the commitment dollar values of GEF projects can be used as a treatment indicator, and NDVI (a satellite based measure of the "greenness" of vegetation) could be used as an outcome measure.

These datasets are all available in the **data** folder included in your download from earlier, and are summarized in the list below.

#### 1. Nigeria State Boundaries

- Description - Spatial features defining the boundaries of first order administrative zones (states) in Nigeria
- Source - GeoBoundaries database of administrative zones<sup>1</sup>
- File Type - Vector (GeoJSON, .geojson)

#### 2. GEF Geocoded Aid Projects

- Description - Geocoded data for 724 GEF projects spanning 4978 locations. Includes projects identified as land degradation, biodiversity, multifocal area, and programmatic. The file *levella.csv* contains project, location, and financial data merged together using unique project and location ids. Project level commitments have been disaggregated evenly across all locations associated with a project. For more detail about this dataset, please refer to the readme PDF file provided with the data.
- Source - AidData
- File Type - Comma Separated Values (.csv)

#### 3. NDVI (Normalized Difference Vegetation Index) Satellite Imagery

- Description - NDVI is a satellite based measure of the "greenness" of vegetation. This is a yearly aggregate of NDVI for 2010.
- Source - NASA LTDR AVHRR v4<sup>2</sup>
- File Type - Raster (GeoTiff, .tif)

#### 0.3.1 Base Layer

To get started, let's add a background layer to QGIS so we have some spatial context when we add our other data.

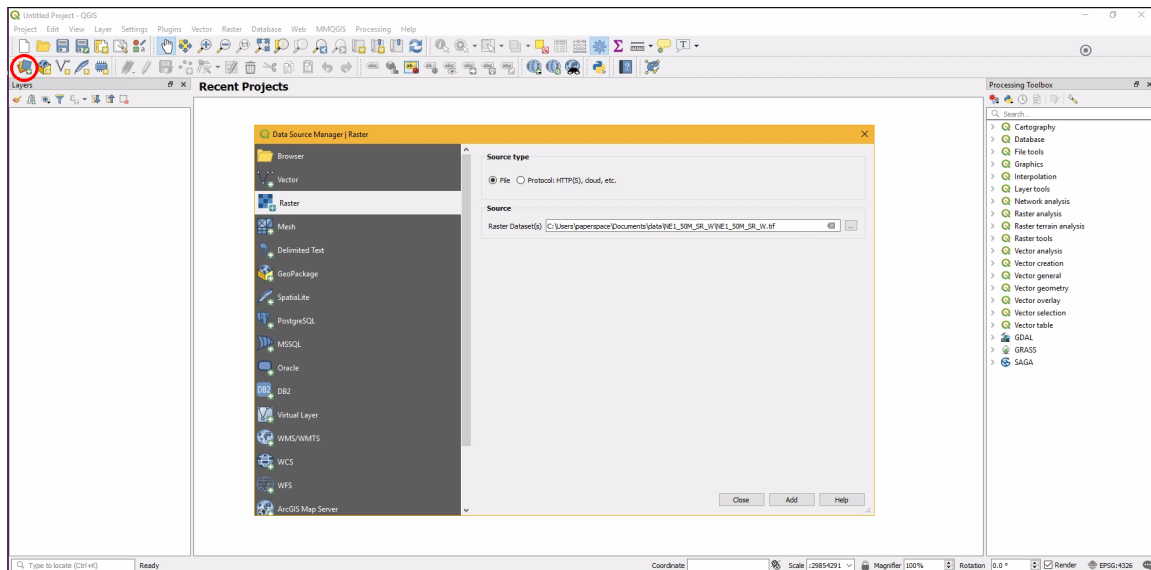
1. Click "Open Data Source Manager" button on the far left of the second row of the top toolbar (shortcut: Ctrl+L).

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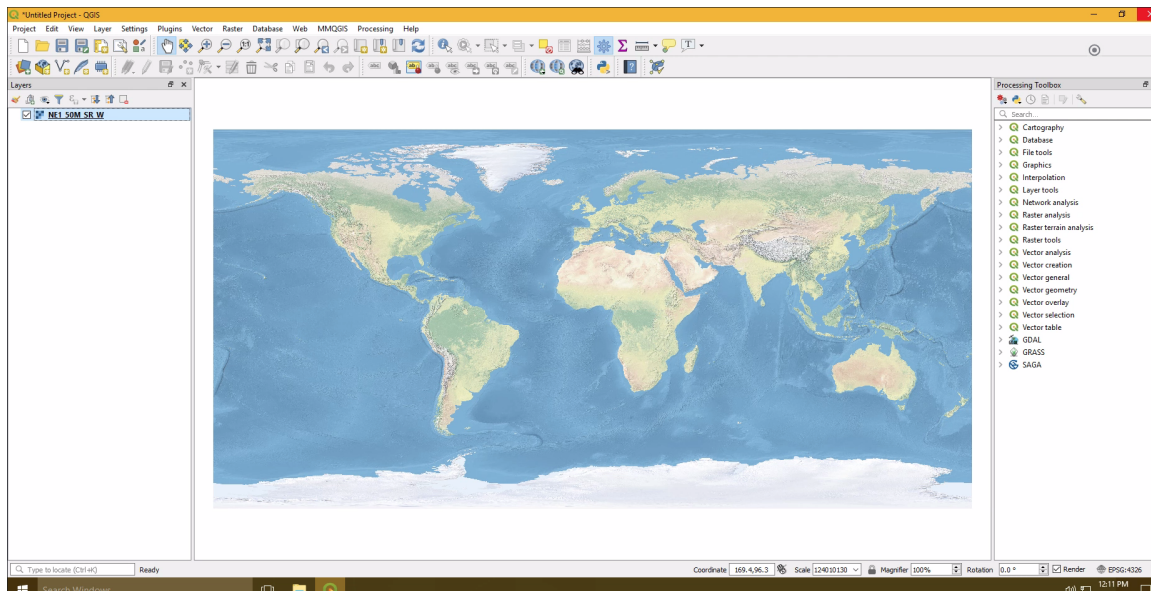
<sup>1</sup><http://www.geoboundaries.org>

<sup>2</sup><https://ltdr.modaps.eosdis.nasa.gov/cgi-bin/ltdr/ltdrPage.cgi>

2. Go to the "Raster" tab and then use the browse button (...) for the "Source" field to navigate to and select the **.../Desktop/data/NE1\_50M\_SR\_W/NE1\_50M\_SR\_W.tif** file



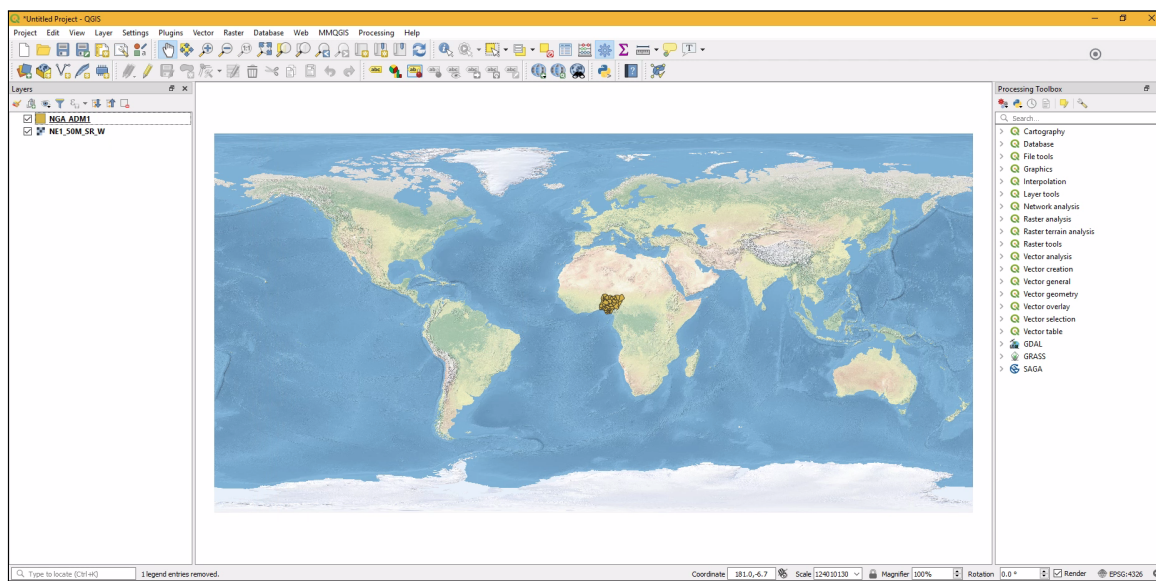
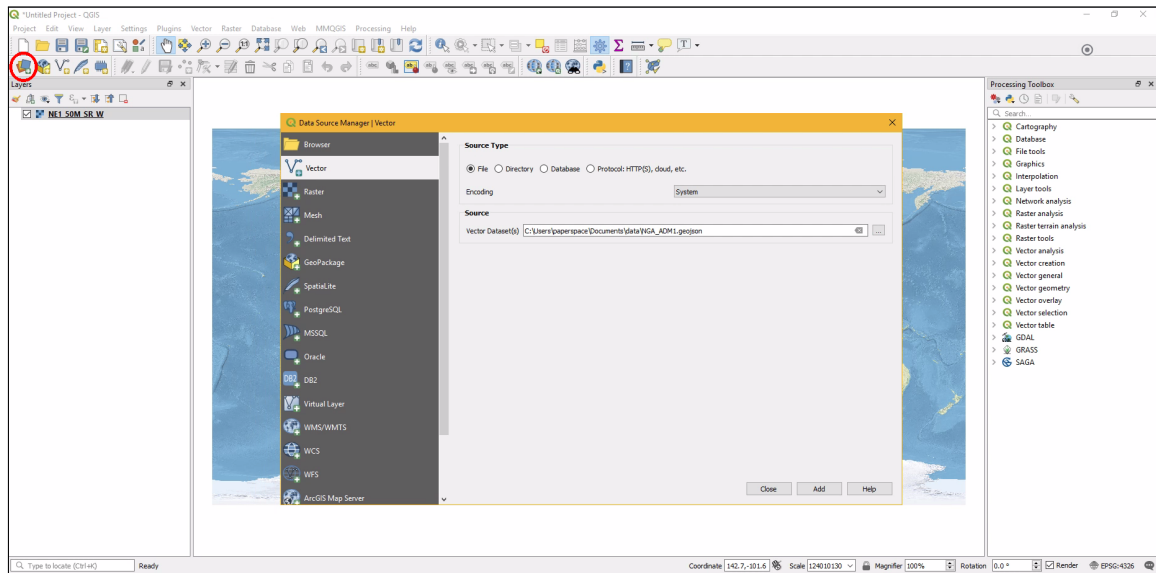
3. Click "Add" to load the base layer, and then click "Close". You should see a map similar to below.



### 0.3.2 Nigeria State Boundaries

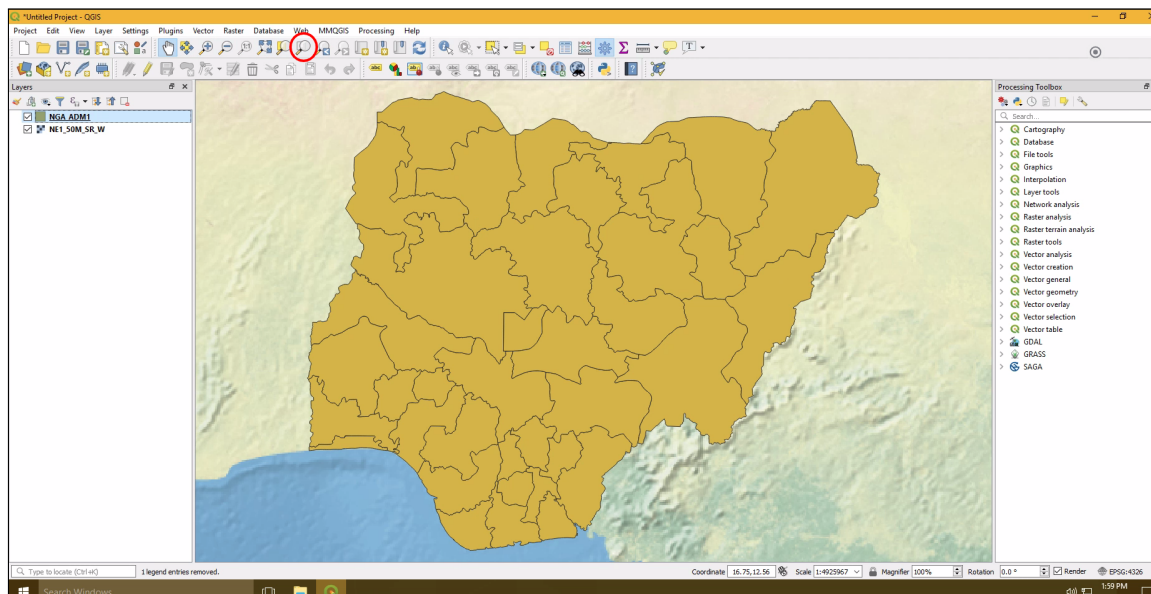
Now we can add in our Nigeria state boundaries.

1. Open the Data Source Manager again, but select the "Vector" tab this time.
2. Find and select the **.../Desktop/data/NGA\_ADM1.geojson** file.
3. Click "Add" to add this layer.



4. You can then right click on the layer in the layer window and select "Zoom to Layer" to get a better view
5. Alternatively, you can use the "Zoom to Layer" button in the top toolbar.

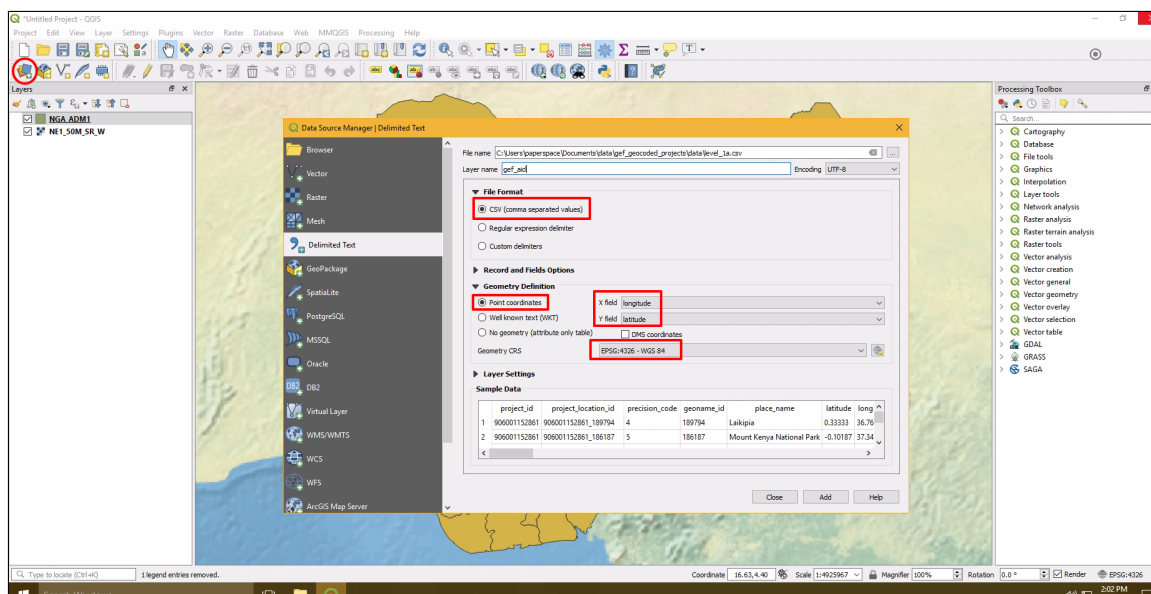




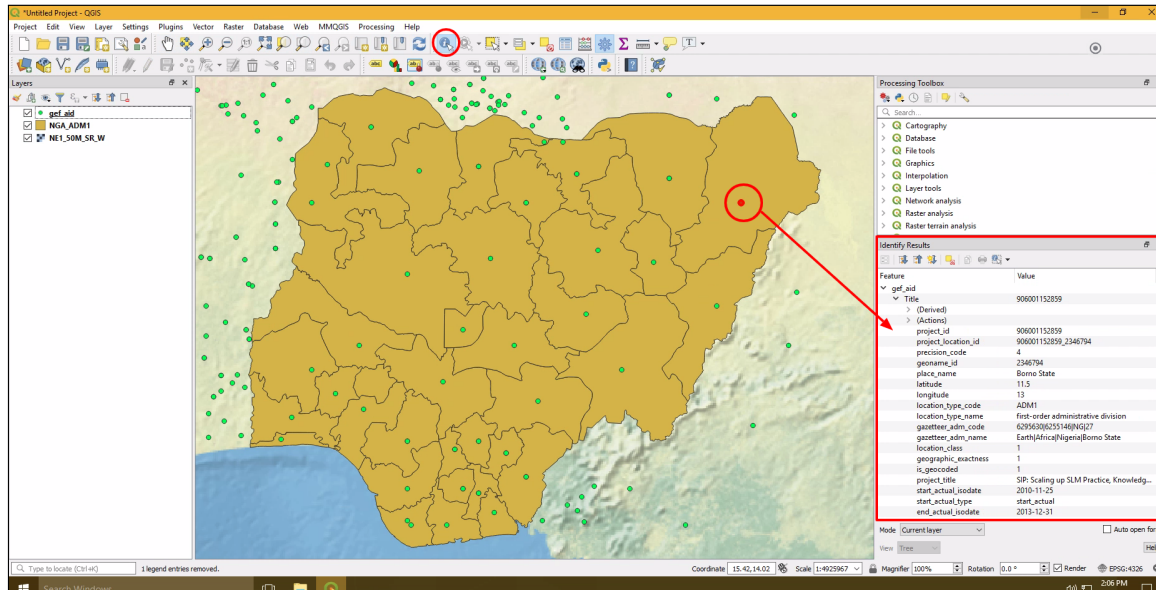
### 0.3.3 GEF Geocoded Aid Projects

Next, we will add our aid projects.

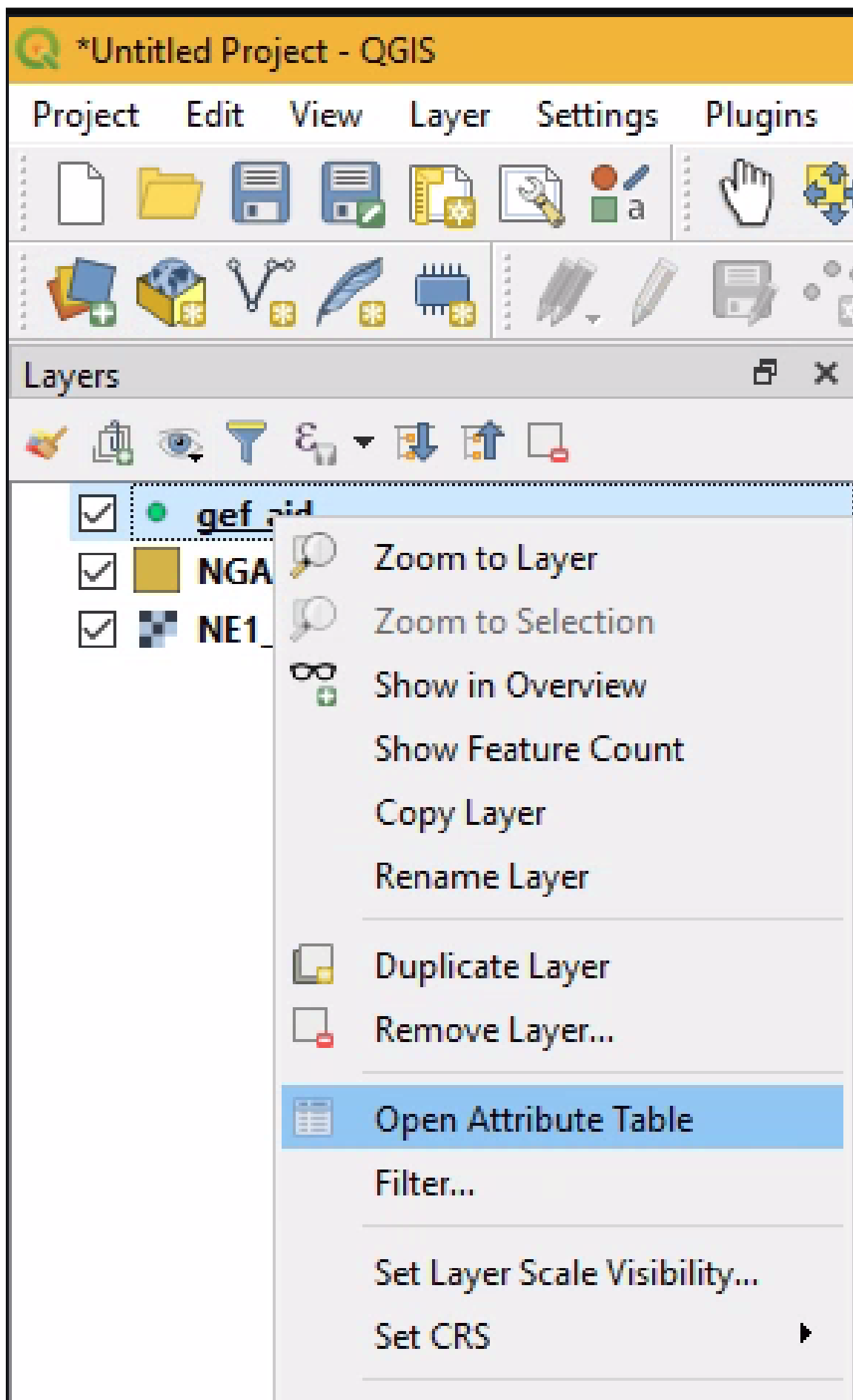
1. Open the Data Source Manager again, and select the "Delimited Text" tab this time.
2. For "File name", select the `.../Desktop/data/geocoded_gef_projects/data/level_1a.csv` file.
3. You can set the "Layer name" to "gef\_aid"
4. QGIS should automatically load the selected .csv file to the window and detect the longitude and latitude fields.
5. If it does not load automatically, make sure the "File Format" is set to "CSV" and "Geometry Definition" is set to "Point coordinates"
6. Set "Geometry CRS" to "EPSG:4326 - WGS 84"
7. Click **Add** to load the selected .csv file, then "Close"



8. You can use the "Identify Features" button (top toolbar, shortcut: Ctrl+Shift+I) to click on any of the points added to the map. This will display details about the point in the "Identify Results" window on the right side.



9. To further explore this data, right click the **gef\_aid** layer and click **Open Attribute Table**. The attribute table displays information associated with each features, or project location, in the layer. Each row represents a geocoded project location, and each column contains a specific information about the project location such as the project title, status, start year, or commitments.



gef\_aid :: Features Total: 4978, Filtered: 4978, Selected: 0

|    | project_id   | project_location_id | precision_code | geoname_id | place_name  | latitude | longitude | location_type_code | location_type_name | azeteer_admin_code |
|----|--------------|---------------------|----------------|------------|-------------|----------|-----------|--------------------|--------------------|--------------------|
| 1  | 906001218062 | 906001218062_9...   | 8              | 933860     | Botswana    | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 2  | 906001218070 | 906001218070_6...   | 8              | 614540     | Georgia     | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 3  | 906001218072 | 906001218072_2...   | 8              | 2453866    | Mali        | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 4  | 906001218066 | 906001218066_1...   | 8              | 1036973    | Mozambique  | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 5  | 906001218068 | 906001218068_3...   | 8              | 3439705    | Uruguay     | NULL     | NULL      | PCLI               | independent p...   | 6295630 625515...  |
| 6  | 906001218076 | 906001218076_3...   | 8              | 3703430    | Panama      | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 7  | 906001218076 | 906001218076_3...   | 8              | 3582678    | Belize      | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 8  | 906001218076 | 906001218076_3...   | 8              | 3624060    | Costa Rica  | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 9  | 906001218076 | 906001218076_3...   | 8              | 3923057    | Bolivia     | NULL     | NULL      | PCLI               | independent p...   | 6295630 625515...  |
| 10 | 906001218076 | 906001218076_3...   | 8              | 3932488    | Peru        | NULL     | NULL      | PCLI               | independent p...   | 6295630 625515...  |
| 11 | 906001218076 | 906001218076_3...   | 8              | 3658394    | Ecuador     | NULL     | NULL      | PCLI               | independent p...   | 6295630 625515...  |
| 12 | 906001218076 | 906001218076_3...   | 8              | 3585968    | El Salvador | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 13 | 906001218076 | 906001218076_3...   | 8              | 3996063    | Mexico      | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 14 | 906001218106 | 906001218106_1...   | 8              | 1062947    | Madagascar  | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 15 | 906001218106 | 906001218106_1...   | 8              | 174982     | Armenia     | NULL     | NULL      | PCLI               | independent p...   | 6295630 625514...  |
| 16 | 906001218106 | 906001218106_3...   | 8              | 3923057    | Bolivia     | NULL     | NULL      | PCLI               | independent p...   | 6295630 625515...  |

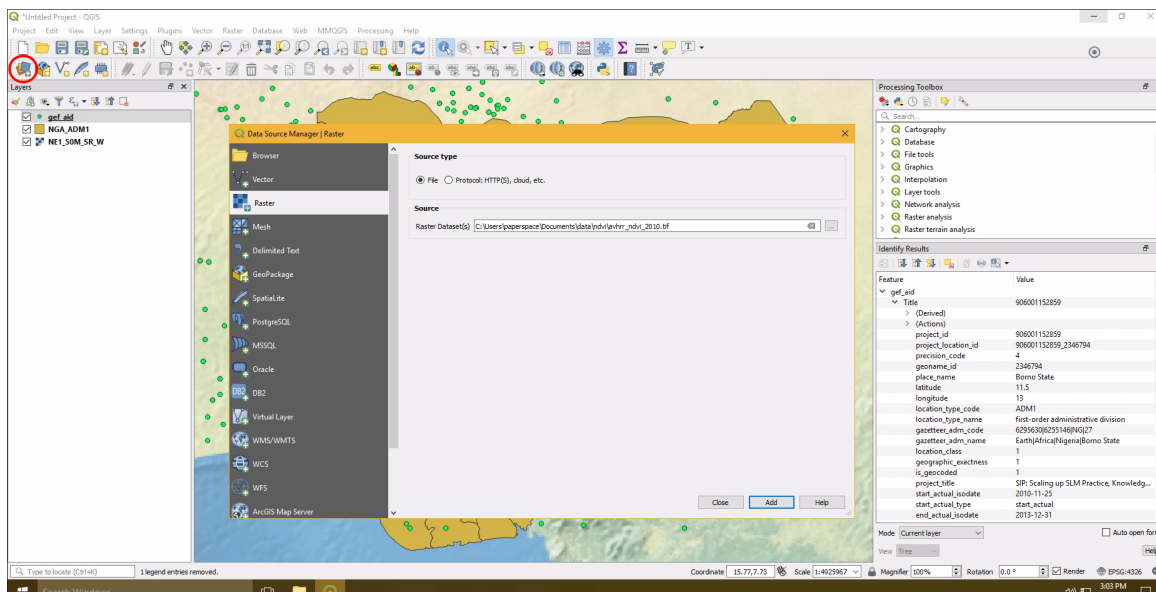
Show All Features

10. The Attribute Table also allows you to select and filter locations, create new fields using the field calculator, and zoom to selected fields. For example, you may wish to filter based on the precision with which project location were able to be geocoded.

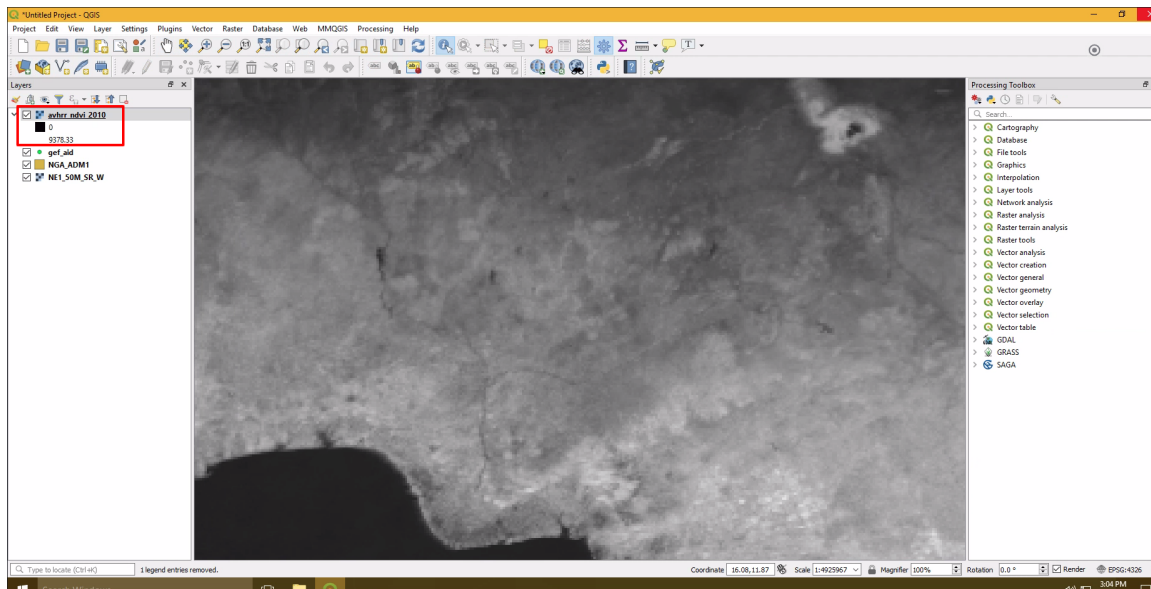
### 0.3.4 NDVI Satellite Imagery

Finally, we will add in our NDVI raster.

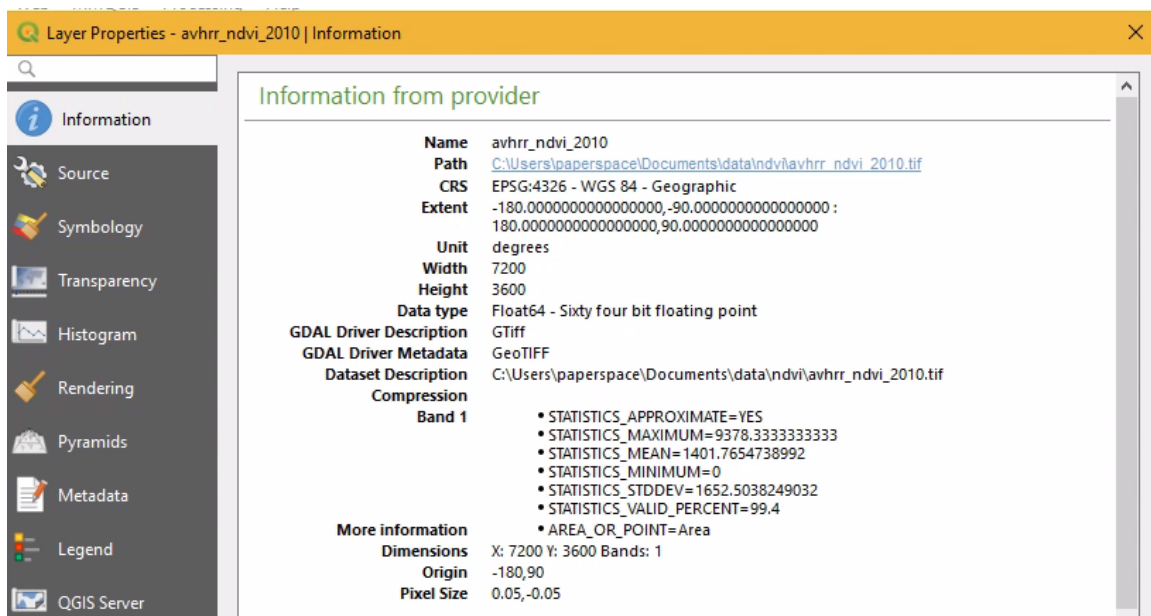
1. Using the Data Source Manager, go to the Raster tab and select the `.../Desktop/data/ndvi/avhrr_ndvi_2010.tif` file, then Add and Close



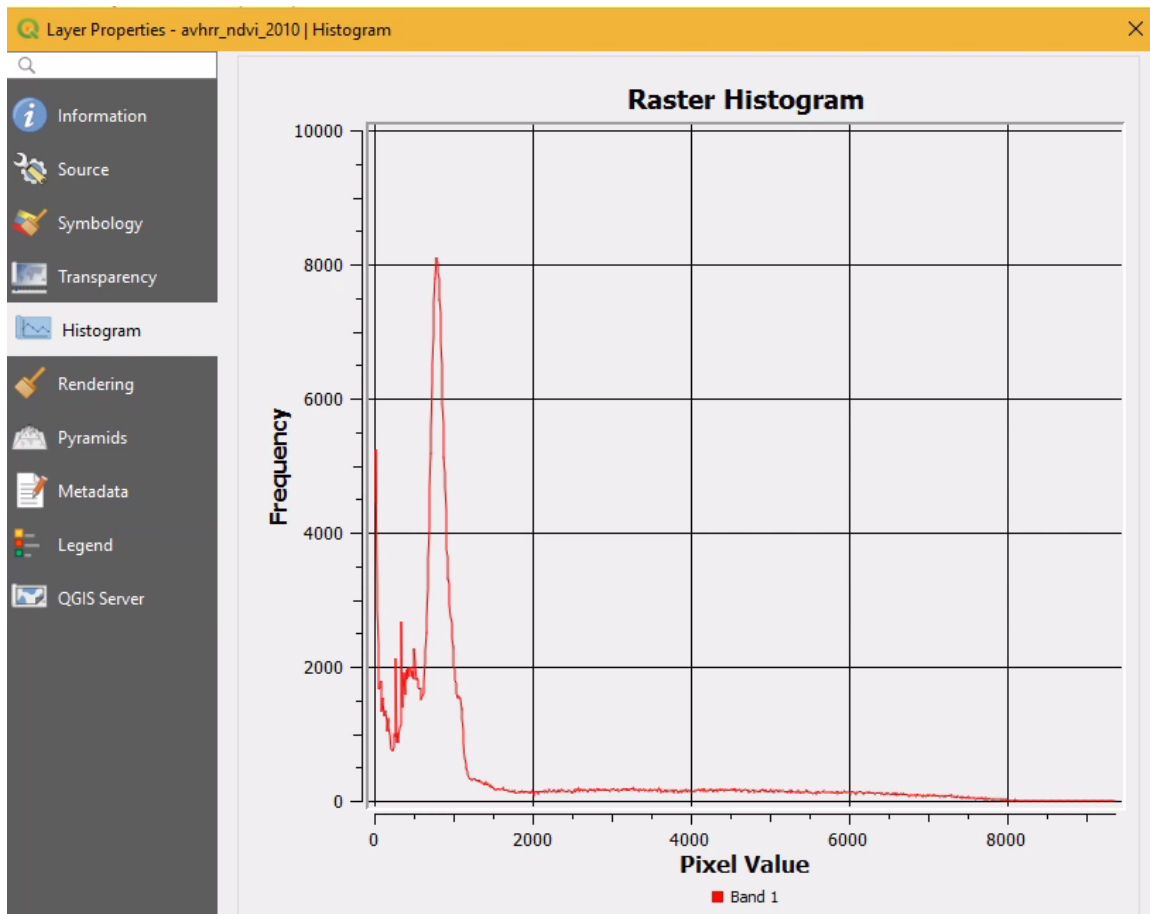
2. The NDVI layer defaults to a grey scale display. To change this, and explore other information about this layer, right click on the layer in the Layers window and select "Properties"



3. The "Information" tab will show basic statistics and metadata for this layer

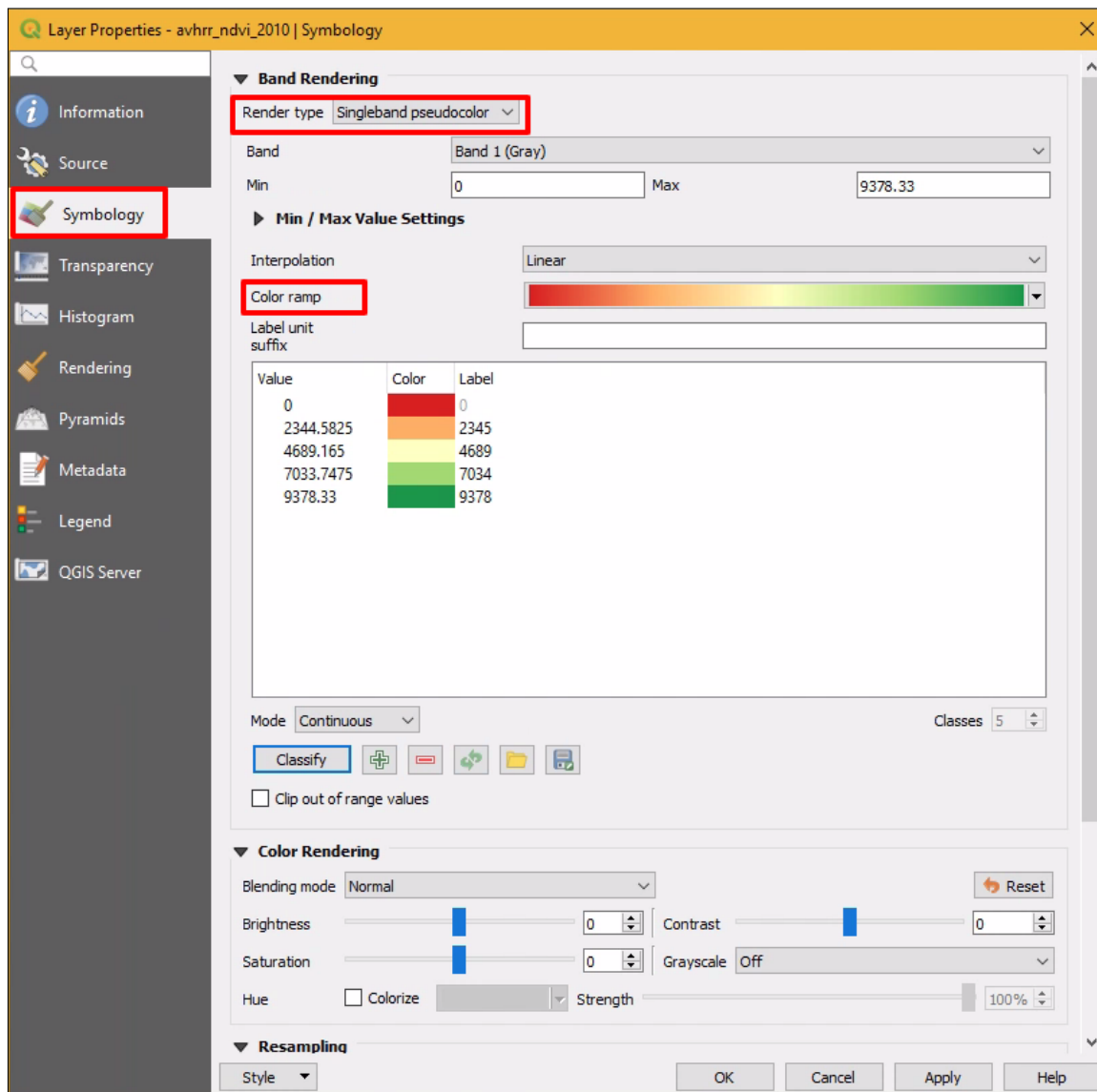


4. Value distributions can be found in the "Histogram" tab

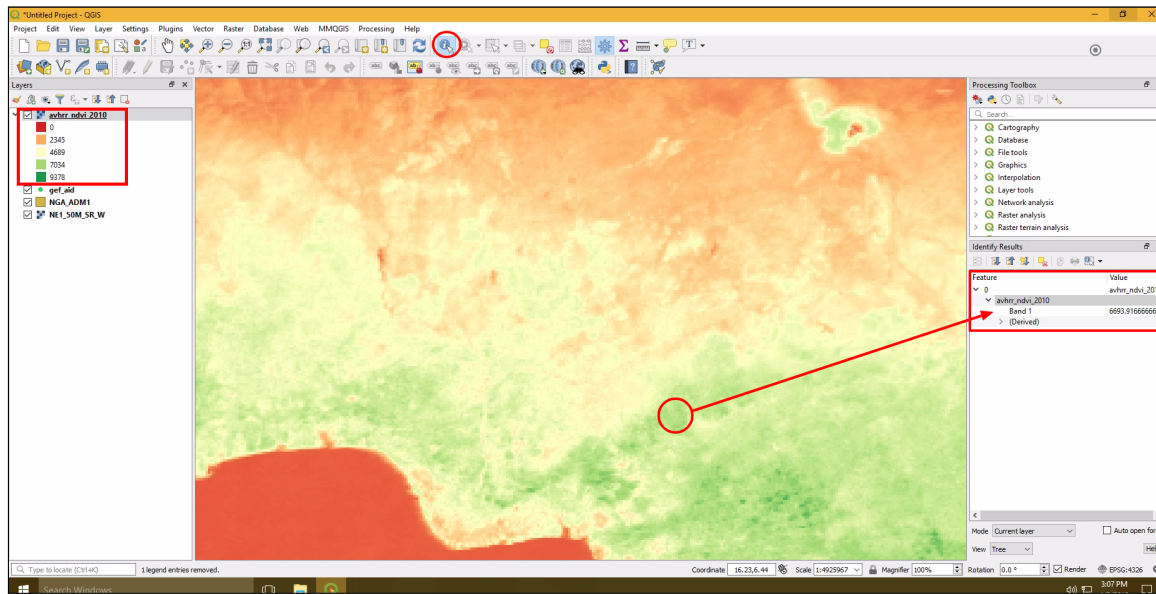


5. Go to the "Symbology" tab to change the style or coloring of this layer to be more intuitive for NDVI. We will Red-Yellow-Green color ramp in order to indicate low NDVI with and high NDVI with green.
  - Change "Render Type" to "Singleband Pseudocolor"
  - Click on the dropdown arrow for "Color ramp" and then go to the "All Color Ramps" option and select "RdYlGn"
  - Next click the "Classify" button, then "Apply" and "OK"

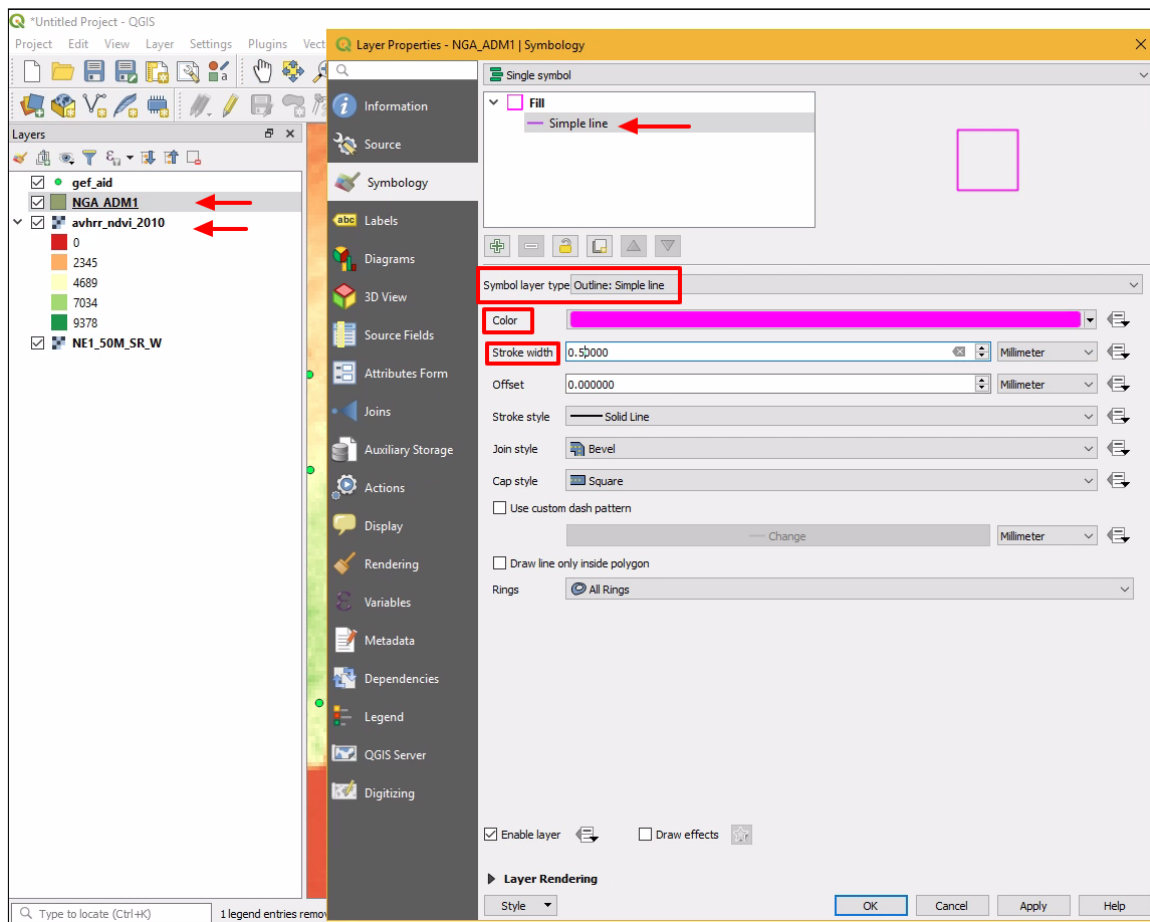




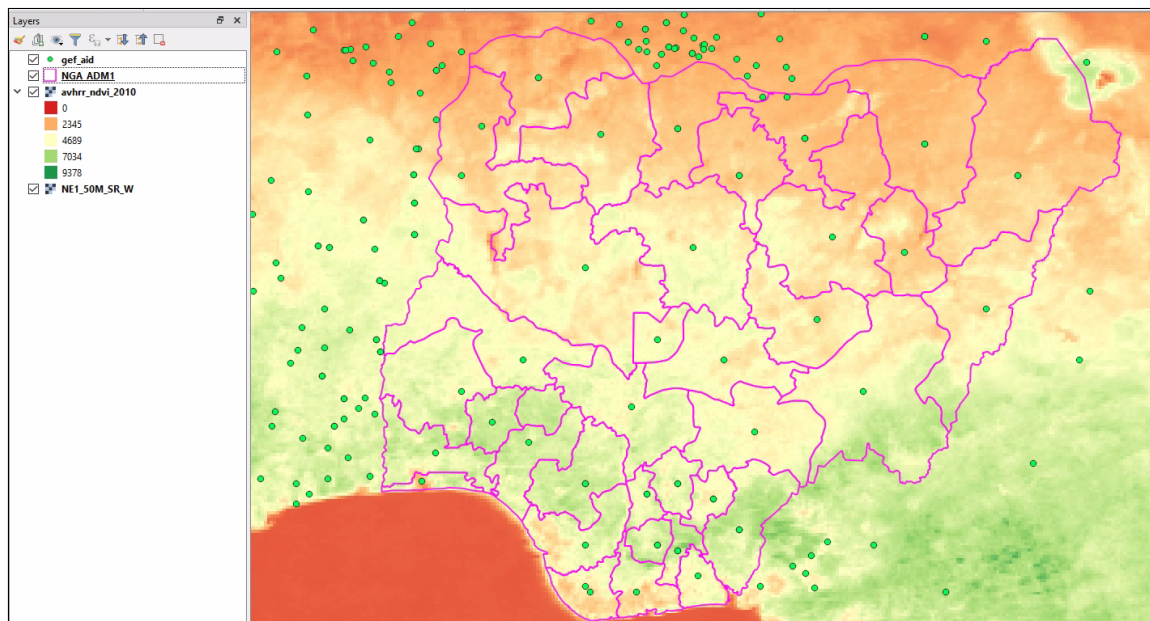
6. The new raster layer style should now be applied, like below



7. You can use the same "Identify Features" tool from before to look at individual pixel values but clicking at different points on the map. The values will appear in the "Identify Results" window on the right.
8. To visualize our Nigeria state boundaries and aid projects on top of the NDVI layer, we can adjust the order of layers in the "Layers" window by simply dragging layers.
9. Move the "NGA\_ADM1" and "gef\_aid" layers above the "avhrr\_ndvi\_2010" layer
10. Then, we can change the boundaries to display as only an outline instead of a solid fill.
11. Right click on "NGA\_ADM1", go to "Properties" and then "Symbology"
12. Click on "Simple fill" (below "Fill" in the white box)
13. Then change "Symbol layer type" to "Outline: Simple line"
14. Change the "Color" and increase the "Stroke width" to improve visibility



15. Then click "Apply" and "OK".



## 0.4 Preparing Data for Analysis

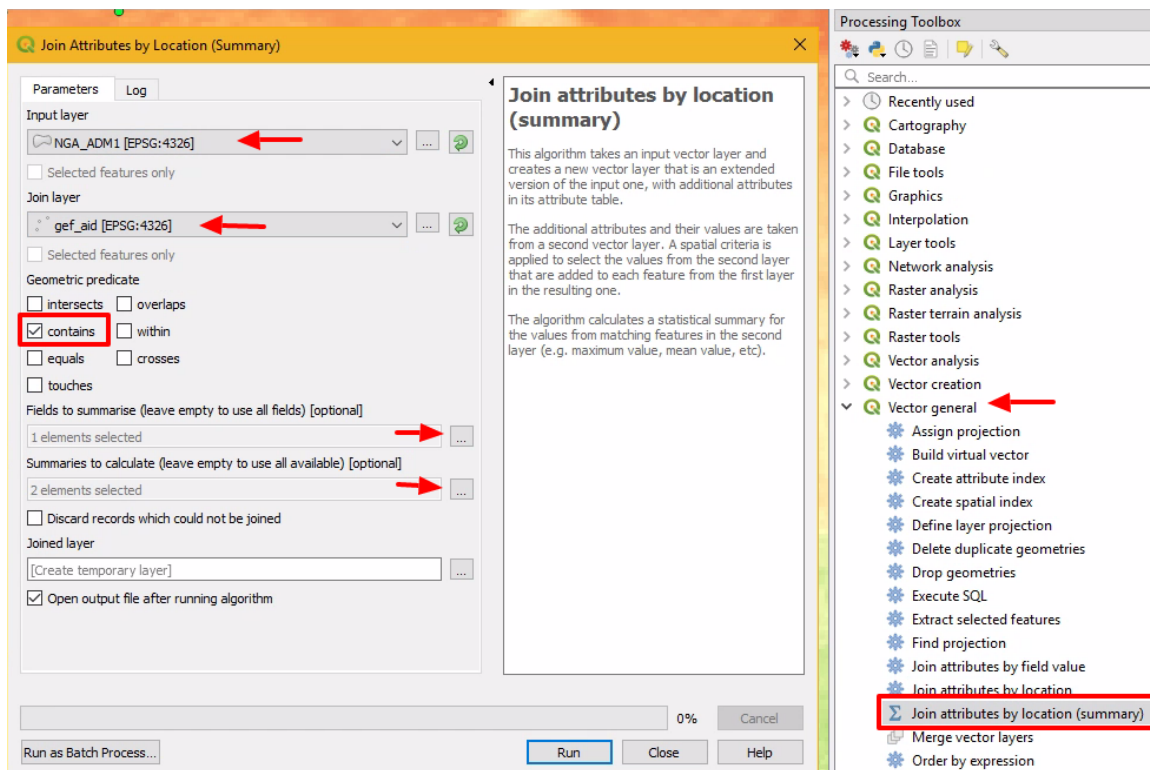
Using states in Nigeria as our unit of analysis, we will now explore how to aggregate both our GEF Geocoded Aid Project (point data) as well as our NDVI satellite imagery (raster data) to these units. This will provide us with a sum of project commitments for each state, as well as a mean NDVI value for each state.

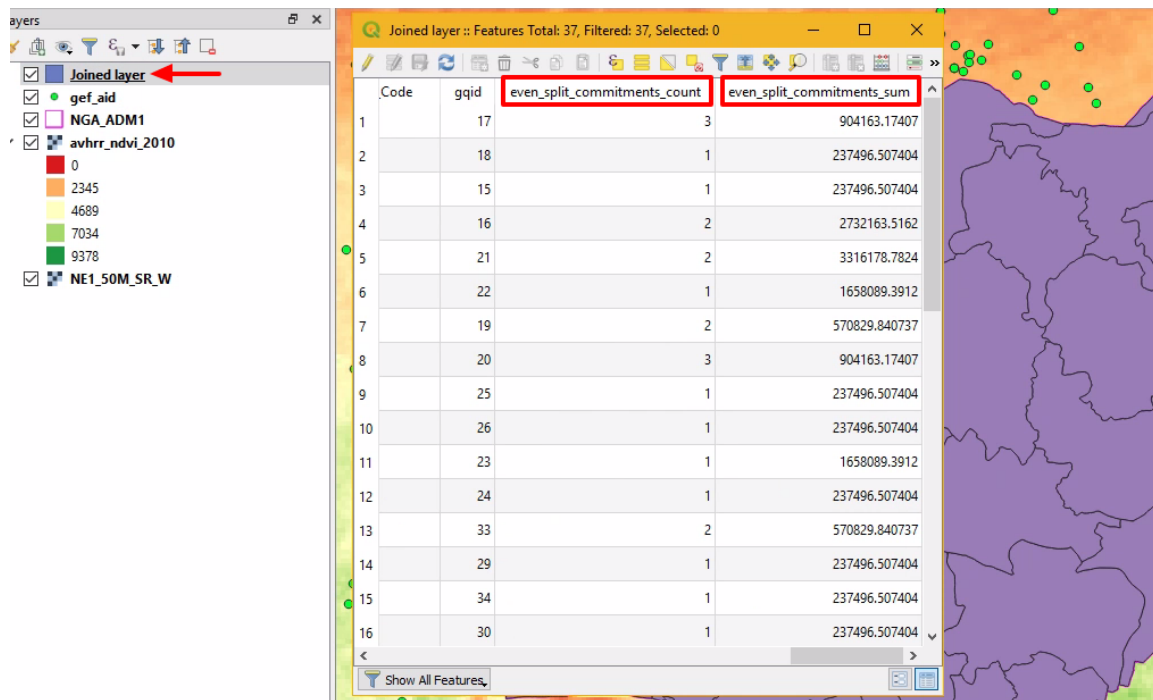
In this section we will first explore the tools and methods used to perform these aggregations manually in QGIS. In the next section we will see how the GeoQuery web platform can be used to make this process drastically faster and easier.

### 0.4.1 Point Data - Aid Projects

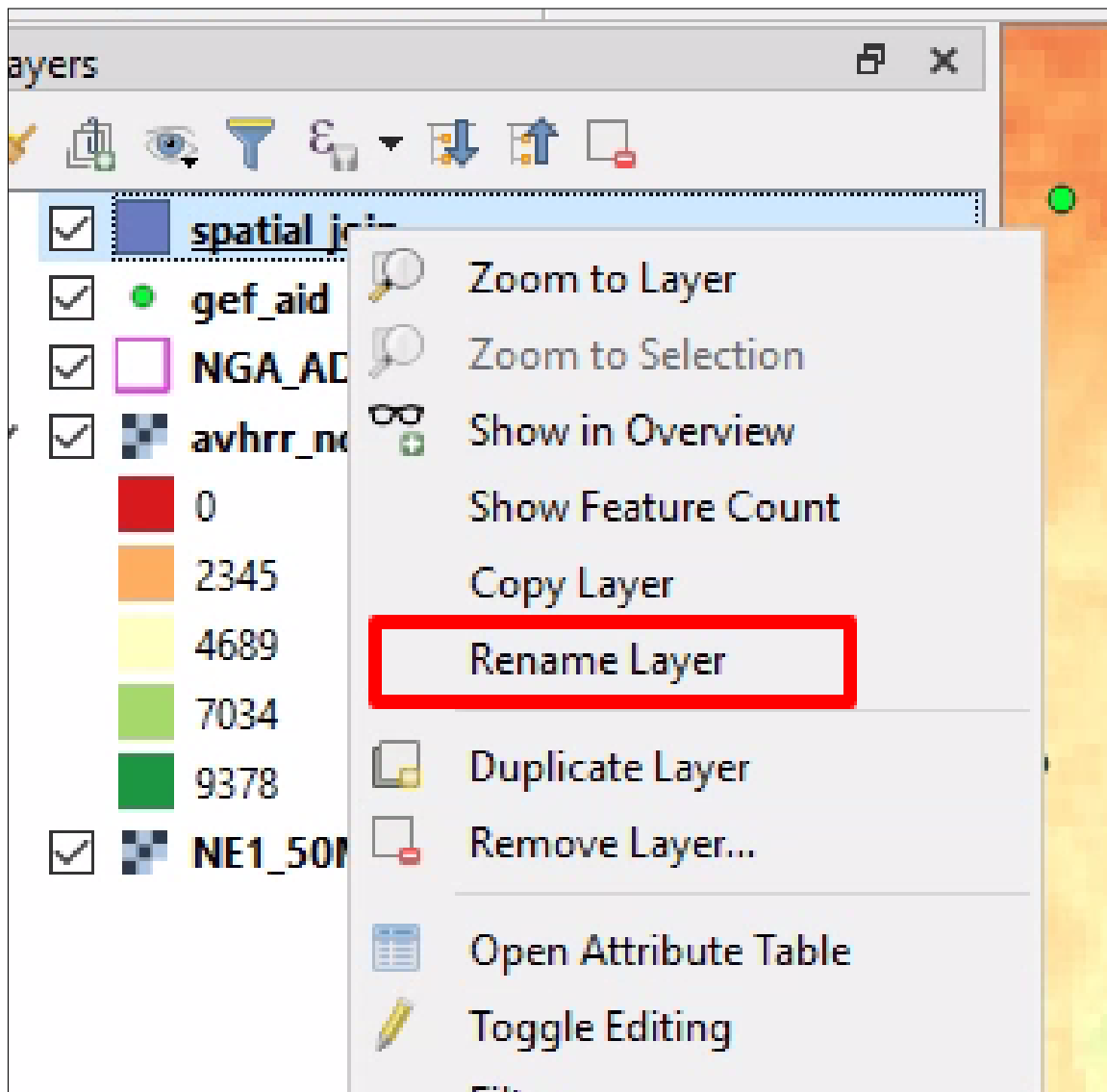
In this section, we are going to utilize a "Spatial Join" tool to calculate the total amount of project commitments going to each state. The spatial join is an operation that aggregates the attribute data from one layer (GEF geocoded aid) to another (Nigeria ADM1) based on a spatial association (e.g., overlapping) and an aggregation function (summation).

1. In the "Processing Toolbox" (right side of window) expand the "Vector general" section and then double click "Join attributes by location (summary)"
2. Set "NGA\_ADM1" as the Input layer (this is the layer we want data aggregated to)
3. Set "gef\_aid" as the Join layer (layer which has data we want to aggregate)
4. Select "Contains" as the spatial operation in "Geometric predicate".
5. Select "even\_split\_commitments" from "Fields to summarise"
6. Select "Count" and "Sum" from "Summaries to calculate"
7. Then click **Run**, and "Close" once it finishes (this may take a minute to complete, and will add a new layer named "Joined layer" to you map when it is done)



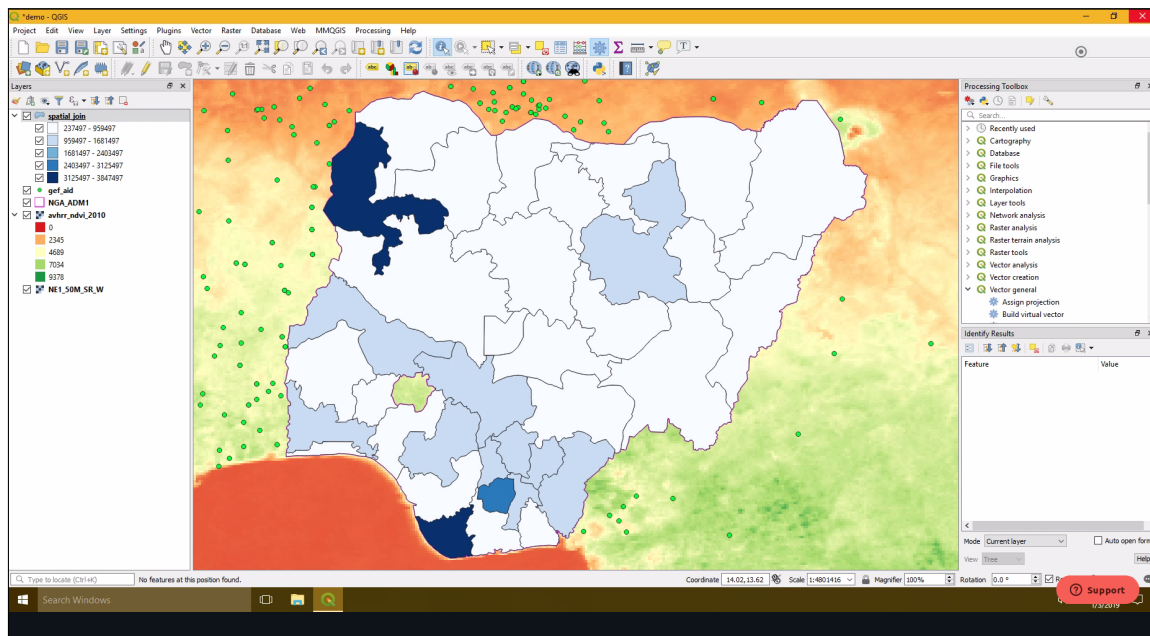
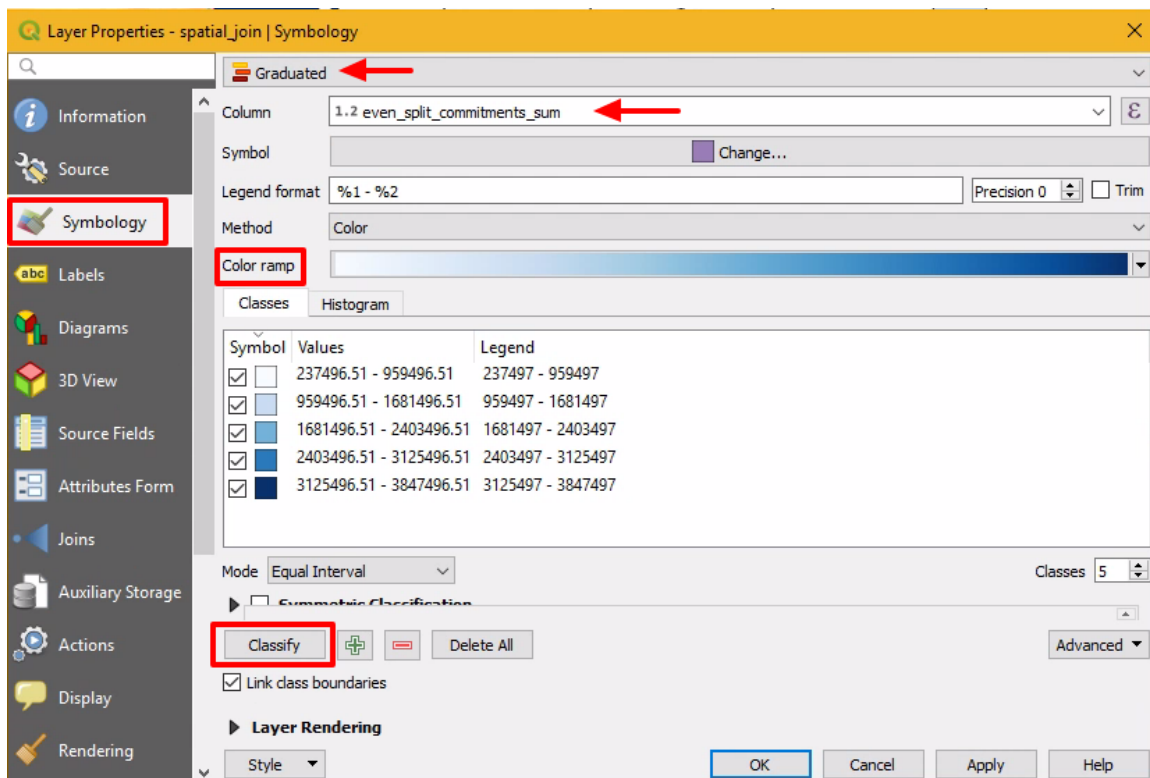


8. Check the attributes by right clicking the new layer and open the attribute table. The "even\_split\_commitments\_count" and "even\_split\_commitments\_sum" columns are the output. The count is the number of projects in each state. The sum is the sum of project commitments for each state.
9. Right click on this layer and select "Rename Layer" to change the layer name to "spatial\_join"



10. Now let's visualize distribution of aid across states in Nigeria
11. Right click on the **spatial\_join** layer and click "Properties", then go to the "Symbolology" tab
12. Change the "Simple Fill" drop down at the top to "Graduated" then select the "even commitment split sum" column from the drop down directly below.
13. There are various data classification mode provided by QGIS, such as "Equal Interval", "Equal Count", "Natural Break (Jenks)", "Standard Deviation", "Pretty Break". These classification modes use different statistical algorithms to break down the data into separate categories. For demonstration only and easy comparison with the later data visualization, we are going to use "Natural Breaks (Jenks)".
14. Click "Classify" button below
15. Finally, click "OK"

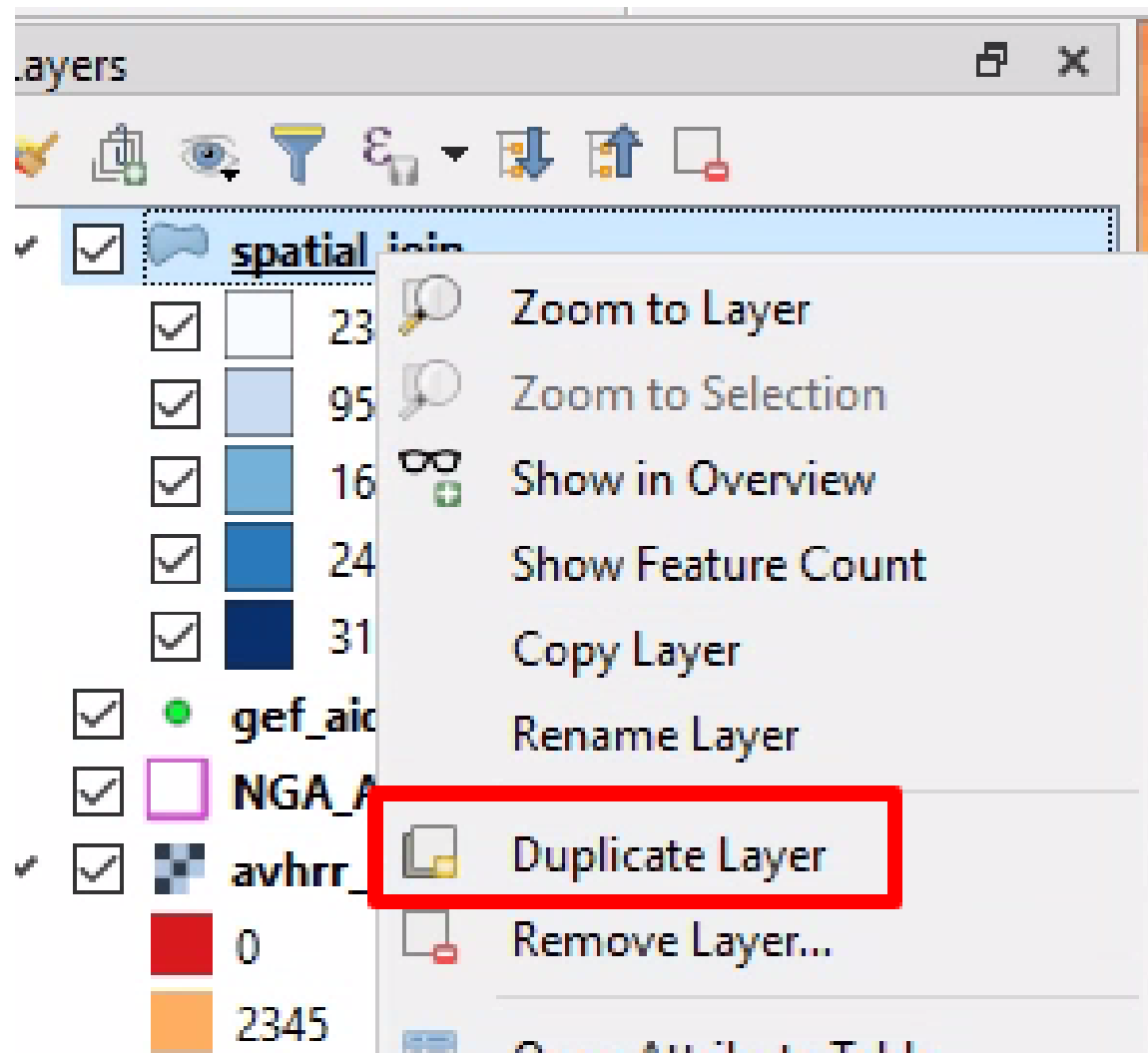




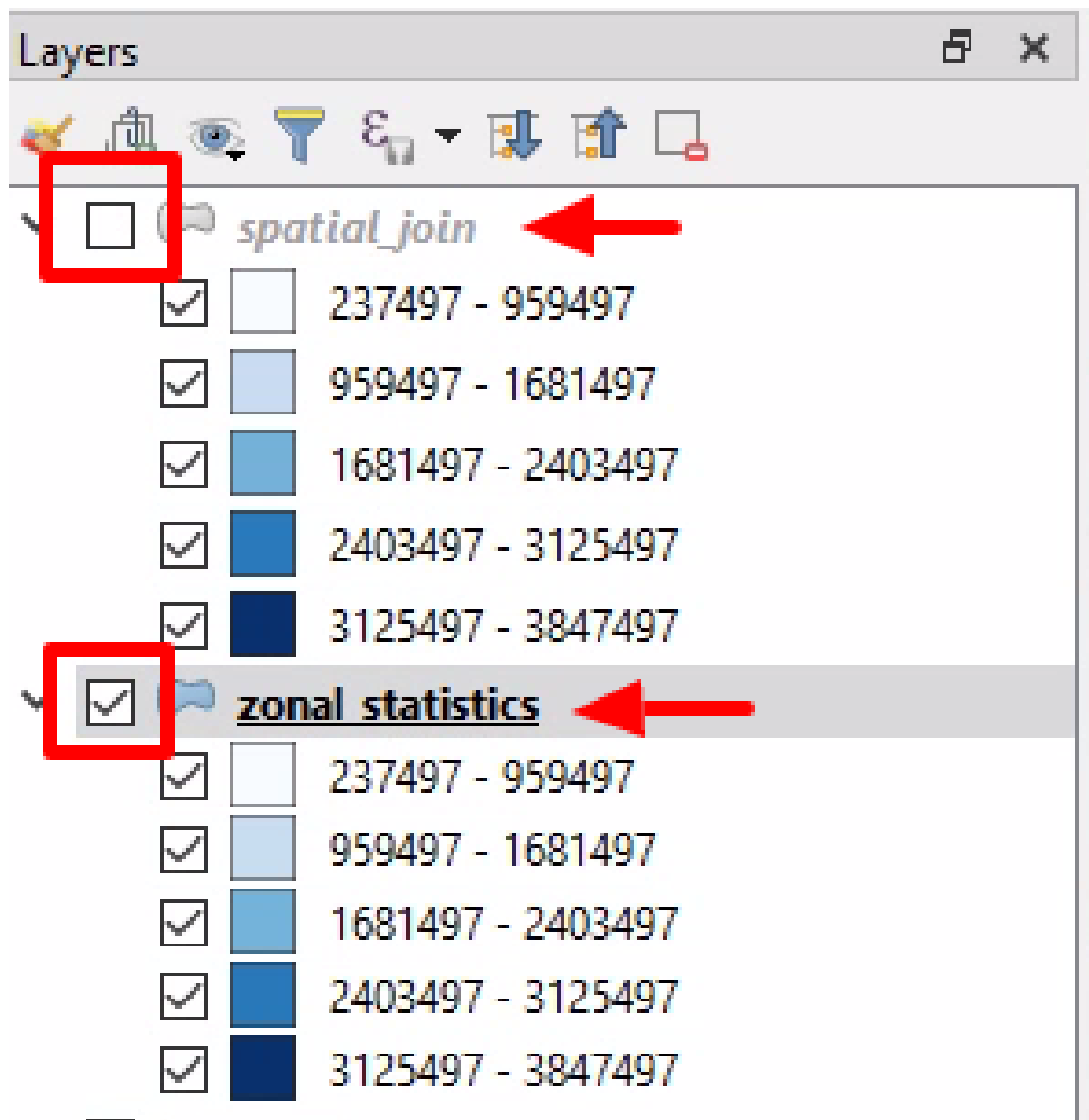
### 0.4.2 Raster Data - NDVI

With the zonal statistics tool, a summary statistic is calculated for each of the administrative states, based on overlapping pixel values from the input raster dataset. In this case, summary statistics of NDVI values for each administrative state will be calculated.

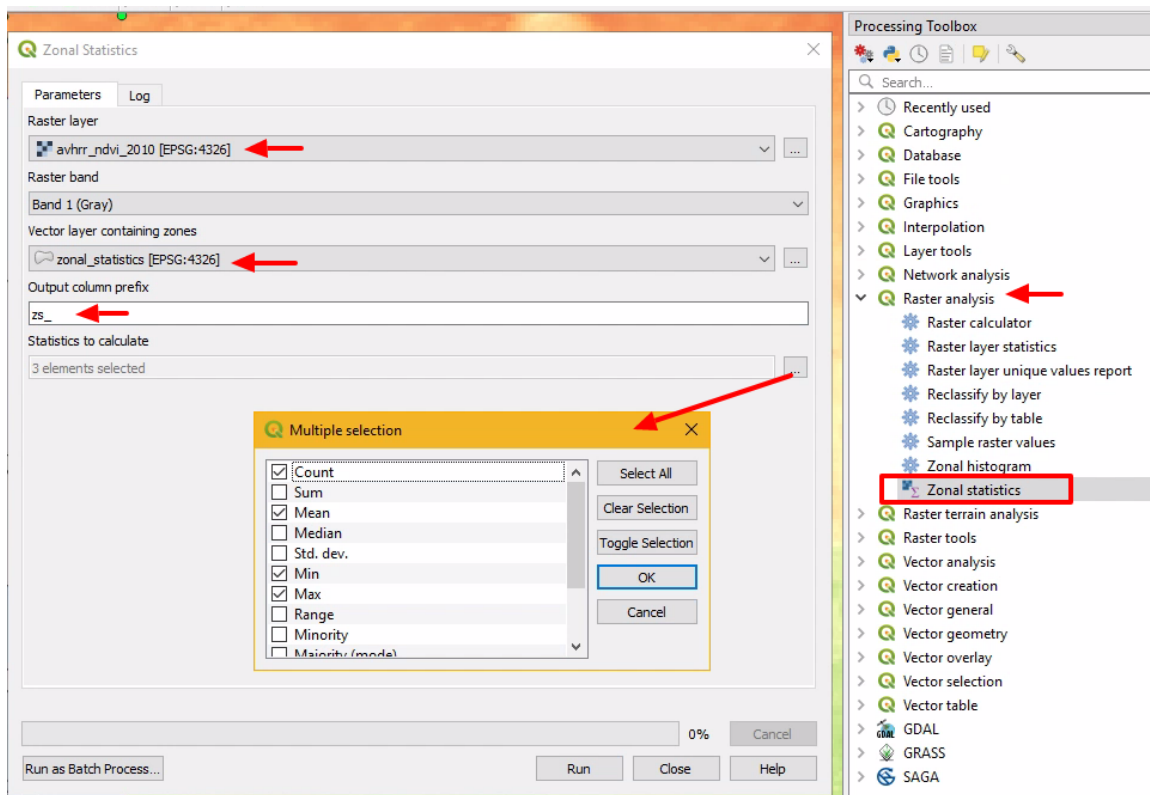
1. First, create a copy of the "NGA\_ADM1" layer by right clicking and selecting **Duplicate**
2. Then rename the new layer ("NGA\_ADM1 copy") to "zonal\_statistics" by right clicking and selecting **Rename**



3. You can adjust the visibility of the "spatial\_join" layer and new "zonal\_statistics" layer by clicking the checkboxes next to each layer. Let's turn off the "spatial\_join" and turn on the "zonal\_statistics" layer



4. Open “Zonal Statistics” by going to the "Raster analysis" menu in the "Processing Toolbox" and then selecting "Zonal statistics"
5. Set “avhrr\_ndvi\_2010” layer to be your Raster layer.
6. Set "zonal\_statistics" to be the vector layer.
7. Set the “Output column prefix” to “zs\_”.
8. Select "Count", "Mean", "Min", and "Max" from the "Statistics to calculate" options
9. Click "Run" and then "Close" when it finishes. This may take a moment to aggregate the raster NDVI value to your Nigeria state boundaries



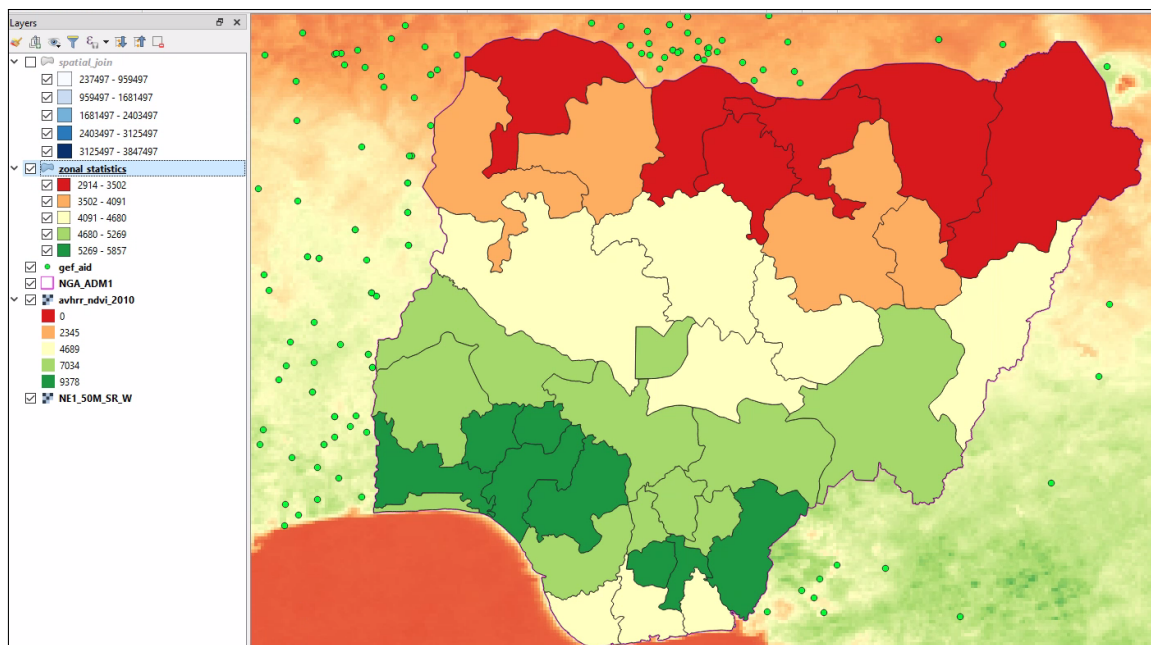
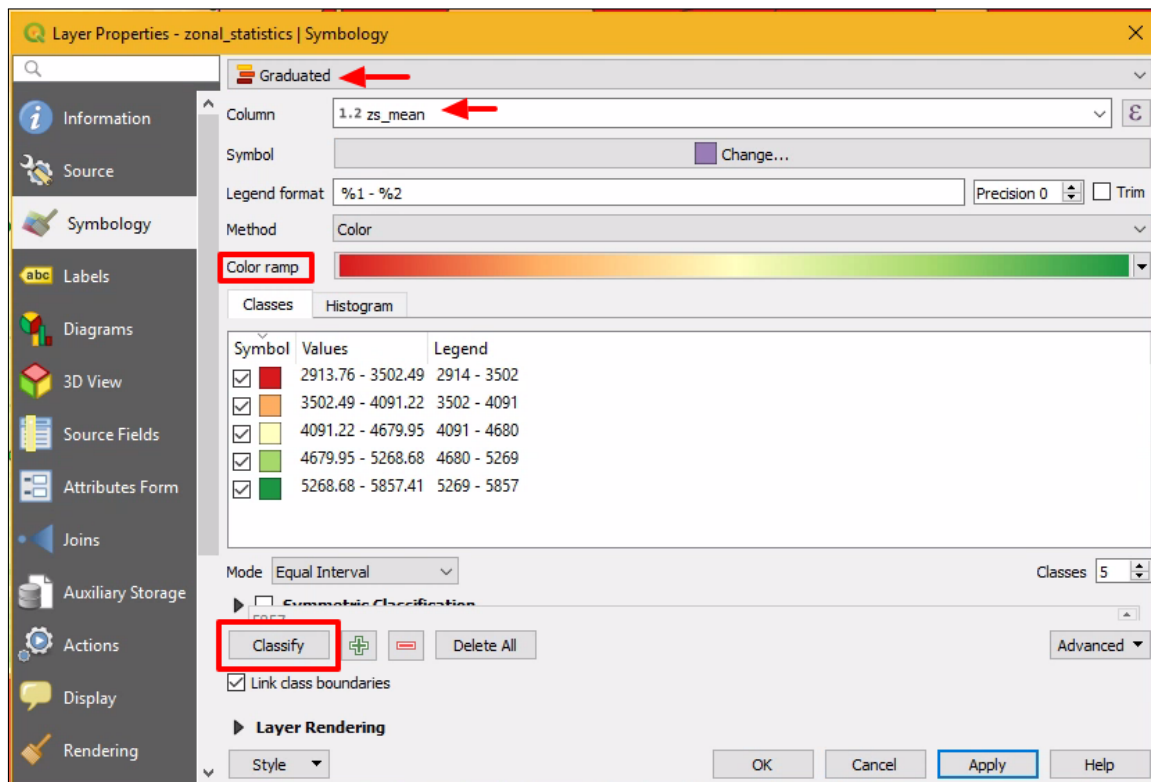
10. Next, right click "zonal\_statistics" layer and click "Open the Attribute Table" to check the new fields added by zonal stats
11. The new field representing the average NDVI value in each state can be found in the "zs\_mean" column. Additional "zs\_" columns have been generated representing the other aggregation methods (count of pixels, min NDVI value, max NDVI values)

zonal\_statistics :: Features Total: 37, Filtered: 37, Selected: 0

|    | itments_sum   | zs_count | zs_mean           | zs_min            | zs_max            |
|----|---------------|----------|-------------------|-------------------|-------------------|
| 1  | 904163.17407  | 779      | 3065.275780915... | 2436.083333333... | 4599.916666666... |
| 2  | 237496.507404 | 1463     | 4485.34455456824  | 3298.333333333... | 5553.083333333... |
| 3  | 237496.507404 | 573      | 3569.268179173... | 1946.833333333... | 4874.166666666... |
| 4  | 2732163.5162  | 167      | 5678.874750499... | 4541.583333333... | 7128.75           |
| 5  | 3316178.7824  | 1194     | 3584.454285315... | 1928.583333333... | 4935.833333333... |
| 6  | 1658089.3912  | 948      | 5053.961849507... | 3904.666666666... | 6496              |
| 7  | 570829.840737 | 674      | 3407.112141444... | 2498.333333333... | 5107.833333333... |
| 8  | 904163.17407  | 790      | 3125.815084388... | 2385.083333333... | 4298.333333333... |
| 9  | 237496.507404 | 877      | 4629.813473964... | 3445.75           | 5489              |
| 10 | 237496.507404 | 2378     | 4356.884636949... | 1509.083333333... | 5753.583333333... |
| 11 | 1658089.3912  | 1109     | 4789.035392245... | 3321.333333333... | 6092.583333333... |
| 12 | 237496.507404 | 123      | 4752.901084010... | 1703.416666666... | 6390.833333333... |
| 13 | 570829.840737 | 1072     | 3003.029695273... | 1777.916666666... | 4823.166666666... |
| 14 | 237496.507404 | 277      | 5857.413357400... | 4844.416666666... | 6897.166666666... |
| 15 | 237496.507404 | 1938     | 5052.861154110... | 3172.25           | 7020.25           |
| 16 | 237496.507404 | 909      | 5148.187660432... | 3513.25           | 6791.583333333... |

Show All Features

12. Now let's visualize these average NDVI value for each state. Right click the "zonal\_statistics" layer and click "Properties" then go to the "Symbology" tab
13. Select "Graduated" from the menu at the top of the style window
14. Select "zs\_mean" from the list of columns
15. Change the Color ramp to "RdYlGn"
16. Then click "Classify", and "OK"





## 0.5 Using GeoQuery

Now that we have explored how to manually prepare data using QGIS, you can imagine what it would be like if you had 20 different datasets you need to aggregate to 10 different sets of administrative boundaries.

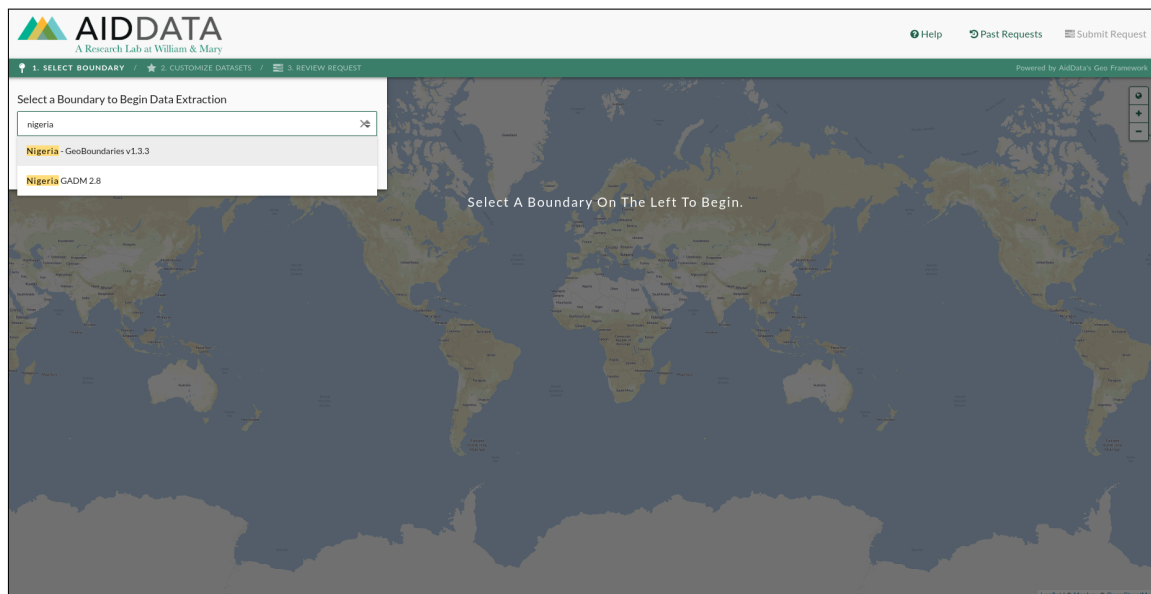
To help reduce technical barriers and processing burdens often associated with incorporating spatial data into research, AidData developed GeoQuery to do the work for you. GeoQuery offers over 45 datasets on aid, conflict, the environment, population, and more that can be aggregated to administrative boundaries for every country in the world.

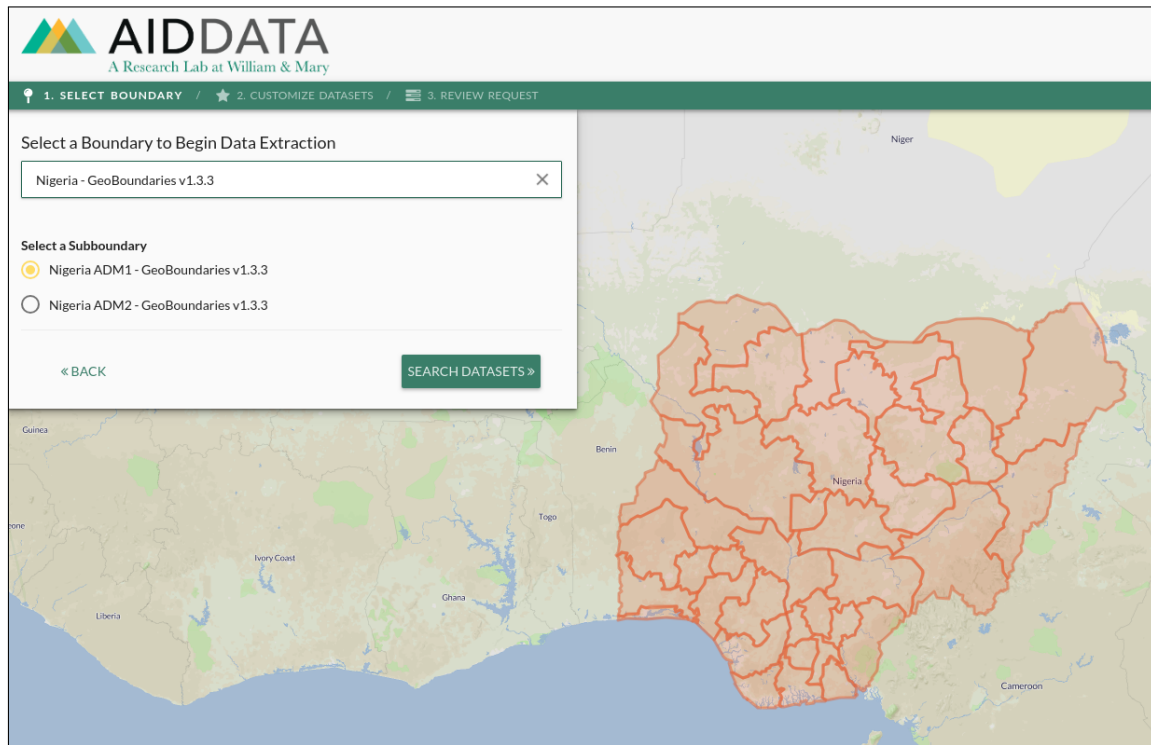
In this section we will look at how you can replicate the work we have just done in a fraction of the time by using GeoQuery.

### 0.5.1 Web Interface

To get started with GeoQuery, go to [geo.aiddata.org](http://geo.aiddata.org) and click the **Get Data** button.

1. The first page of GeoQuery is where you can select the unit of analysis - or the geographic boundaries you are interested in aggregating data to. Let's search for "Nigeria"
2. Select ADM1 or state option for Nigeria (**Nigeria ADM1 Boundary - GADM 2.8**)





3. Click the **Search Datasets** button to load all datasets in GeoQuery with data for Nigeria
4. Select **Global Environment Facility Geocoded Aid Data v1.1.0** on the left of the data selection screen. For this example, we will leave the default "All Sectors" filter and not select any additional filters. Other filters available include: project title, project status, commitment amount, start and end year, as well as location type and other geocoding details.
5. Click the **Add to Request** button.

1. SELECT BOUNDARY / 2. CUSTOMIZE DATASETS / 3. REVIEW REQUEST

Submit Request >

Select a Different Boundary

All Categories

Datasets (44/44) Advanced Options

World Bank Geocoded Aid Data v1.4.2

**Global Environment Facility Sectors Geocoded Aid Data v1.1.0**

Chinese Official Finance v1.1.0 - All Flow Types

Chinese Official Finance v1.1.1 - OOF-like Flow

Chinese Official Finance v1.1.1 - ODA-like Flow

Protected Areas (IUCN Categories)

VIIRS Nighttime Lights

DMSP-OLS Nighttime Lights

Precipitation (Yearly Average)

Air Temperature (Yearly Average)

UCDP Conflict Deaths

Ground Slope

Physical Elevation

Selection 99 projects / 1698 locations

Global Environment Facility Sectors Geocoded Aid Data v1.1.0

Extract data from Global Environment Facility Sectors Geocoded Aid Data V1.1.0 within Nigeria ADM1 - GeoBoundaries V1.3.3

Customization

Sectors Names (4)

☒ All Sectors Names

☐ Biodiversity

☐ International Waters

☐ Land Degradation

☐ Multi Focal Area

CREATE MORE FILTERS

6. Next click the **Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR)** dataset from the menu on the left
7. Choose **Mean** as the Extract Options, and **2010** under Years.
8. Click the **Add to Request** button.

1. SELECT BOUNDARY / 2. CUSTOMIZE DATASETS / 3. REVIEW REQUEST

Submit Request >

Select a Different Boundary

All Categories

Datasets (44/44) Advanced Options

VIIRS Nighttime Lights

DMSP-OLS Nighttime Lights

Precipitation (Yearly Average)

Air Temperature (Yearly Average)

UCDP Conflict Deaths

Ground Slope

Physical Elevation

On-Shore Petroleum

Yearly Daytime Land surface temperature - MODIS

MODIS Land Cover (GLCF, Version 5.1)

**Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR)**

Population Density (GPW V4, UN Adjusted)

Selection

Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR)

Extract data from Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR) within Nigeria ADM1 - GeoBoundaries V1.3.3 calculating Mean in 2010

Customization

Extract Options (1/3)

☐ All Extract Options

☐ Min

☒ Mean

☐ Max

Years (1/36)

☐ 2011

☒ 2010

☐ 2009

☐ 2008

☐ 2007

☐ 2006

9. Click Submit Request in the upper-right, then Review Request.
10. Enter the email address you would like the results sent to on the right, and click submit

With the above steps completed, your request will have triggered a job on the SciClone high performance computing cluster at the College of William and Mary. All jobs are processed dynamically,

so depending on the complexity of your request you will likely receive a completion email within 5 minutes to approximately 4 hours for extremely large or complex jobs.<sup>3</sup>

When your job is complete, you will receive an email directing you to the permanent download page for that data. You can also always retrieve your history of data requests and downloads by clicking "Past Requests" at the upper-right of GeoQuery and entering your email address.

RETURN TO CURRENT REQUEST

START A NEW REQUEST

Request Status

Submitted Processing **Completed**

REQUEST ZIP DOCUMENTATION PDF RESULTS CSV

**Request 01-03-19 12:23 is ready for download!**

- Submitted: Jan 03, 2019
- Boundary: Nigeria ADM1 - GeoBoundaries v1.3.3
- Customization: 1 AISData Selection and 2 External Dataset Selections

**CSV Column Names**

Each CSV will contain a column labeled "asdf\_id" which has values for each feature that are unique (within that boundary dataset), one or more columns for your extract data, followed by the original source attributes for the boundary file (e.g., from GADM).

The standard format for extract data column names is a three part string delimited by periods (.)

Example: <dataset>.<filter>.<method> ~ gpw\_v4\_count.2010.sum

For more details, please read the documentation pdf accompanying your request results.

Selections included in Request 01-03-19 12:23

Global Environment Facility Sectors Geocoded Aid Data v1.1.0 DETAILS

Extract data from Global Environment Facility Sectors Geocoded Aid Data v1.1.0 within Nigeria ADM1 - GeoBoundaries V1.3.3

Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR) DETAILS

Extract data from Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR) within Nigeria ADM1 - GeoBoundaries V1.3.3 calculating Mean in 2003 and 2010

DMSP-OLS Nighttime Lights DETAILS

Extract data from DMSP-OLS Nighttime Lights within Nigeria ADM1 - GeoBoundaries V1.3.3 calculating Mean in 2003 and 2010

If for some reason you cannot submit a new job or it is taking more than a few minutes to complete, you can view the results page for an existing request we created for the same data:

<http://geo.aiddata.org/query/#!/status/5c2e4511c15e002940b7ff8f>

## 0.5.2 Understanding Results

Once your request is completed, you can download three different files: a PDF containing descriptions of your data, a CSV containing your data itself, and a zip file containing everything generated during your request (including CSV and documentation). If you download the CSV and open it in a common program such a Libre Office or Excel, you will see an output very similar to that seen below.

|   | A       | B   | C                                    |
|---|---------|---|--------------------------------------|
| 1 | asdf_id | globalenvironmentfacility_geocodedresearchrelease_level1_v1_1_0.2f7c253.sur | ltldr_avhrr_ndvi_v4_yearly.2010.mean |
| 2 | 0       | 13879.0323585   | 4068.06387235                        |
| 3 | 1       | 1979661.38747   | 2503.54696242                        |
| 4 | 2       | 2282784.5174  | 2644.79167597                        |
| 5 | 3       | 2507967.70174   | 7207.18815481                        |
| 6 | 4       | 4927579.805   | 6878.50744427                        |
| 7 | 5       | 7424211.90277   | 3532.9963398                         |

Each row represents a geographic boundary, and each column represents data associated with that boundary. In the PDF automatically prepared for you, you will find a description of exactly what each column means, how it was generated, and how to cite the underlying information. To identify what a column name means, the quickest way to find it is to open your documentation PDF and

<sup>3</sup>The average request time is about 2 minutes but in some cases jobs may take 24 hours (or longer) depending on the number of users on the system (i.e. if many users concurrently put in extremely complex jobs). If you have put in a request for a job and it has been longer than 24 hours, you can reach out to the GeoQuery support team at [geo@aiddata.wm.edu](mailto:geo@aiddata.wm.edu).

search through it (i.e., ctrl+f ) for the name of the column. Units and other key information are provided in the documentation as well.

#### Selection 2 - Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR)

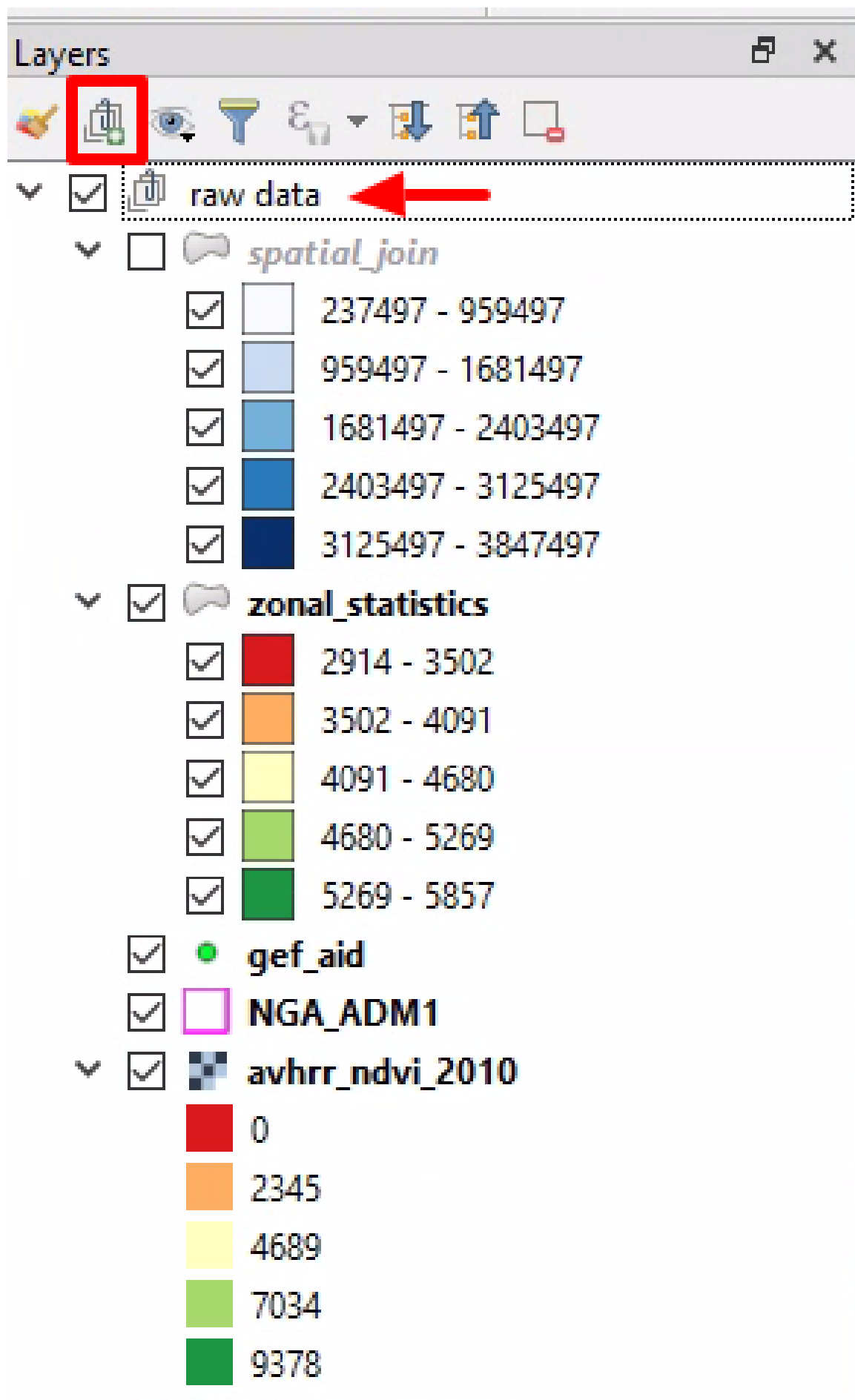
|                        |  |
|------------------------|--|
| Title                  | Normalized Difference Vegetation Index - NDVI (LTDR v4 - AVHRR)  |
| Name                   | ltdr_avhrr_ndvi_v4_yearly  |
| Version                | 4  |
| Column Names           | Format:<br>"ltdr_avhrr_ndvi_v4_yearly.<temporal>.<method>"<br>for all combinations of <temporal> and <method><br>which can be found in the "Temporal Selection" and<br>"Extract Types Selected" fields below (1 columns<br>total)                            |
| Temporal Selection     | 2010   |
| Extract Types Selected | mean (average NDVI value per unit of analysis)   |
|                        |  |
| Description            | Yearly value for Normalized Difference Vegetation Index (NDVI). Created using the NASA Long Term Data Record (v4) AVHRR data.  |
| Details                | Created by aggregating daily data to monthly by taking the maximum value, then averaging the monthly data to get yearly values. All negative NDVI values were truncated to 0 and saturated pixels were adjusted to the max of the normal NDVI range (10000). |
| Bounding Box           | [[[-180.0, 90.0], [-180.0, -90.0], [180.0, -90.0], [180.0, 90.0], [-180.0, 90.0]]]   |
| Date Added             | 2017-07-25   |
| Date Updated           | 2017-07-25   |
| Source Name            | NASA/Goddard Space Flight Center   |
| Source Link            | <a href="http://ltdr.nascom.nasa.gov/ltdr/ltdr.html">http://ltdr.nascom.nasa.gov/ltdr/ltdr.html</a>  |
| Citation               | Pedely JA, Devadiga S, Masuoka E et al. (2007) Generating a Long-term Land Data Record from the AVHRR and MODIS Instruments. Proceedings of IGARRS 2007, pp. 1021–1025. Institute of Electrical and Electronics Engineers, NY, USA.                          |
| Variable Description   | positive NDVI values 0:10000   |
| Resolution             | 0.05   |
| Factor                 | 10000.0  |

### 0.5.3 Visualizing Results in QGIS

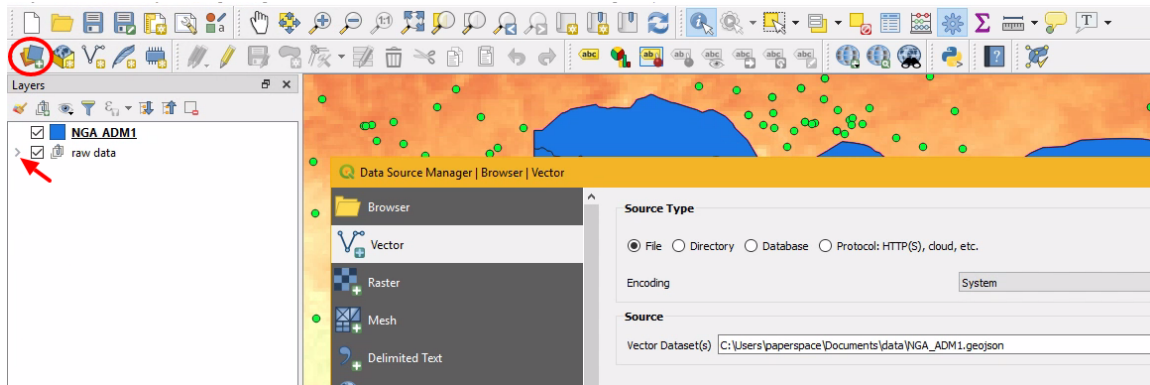
In this section, we are going to visualize the data that you request from the last section. To save time, we included the request results in the *data* folder for you.

1. First, let's move all of our existing layers into a group so that we can manage our data more easily.
  - Use the "Add Group" button in the "Layers" window to create a new group called "raw data"
  - Then select all the existing layers and drag them into this group
  - You can now toggle the visibility of this group or collapse the group's contents to make room

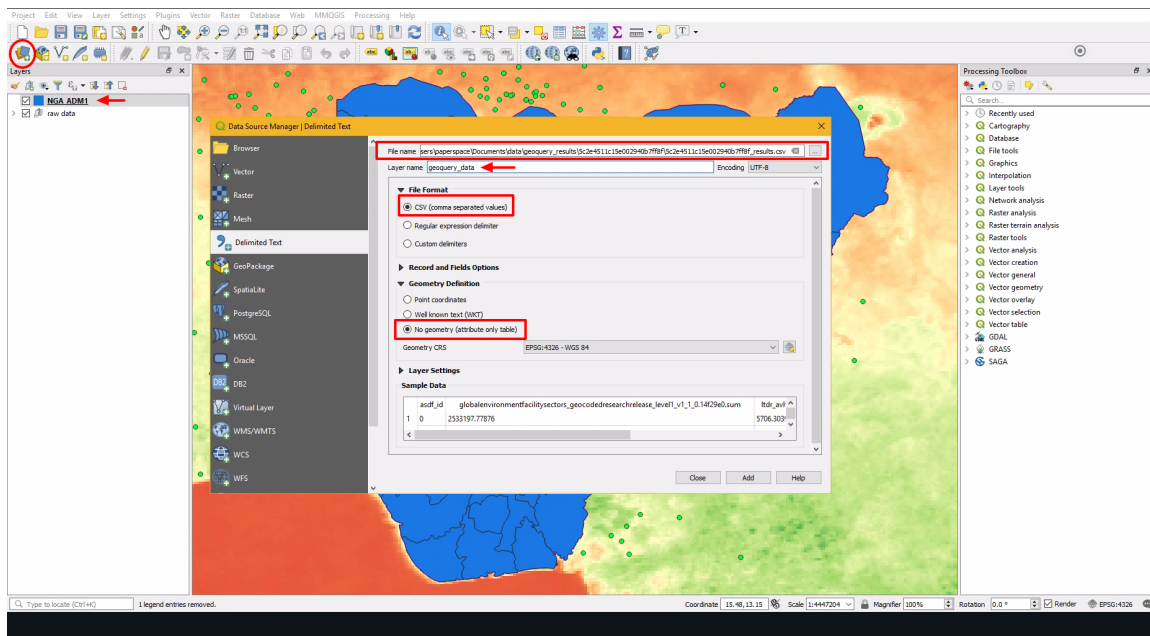




2. Next, let's load in a fresh copy of our Nigeria state boundaries

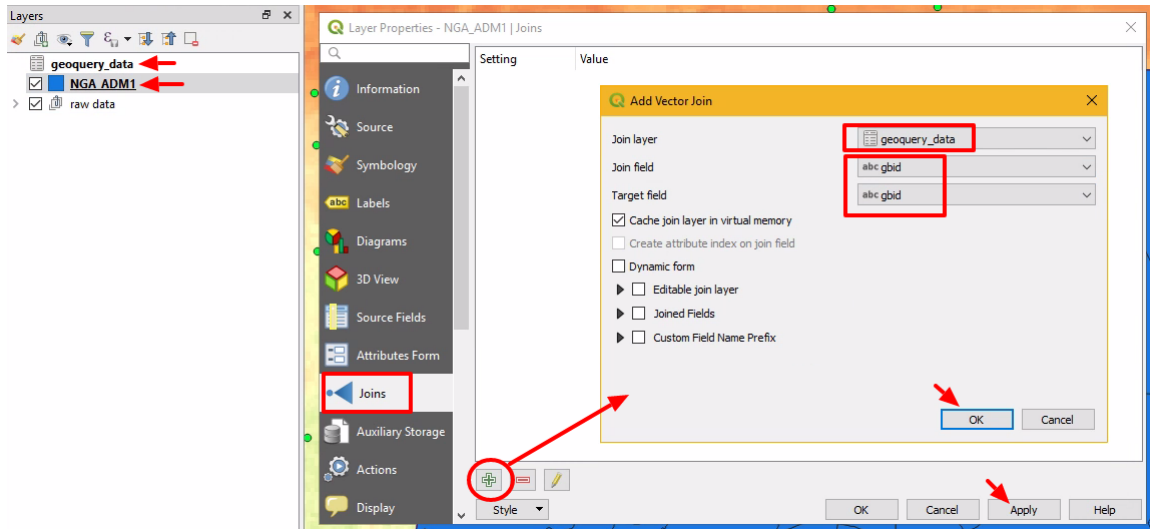


3. Now we will add the GeoQuery results to QGIS as a data only layer. We will join this to our Nigeria State boundaries after.
4. Add the .csv file by opening the Data Source Manager and using the "Delimited Text" tab to add the **.../Desktop/data/geoquery\_results/5c2e4511c15e002940b7ff8f/5c2e4511c15e002940b7ff8f\_results.csv** file
5. Name the layer "geoquery\_data"
6. Since this .csv is an attribute only file, make sure to select "No geometry" in the Geometry definition.
7. Click "Add" and then "Close"

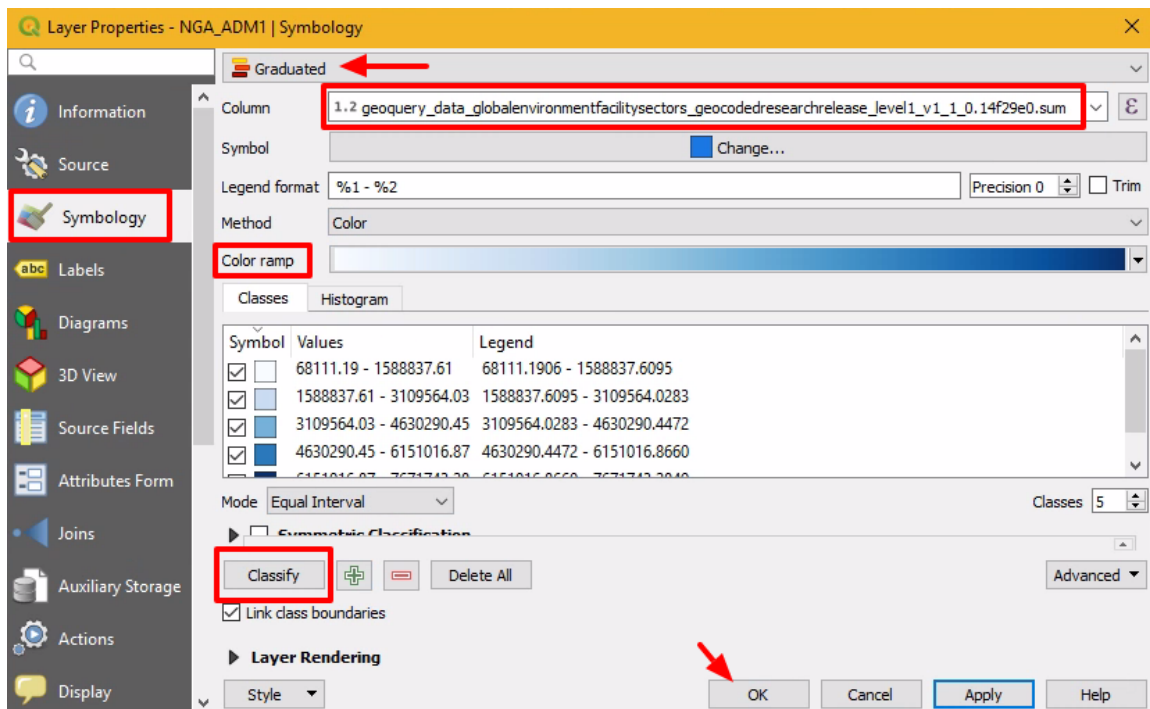


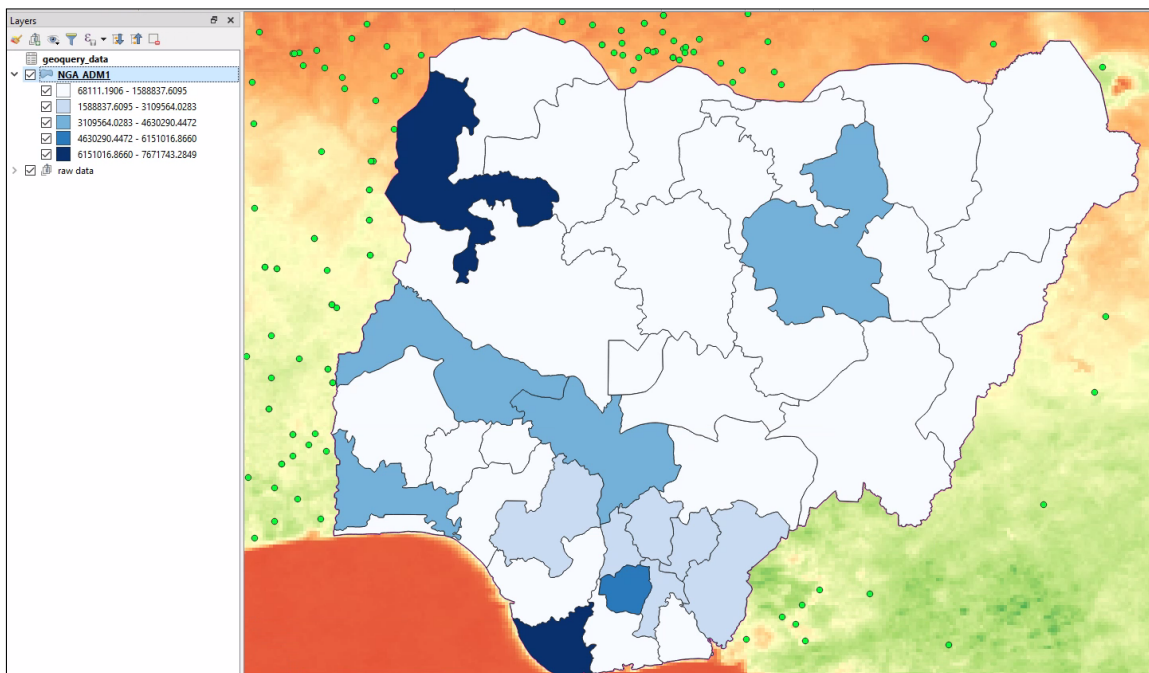
8. Now let's join the GeoQuery data to our boundaries by right clicking on the new "NGA\_ADM1" layer and going to "Properties" and then the "Joins" tab
9. In the "Joins" tab, click "+" sign on the bottom.

10. Choose "geoquery\_data" as "Join Layer".
11. Select "gbid" as both the "Join field" and "Target field"
12. Click "OK" and then "Apply"

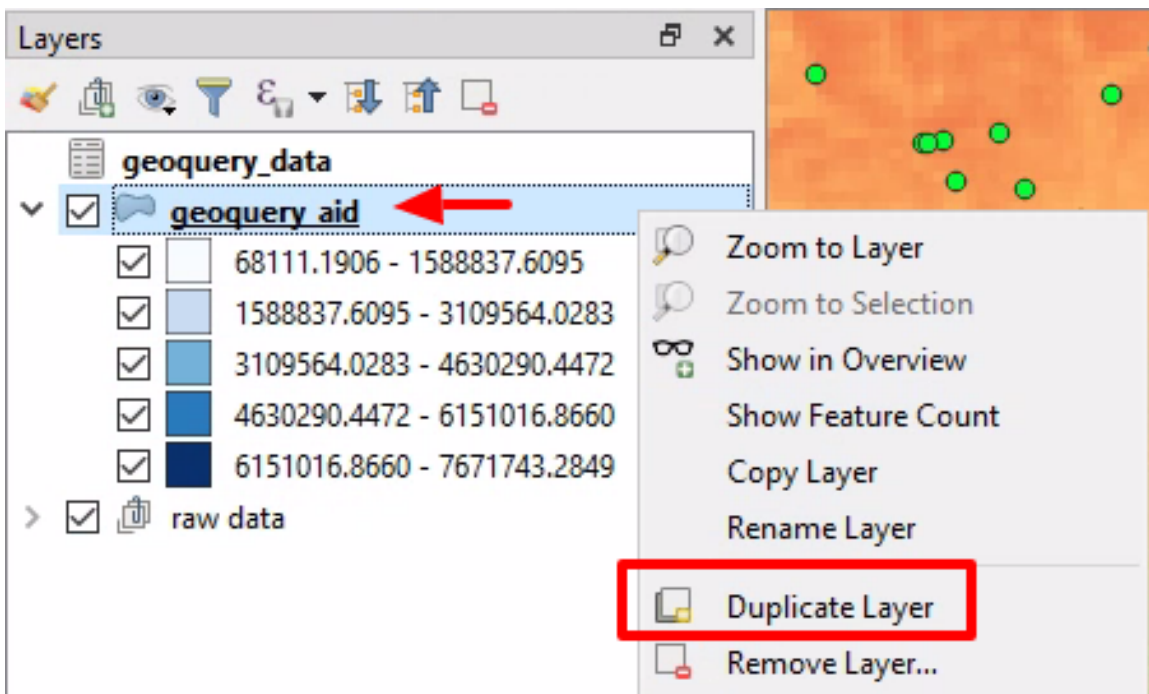


13. Without closing the Properties window, go to the Symbology tab to style our layer with the newly joined data
14. Change the "Simple Fill" drop down at the top to "Graduated".
15. Select "geoquery\_data\_globalenvironmentfacilitysectors\_geocodedresearchrelease\_level1\_v1\_1\_0.14f29e0.sum" as the column.
16. Set the color ramp to "Blues"
17. Click "Classify" and the "OK"



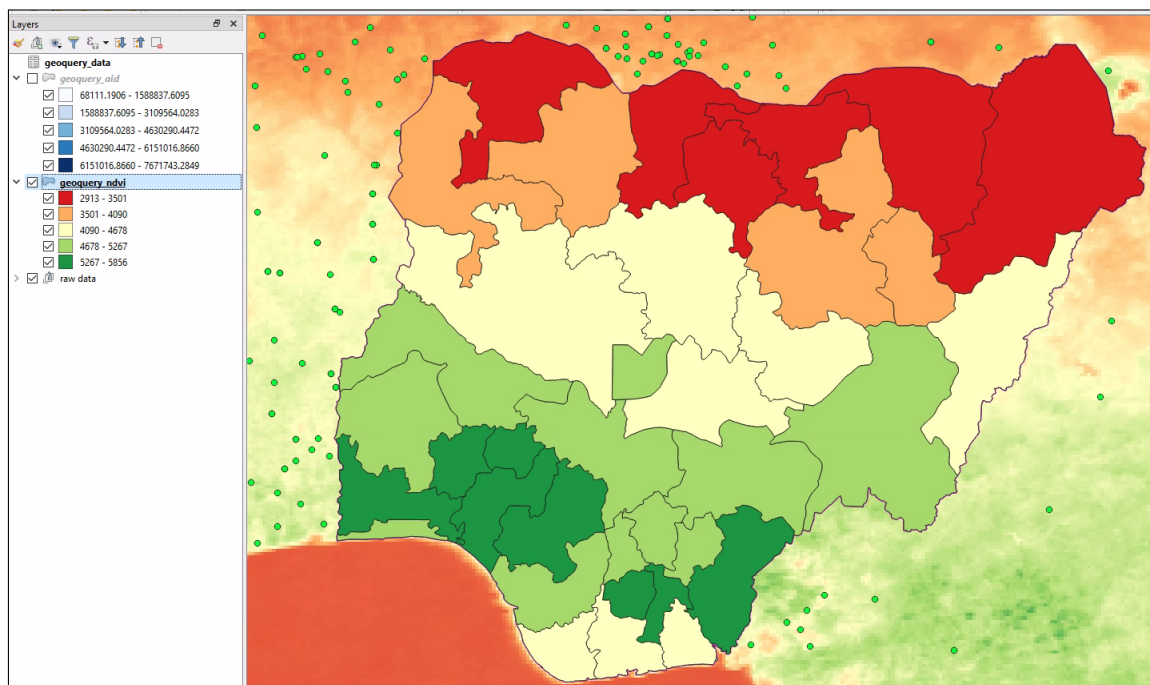
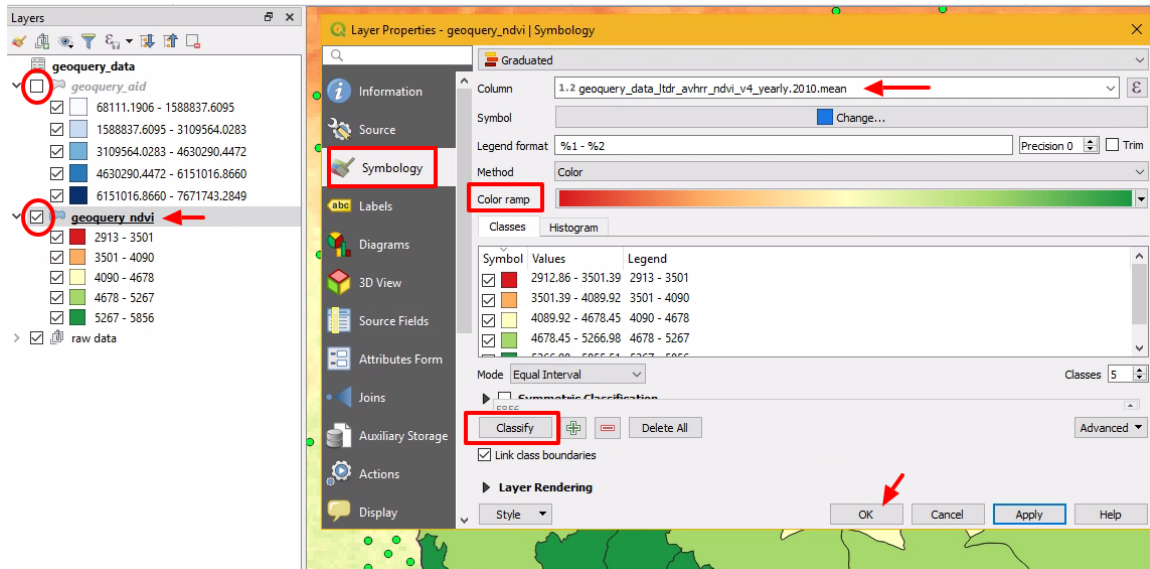


18. To visualize the NDVI data from GeoQuery, we will rename our layer to "geoquery\_aid", create a duplicate of the layer, and rename the duplicate to "geoquery\_ndvi"



19. Open the layer properties for the "geoquery\_ndvi" layer and go to the "Symbology" tab.  
 20. Change the column to "geoquery\_data\_ltdr\_avhrr\_ndvi\_v4\_yearly.2010.mean" in the column.  
 21. Set the color ramp to "RdYlGn"

22. Click "Classify" and then "OK".



For general raster data, GeoQuery should usually provide similar results to the zonal statistics method used in QGIS, but improvements in underlying algorithms often result in at least some difference. Differences may be more noticeable in some cases for a variety of reasons including raster measurement data resolution and the size of boundary features being used.

The methods for aggregating aid data used in GeoQuery are substantially different than the point

based method we explored in QGIS. GeoQuery uses codes assigned during the geocoding process to associate each project location with more realistic polygon based geometries. Aid is then dispersed across these polygons rather than being assigned to a single point location.