Intermediate GQIS Tutorial:
Add XY Data, Rasters & Heatmaps

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This tutorial will introduce novice users to using a variety of raster tools within QGIS. The spatial questions that will be examined are:

- How has the population changed between 1995 and 2000?
- Where was conflict occurring in Africa in 1995 and 2000?
- How does the density of fatalities relate to the change in population?

The tutorial will cover the following tools:

- Adding Rasters
- Identifying Features & renaming Layers
- Stylizing Rasters
- Raster Calculator
- Viewing Metadata of results
- Adding XY Data from Excel
- Select by Expression Review
- Setting Coordinate Systems
- Creating Heatmaps using Plugins
- Clipping Rasters

Accessing the Data:

1. If you are working in the Data Lab, the tutorial data is available in **S:\Tutorials & Tip Sheets\Tufts\Tutorial Data\QGIS_Intermediate_Rasters**

2. You can download the data that will be used in the tutorial as well. Save it to a known location, such as your H drive or USB.

Data Set Name	Link	Source
Population Density Grid, v3 (1990, 1995, 2000) People per Sq Km Download: - 1995; .ascii at 2.5' - 2000; .ascii at 2.5'	http://sedac.ciesin.columbia.edu/data/set/gpw-v3-population-density/data-download	Socioeconomic Data and Applications Center (SEDAC), hosted by CIESIN at Columbia University
ACLED Version 7 (1997 – 2016)	http://www.acleddata.com/data/acled-version-7-1997-2016/	Armed Conflict Location & Event Data Project
Continents	http://www.gadm.org/	Global Administrative Boundaries (GADM)

## Adding & Stylizing Raster Datasets

1. Open QGIS Desktop

2. There are several ways to add data; the browser, Layer → Add Raster Layer, or by using the Add Raster Layer icon.

3. Select both the zipped population density folders by holding down the shift button and press open.

4. Each zip file contains 2 grid files. The **a** in the filename suggests that the population counts were adjusted to match the UN totals. We will use the adjusted grids for this tutorial. Select **glds00ag.asc** and press ok.
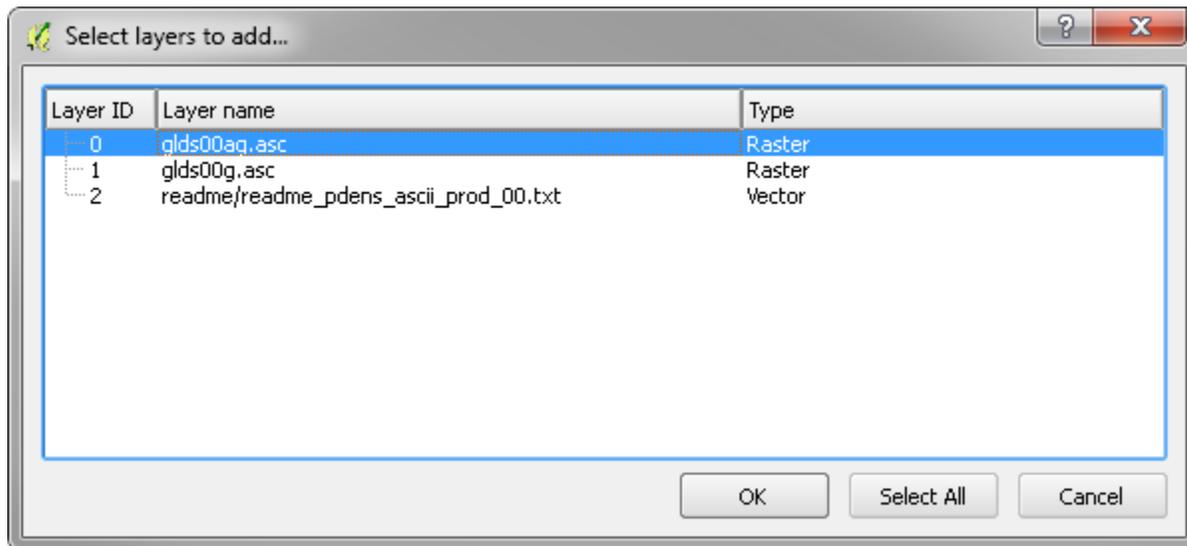
5. The layer doesn't have a Coordinate Reference System (CRS) defined, and since the grids are in lat/long, choose **WGS 84, Authority ID: EPSG:4326**.

6. Repeat this step for the 2nd layer we selected: **glds95ag.asc.**

7. **Both Rasters have been added.** The raster is in a grayscale color scheme where darker pixels indicate lower population densities and lighter pixels indicate higher population densities. Let's change the color scheme so it makes more sense!

8. Double click on the **glds95ag** to open the **properties**.

9. In the **Style** tab, change the Render type to **Singleband Pseudocolor.** Choose a light to dark color scheme and press **classify.** Note all the color rendering options at the bottom of the toolbox.
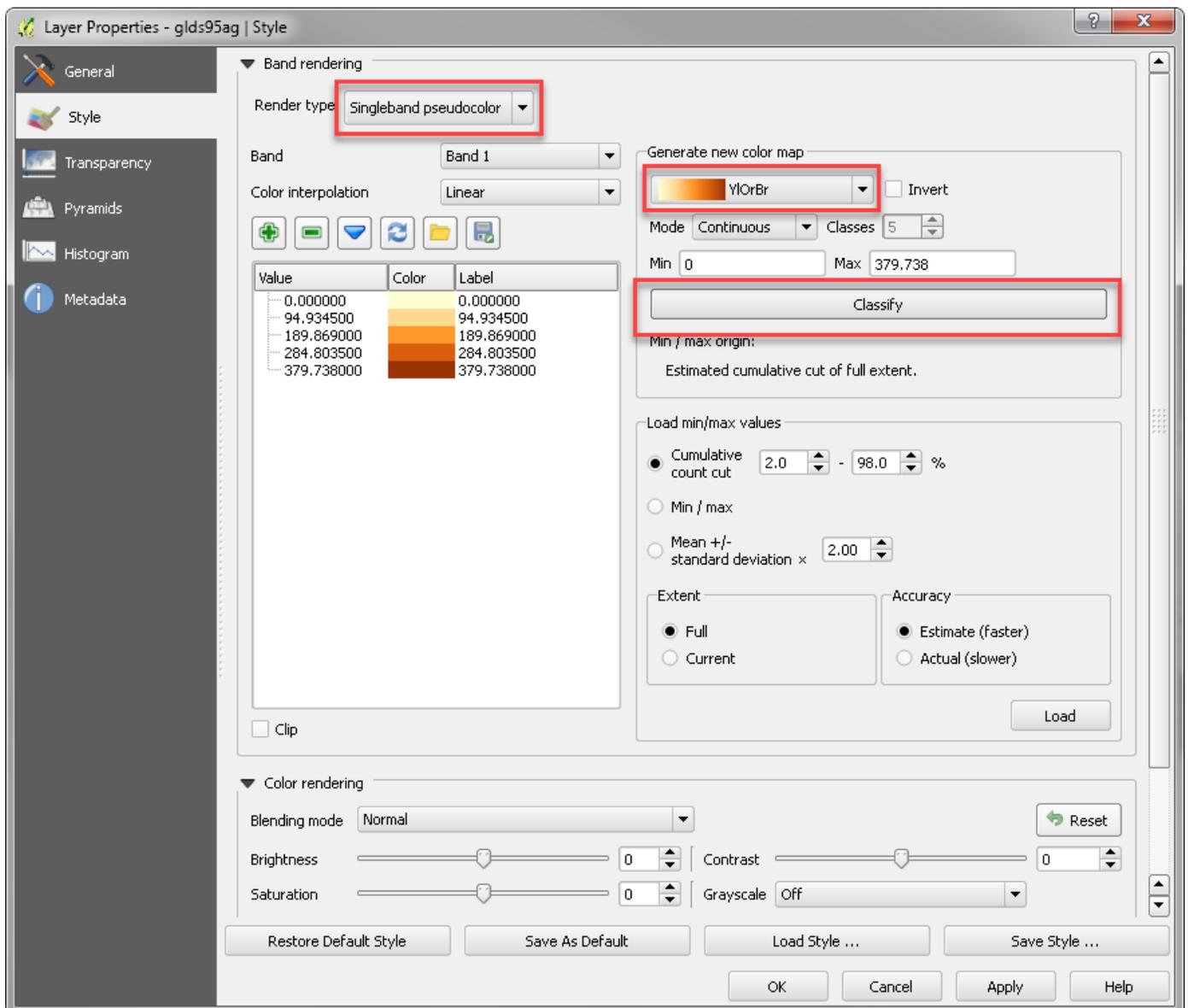
10. Repeat these steps with the **glds00ag layer,** selecting the same color ramp.

11. We can turn on and off the top layer to see the difference between the two for quick comparison.

12. For good data management practices, let's change the name of these two layers. Right click on **glds95ag** and select **Rename.** Let's change the name of this layer to **Population Density 1995.** Then, rename **glds00ag** to **Population Density 2000.**

Using Raster Calculator to Calculate the Change in Population Density

In order to determine how the population density per square kilometer has changed between 1995 and 2000, we will use the **Raster Calculator**.

1. In the menu toolbar, select **Raster → Raster Calculator.**
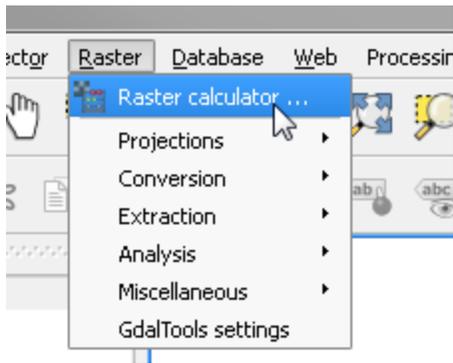
2. Notice how our layers new names now show under **Raster Bands**. In order to calculate change, we need to write a simple equation where our 1995 layer is subtracted *from* the 2000 layer, so positive numbers represent an increase and negative numbers represent a decrease.

   To enter this Expression, double click on **Population Density 2000@1**, click the **subtraction operator**, and double click **Population Density 1995@1**. Note: the @1 represents the band number. This dataset only has 1 band.

3. Change the Output Layer location by clicking on the … Navigate to a personal storage location, such as your H drive, and save the new layer as **PopChange95_00.** Make sure **Add Result to Project** is checked.
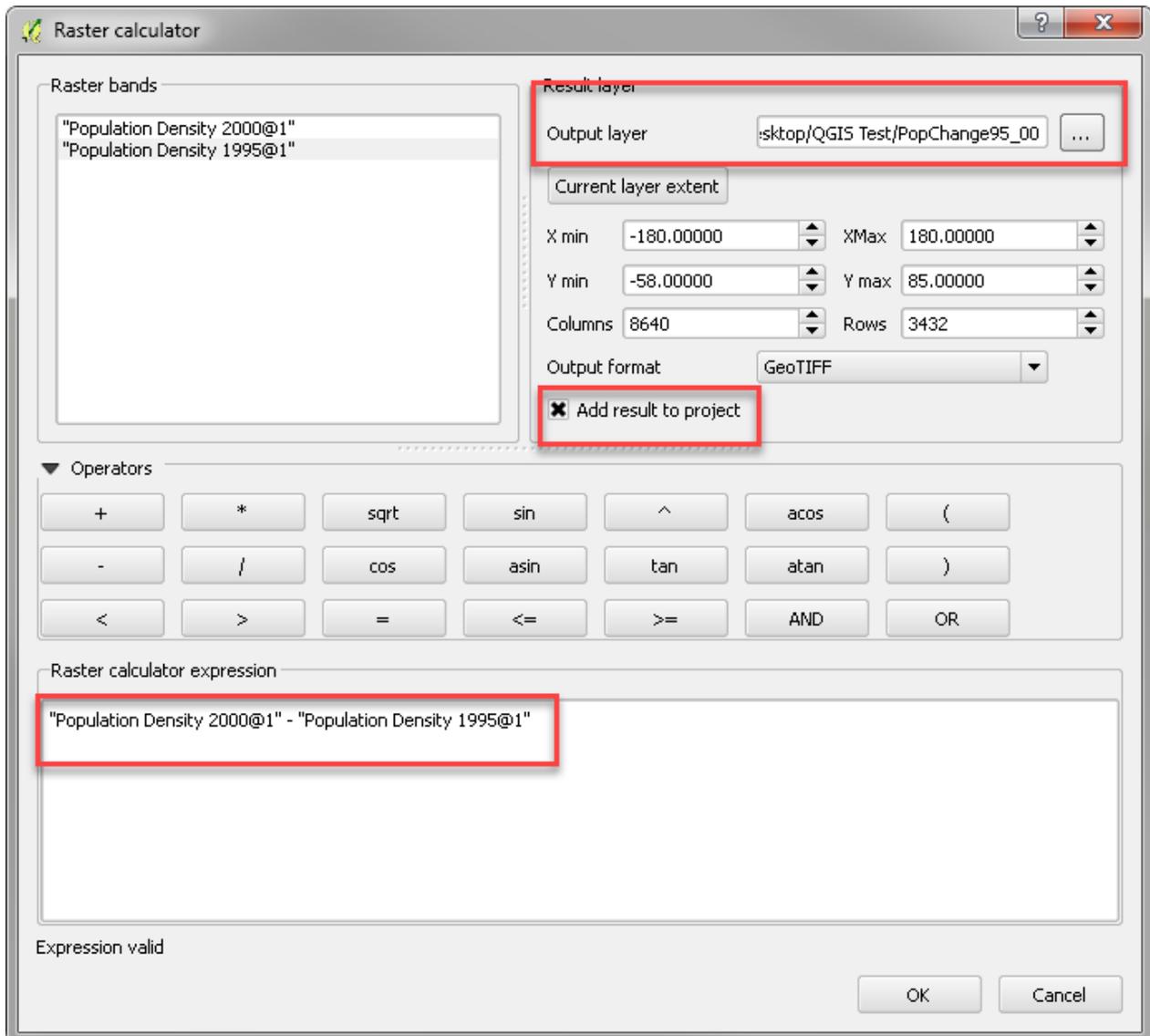
4. Now, we have a grey scale image representing the change in population. Let's change the color scheme so it makes more sense! Double click on **PopChange95_00** to get to the **style** tab.

5. Let's examine the **Metadata** Tab to understand some general **statistics**.
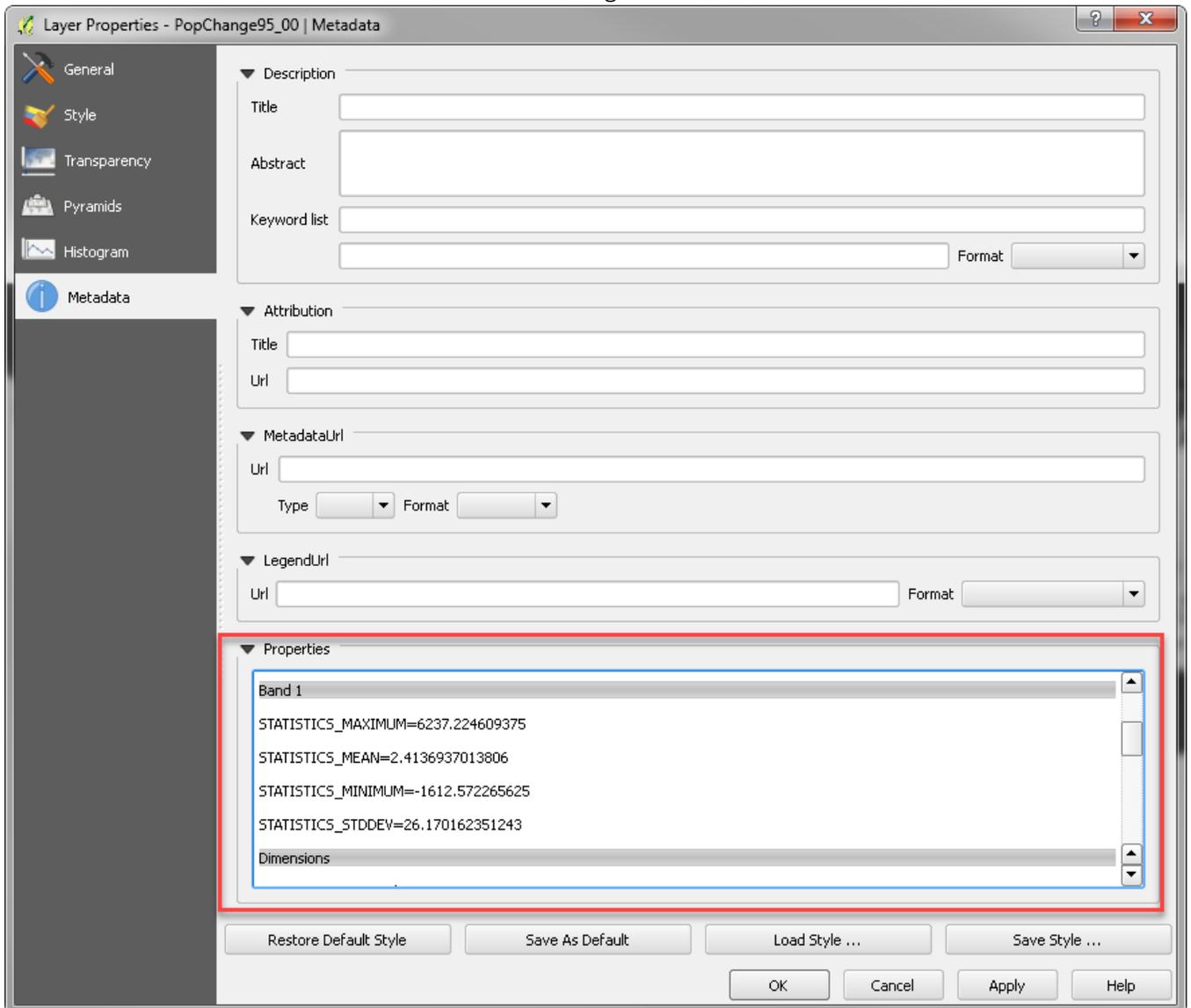
6. In the **Style** tab, change the Render Type to **Singleband Pseudocolor,** change the **Color Interpolation** to **Discrete**, change the **mode** to **Equal Interval** and change the number of classes to **3** to represent decrease, no change and increase. Select a diverging color scheme (light in the middle). Press **Classify.**

7. **Double click** in the **Value** field to edit the break numbers. Follow the screen shot below to change the numbers and labels to match. Then, press the plus sign to add a unique class. Change the value to -1615, make it grey, and call this no data. You'll notice once you type in your values and labels, the Mode has switched back to Continuous and the classes are greyed out. Press OK.
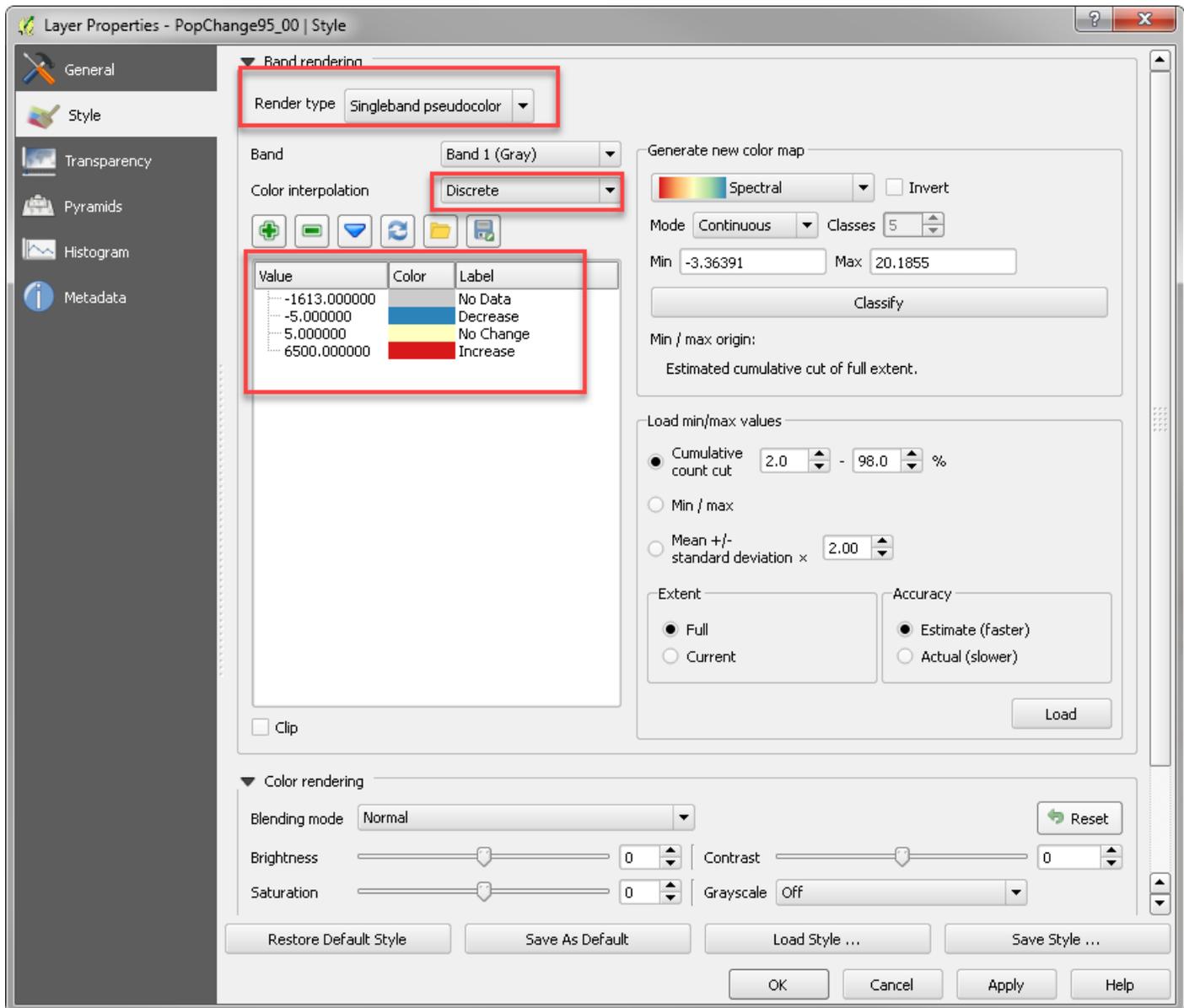
8. Now we can see areas of increased population, decreased population and no change.

Adding XY Data from Excel

Now, in order to bring in our ACLED conflict data points from 1997 t0 2016, we will add the data from Excel.

1. First, let's explore the Excel data sheet. Open the **ACLED-Version-7-All-Africa-1997-2016.**

2. Notice the different attribute headings and which columns contain our location information. Latitude and Longitude have this information in **Decimal Degrees.**

3. We need to save this file as **a text file**. Use the **Save As** function in your program to save it as a **Tab Delimited File** or a **Comma Separated Values (CSV)** file.

4. In QGIS, go to **Layer → Add Delimited Text Layer…**
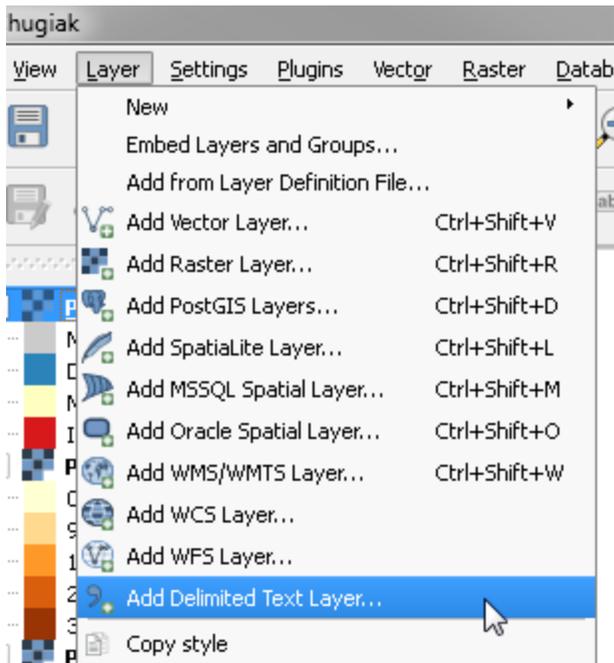
5. In the toolbox, click **Browse** to navigate to where you saved the CSV. Once you select the CSV, it auto populates with information.

   Make sure that you have **File Format = CSV** and double check that the **X Field is set to Longitude** and the **Y field is set to Latitude**. These are easy to mess up and where people go wrong ALL THE TIME! Press OK.
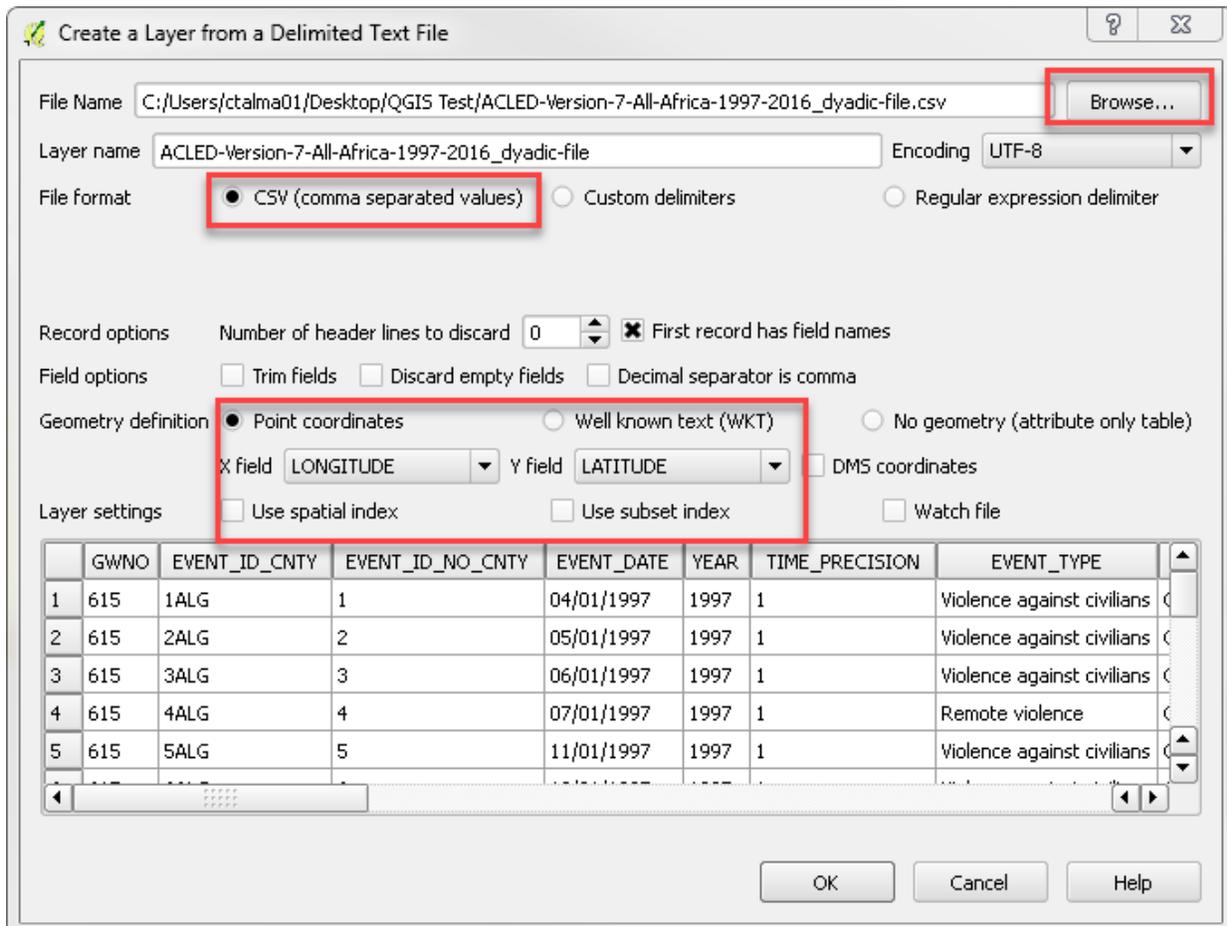

6. Some errors will pop up if there were problems in the Database. Press Close

7. The next box lets you select the **Coordinate System**. Since we are working in **Decimal Degrees**, we need to put it into a Geographic Coordinate System, such as WGS 84. **Select WGS84 and press OK.**
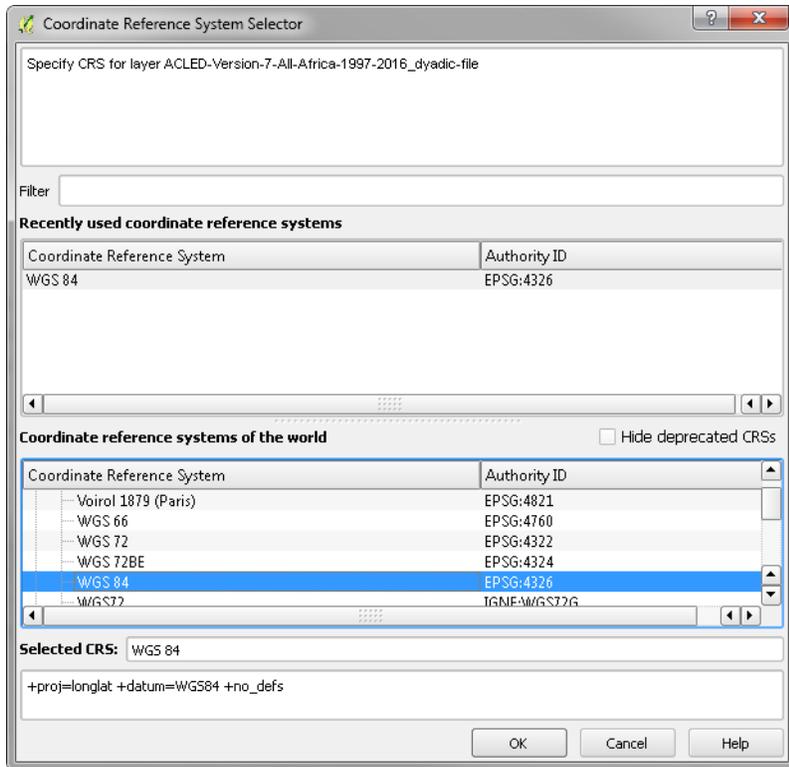
8. The points have now been added to the map.

9. Just like ArcMap, you need to save this as a **shapefile**! Right click on the new layer and select, **Save As.**
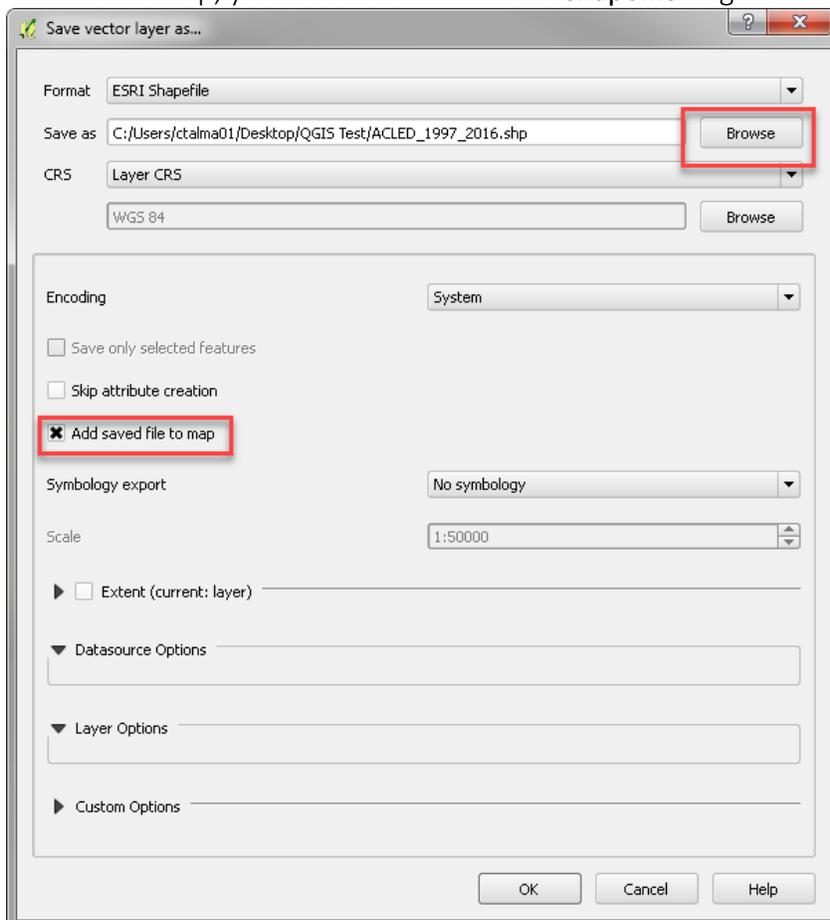
10. Make sure the Format is ESRI Shapefile (or your preferred format). Click **Browse** to select where you will save the layer. Save the Dataset as **ACLED_1997_2016.** Check the box that says **Add saved file to map.**

11. Now the Shapefile has been added. Let's remove the CSV points.

Creating Heat a Map of Conflict Data

The next goal is to create a density or heat map of conflict between 1995 and 1997 in Africa.

1. Since we will now be focusing on Africa, we need to select a project for Africa. In the bottom right, click on the Coordinate System Icon.


2. Check **Enable "on the fly" CRS transformation.**

3. Search for Africa and then scroll up to Africa_Albers_Equal_Area_Conic. **Highlight** it and press ok.

4. Now we need to select Conflict points from 1997 to 2000. Right click on the points and **open the Attribute Table**.

5. Click the **select features using an expression** icon. Let's create an expression to select the points from 1997 – 2000. Follow the screen shot below:
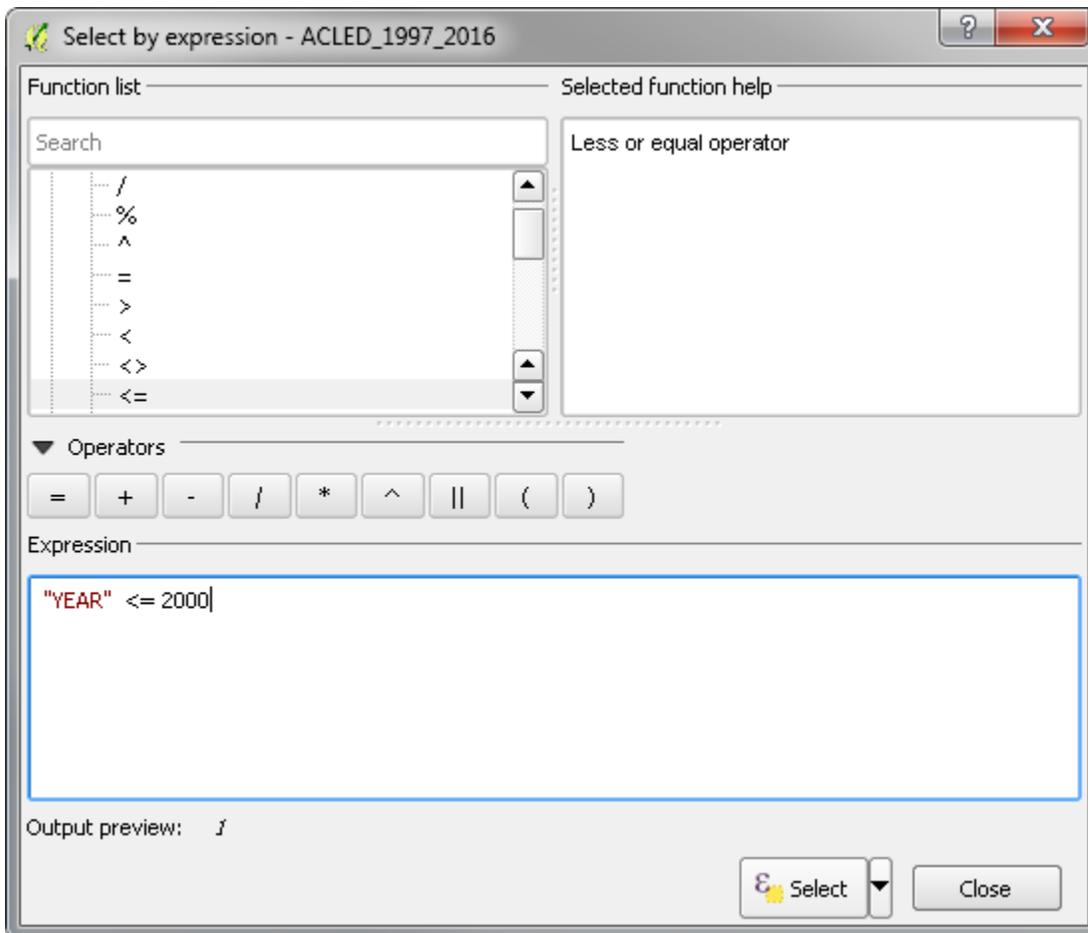

6. Right click on the ACLED points and click **Save As.**

7. **Browse** to where you will save the data and name in **ACLED_1997_2000.** Make sure to check **Save only selected features** AND **Add saved file to map.** Press the **browse next to the WGS 84.** Let's set the projection to the **Africa Equal Albers** under our recently used projections. Press Ok.
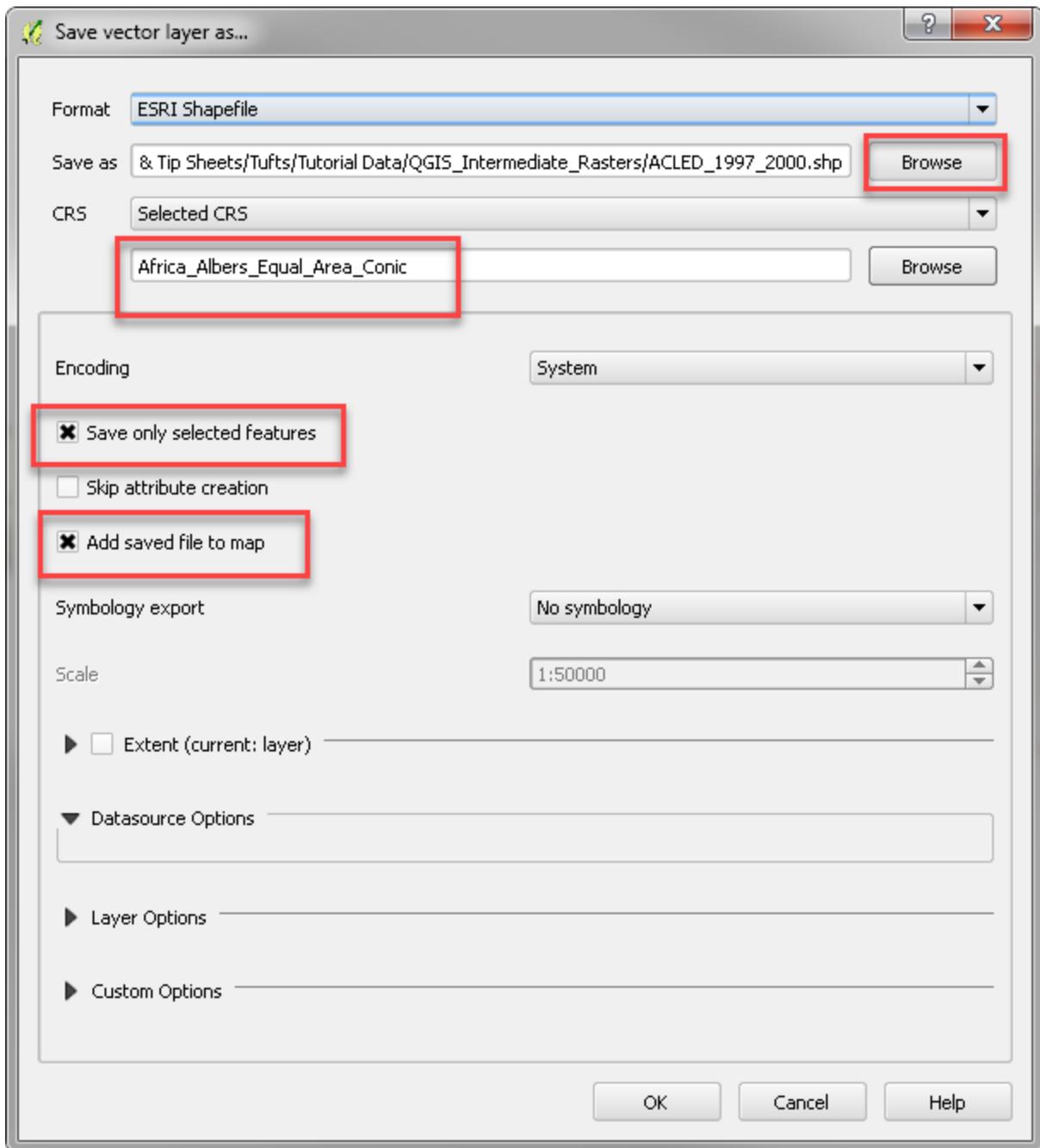
8. Now that we have our conflict points from 1997 to 2000 in the correct projection, which uses meters, let's create a heat or density map. To do so, we need to add a Heatmap Plugin.

9. Go to the **Plugins→ Manage and Install Plugins**

10. Search "**heatmap**" and **check** it. This enables it. Pres **Close**.

11. Now, go to **Raster → Heatmap.**

12. Select the **ACLED_1997_2000** as your points. Select an Output raster location. You can adjust the radius you want to use as well. For now, we will keep the default at 300000meters. Press OK.
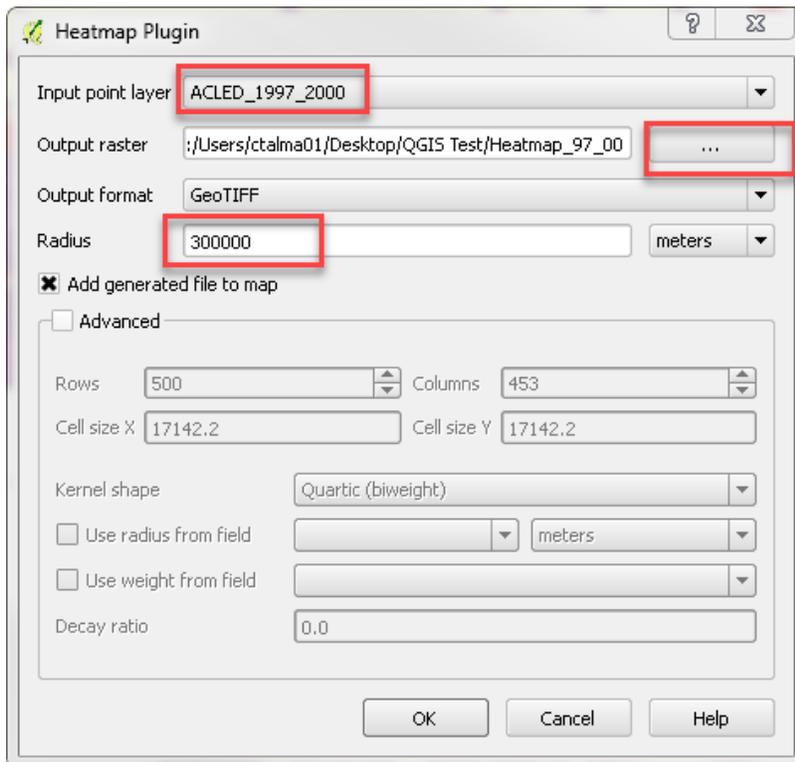
13. The result will be added to the screen. Notice how there is not a raster behind every point.

14. Now, let's run the heatmap, but adjust the advanced options to have the heat map represent the number of fatalities.

15. Go to **Raster → Heatmap.** Again, select the points and the place where you will save the output. Name it **Fatalities_Density**. Increase the radius to 400,000m and check **advanced** – more options will appear.

16. Check **Use weight from field** and select **fatalities**. Press ok.
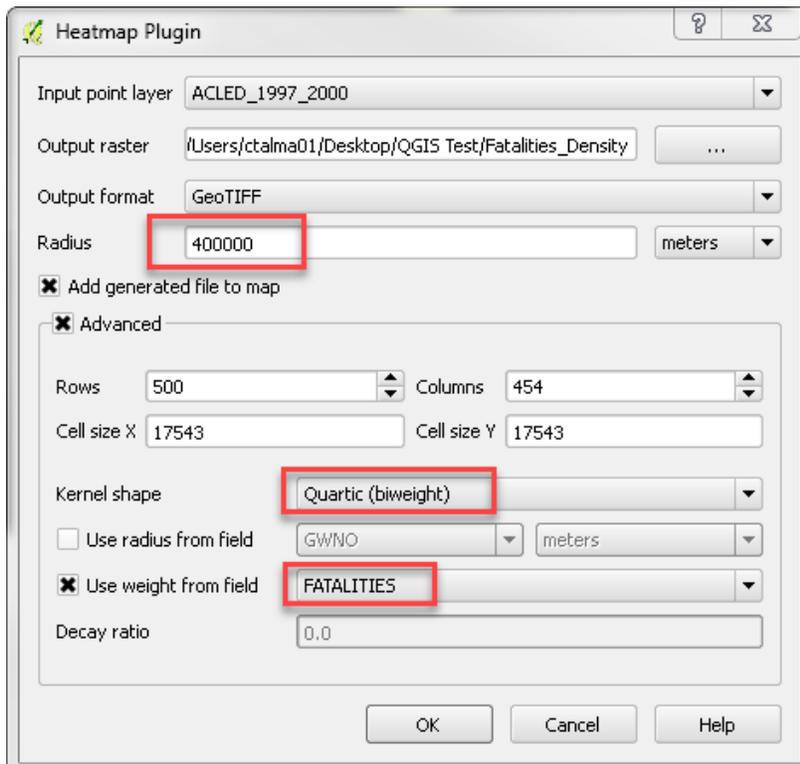
17. Explore the differences between the two maps.

Clipping rasters

The heatmap is really interesting, but we might want it to be clipped to Africa for better visualization.

1. If you haven't already, pull in the Africa shapefile.

2. Go to **Raster → Extraction → Clipper**

3. Select **Fatalities_Density** as the input file. Click **select** next to the Output file to choose where you will save the clipped raster. Name it **Fatalities_Density_Clipped.**

4. For the **Clipping Mode**, select **Mask Layer.** Make sure it is sect to **Africa**. You can change it if it is not correct.
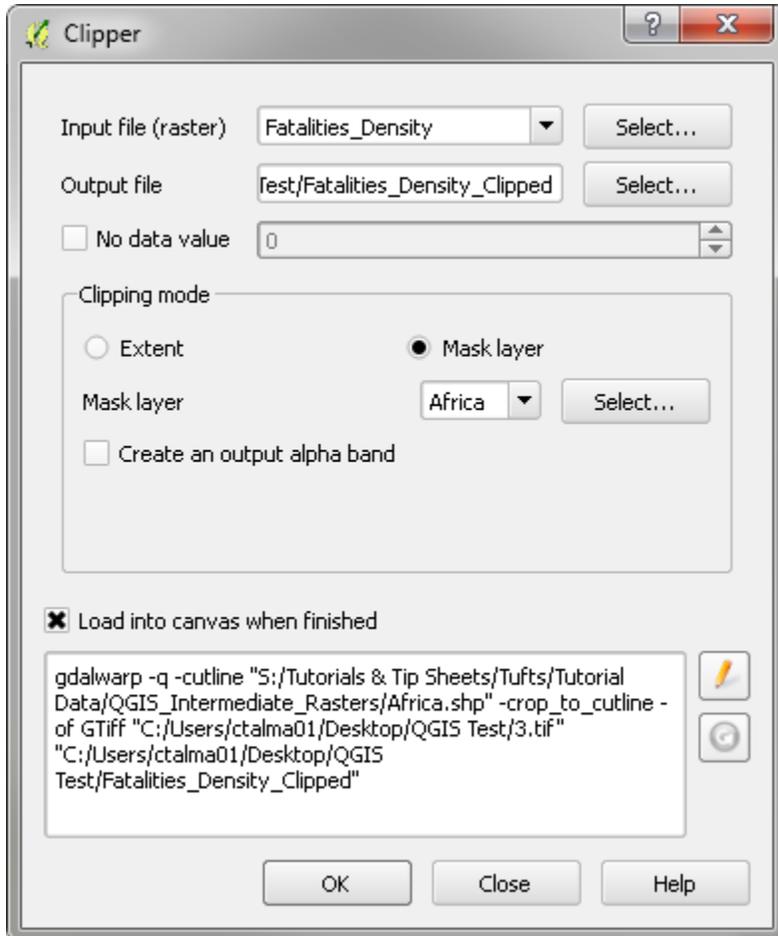
5. Notice how the raster now comes out as a square, even though we've clipped it. That's because it's adding in "no value" values. Open the **Properties** and go to the **Transparency tab.**

6. Check the **No Data Value** and add in 0 as an additional no data value.
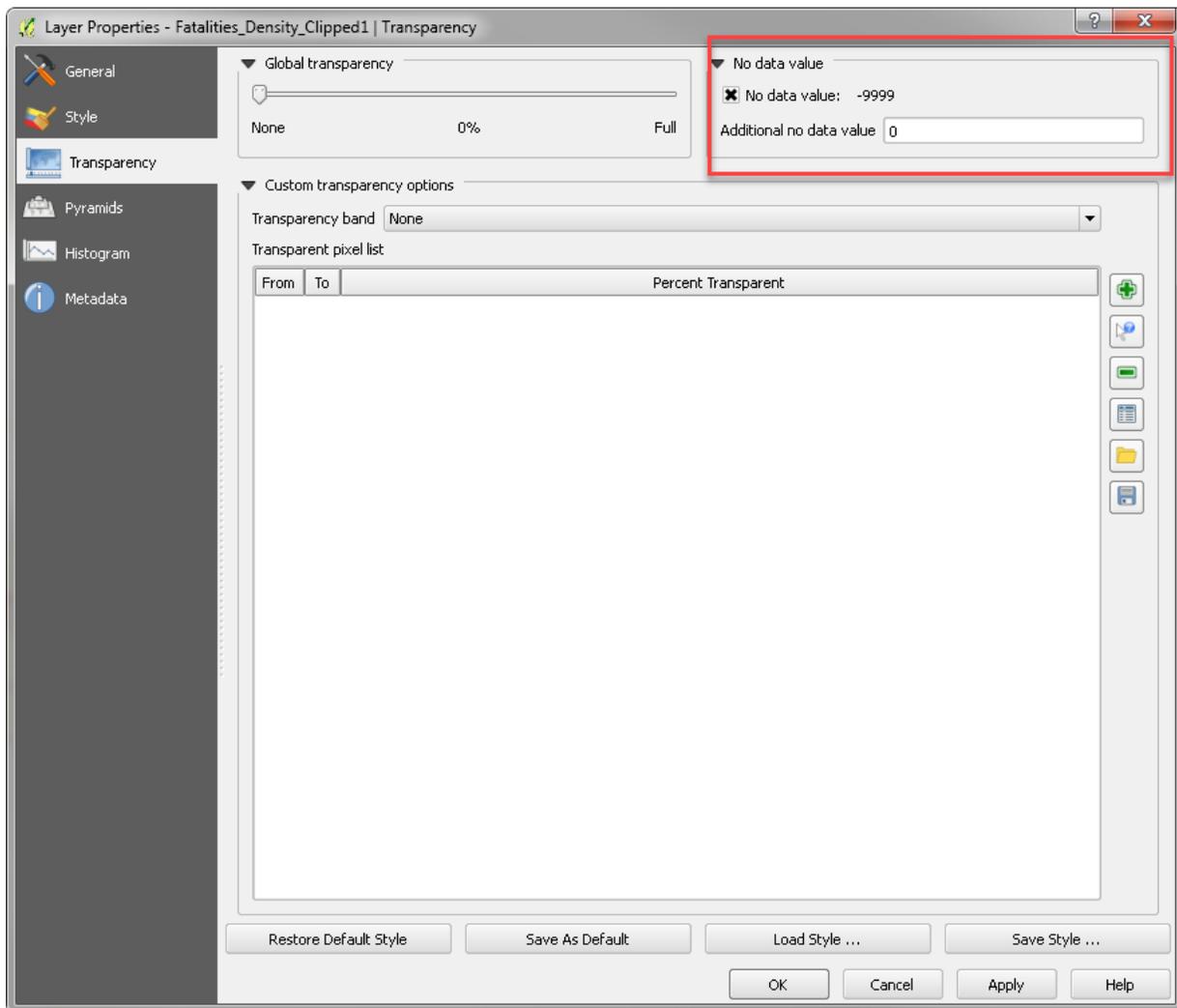
7. Now, let's set an appropriate style. Change the Render Type to **Singleband Pseudocolor.** Select a color ramp from low to high and press **classify**.

8. You can **change** the **transparency** of this layer as well to see where there are high density of fatalities in comparison to where there was a change in population.

9. Examine the map.