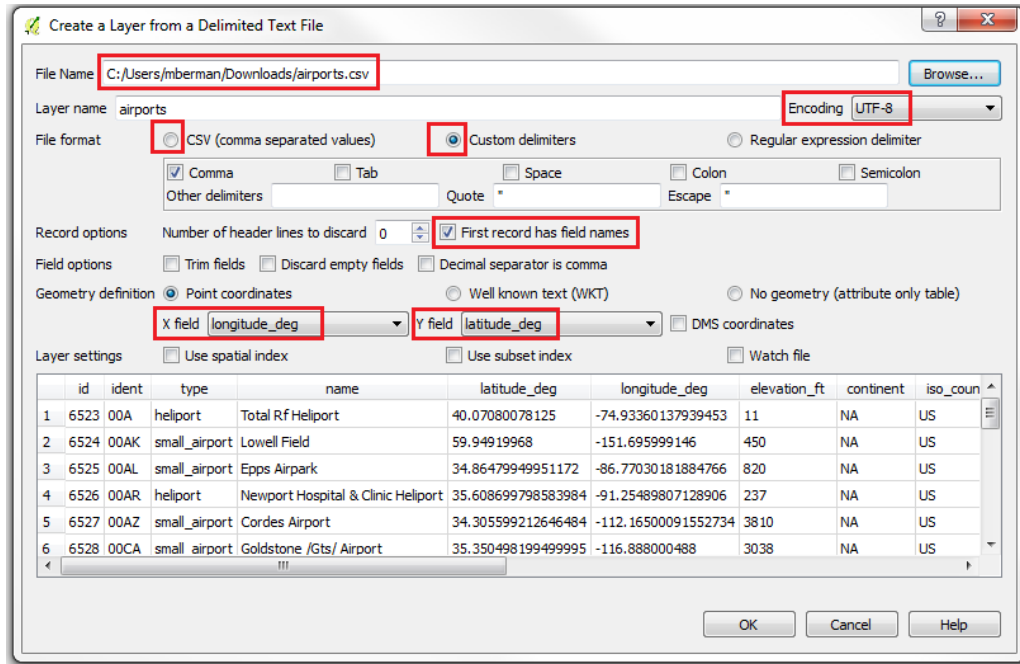**Module 2: Thematic Mapping with Point in Polygon Query**   Tutorial by Lex Berman
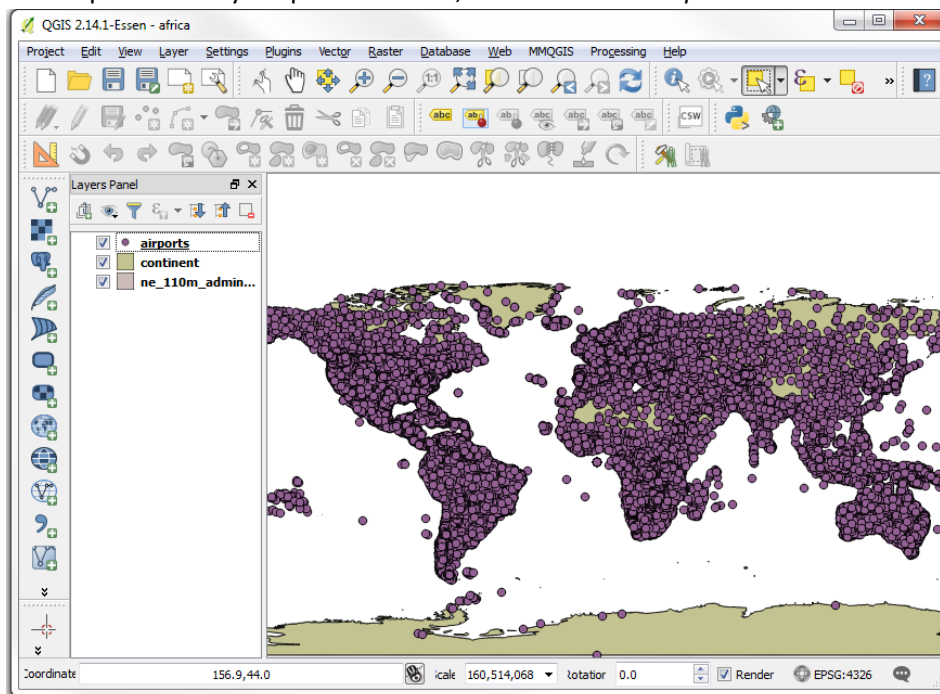
This goal of this exercise is learn how to import tabular data to QGIS, to run spatial selections, point in polygon analysis, and to create thematic maps, as well as areal calculations for thematic maps.
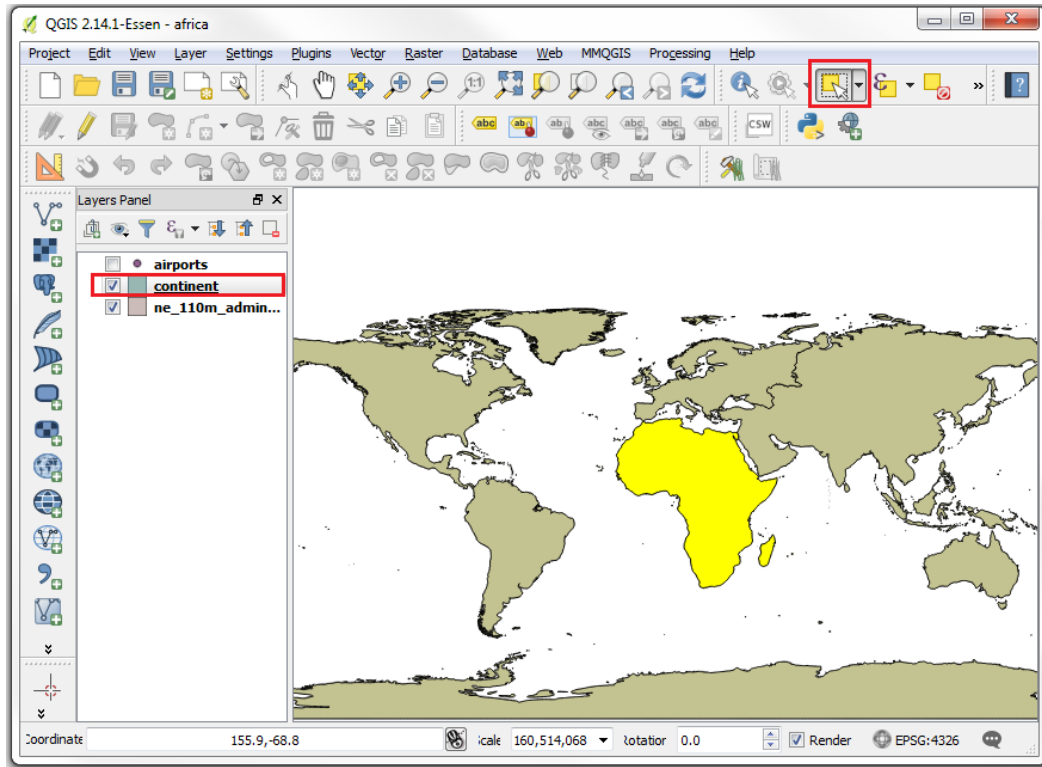
1. Original Data Source   http://ourairports.com/data/

2. In the **mod_2_thematic** folder, open *airports.csv* in QGIS using **Add Delimited Text** data
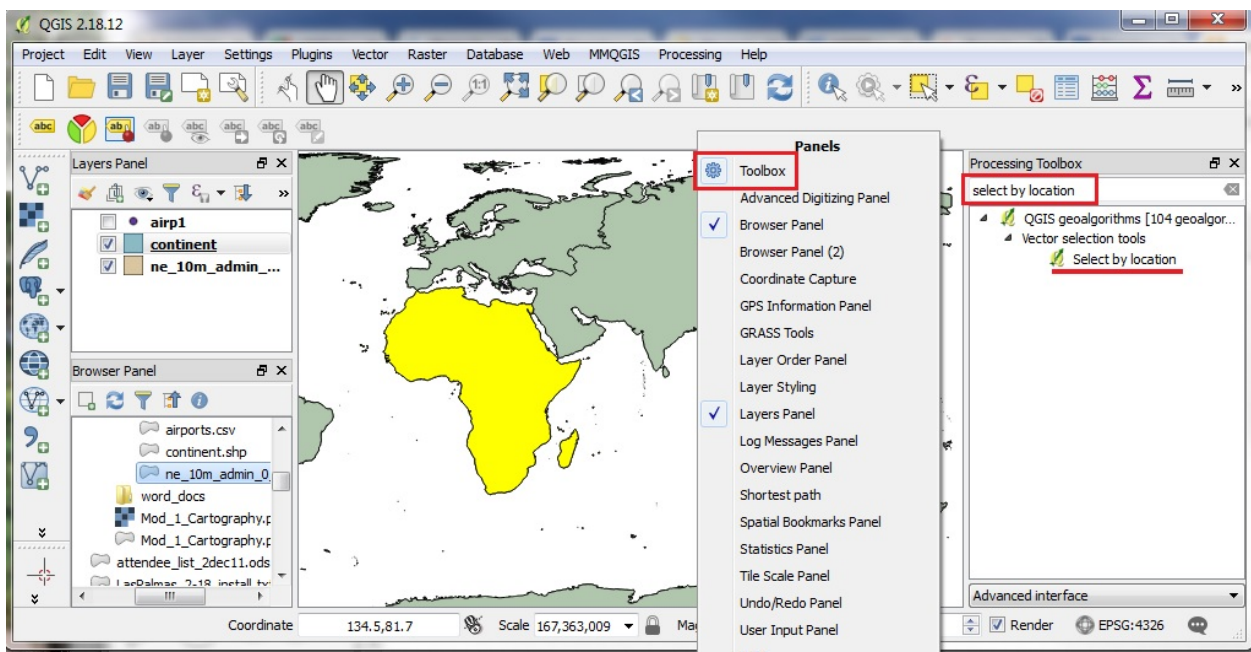

3.   Airports .csv layer opens in buffer, SAVE AS NEW "*airports*" SHAPEFILE LAYER , and CLOSE .csv file!
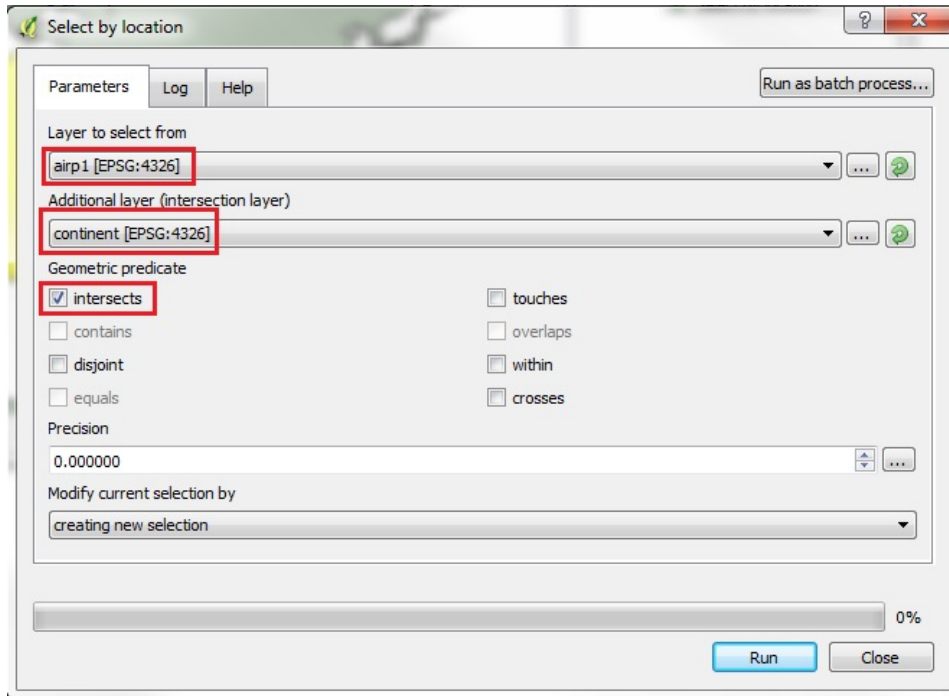
4. turn off visibility of *airports* layer, then make *continents* layer ACTIVE, use SELECT tool to select Africa
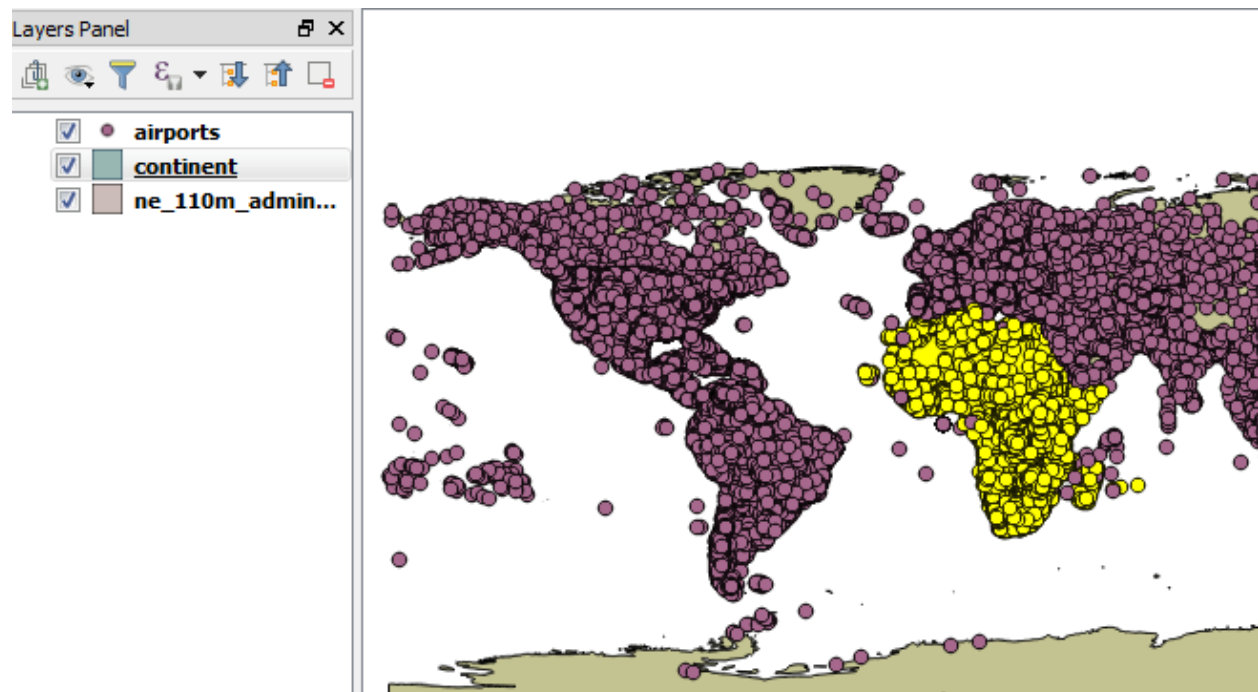

5. Turn on the PROCESSING TOOLBOX then search for SELECT BY LOCATION and double-click on the tool
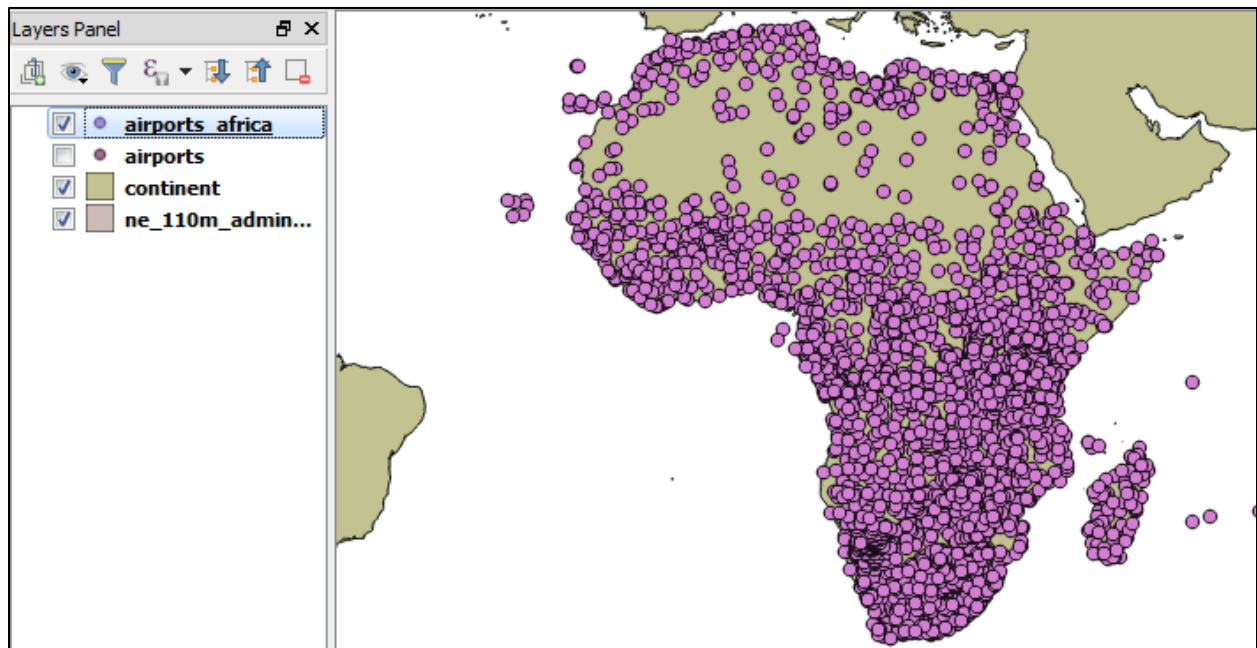
6. In the dialog, set Layer to Select From as "*airports*" and Additional Layer (intersection layer) as "*continents*" then set the Geometric predicate to "intersects." In QGIS 2.18 the SELECTED FEATURES in the intersection layer will be used BY DEFAULT, and there is no longer a box for ONLY SELECTED FEATURES. Accept Modify Selection as "creating new selection" before hitting RUN
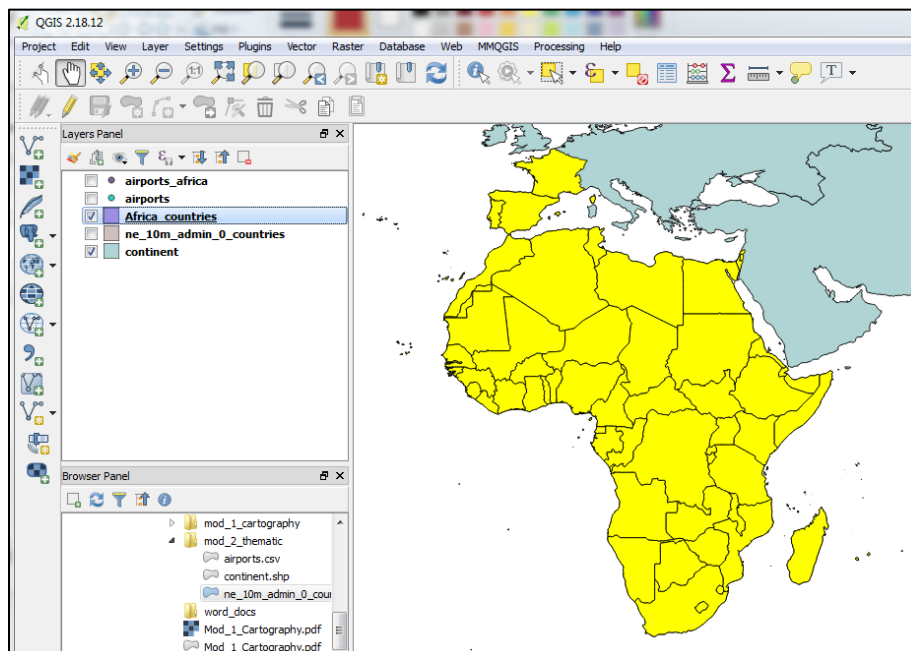

7. airports that intersect continents selection will be chosen, right-click on airports layer and SAVE THE SELECTED airports to new shapefile called *airports_africa*, making sure to tick the SAVE ONLY SELECTED FEATURES option!

8. now Deselect Features, and turn off visibility of original *airports* layer. Zoom to layer *airports_africa*

9. Turn off the *airports* layers, and make *continents* active, then select AFRICA feature again. Use SELECT BY LOCATION to select features in Natural Earth Countries that intersect with the *continents* selection.   The result should be only the countries that intersect with the continent of Africa (except for a few European countries that are linked to states in Africa).   Be sure to SAVE THE SELECTION by right clicking the ne_100_admin layer and SAVE AS a new shapefile called *Africa_countries* before continuing.

10. Fix the anomaly countries in Europe by Deselecting all features in the Africa_countries layer, then make the layer EDITABLE.   When editable, all nodes of the polygons will be turned into red X nodes. Now choose the SELECTION tool and select SPAIN, and click on the CUT feature button to remove it.
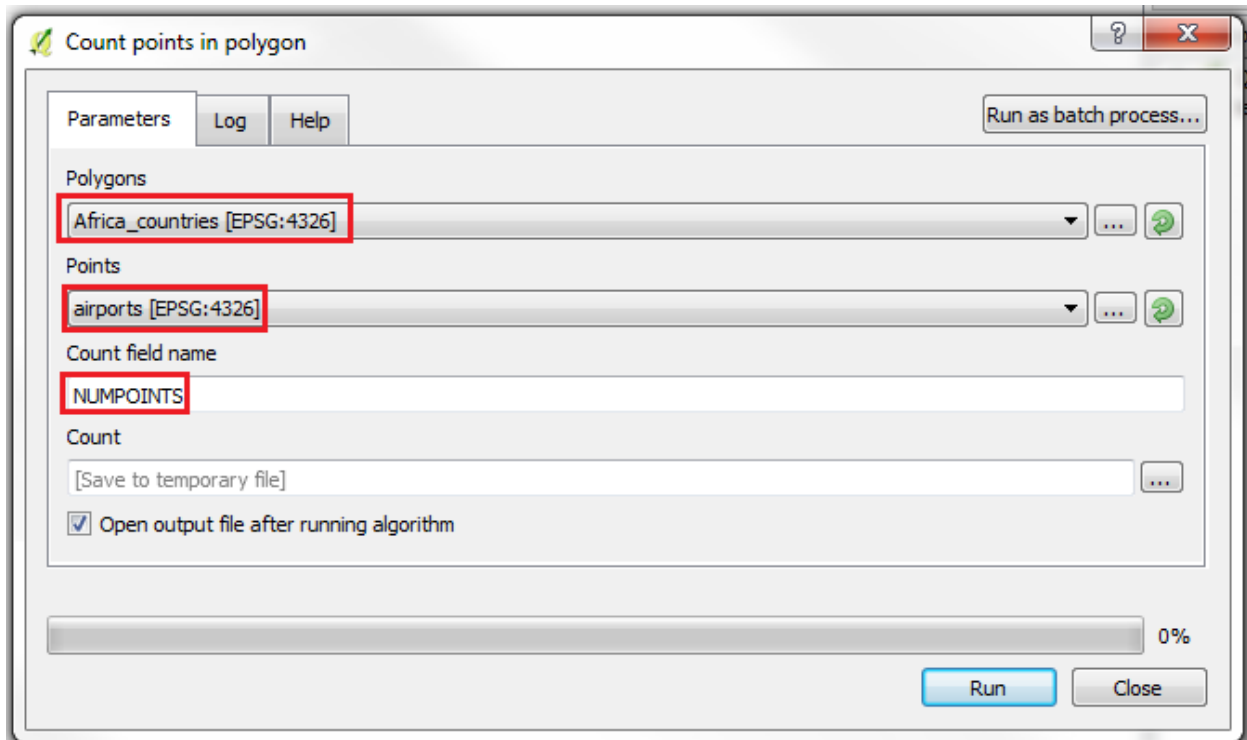

Continue this process by selecting France, and CUT feature, then select Portugal and CUT feature. Now we will have removed those states that are NOT actually on the African Continent. Click the EDITABLE button again and choose to SAVE EDITS.

11. Turn off the *Continent* layer and the *ne_110_admin* layer, then we can proceed to VECTOR | ANALYSIS | POINTS IN POLYGON procedure. To begin this part, we want only the *Africa_countries* and *airports_africa* to be visible layers (checked on the Layer List).
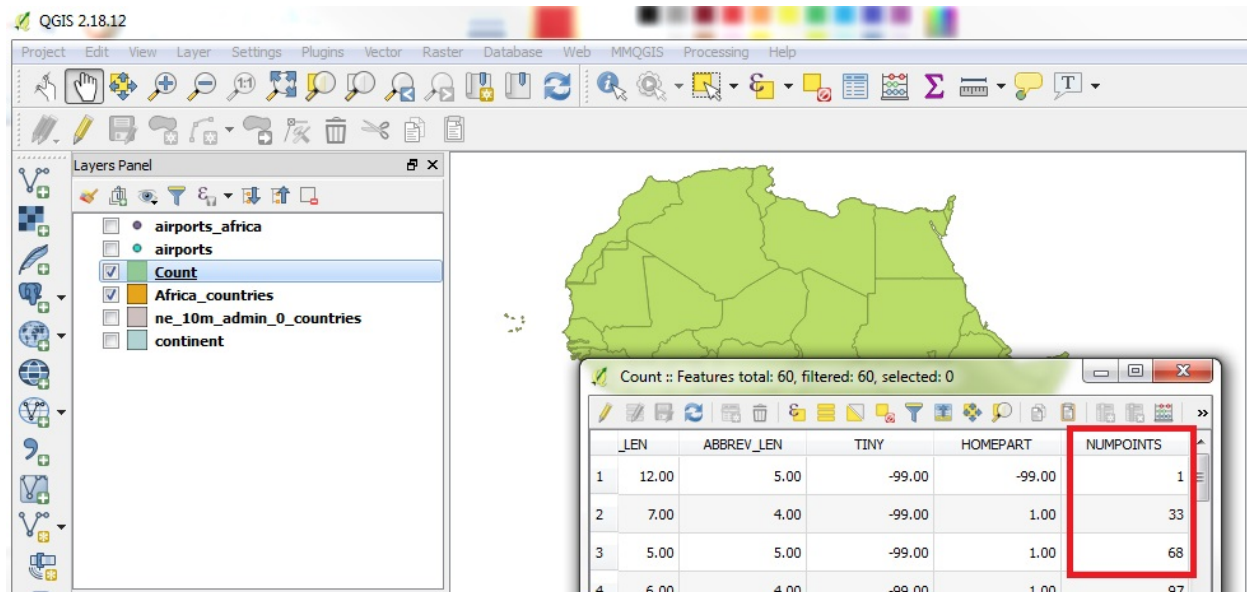
Next we go back to the Processing Toolbox and search for "points in polygon" and double-click the "count points in polygon" tool.

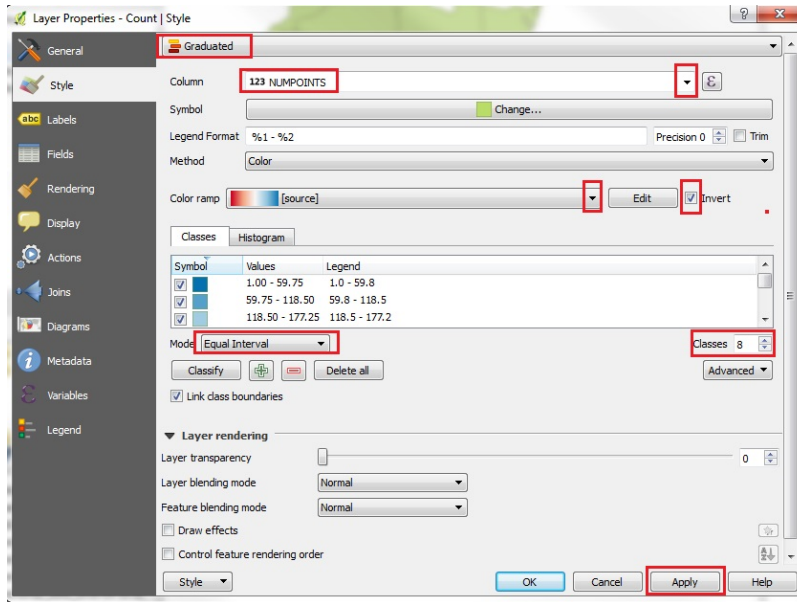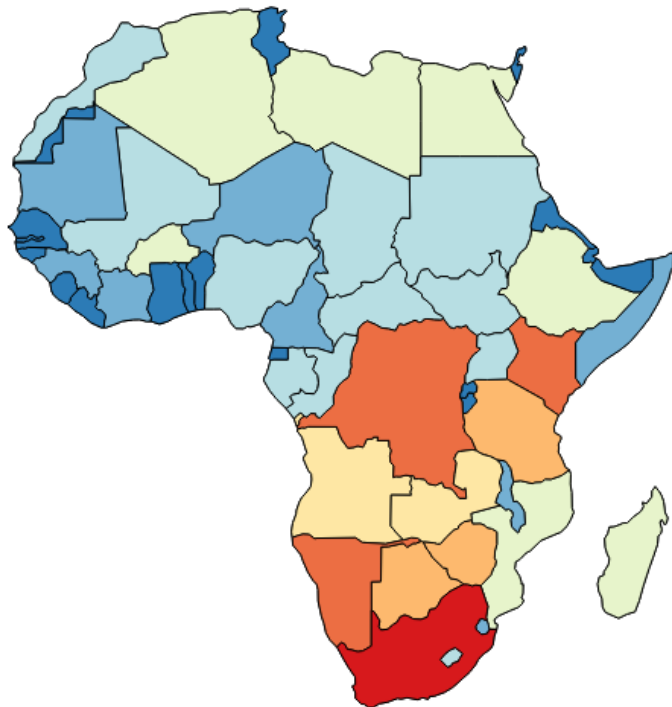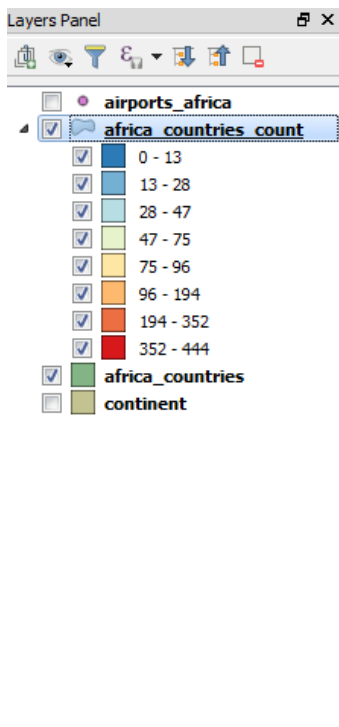12. Set polygons = *africa_countries*, points = *airports_africa*, count field name = NUMPOINTS

In QGIS 2.18 by default the COUNT value will be the total number of points that fall within each polygon, and this SUM will be added as an integer into a new column, called "NUMPOINTS" into a temporary Shapefile called "*Count.*" In the attribute table, the new field is added to the right of the other columns.

13. Symbolize the NUMPOINTS values in a choropleth map.   Right-click on the *count* layer and go the PROPERTIES | STYLE tab.   Change the setting from SINGLE SYMBOL to GRADUATED COLOR, then pick the column containing the values, NUMPOINTS from the drop-down menu of columns. Choose a color ramp, and the Classification Mode, number of classes, (and hit CLASSIFY if the setting does not auto-update the preview).   Hit APPLY to apply the changes on the map view, and OK to close the dialog.

13. Depending on your symbolization selections, the choropleth map will reflect the total number of airports in each country. Here using Natural Breaks, 8 classes, inverted RdYlBu (red yellow blue) ramp.

14. In order to calculate the number of airports PER SQUARE KM of each country, we must first REPROJECT the CRS of the *africa_countries_count* layer to a "real-world" coordinate system. The current standa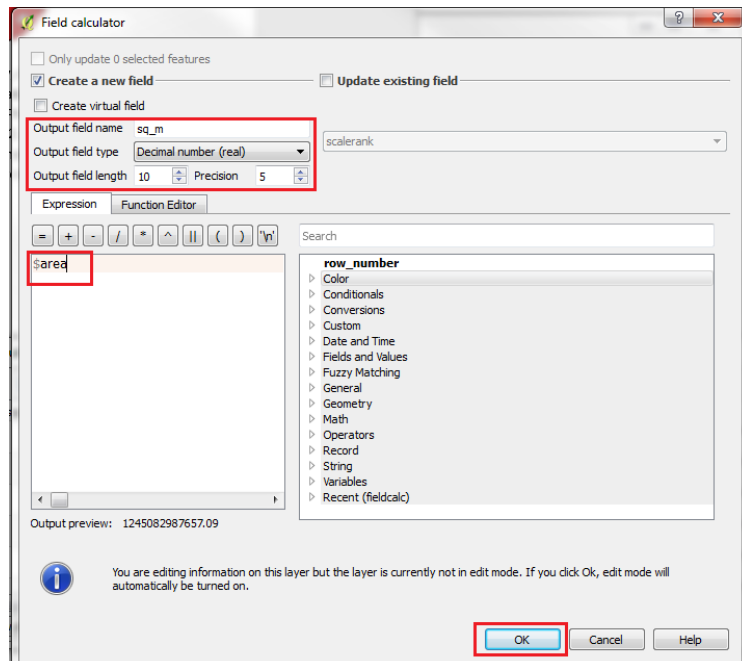rd global project of WGS-84 is in decimal degrees. We need to SAVE AS a Projected Coordinate System, such as "Africa Albers Equal Area Conic" which has EPSG Number 102022. After saving this layer with a new name *africa_countries_102022*, you need to RESET the PROJECT | PROPERTIES | CRS to that projection, and make sure that the correct EPSG Number is shown on the lower right for the current project.

15. Since the Albers 102022 projection is in units of Meters, we will first create a new field with Square Meters. Open the Attribute Table of *africa_countries_102022*, then Field Calculator, New Field (named "sq_m"), field type = decimal number (real), field length 20, precision 5, then in the expression form type $area, and OK

16. Check the new column containing the area for each polygon in square meters (the projection units)

17. Now we can repeat the field calculator step to create a field containing Square Km. From the Attribute Table, go to Field Calculator, New Field (named "sq_km"), field type = decimal number (real), field length 20, precision 5, then in the expression form type the name of the field in double quotes and divide it by 1,000,000. The expression, in this case, looks like this: ["sq_m" / 1000000]. Now you should have figures, such as 26,238 sq_km for Burundi. Toggle the editor to save the edits.

18. We can now calculate a new column, which will "normalize" our raw count of airports for each country by the area in square km for each country. This will give us airports per sq km. To do this we return to to Field Calculator, New Field (named "airp_sqkm"), field type = decimal number (real), field length 20, precision 10, then in the expression form divide the PNTCNT field by sq_km field. The expression, in this case, looks like this: ["PNTCNT" / "sq_km"]. This will be a very small number (so we need 10 places past the decimal in precision). Save the edits.

19. Finally, we can use the newly calculated field to generate a choropleth map of airports per sq km. Even using exactly the same Style [graduated, Natural Breaks, 8 classses, RdYlBu inverted ramp], the difference between the raw count of airports per country map, and the number of airports per sq km map is striking!

Cartography is an interpretive art form, depending on how you normalize and how you classify the data.

airports per sq_km

	airports_countries_102022
☑	0.000000 - 0.000044
☑	0.000044 - 0.000092
☑	0.000092 - 0.000138
☑	0.000138 - 0.000208
☑	0.000208 - 0.000267
☑	0.000267 - 0.000365
☑	0.000365 - 0.000828
☑	0.000828 - 0.001127

number of airports

	africa_countries_count
☑	0 - 13
☑	13 - 28
☑	28 - 47
☑	47 - 75
☑	75 - 96
☑	96 - 194
☑	194 - 352
☑	352 - 444