ADDA Lab

Spatial Data Analysis and Geoprocessing

Site Selection using basic geoprocessing tools in QGIS

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Overview, Objective, and Skills

Learning Objective:

The key advantage of a GIS is that it can answer questions using its spatial-analytical capabilities. These capabilities use the spatial and non-spatial data in the database. Vector data can be analyzed to reveal how different features interact with each other in space. There are many different analysis-related functions in GIS. Functions that will be reviewed in this lab activity include:

Spatial query - A statement or logical expression that selects geographic features based on location or spatial relationship. Buffering - Rings drawn around features at a specified distance. Clipping - "Cookie cutting" of one layer using another.

Scenario:

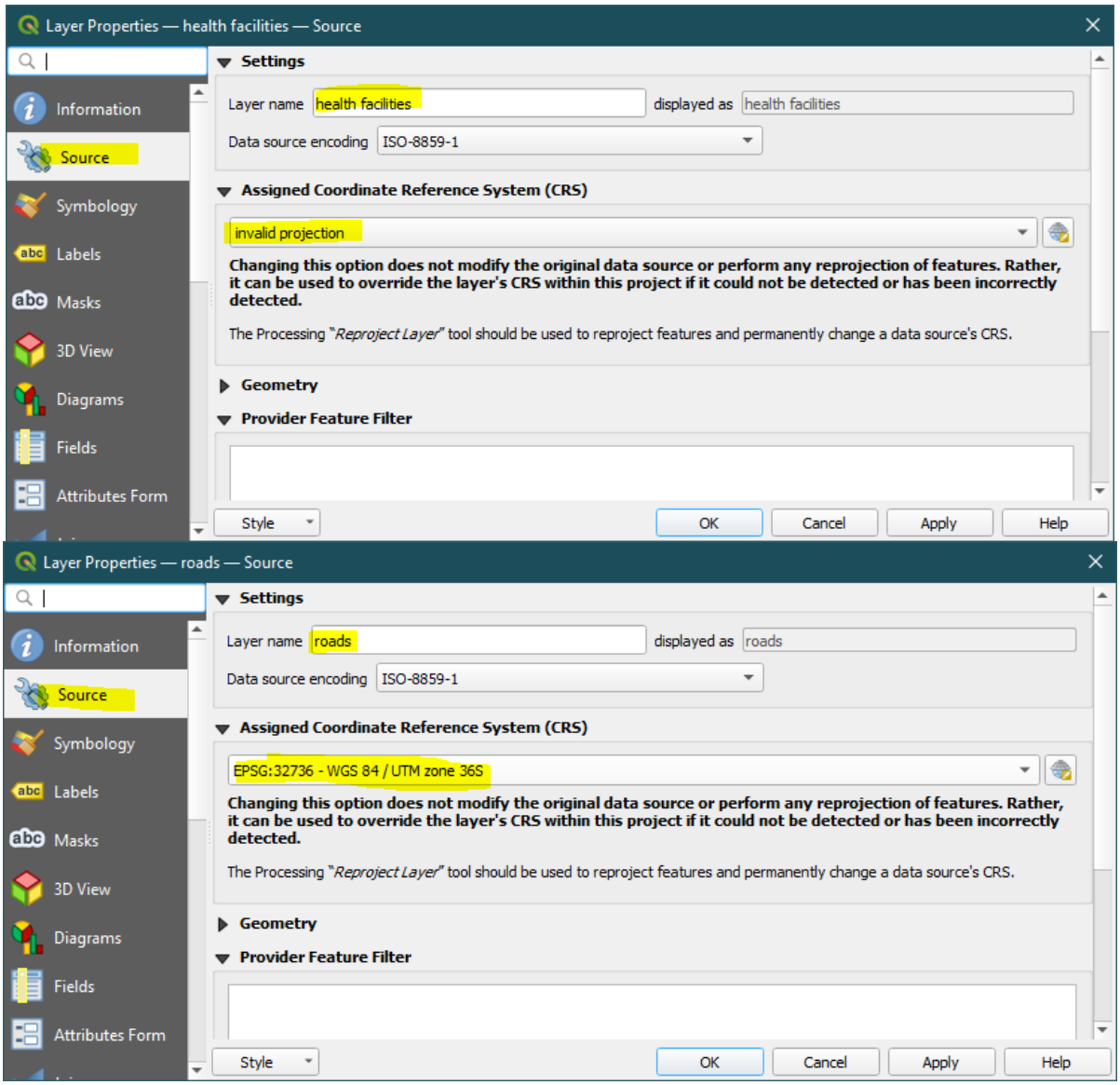
As part of an initiative to improving access to healthcare, a certain non-governmental organization is conducting a study in Malawi to identify distribution and accessibility of health care facilities in the nation. As a GIS specialist working in the Ministry of Health, you were asked to find out what percentage of health facilities within Lilongwe District are located within 5km from the main roads. This is important in the context of increasing population in the urban areas, it becomes more important to increase health care access to the most densely populated areas. You have been provided with many GIS data layers including Malawi Roads layer, health facilities layer, and Malawi district boundary layer.

Projection:

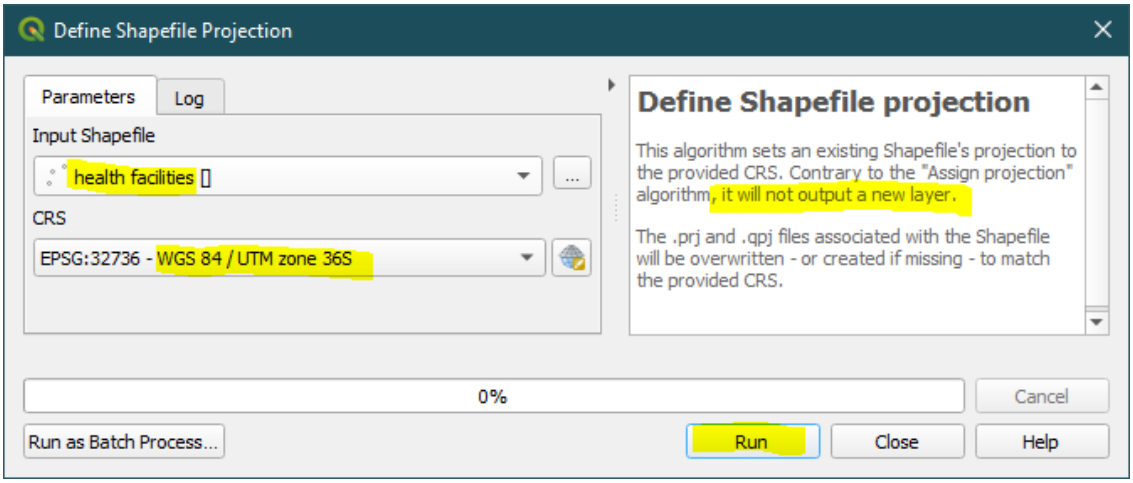
All data are projected to EPSG: 32736, WGS 84 / UTM Zone 36S

Section one: Download and Explore your data

1. Download and unzip Lab 7 data to your folder
2. Open **QGIS Desktop 3.22**.
3. Add the following shapefiles to the new QGIS project: **Roads, Healthcare Facilities, and District Boundaries.**
4. You might notice that roads and district boundary files are lining up well but the healthcare facilities is showing up somewhere else. You should right click on each layer and see what the projection is for the layers.



5. It is clear that Health Facilities is lacking projection details. Your customers provided you with the projection details (specified on page 1). According to that information, your healthcare facilities should also be projected to WGS 84/*UTM zone36s*
6. You can temporarily change the projection under the Source tab – but it can create problems when you are trying to do analysis later on. Let's assign that projection to this layer so it is permanently part of the data.
7. Search for **Define Shapefile Projection** under **Processing Toolbox.** This tool writes projection parameters to the meta data and hence does not require creating new data layer.



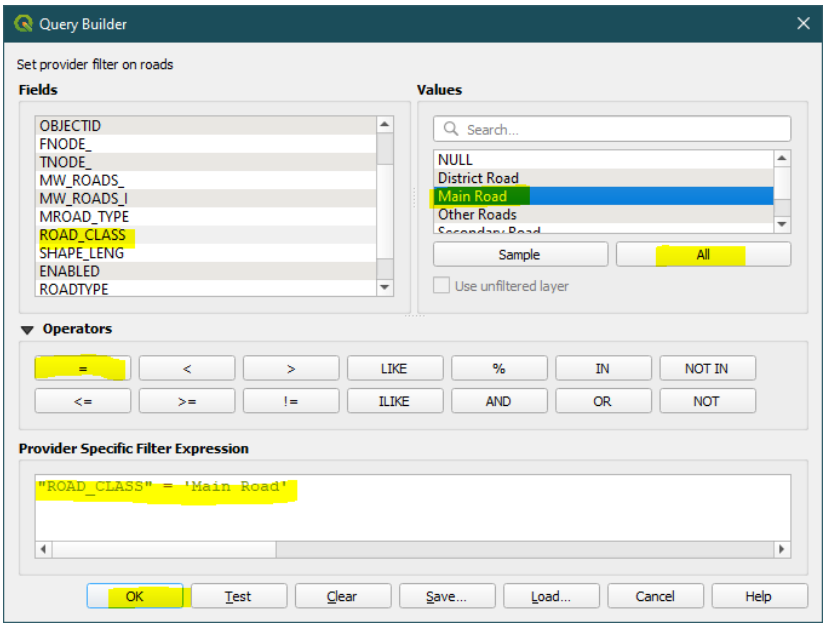
8. To ensure projection is appropriately stored in meta data, you can go through and do this for other data layers as well.
9. Open the attribute tables for the three layers and familiarize yourself with the attribute names and values of the layers

Section two: Extract "Main Roads" from the roads layer

1. In order to isolate all the major roads (called main roads in the attribute), we need to identify which attribute column contains the attribute "main road".
2. Switch off all the layers in the layers panel except the roads layer
3. Open the attribute for the roads layer. Explore the table fields and their associated values. You will note that the "**Main Road"** value falls under the Road_Class field (Attribute).
4. Close the attribute table

Now, we will build a filter using query builder that will only show the main roads.

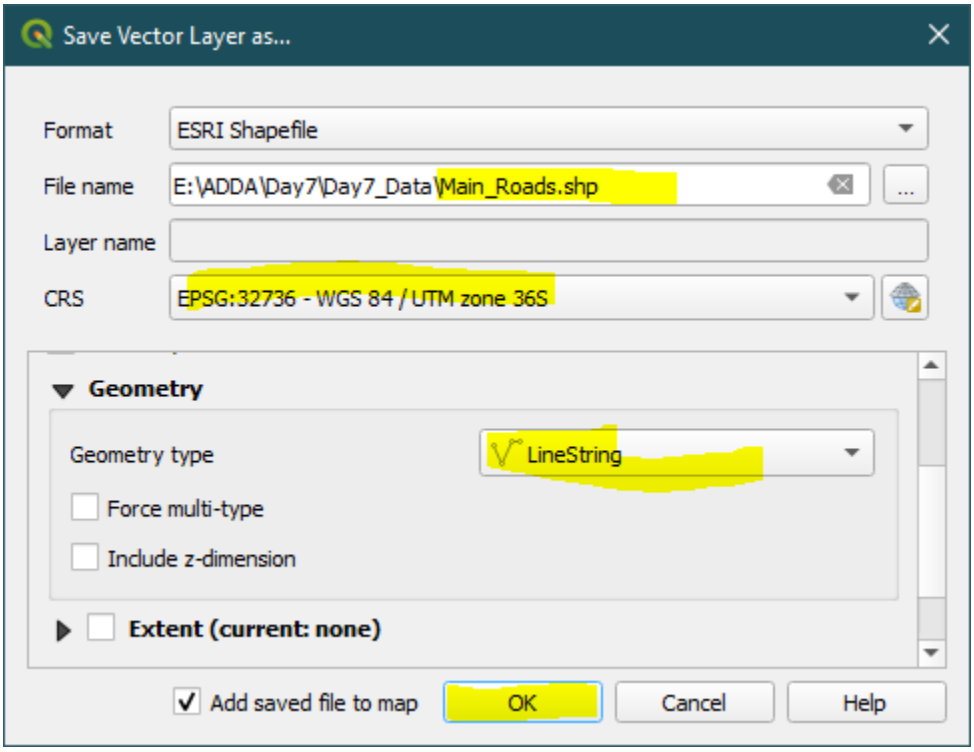
5. Open the layer properties for the roads layer and click on the Source tab
6. Click on the Provider Feature Filter
7. Click on Query Builder
8. This opens the query builder window. Build a query that says "ROAD_CLASS" = 'Main Road'



9. Click *OK* twice. This will filter Roads layer to only show the Main Roads:

To save the selected main roads,

10. Right click on the roads layer.
11. Select **Export** → Select **Save Features As**
12. Navigate to your lab folder and save the layer as **Main_Roads.shp**
13. To clear the selection in the roads layer, open again the query layer properties and the query builder. Click on **Clear**
14. Click **OK** twice

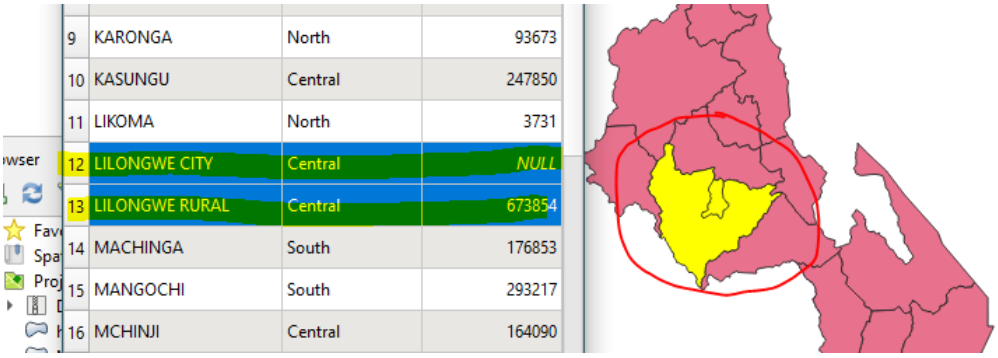


Section 3: Extract Lilongwe District from the district boundary layer

1. Switch on the **mw_districts** layer in the layers panel.
2. Open the attribute table and identify the attribute that contains the district name field.
3. Can you spot Lilongwe district? What do you notice?

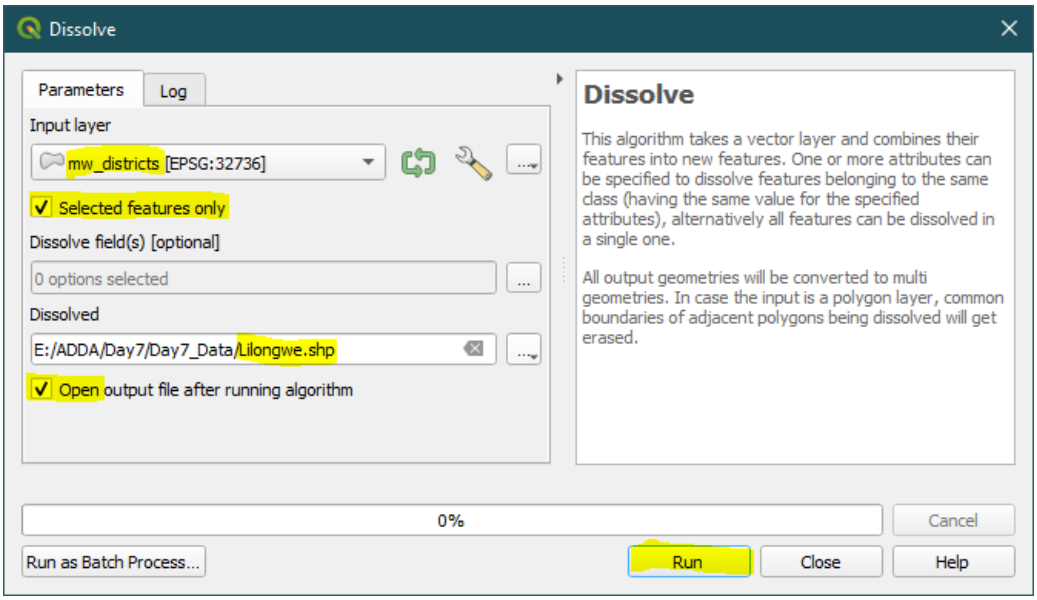
Yes – there are two entries listed for Lilongwe. One is showing the actual city boundary whereas the other polygon is showing the rest of Lilongwe district. Our goal is to create one polygon that actually contains both areas. Let's see how GIS can help us do this.

4. Now, back in the attribute table, select both rows of data that refers to Lilongwe (City + Rural). You can do this by holding down the 'Control' button as you click both rows.



9	KARONGA	North	93673
10	KASUNGU	Central	247850
11	LIKOMA	North	3731
12	LILONGWE CITY	Central	NULL
13	LILONGWE RURAL	Central	673854
14	MACHINGA	South	176853
15	MANGOCHI	South	293217
16	MCHINJI	Central	164090

5. Now, search for **Dissolve** in the **Processing** Toolbox.
6. Open the tool **Dissolve** under **Vector Geometry** group of tools.
7. Select mw_districts as input layer. Click "selected features only" – this will ensure that the dissolve function will remove all internal boundaries between polygons and apply this only to the selected polygons.

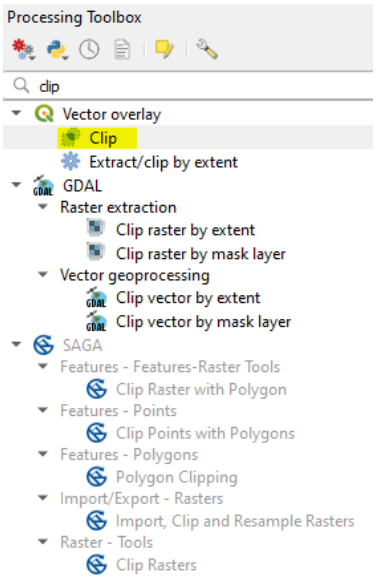


8. Click Run. Check the resulting layer. It should now have City and Rural parts of Lilongwe district combined into one. When you do dissolve, remember, the resulting layer has to pick attributes from one of the two original polygons. Which one is retained in this case? Check the attribute table and verify.

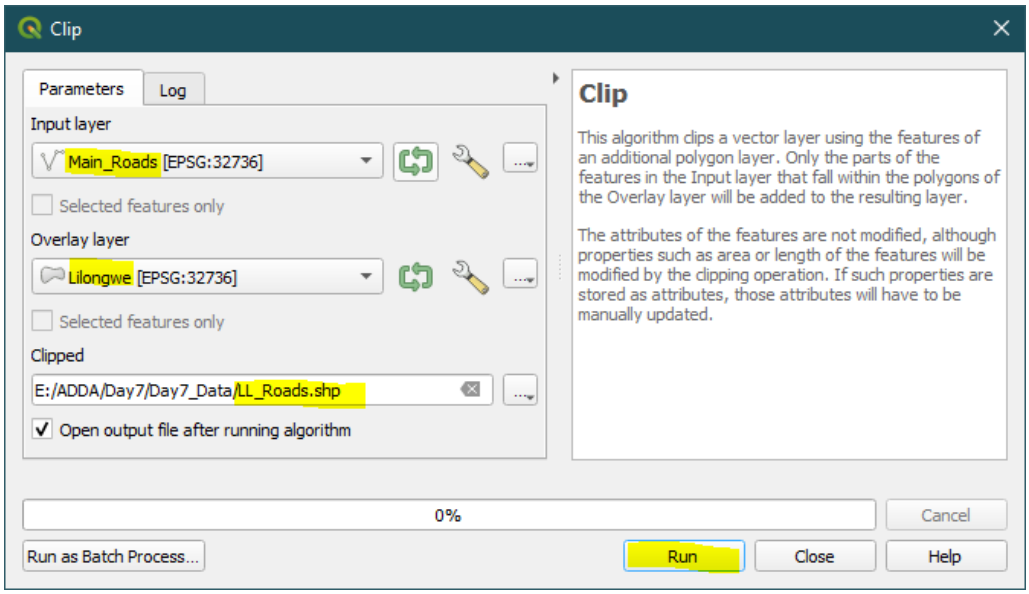
Section 4: Clipping data to Lilongwe District polygon

Since our study area is Lilongwe District, it makes sense to clip all the data to cover just Lilongwe District. This will ensure that our data and maps look clean and we are not constantly processing whole country data for every step involved. It saves time and storage space. We will use the **Clip** tool to accomplish this.

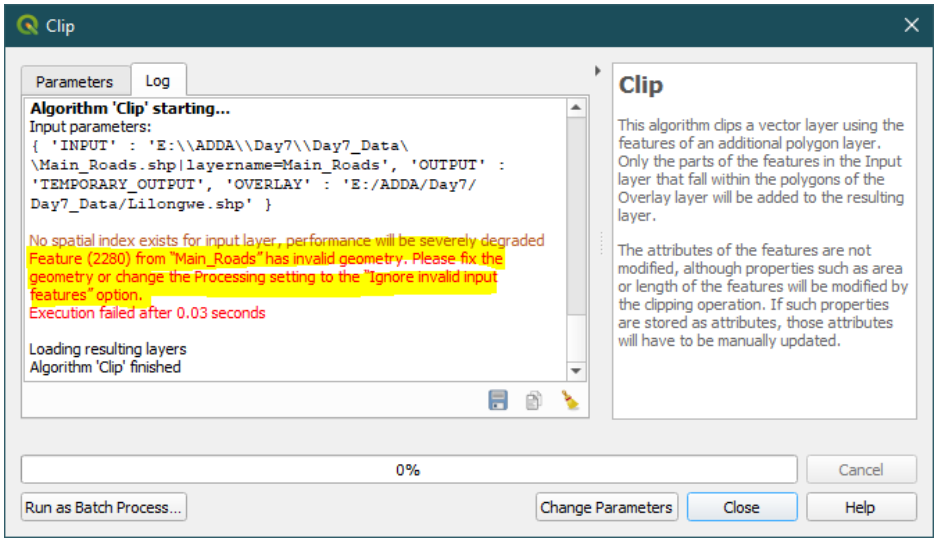
1. Under **Processing Toolbox**, search for **Clip** tool.
2. Many clipping tools are available – since QGIS is a package of multiple software in one (QGIS, GDAL, GRASS etc) package, some tools that are implemented in other software also show up in the results. You need to explore and be familiar with how these tools vary (or similar). For this work, pick **Clip** that is under **Vector Overlay** toolset.



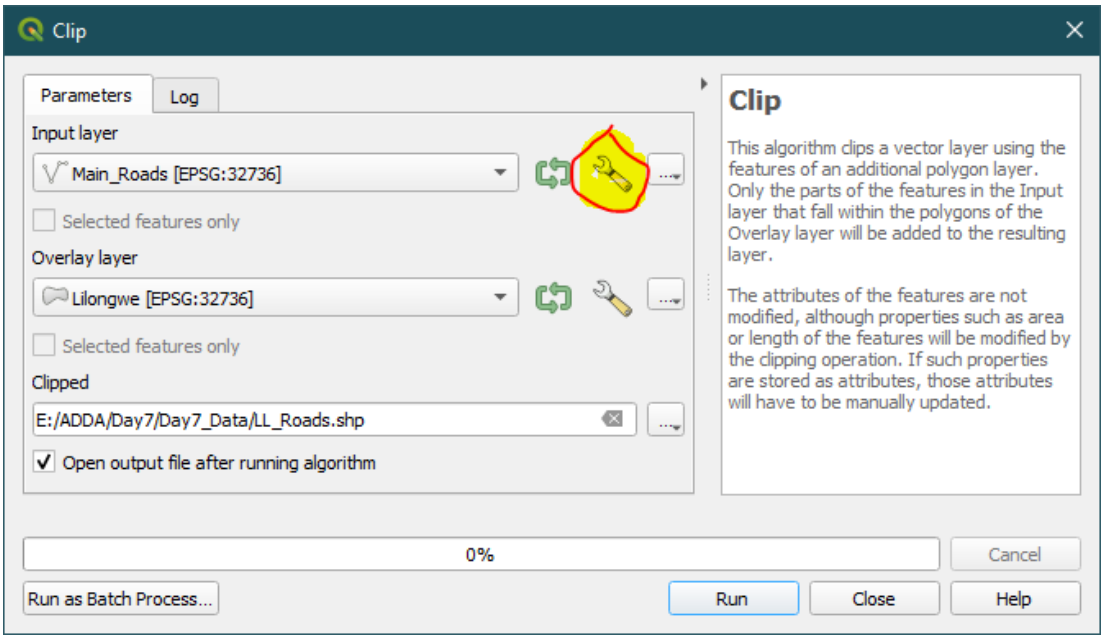
3. Now, the input layer is the layer containing features of interest (roads and health facilities) whereas the overlay layer is the layer that we are using to define the area of interest (Lilongwe district).

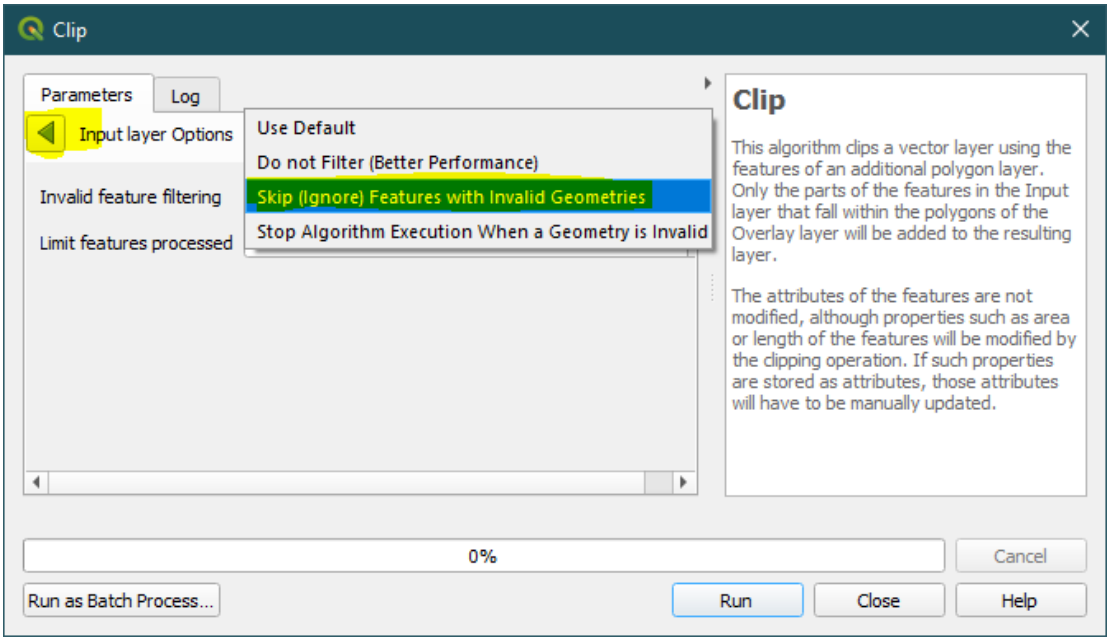


4. Click **Run**. It is possible that you got the following error.

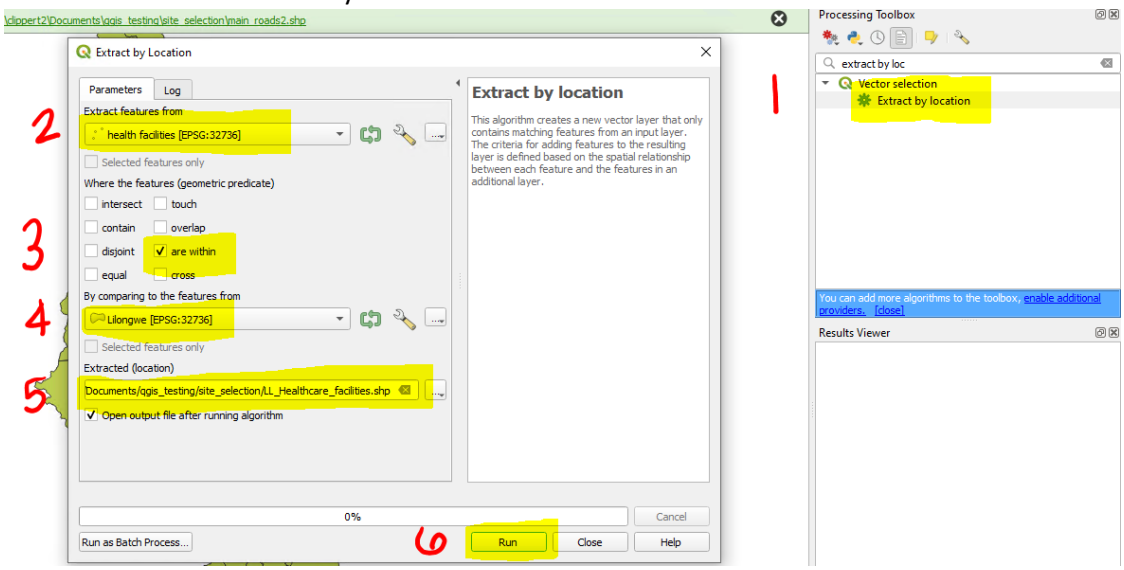


5. Go back to the parameters and click **Processing Setting** button





6. We are going to do a similar process to extract the Health Facilities in the Lilongwe district as well. Under **Processing Toolbox**, search for **Extract by Location** tool.
7. We will Extract Features from the 'Health Facilities' layer where the features 'are within' the 'Lilongwe' layer. Be sure to save the Extracted layer to file

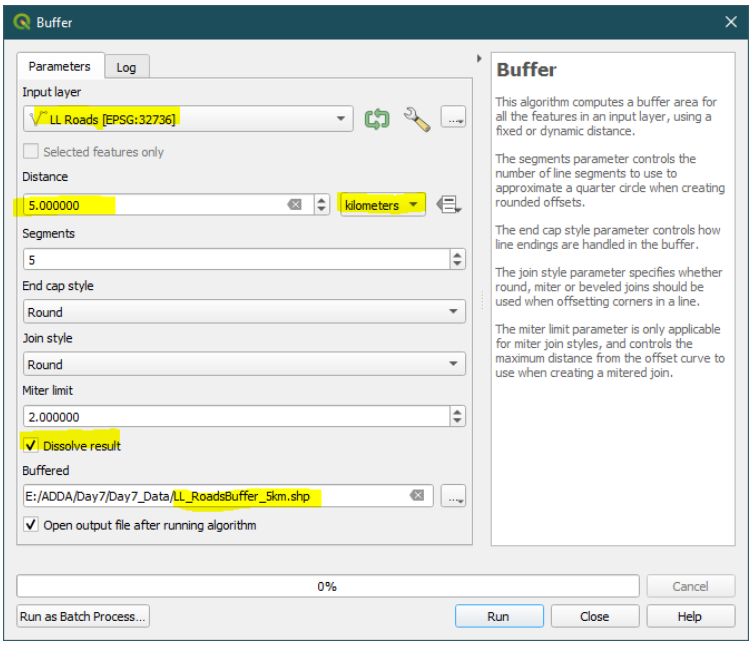


8. When done, turn off all layers except Lilongwe District, Lilongwe Health Facilities, and Lilongwe Main Roads.

Section 6: Creating a 5 km buffer zone from the main roads

Now, we are interested in finding what percentage of all the health facilities in the district are located within 5 km distance from the nearest highway (**Main Roads)**. To answer this question, we have to create a 5-km buffer zone with respect to the main roads, and also find out how many of the health facilities within the district fall within the 5-km buffer zone. Let's get this started.

1. Under the **Processing Toolbox,** search for **Buffer** tool.



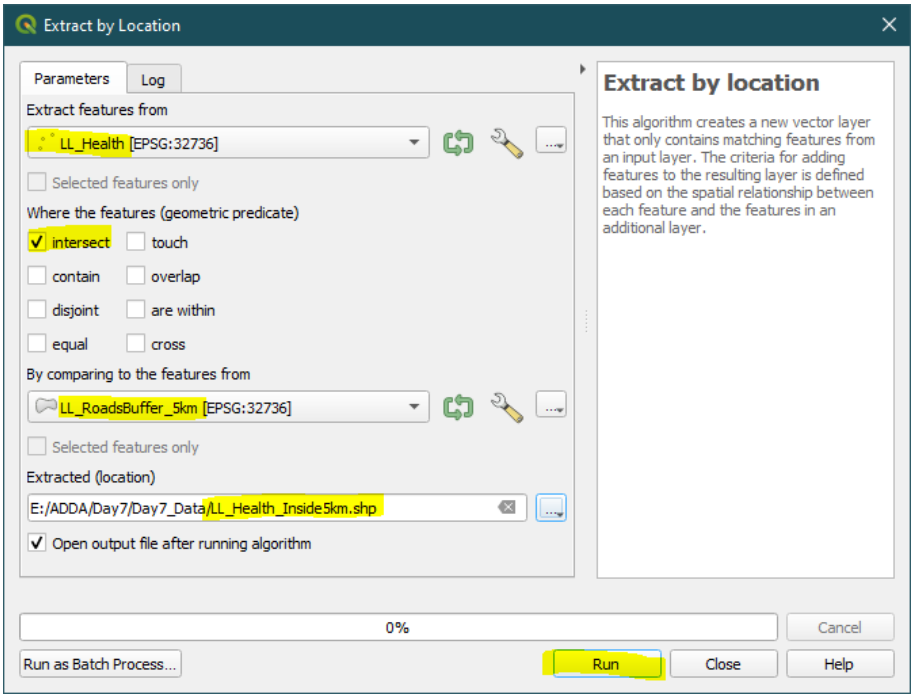
The default distance is in meters because our input dataset is in a Projected Coordinate System (UTM) that uses meter as its basic measurement unit. You can keep it in meters (5000 meters) or change it to 5 kilometers.

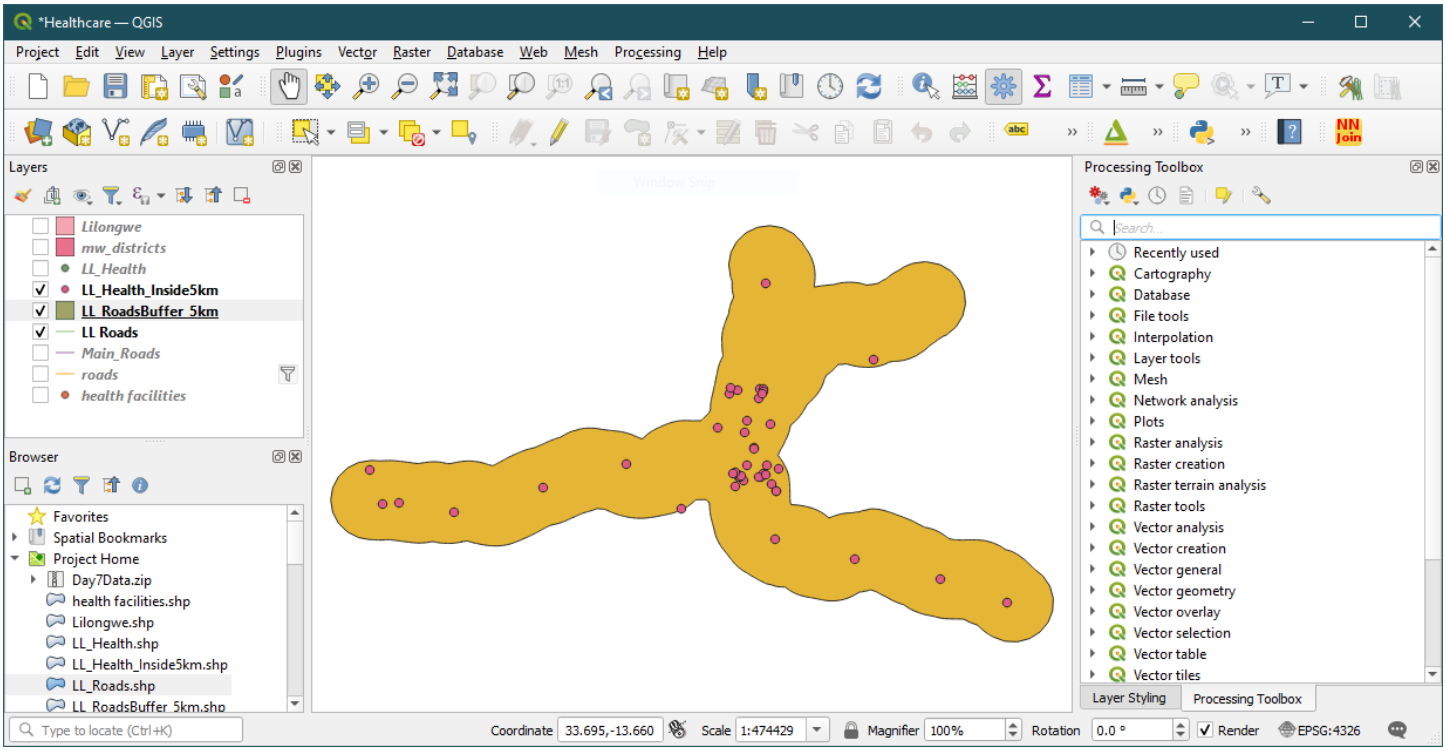
The new layer gives you all the areas in your region which are within 5km of a road.

Curious? What does the **Dissolve result** option do? Repeat the procedure this time with Dissolve result option unchecked. Compare the two output layers.

Section 7: Extract Health Facilities within the 5km main road buffer

1. Search for and select **Extract by Location** tool





Now, having completed all the tasks, you still need to do some calculations and provide the answer to the original question.

Total number of Healthcare facilities in Lilongwe District: _____

Total number of Healthcare facilities within 5-km highway buffer zone in Lilongwe District: _____

Percentage of healthcare facilities in Lilongwe District that are within 5-km zone: _____

Submission: Make a "beautiful" cartographic map of your results and include your analysis results, summary of your findings, and a personal reflection in a word document.

Advanced Exploration:
Congratulations! You have successfully applied your understanding of spatial analysis methods and GIS tools to address the problem. Now, your answer is just the starting point of further analysis that looks into where people or living in comparison to where the health centers are. If the government of Malawi's mandate is to provide health facilities within 500 meters for every living citizen of Malawi, are we meeting those currently? Where do we need to put new health facilities to fill existing gaps? Those are some of the critical questions that can be answered using GIS. To answer these questions, you can actually download buildings layer from Open Source Mapping (OSM) network (free) and then carry out buffer analysis of 500 meters with respect to each health care center. Those houses that fall outside of those buffer zones are obviously not being served by the government mandate. So now, you are empowered to identify gaps in critical services and come up with a proposal to the government – or this can be presented as an opportunity for health care providers to expand into those areas.

If any of you take this study to that next level, do share them with Dr. Suresh Muthukrishnan / Dr. Emmanuel Chinkaka so we can give you feedback!

Well Done! Map On!