MODULE I - INTRODUCTION TO GIS FOR MANAGING STREET LIGHTING DATA

INTRODUCTION

The course aims to showcase modern geospatial tools which facilitate a strategic planning of dynamic lighting solutions and strategic embedding of dynamic lighting scenarios into municipal strategies and action plans. Exploiting and using geospatial data into dedicated software packages (GIS - Geographic Information System), the attendants will see how to efficiently operate and manage lighting data and information while reducing planning and decision time and costs.

The main objectives of the course therefore are:

- ✓ to review GIS concepts and technologies (theory)
- ✓ to present procedures for geodatabase creation and use within GIS software environments (theory / practice) to showcase GIS potential in supporting street lighting planning (practice)

Main contents:

- ✓ How to use and manage geospatial data in dedicated GIS environments
- ✓ How to design GIS database for street light management
- ✓ How to develop a comprehensive inventory (pole locations, quantity, wattage, condition, type, etc.) of street lights
- ✓ How to plan dynamic lighting using geospatial data

Step 1. Download open source software QGIS

QGIS - It is a free and open-source cross-platform desktop Geographic Information System (GIS) application that supports viewing, editing, and analysis of geospatial data.

Download it: https://www.qgis.org/en/site/

Step 2. - Learn to work with QGIS Browser

The interface to QGIS Browser is simple and clean (as is shown in the figure below).
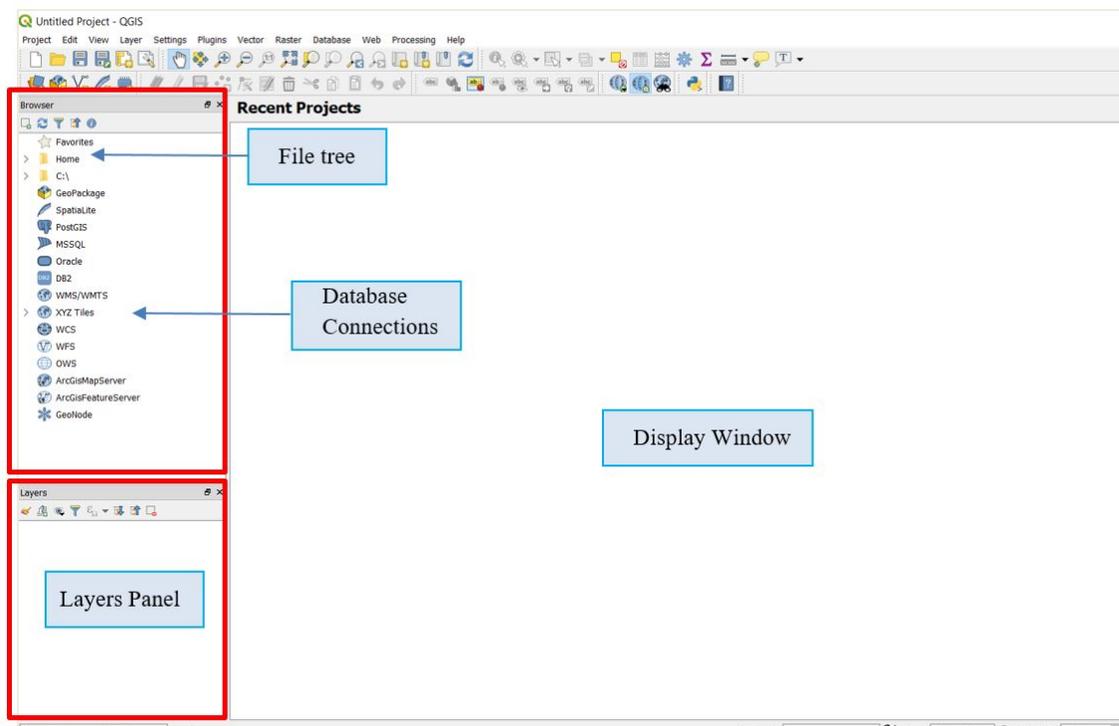
*Note: Your QGIS Desktop window may look slightly different than the one pictured above.*

Look at the **File Tree.**
Click the arrow to the left of the C: drive. You will now see all of the subfolders directly under the C:/ folder.
In the **Layer Panel** you will see all loaded and displayed data.

To change the language of the menu/functions:
Settings > Options > General > choose "American English"
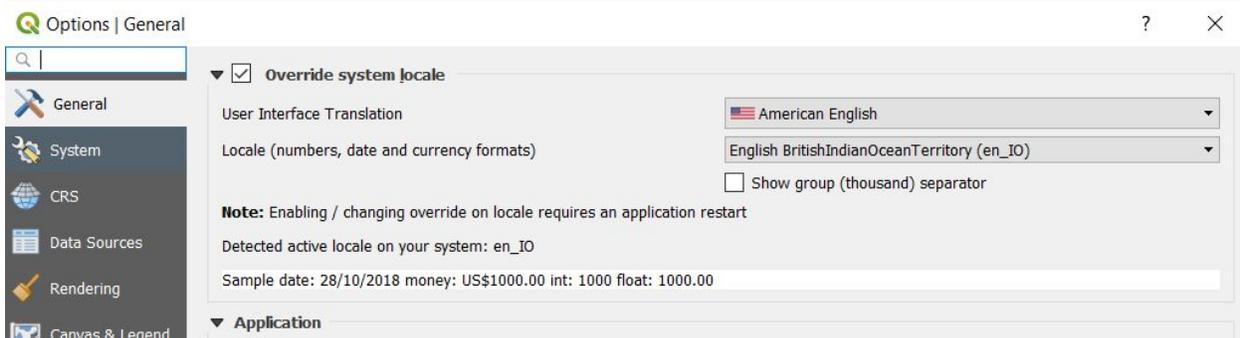
Step 3. - Loading and viewing geospatial data in QGIS Desktop

The data that can be imported in GIS environments are of different types (vector, raster, 3D, etc.). All data contains some attributes (right-mouse click / Open Attribute Table) which can be used to perform queries and analyses.
For the scope of this exercise, let's import three type of data:

A. Vector data:

1. Click the Add Vector Layer button.
    Alternatively, you can click Layer | Add Layer | Add Vector Layer.
    (add following data:
    - buildings,
    - cycleways,
    - powerlines,
    - railways,
    - roads,
    - water,
    - waterways.)
2. Another way to interact with both the spatial features and the attributes is the Identify button. Click the Identify button.

B. Raster data:

1. Click the Add Raster Layer button
    Alternatively, click Layer | Add Layer | Add Raster Layer.
   (see: Step 4. - Online data)

C. Delimited data:

1. Click the Add Delimited Layer button

Alternatively, click Layer | Add Layer | Add Delimited Layer.
(add following data:
- streetlight_public_Trento)
2. Save as "ESRI Shapefile"- named: "streetlight_public"
3. Click the Identify button.

Further hints and suggestions:

- **Save project!!**
- The order of the layers in the panel can be changed simply dragging the layers.
- Open the attribute table of a layer and examine the included information.
- Double click on a layer and inspect all information, symbols, etc.
- Check the **Symbology tab**, pick existing Basic colors or define a color via A) hue, saturation and value (HSV) or B) red blue and green (RGB) values.
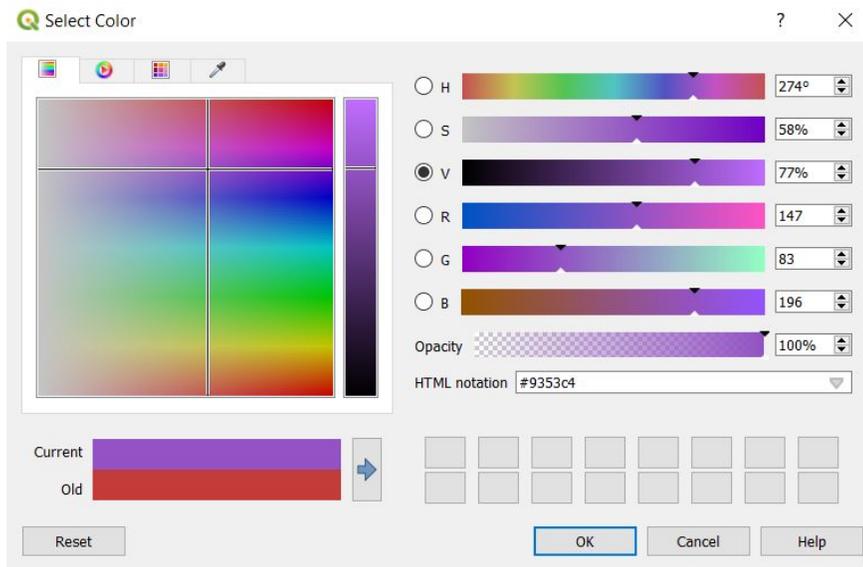
1. Change the colours or symbols for the following layers:
   a. streetlight_public
   b. buildings,
   c. cycleways,
   d. powerlines,
   e. railways,
   f. roads,
   g. water,
   h. waterways.

**Instead of making the entire layer one color you will assign a unique color to each type of luminaire.**

1. Open the Attribute Table of the streetlight_public layer.
2. Open the Layer Properties and switch to the Symbology tab. So far you've used the default Single Symbol type and now you will switch to Categorized.
3. Now you have the option of choosing an attribute column to symbolize the layer by.
4. Select "TYPE_02" and click Classify.
5. Change the colours or symbols.
6. See the result on the map.

Labels can be added to a map to show any information about an object.

Any vector layer can have labels associated with it. These labels rely on the attribute data of a layer for their content

1. Go to the menu item **View ▸ Toolbars.**
2. Ensure that the **Label** item has a check mark next to it. If it doesn't, click on the **Label** item, and it will be activated.
3. Click on the "streetlight_public" layer in the **Layers list**.
4. Click on the following toolbar button: **labeling** abc
5. This gives you the Layer labeling settings dialog.
   You'll need to choose which field in the attributes will be used for the labels.
6. Choose the **Single labels** and **Label with**: TYPE_02.
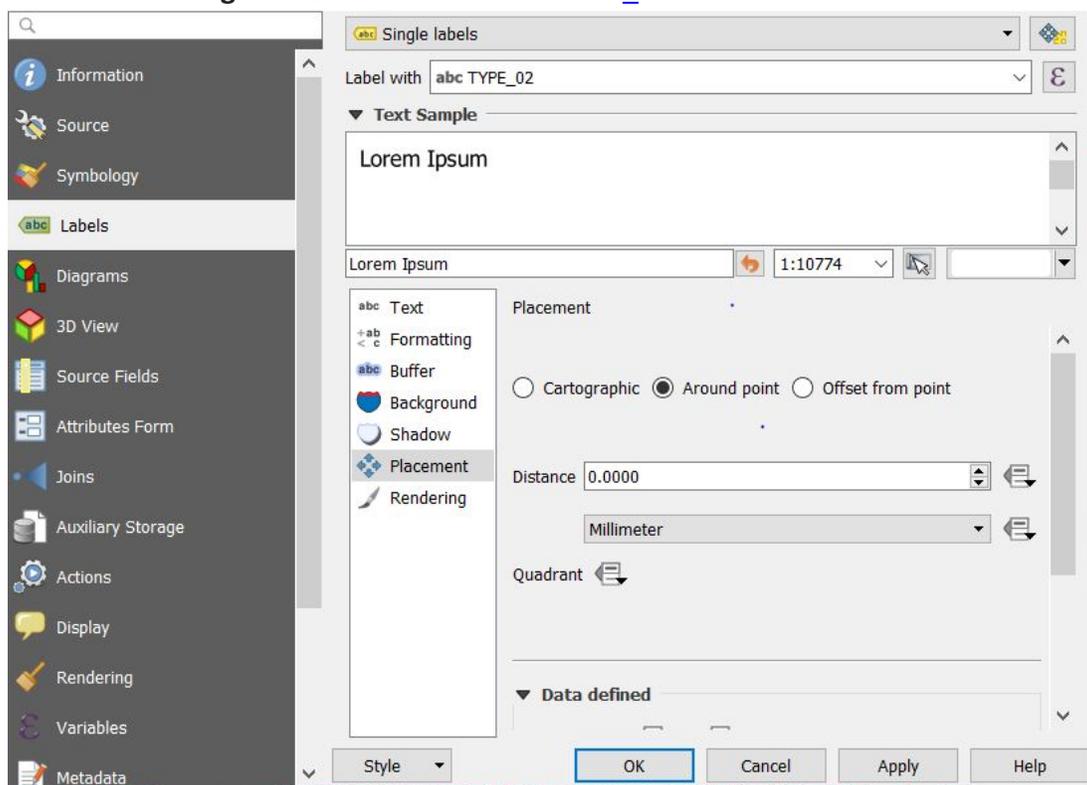
Step 4. - Online data

Data can be loaded and visualized from the local disc of your computer but they can also be loaded from remote servers using specific sources (e.g. a municipality's repository, Google's server, etc.). Different protocols exist to load such data, for example the WMS (Web Map Service) which provides georeferenced map images, the WFS (Web Feature Service) which provide vector data and the WCS (Web Coverage Service) which provides raster data.

1. Go to **Layer ‣ Add WMS Layer**....
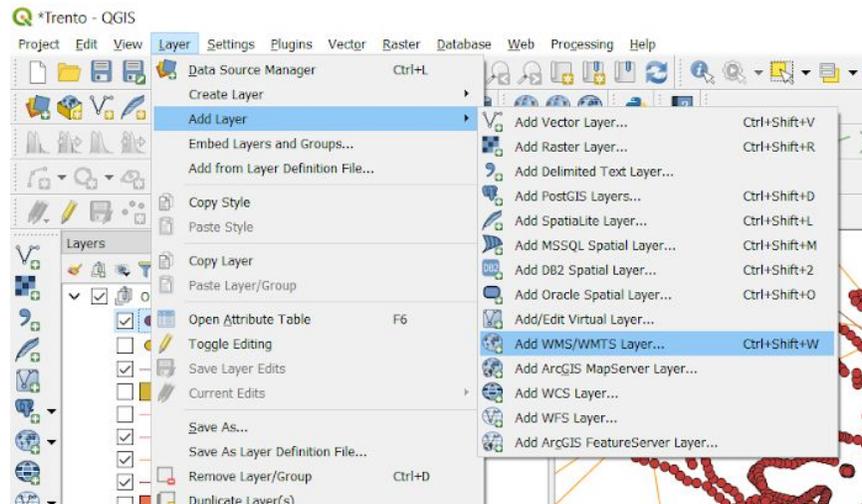
2. In the Layers tab, click on New.
3. Name your connection "WMS" and insert as URL: http://webapps.comune.trento.it/ogc
4. Next, click on the **Connect** button to fetch the list of available layers .
5. Select the layer Ortofoto 2015.
6. Choose JPEG as the format. Change the Layer name if you wish and click **Add**.

Step 5. - QGis plugins

QGis has already many functionalities but more can be loaded using the plugins module.

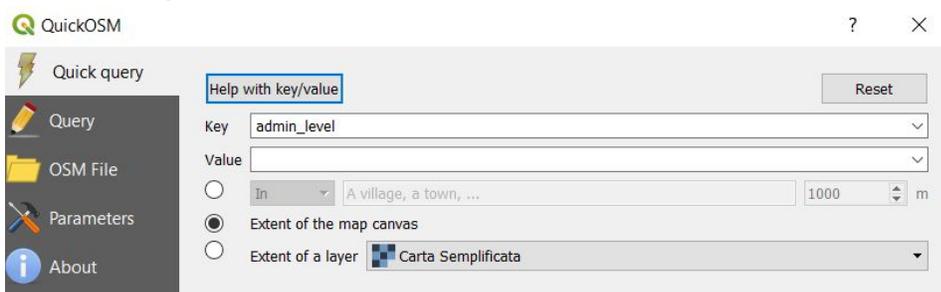Two interesting plugins are:
QuickOSM and QuickMapServices (QMS):

1. **Install the** QuickOSM plugin.

2. The plugin adds two new buttons in the QGIS Toolbar and is accessible in the **Vector ▸ QuickOSM** menu.

3. Open the **QuickOSM** dialog. The plugin has many different tabs: we will use the **Quick Query** one.

4. You can download specific features by selecting a generic **Key** or be more specific and choose a specific **Key** and **Value** pair.

Tip
*if you are not familiar with the Key and Value system, click on the **Help with key/value** button. It will open a web page with a complete description of this concept of OpenStreetMap*

5. Look for **building** in the **Key** menu and let the **Value** empty: so we are downloading all the **building** features without specifying specific values.
6. Select Extent of a layer and choose "streetlight_public".
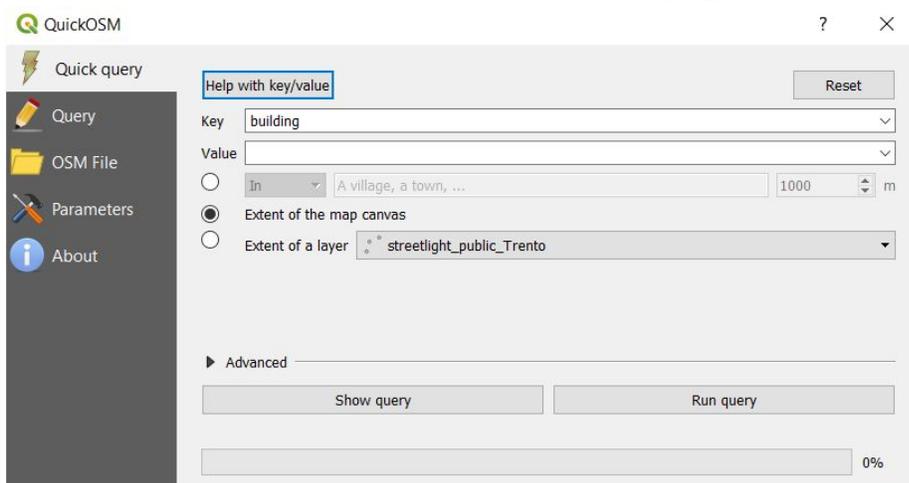
7. Click on the Run query button.
8. Change the style of the Building's layer.
9. Check the difference between original data "Buildings" vs "Online Buildings".

Warning

QuickOSM creates temporary layer when downloading the data. You have to save them permanently.
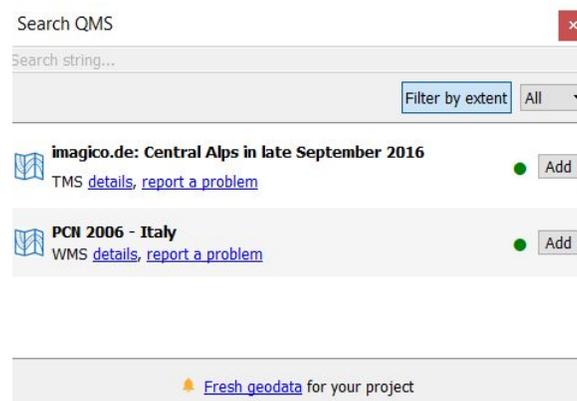
10. **Install the** QuickMapServices (QMS) plugin.

11. Open the plugin's search tab by clicking on **Web ▸ QuickMapServices ▸ Search QMS**. This option of the plugin allows you to filter the **available base maps** by the current extent of the map canvas.
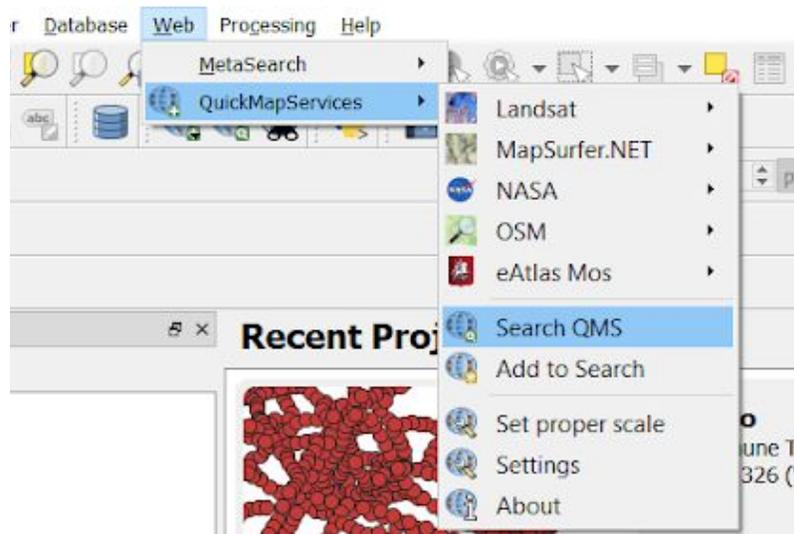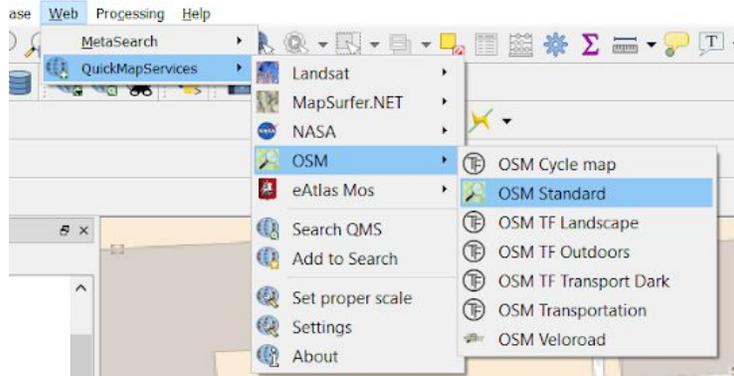

12. Click on the **Filter by extent** and you should see one service available.

13. Click on the **Add** button next to the map to load it.

14. Open the plugin's search tab by clicking on **Web ▸ QuickMapServices ▸ OSM ▸ OSM Standard**.

## Step 6. - Setting Map Projections and Coordinate Systems in QGIS

First we will examine the map units and distance units set for this "unprojected" map.

1. From the menu bar, select Project | Project Properties.
2. Click the CRS tab to view the Coordinate Reference System information for the project file.
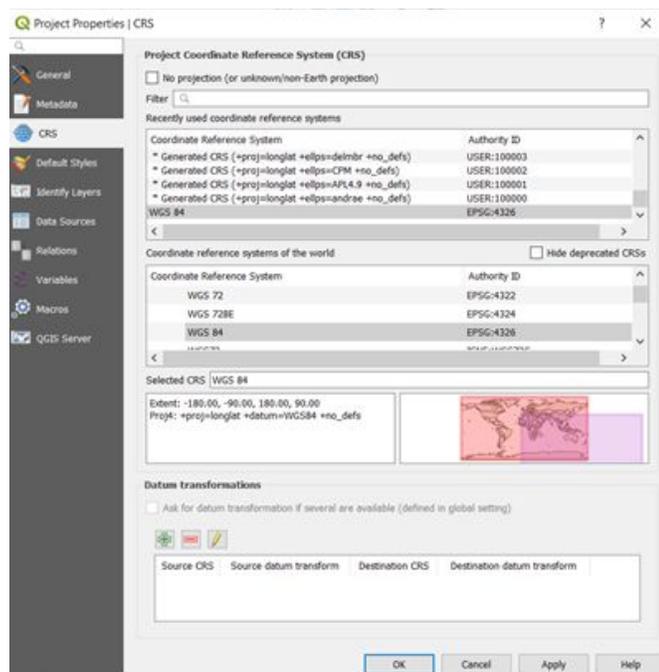
Notice that the selected coordinate system is set to WGS 84, which is an unprojected coordinate system.
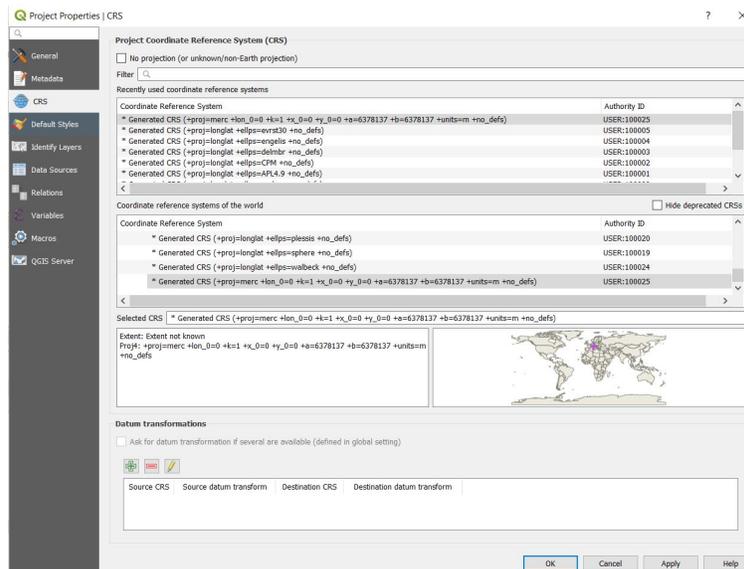
Step 7. - Editing geospatial and non-spatial data

A. Vector data:

Editing allows you to add, delete and modify features in vector data sets.

1. Click Layer | Toggle Editing.

*Multiple layers can be edited at a time. The layer currently being edited is the one selected in the **Layers panel***.


EDITING TOOLBAR IN QGIS

2. Add point (luminaire) feature to "streetlight_public" layer.
3. Fill out the visible attribute table.
4. Modify a single attribute in "attribute table"
5. Modify the attributes of all selected features simultaneously (see point F.)
   (i) change 100 W to 2000 W
   (ii) deselect Features
   (iii) Select the features from "streetlight_public" layer, equal to "2000 W" (How many matching features were selected?).
   (iv) change 2000 W to 100 W
   (v) save edits.

6. Select the feature(s) to move. Use Move Feature(s) tool
7. Use the "Panels | Advanced digitizing panel" to accurately set the origin point coordinates. In that case:

a. first click on the ![ruler icon] button to enable the panel;
b. type x and enter the corresponding value for the origin point you'd like to use. Then press the ![lock icon] button next to the option to lock the value;
c. do the same for the y coordinate;
d. click on the map canvas and your origin point is placed at the indicated coordinates.

8. Save changes.

## Step 8. - Querying and Extracting Subsets of Data

Vector data can also be analyzed to reveal how different features interact with each other in space. **The goal:** To ask a question and solve it using analysis tools.

1. Right-click on the "streetlight_public" layer in the Layers list and open the Layer Properties.
2. Go to the Source menu.
3. Under Feature subset click on the [Query Builder] button to open the Query builder dialog.
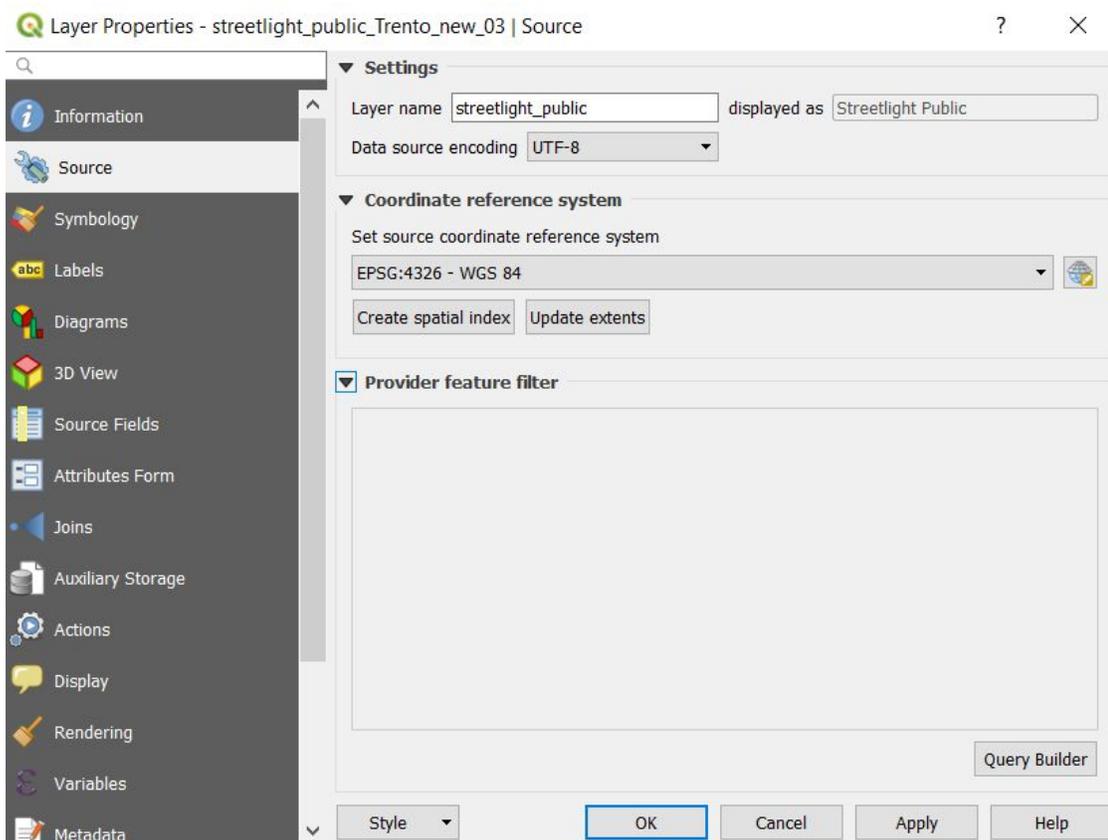
1. Build Query:
   a. show the "lighting points" where the value of [power] is equal to [100] - check the result on the map
   b. show the "lighting points" where the value of [height] is higher than [10] - check the result on the map
   c. show the "lighting points" where the value of [power] is equal to [150] AND where the value of [height] is higher than [10] AND where the value of [TYPE_02] is equal to [metal halides] - (i) check the result on the map; (ii) (How many matching features were selected?)
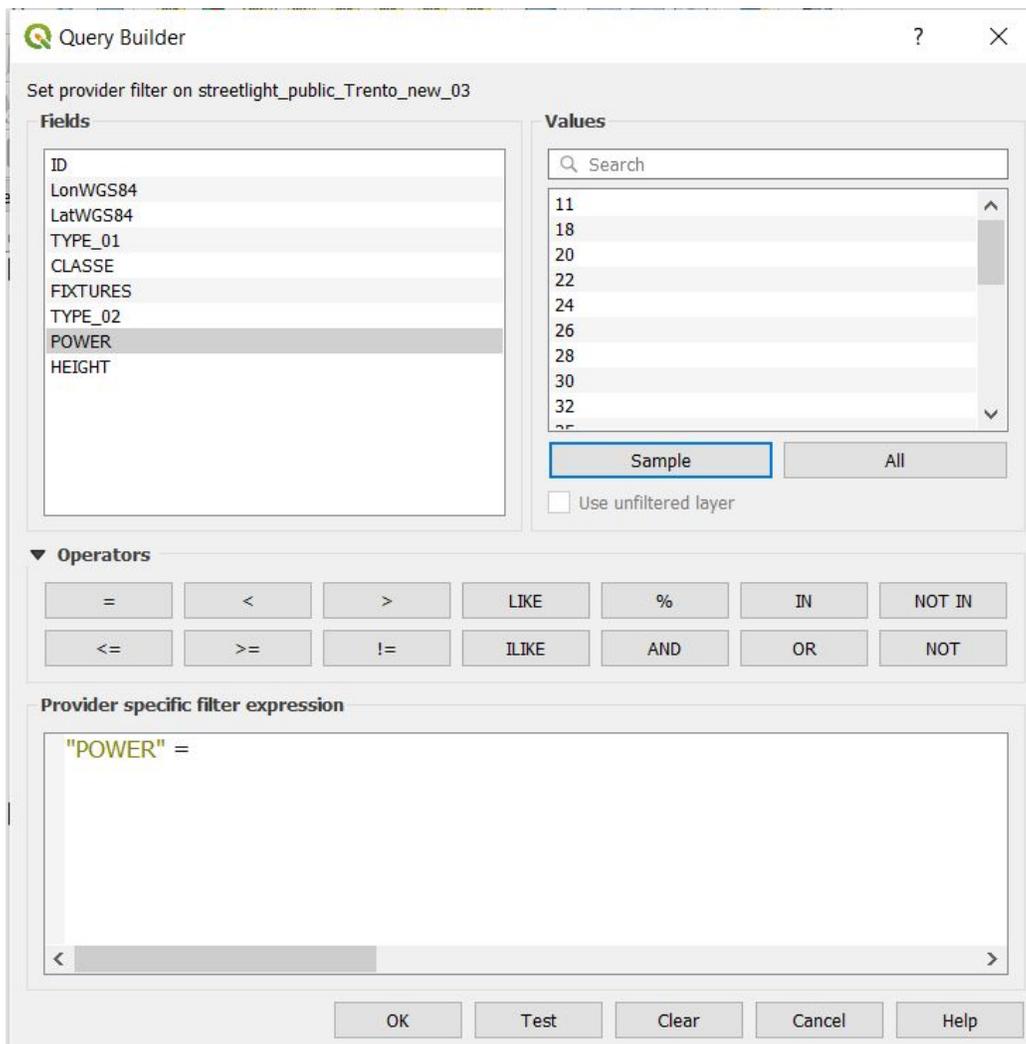
2. Save "point c" as new .shp and named "streetlight_public_query".
3. Clear the Query.

Step 9. - Create Thematic Map

1. From the menu bar choose Project | New Print Layout.
2. Click on the **Add New Map** button:
3. Click and drag a box on the blank page. The map will appear on the page.
4. Move the map by clicking and dragging it around.
5. Resize it by clicking and dragging the boxes in the corners.
6. Add following items:
    a. Add Label
    b. Add Legend
    c. Add Scale Bar
    d. Add Picture: North Arrow
7. Export map as PDF.
8. Export map as Image.