1 Exercise 1

Overall Objectives:

To determine the ratio of high-density informal settlements within a set of administrative spatial units in Ouagadougou, Burkina Faso, using spatial analysis methods.

1. Background

This is an instructor led exercise. The objective is to determine the proportion of high-density informal settlements in three administrative units in Ouagadougou. This type of information can be often useful for spatial planners, as administrative units - while far from perfect – are often used to direct evidence-based urban policy making. Informal settlements have been rapidly evolving in Ouagadougou within the past two decades and as such, this exercise aims to highlight the use of geographical and remotely sensing products to efficiently and accurately provide crucial and relevant information to stakeholders.

In this task, three types of spatial layers will be used, a very-high-resolution (50-centimeter spatial resolution) land-cover map of Ouagadougou, a land-use map (street block resolution) as well as a layer consisting of the three administrative units. The final objective is to aggregate at an administrative level the proportion of high-density informal settlements the land-use map. Finally, the results will be exported as maps.

1.2 Data

The data used for this exercise are:

a) A very-high-resolution land-cover map (file name: **land_cover_clipped.tif**) [1]
b) A land-use map at the street block level (file name: **land_use_clipped.tif**) [2]
c) An administrative disaggregation of Ouagadougou (file name: **admin_units.shp**)

1.3 Software

The software used in this exercise is QGIS 3.4 [3].

1.4 Methods

1.4.1 Installing necessary Plug-ins

First, launch QGIS 3.4 and install the LecoS plugin. *Lecos* is a module that allows several spatial analysis methods to be implemented in an efficient and user-friendly manner.

Install the LecoS plugin:

- **MENU Plugins ► Manage and Install Plugins► Type "lecos" in the search bar and click on it ► Install Plugin**

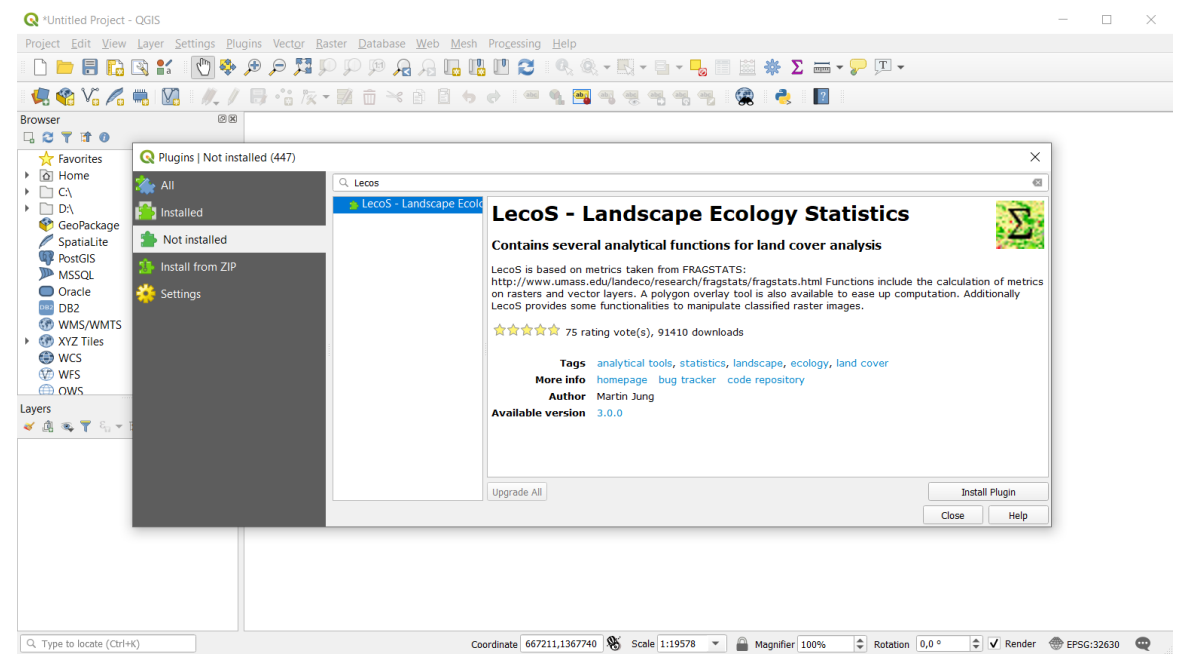

Figure 1. LecoS is a module that enables several land-cover and land-use analytical functions in an efficient manner.

Optionally, the *QuickMapServices* module may be installed to allow for the loading of basemaps (ie., OpenStreetMaps or Google Earth imagery) to assist with visualization for the tasks at hand.

Install the QuickMapServices plugin:

MENU Plugins ► Manage and Install Plugins► Type "QuickMapServices" in the search bar and click on it ► Install Plugin

After the module is installed, the internet maps should be downloaded:

- **MENU Web ► QuickMapServices► Settings**

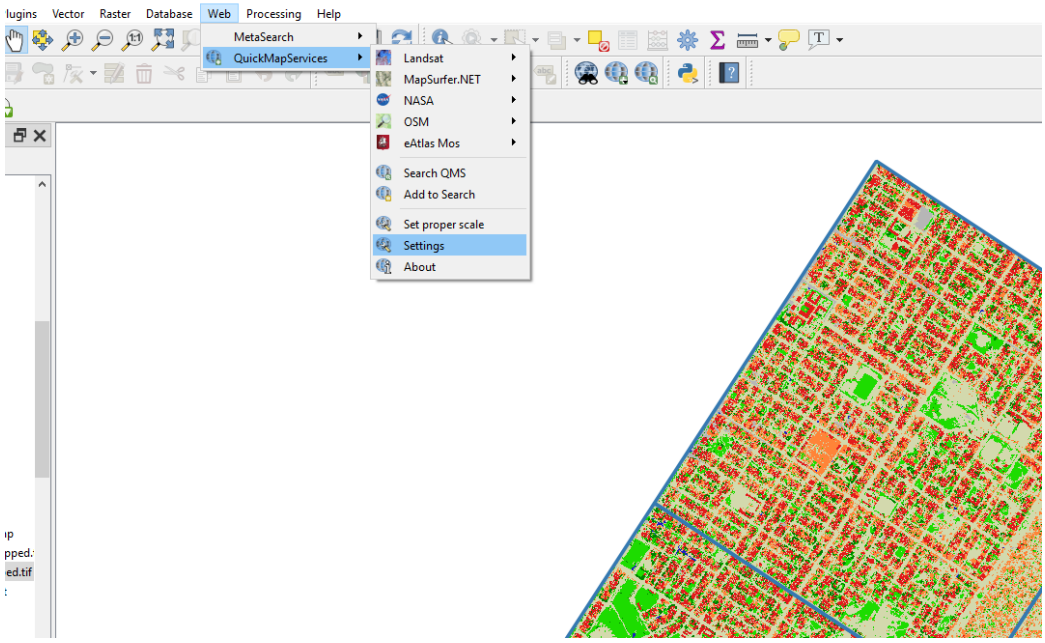

Figure 2. The settings menu of QuickMapServices

In the window that pops up:

- **More Services ► Get Contributed pack► Visibility ► Tick on Google and osm and untick the rest (Figure 3) ►Save**

Keep in mind that it might be computationally intense and internet dependent.

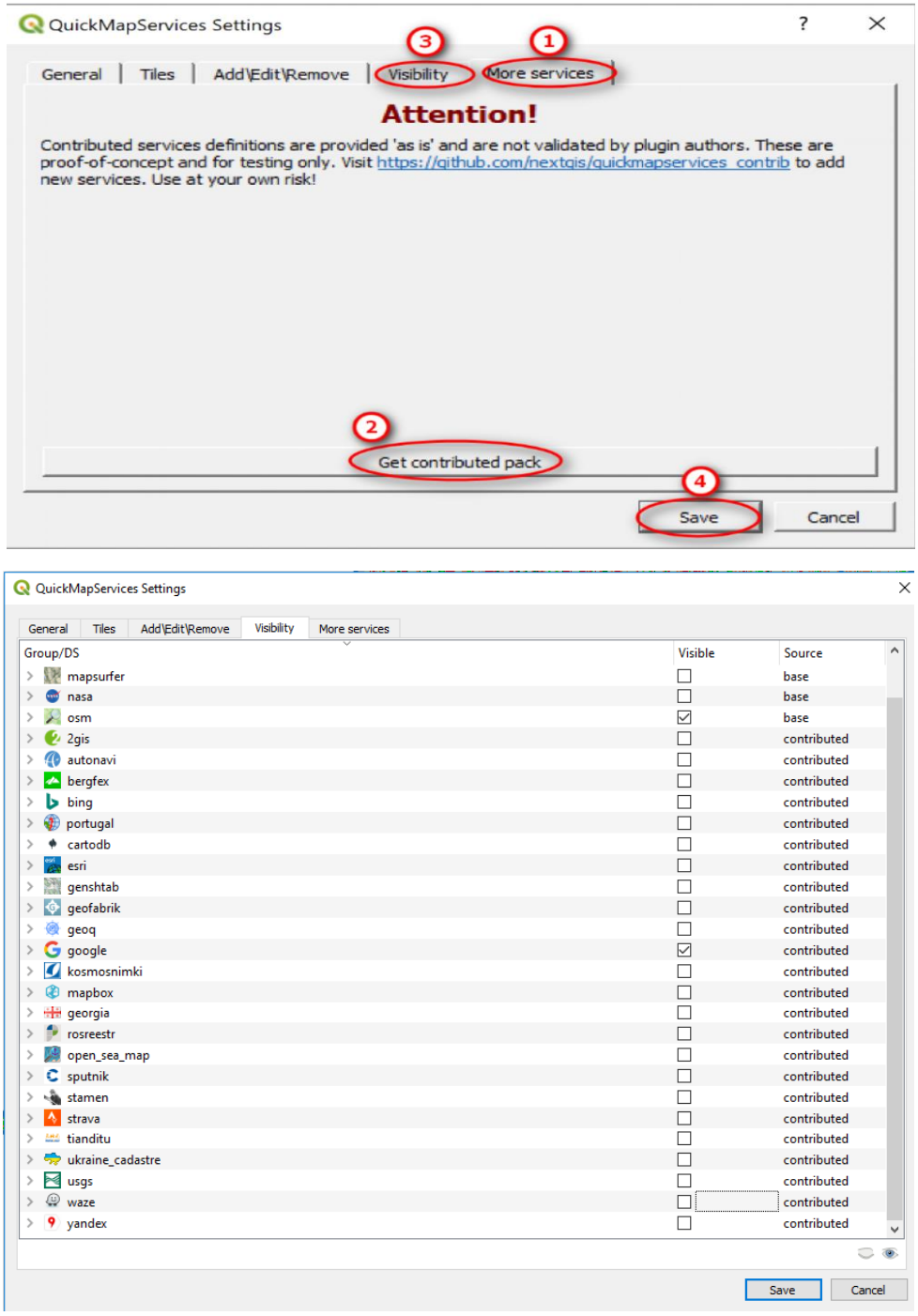

Figure 3. Steps to load basemaps with QuckMapServices

1.4.2 Importing and Visualizing the Data

In the QGIS Browser navigate to the folder containing the data for this exercise (…../Exercise_1/Exercise_Data) and import the data as layers, ideally in this order (‘**Land_Use_clipped**’, ‘**Land_Cover_clipped**’ and ‘**Admin_Units.shp’**). To do so:

- **Browser ► Navigate to the exercise files ► Right click on each file ► Add Layer to Canvas/Project (Figure 4)**

Alternatively, to import them, you may a) double click on each file or b) by a ‘drag and drop’ fashion. The priority of visualization follows a top to bottom rule, which means that the top layer overlays the others. By ticking and un-ticking each layer you can visualize various layer combinations. The order of the layers in the **Layers list** controls the order in which they are displayed in the **Canvas**. For example, if you drag and drop the **admin_units** layer above the other two layers it will be overlaying them, so make sure to do that!

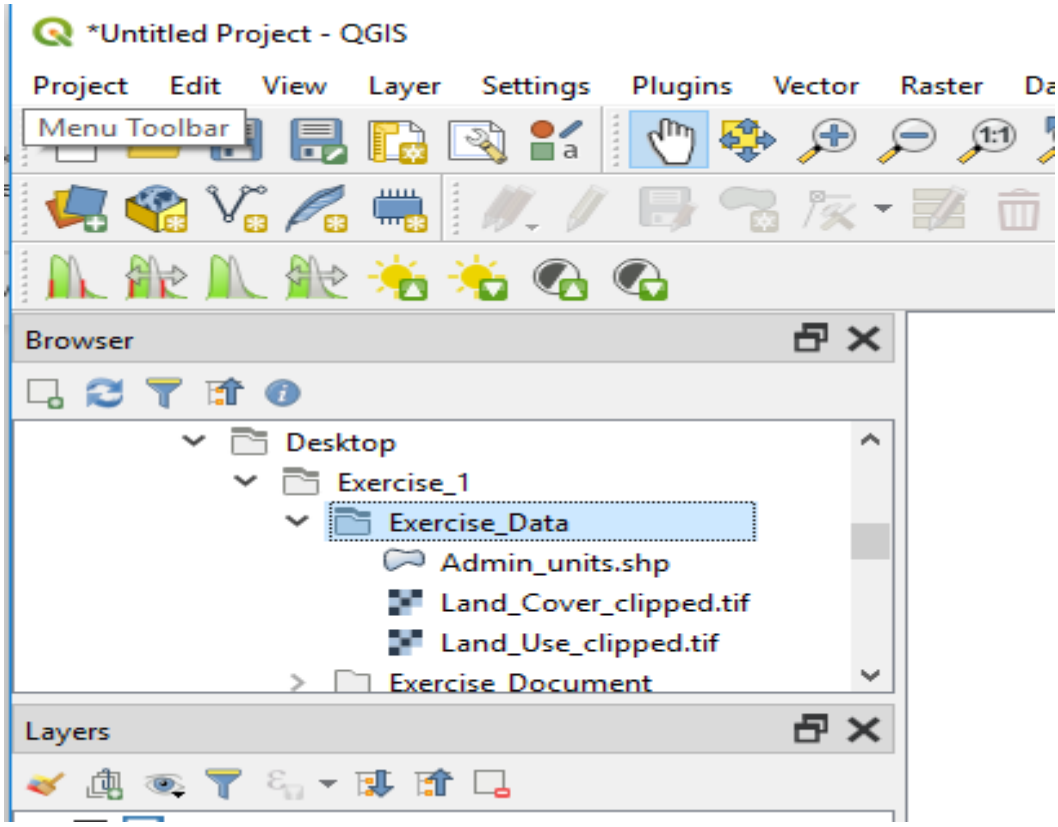

Figure 4. Importing the exercise data from the QGIS Browser window.

You can also add a satellite basemap from the QuickMap addon we previously installed:

- **MENU Web ► QuickMapServices ► Google ► Google Satellite (Figure 5)**

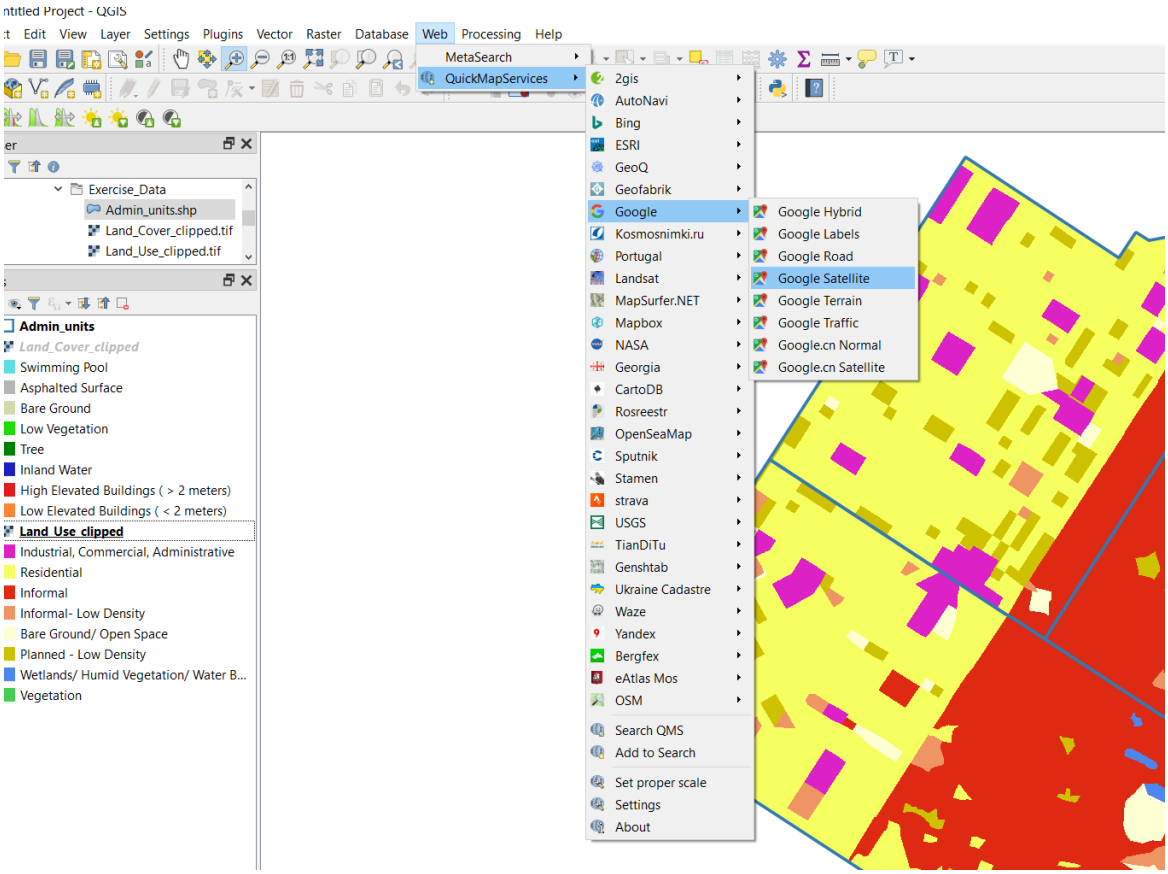

Figure 5. Adding a satellite basemap

We can now investigate these maps in more detail and in different combinations. On the bottom left of the screen where the three layers are added, there is also information about the land-cover and land-use classes displayed and their corresponding color in order to identify them when visualized (Figure 6).

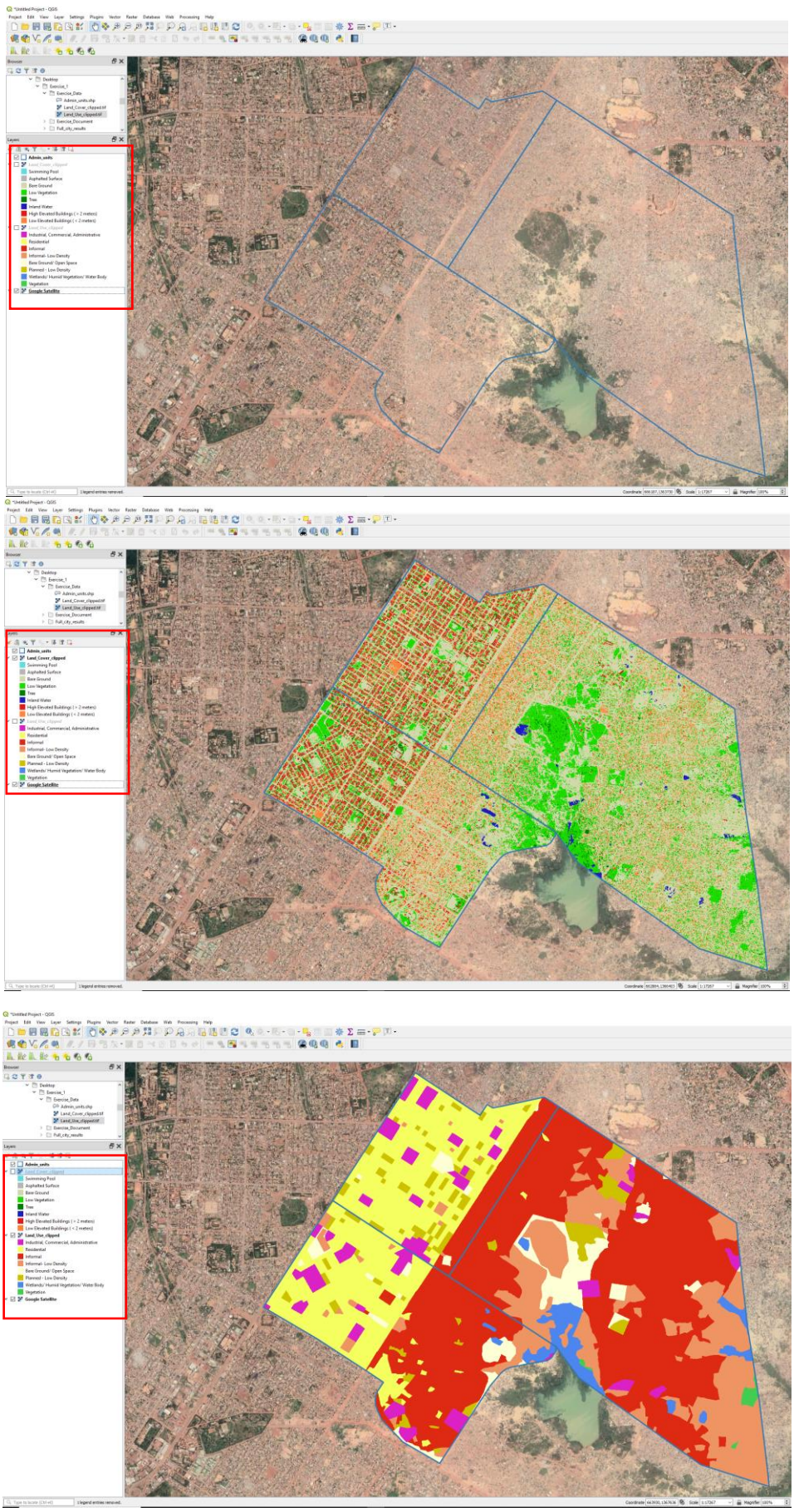

Figure 6. Visualization of the administrative units overlaying the land-cover map, the land-use map and the Google Satellite Imagery and the associated legend.

The land-cover layer will not be used for this part of the exercise, but it is still an interesting layer to visualize. If we would like to zoom in to visualize a part of the area in more detail, we can click on the magnifier icons (Figure 7) and draw a rectangle in the area we want to zoom in to.

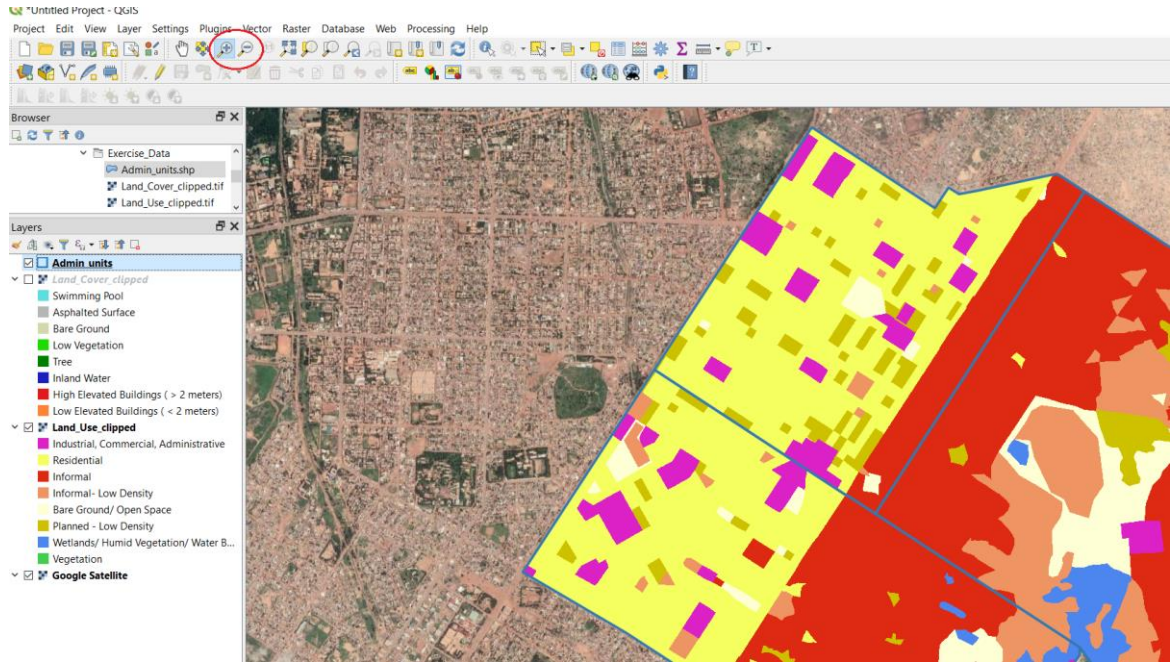

Figure 7. Zoom in/out functions of QGIS layers

To go back the original extent we can right click one of the layers and click the ***Zoom to Layer*** choice (Figure 8).

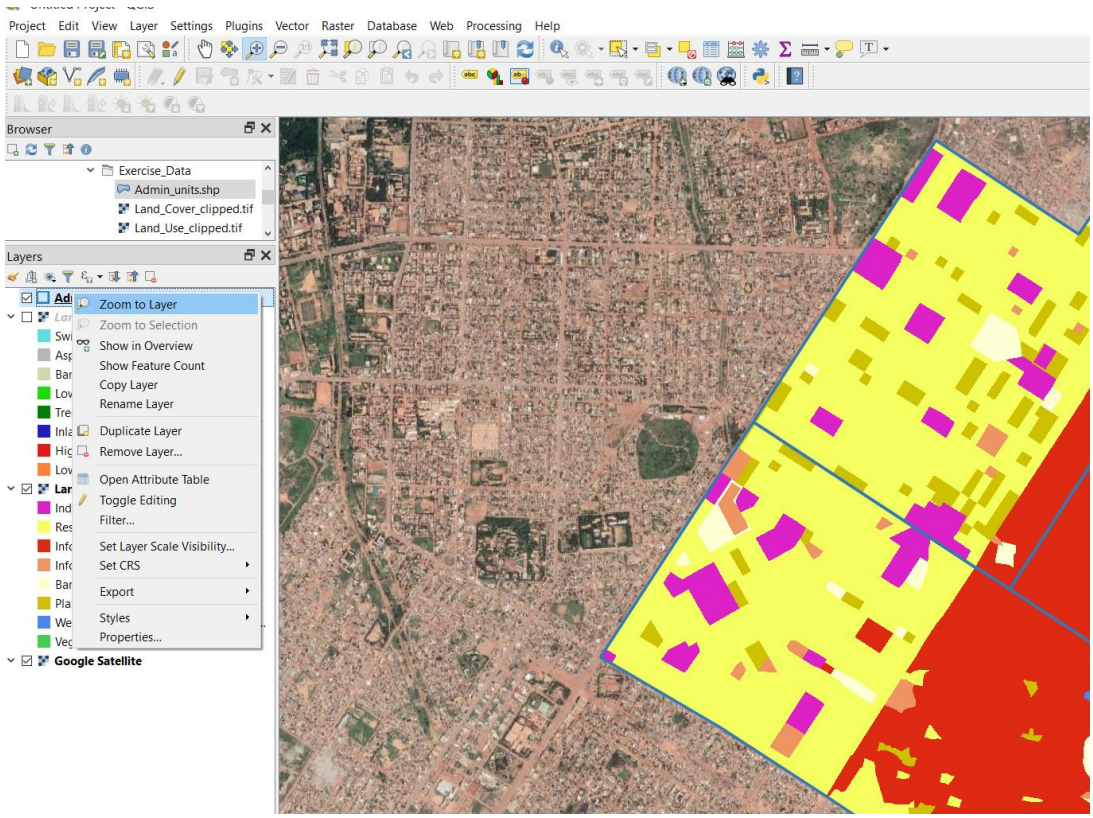

Figure 8. Zooming back to initial extent

As shown in a more zoomed in fashion in Figure 9, several land-cover and land-use classes are included in these geographical layers. In this exercise we will summarize one indicator, namely the proportion of high-density informal settlements from the land-use product.

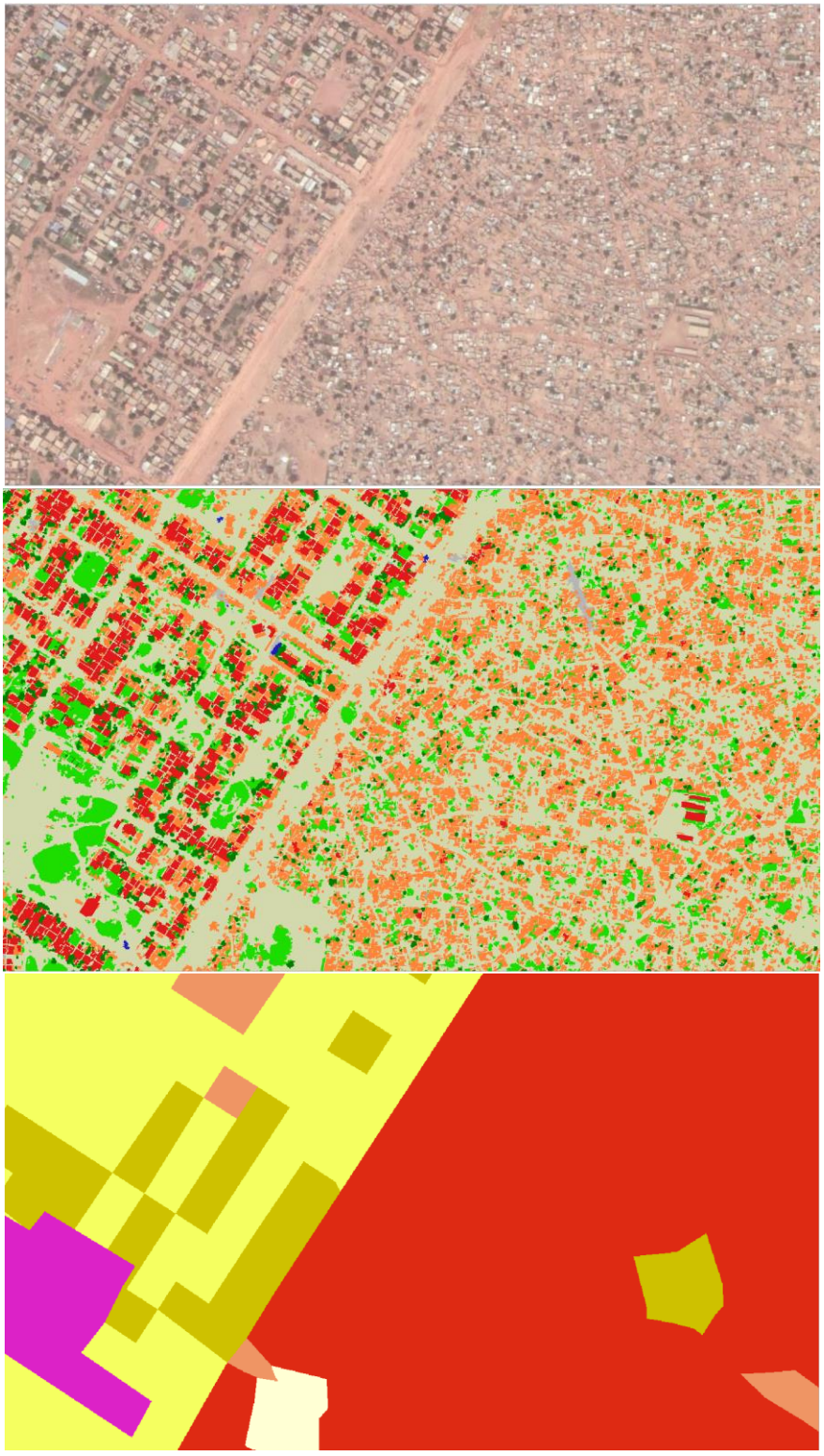

Figure 9. Zoom on an area over different spatial layers, a) Google satellite images, b) land-cover and c) land-use

1.4.3 Extracting Indicators

Now that we are familiar with our data, it is time to start the analysis: As illustrated in Figure 10 below, we open the LecoS menu suitable for our task:

MENU Raster ► Landscape Ecology ► Landscape vector overlay

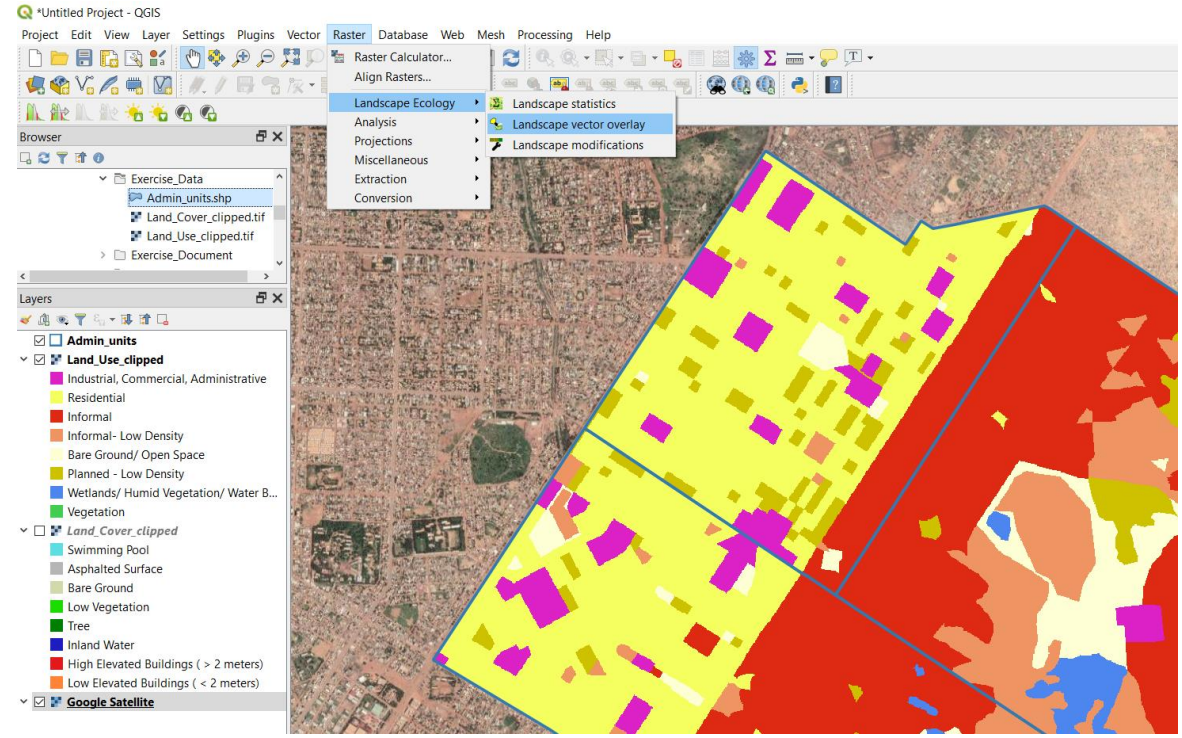

Figure 10. Landscape vector overlay of the LecoS module.

In the ***Polygon Batch Overlay*** pop-up window that appears, select **Land_Use_clipped** as the ***Landscape layer*** and **Admin_units** as the ***Overlaying grid***. Next tick on ***Save in attribute table*** and **untick** the ***Save in file*** option. At the ***Setting****s* select ***Class*** and at the ***Choose class*** **3** (the corresponding ID for the high-density informal settlements). Then, select ***Landscape Proportion*** at the ***Selected Metrics*** section. Finally, click **OK**. After the module runs, it will have computed the proportion of the selected land use class for each administrative unit (Figure 11). This process might take a while, so please be patient. When the task is finished close the window (**Cancel** button).

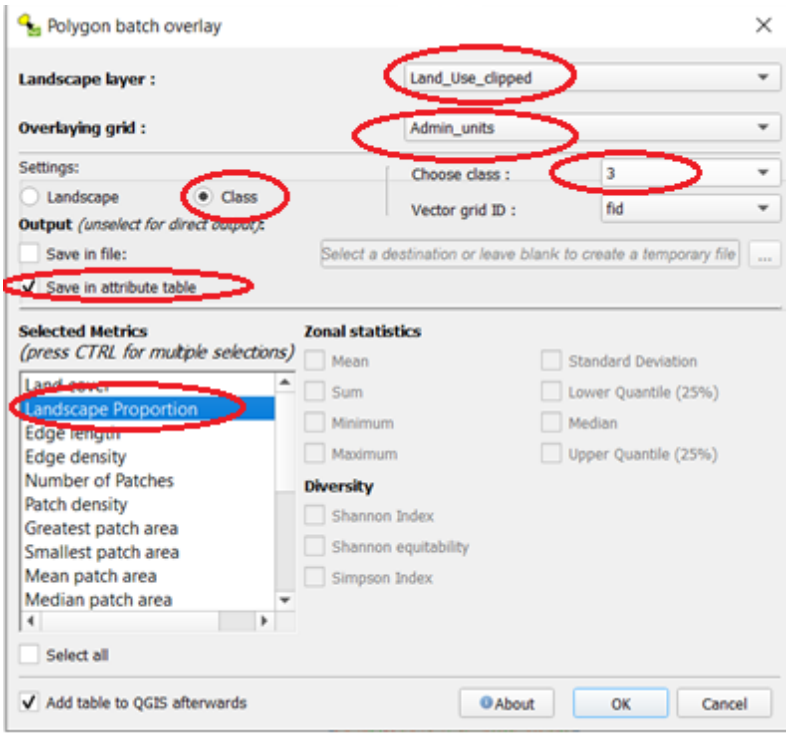

Figure 11. Extracting the proportion of high-density informal settlements from the land-use map at the administrative units' level

1.4.4 Creating a Symbology for the map

Now we can visualize the results. By right clicking on the *Properties* of the *Admin_units layer,* we now go to the *Symbology* tab (the paintbrush icon, third from top).

- **Right click on Admin_units layer► Properties ► Symbology tab (Figure 12a and b).**

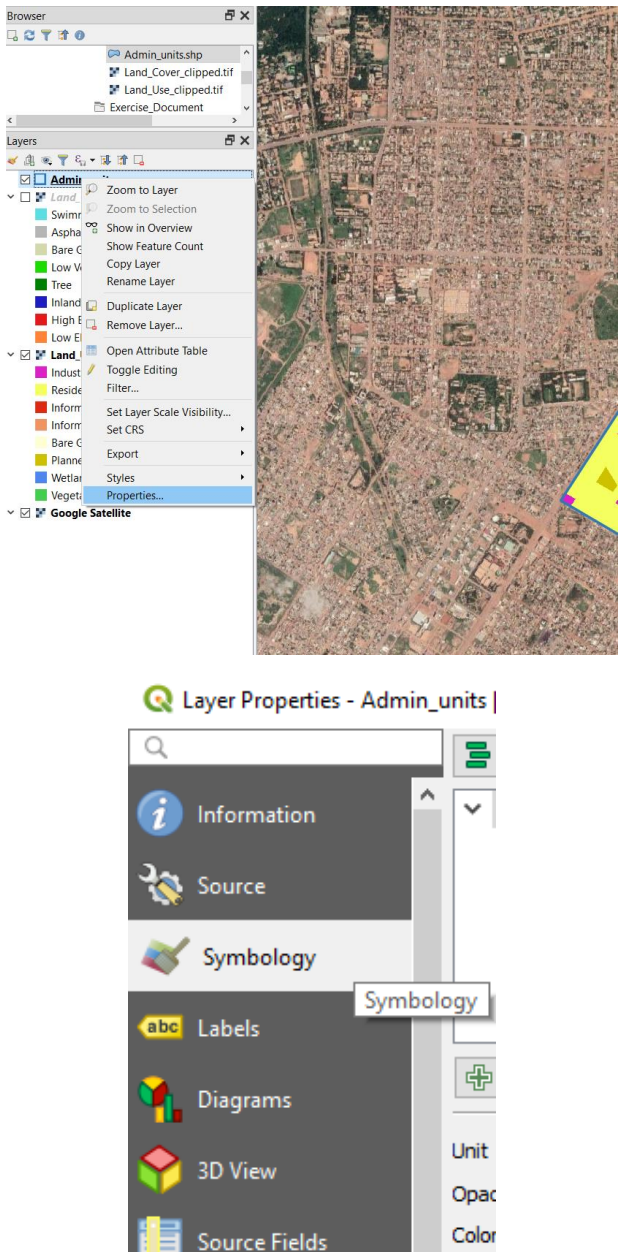

Figure 12a,b. Symbology tab of the **Admin_units** layer

There, we select ***Graduated*** and at the ***Column***, the ***LanPro*** option. Afterwards, click on the ***Symbol*** line and on the menu that pops-up press the '**plus**' button which should activate the ***Simple Fill*** option and then press **OK** (Figure 13).

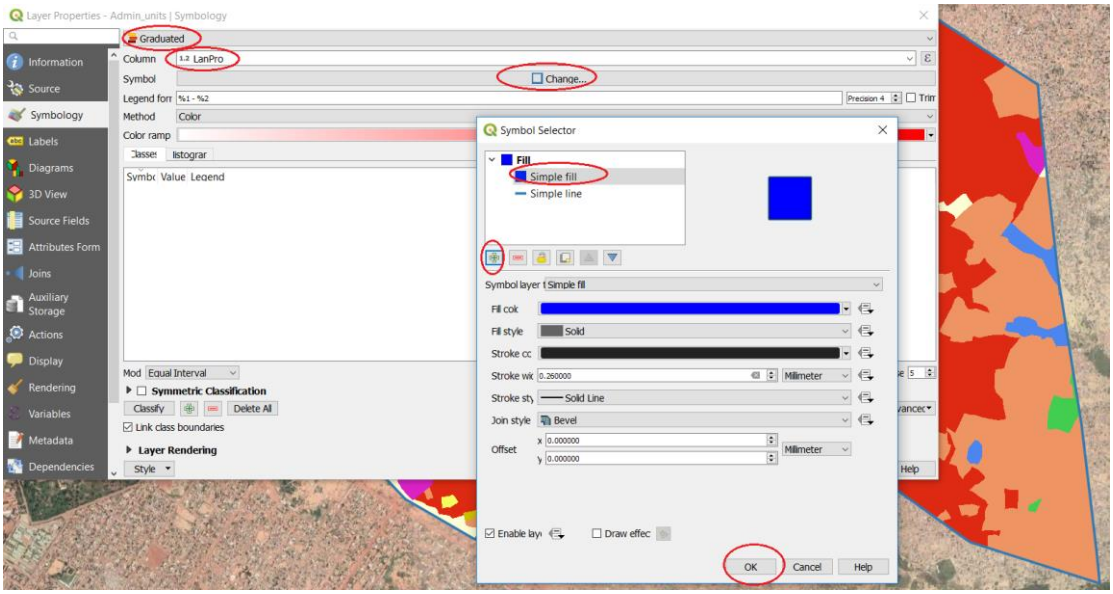

Figure 13. Symbology tab of the **Admin_units** layer

Then, **right** click at the ***Colour Ramp*** and select the ***Reds*** color palette (Figure 14).

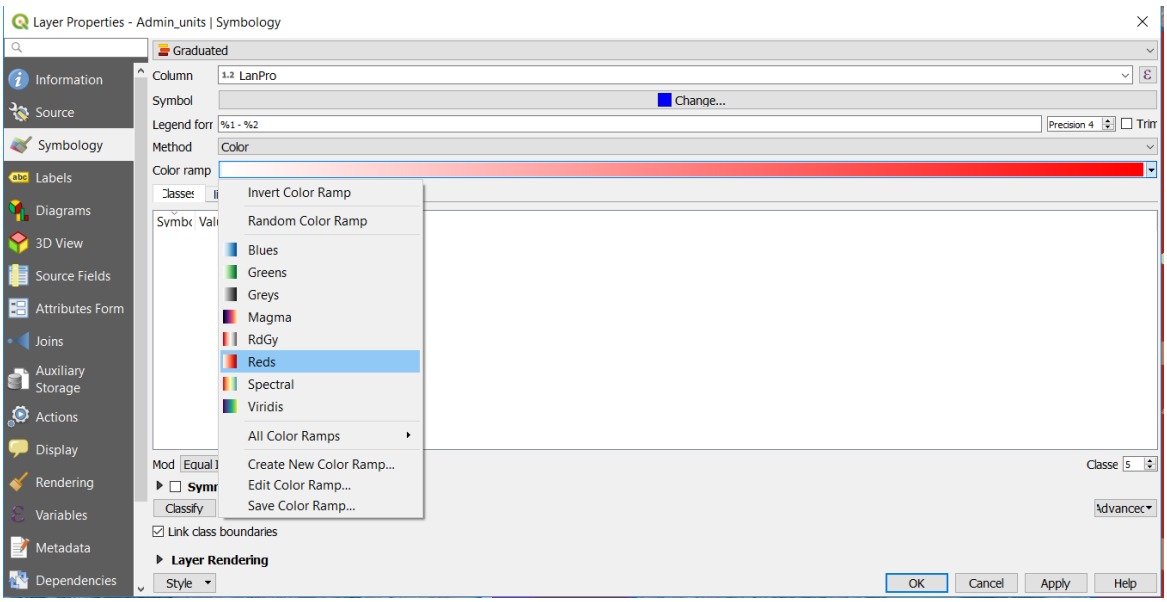

Figure 14. Selecting a color palette.

Finally, at the ***Mode*** option select ***Quantile (Equal Count)*** set the ***Classes*** to 3, press ***Classify*** and then ***OK*** (Figure 15).

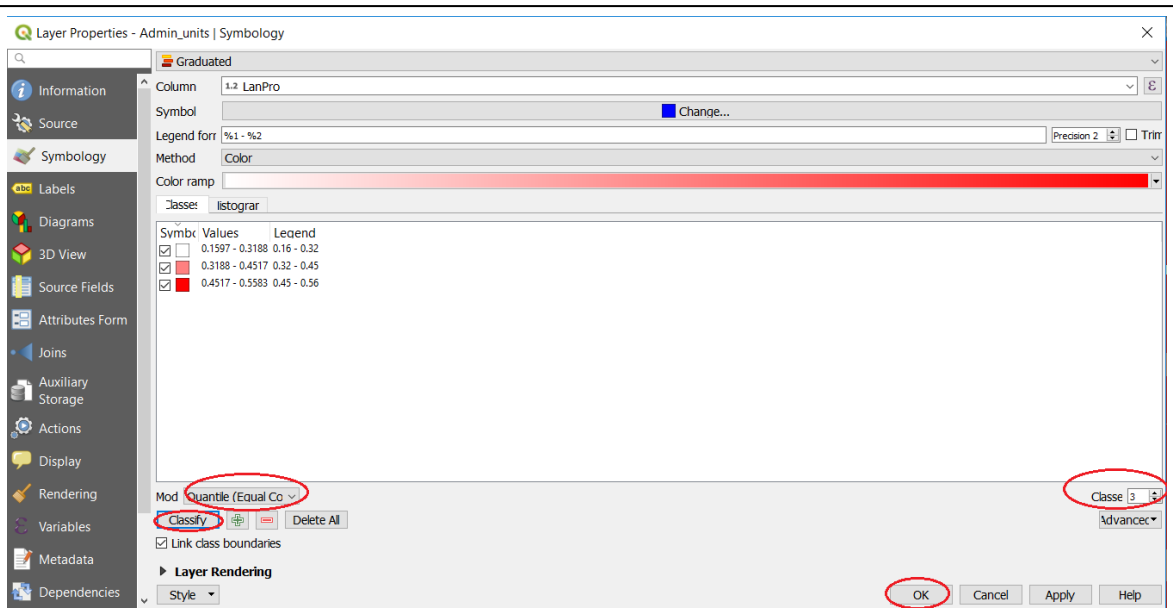

Figure 15. Classifying the desired outcome

Now, the administrative units visualize the proportion of high-density-informal settlements within each administrative unit (Figure 16).

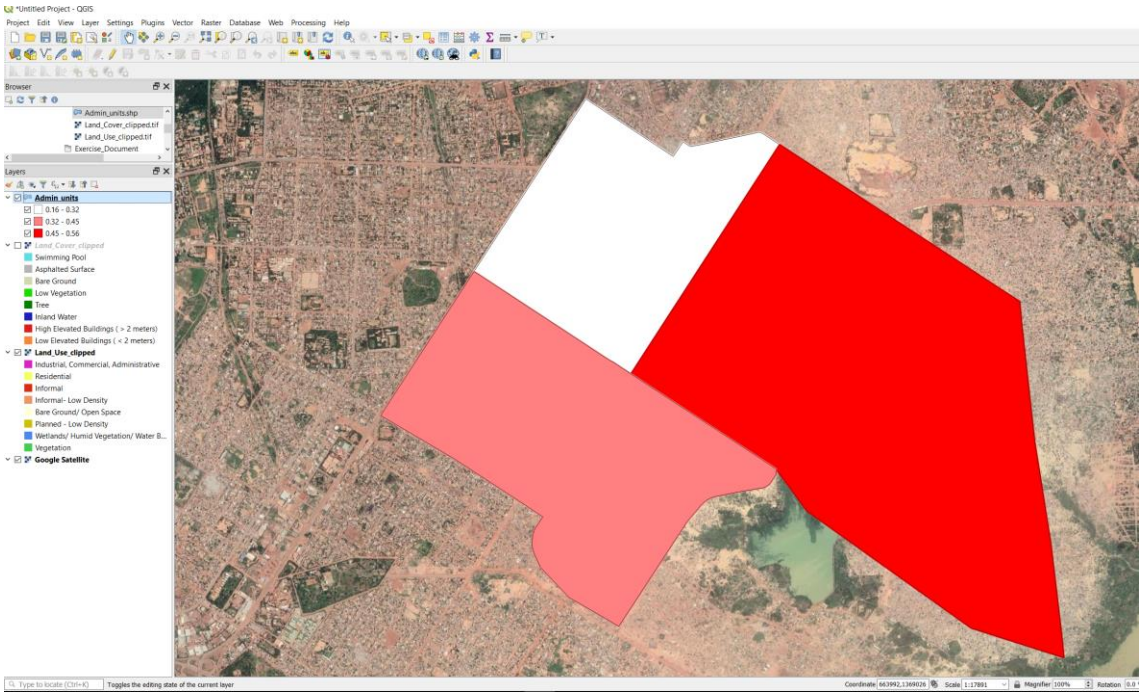

Figure 16. Proportion of high-density informal settlements in each administrative unit.

1.4.5 Creating a Map

Additionally, for this workshop, the computed outputs for all administrative units of Ouagadougou have been prepared. This was done beforehand, to save time for this exercise. However, the methods are exactly the same, only involving larger geographical areas. Through the QGIS browser navigate to the exercise folder (**Exercise_1/Full_city_results/)** and import the file '**Full_city_results.shp**". To make sure you are able to see the whole area the file extends on, right click the ***Full_city_results*** layer and click the ***Zoom to Layer*** option (Figure 17).

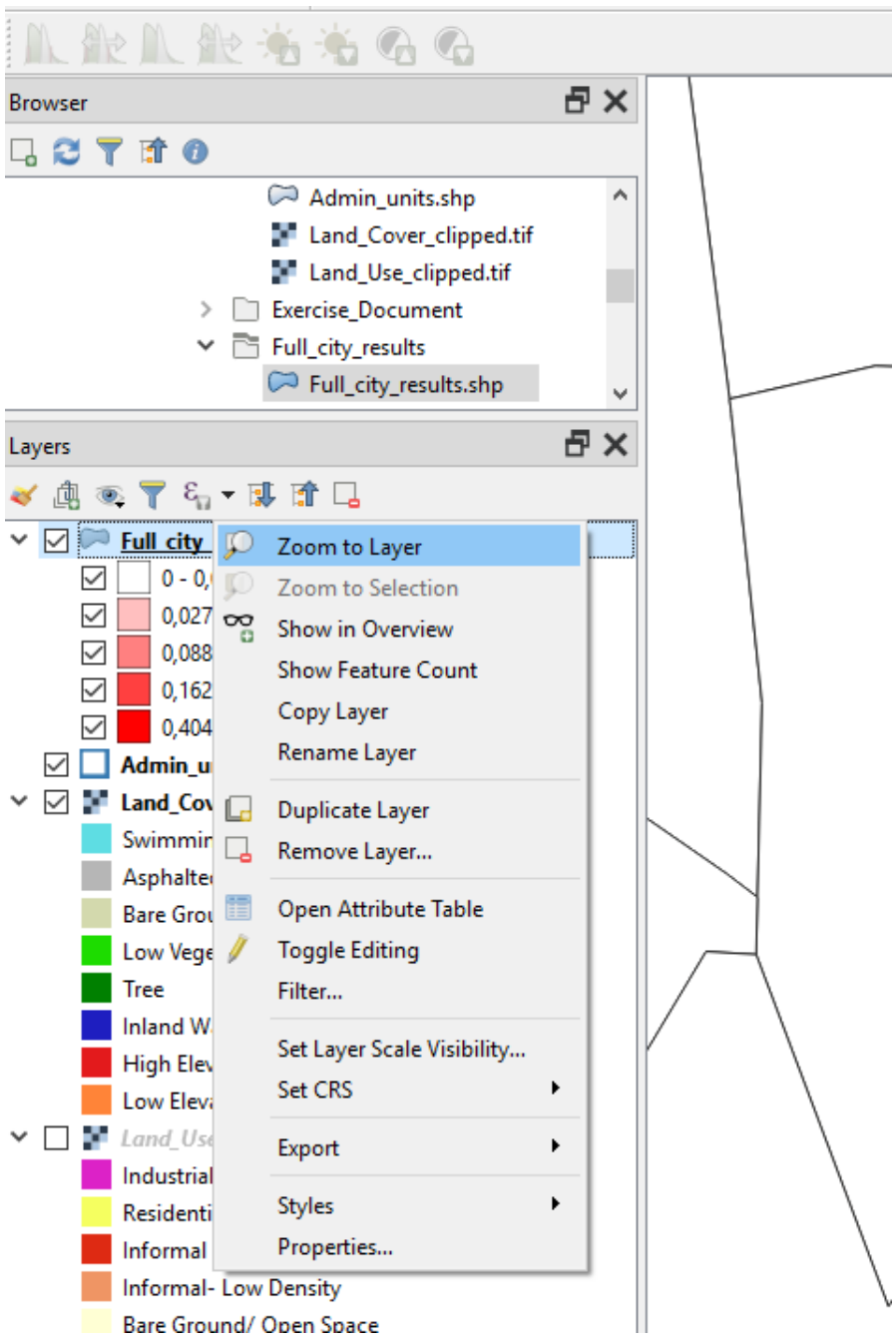

Figure 17. Zooming to the extent of a specific layer

The file is be already reclassified to show the proportion of high-density informal settlements in each unit (Figure 18).

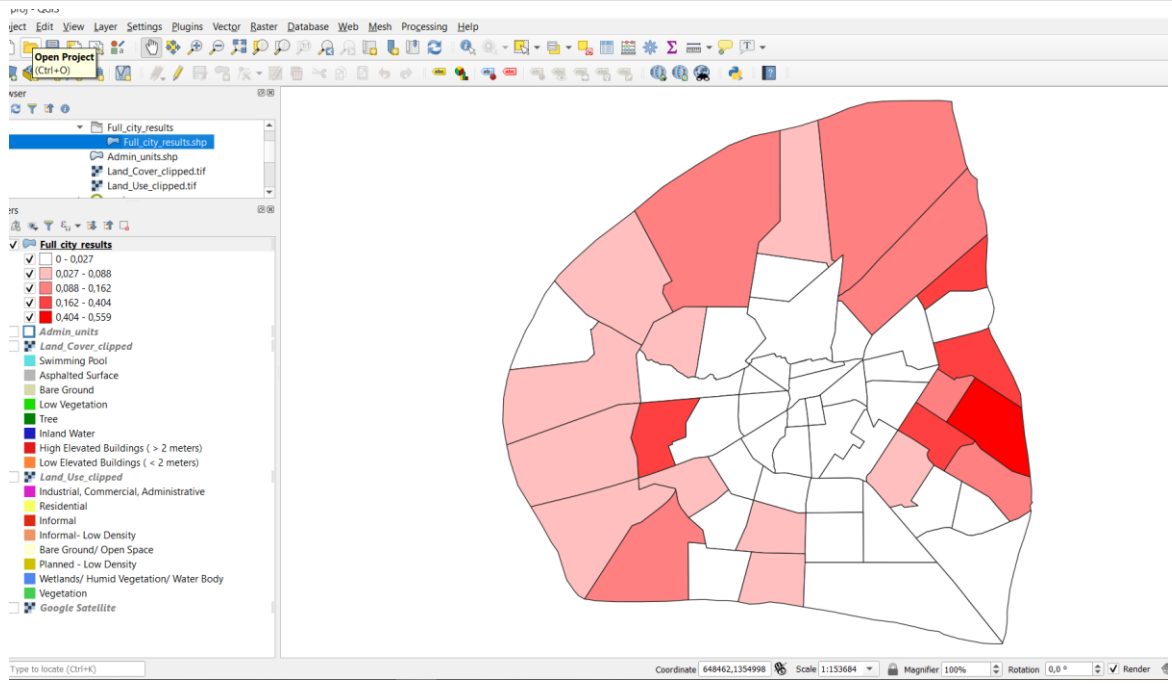

Figure 18. Proportion of high-density informal settlements for the whole extent of Ouagadougou

Map design and semiology is a large field to fit the scope of this workshop. However, interested participants can follow on their own one of the many tutorials available online. A more detailed tutorial on QGIS' Map Composer to make a good map can be followed in [4]. To create a simple map, first remove all layers except the ***Full_city_results***:

- **Right click on each layer to be removed ► Remove Layer (Figure 19) ►Click OK**

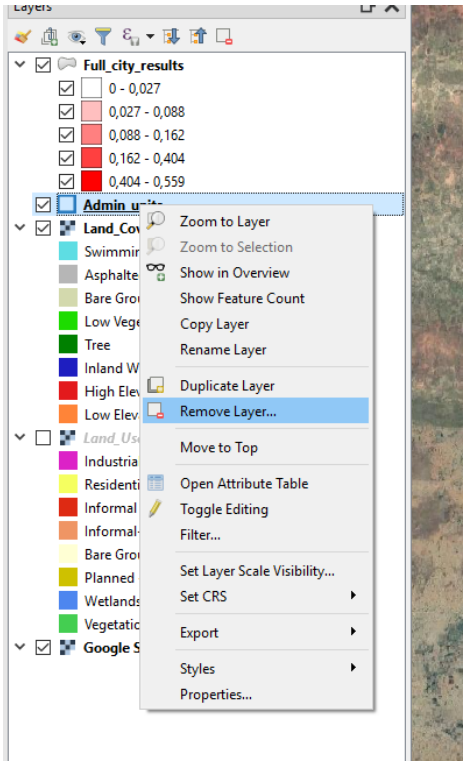

Figure 19. Removing layers

Afterwards, access the Layout Manager:

- **MENU Project ► Layout Manager (Figure 20)**

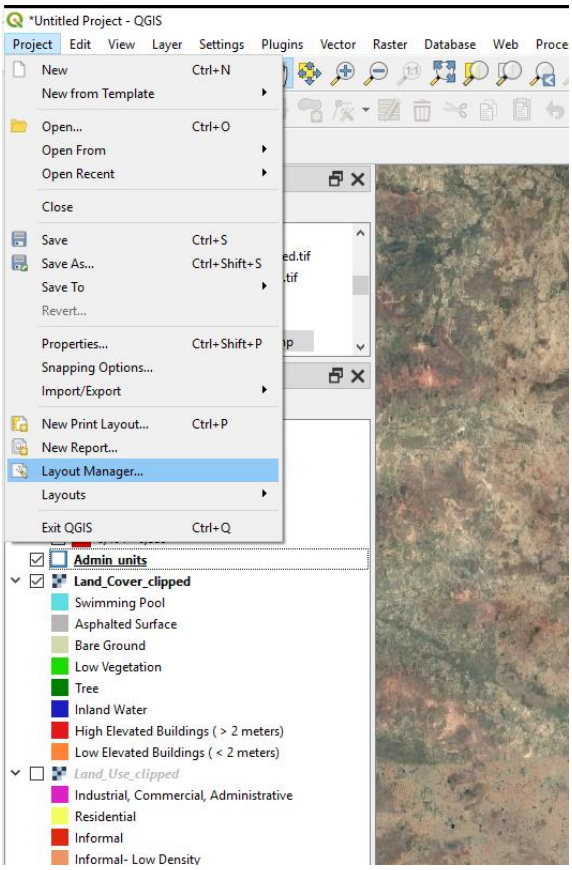

Figure 20. Accessing the Layout Manager

On the window that pops, give a name to the map such as “Proportion of informal settlements at an administrative level in Ougadougou”:

- **Layout Manager ► Create (Figure 21)**

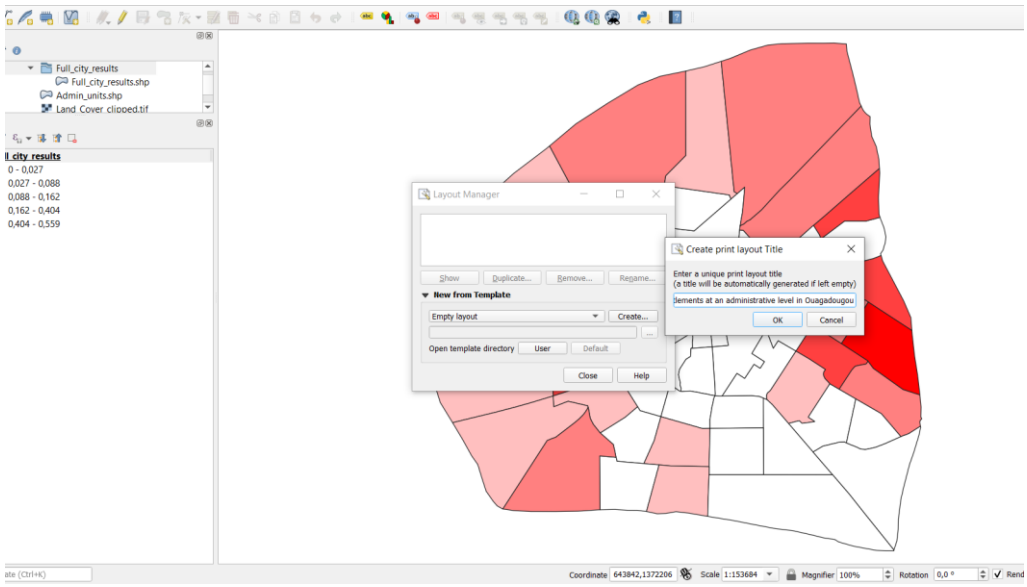

Figure 21. Creating a Layout map title

By doing that, the map composer window launches. In the map composer:

- **Add Item ► Add Map (Figure 22) Draw a rectangle on the display to load the data layer (Figure 23)**

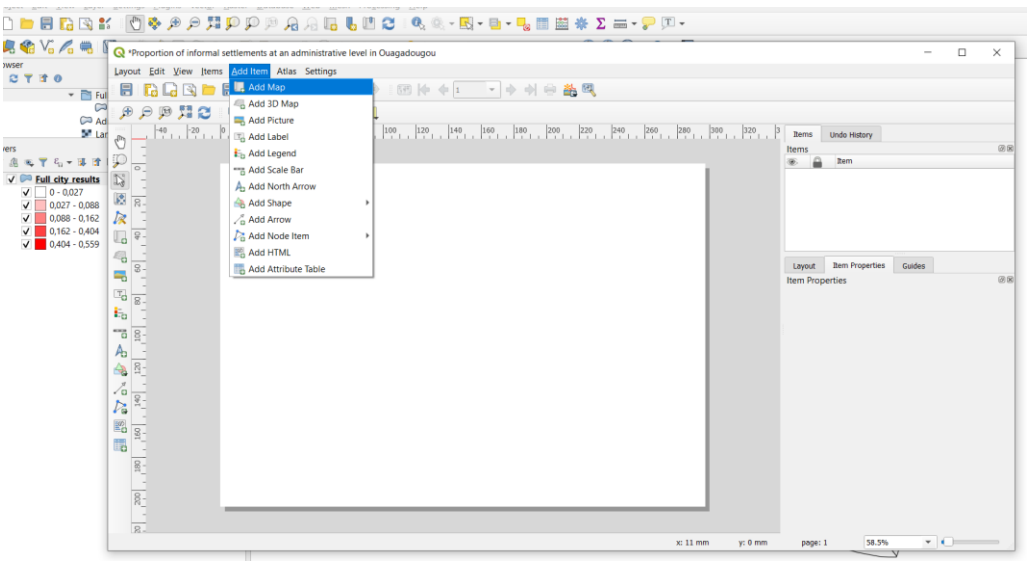

Figure 22. Adding a map item in the map composer

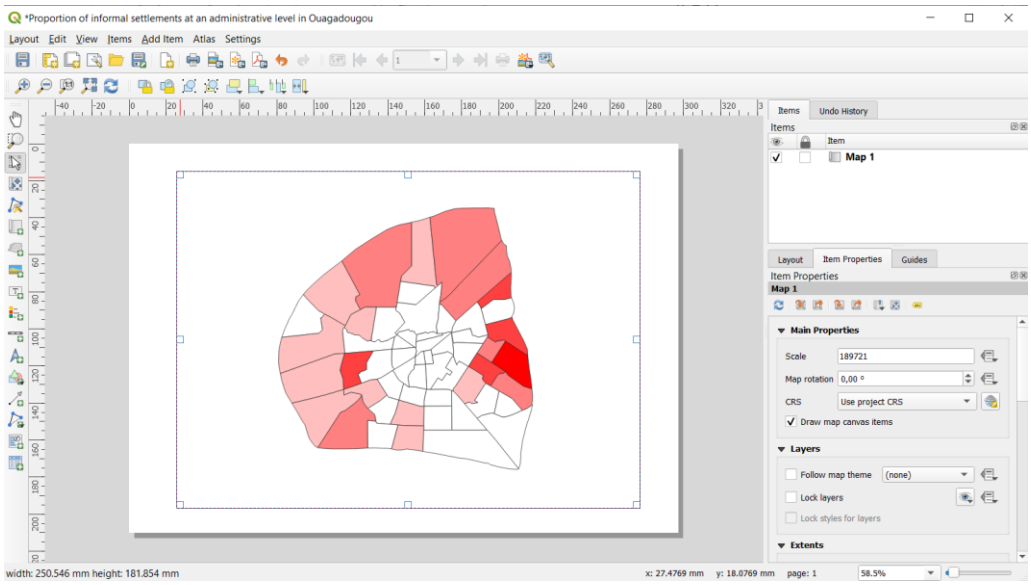

Figure 23. Drawing a rectangle to load the map within

Afterwards, we can add a legend by:

- **Add Item ► Add Legend ► Draw a rectangle on the display to load the legend (Figure 24)**

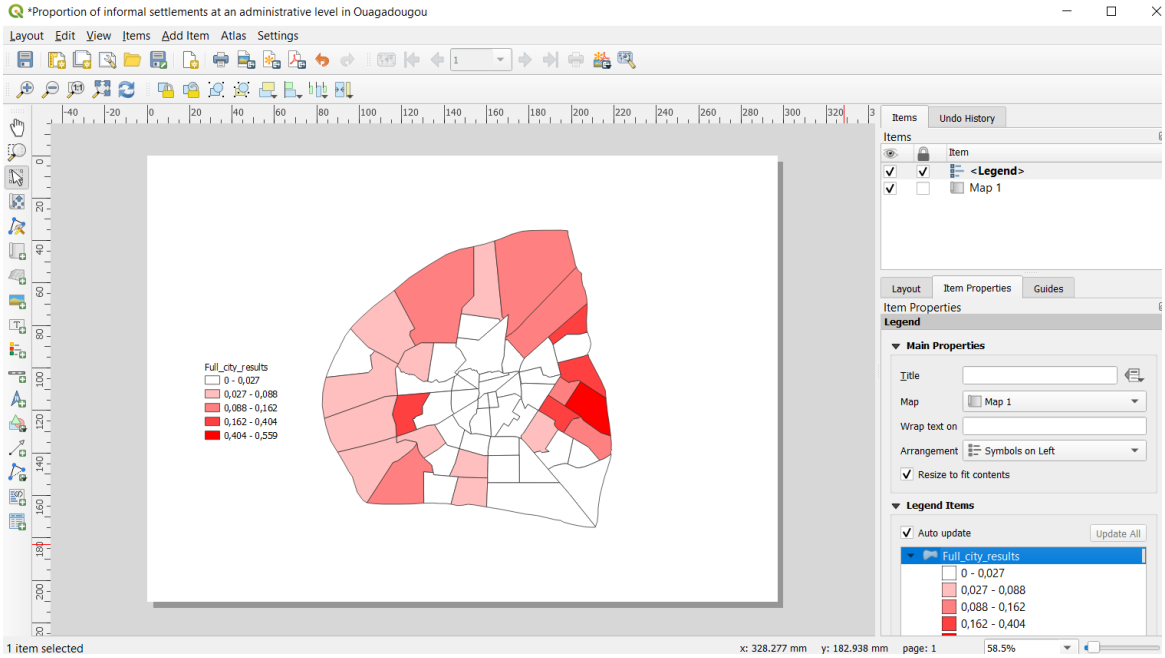

Figure 24. Adding a legend for the desired map

To name our legend in the way we want, we first click on the upper right corner on the ***Items*** section on the ***Legend*** line. Then at the bottom right (**Item Properties**) and **Legend Items** sections we double click on the ***Full_city_results*** line and rename it in something more informative such as **informal settlements** (Figure 25).

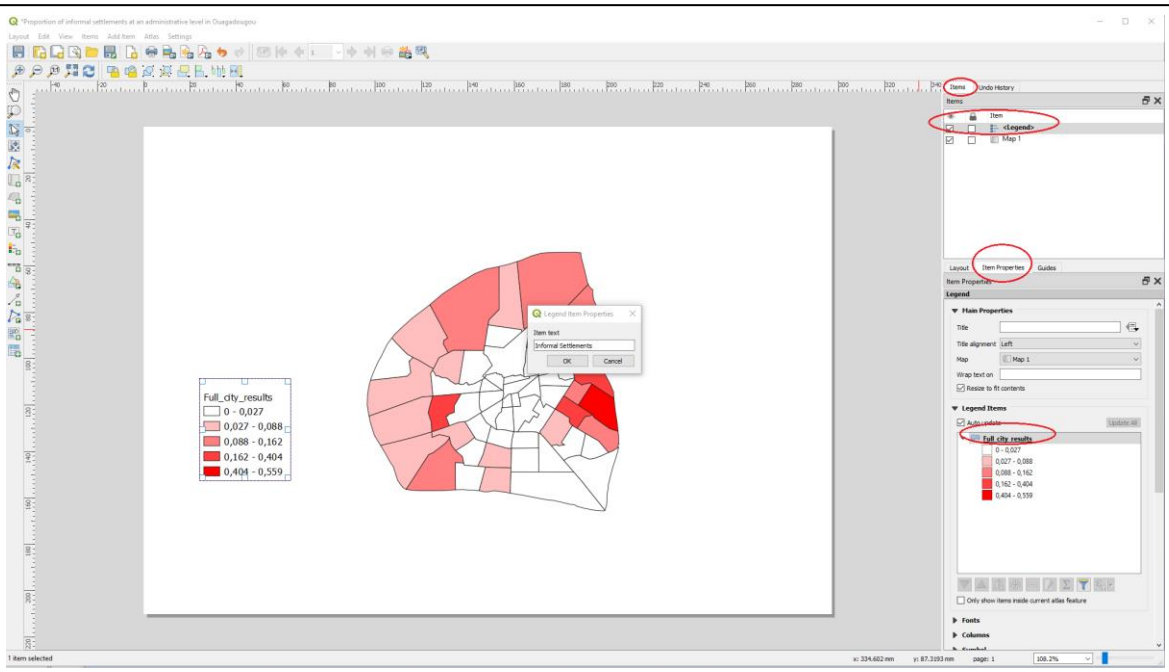

Figure 25. Renaming the title of the legend

Finally, we can add a title *(**Add Label**)* by:

- **Add Item ► Add Label► Draw a rectangle on the display to load the title (Figure 26)**

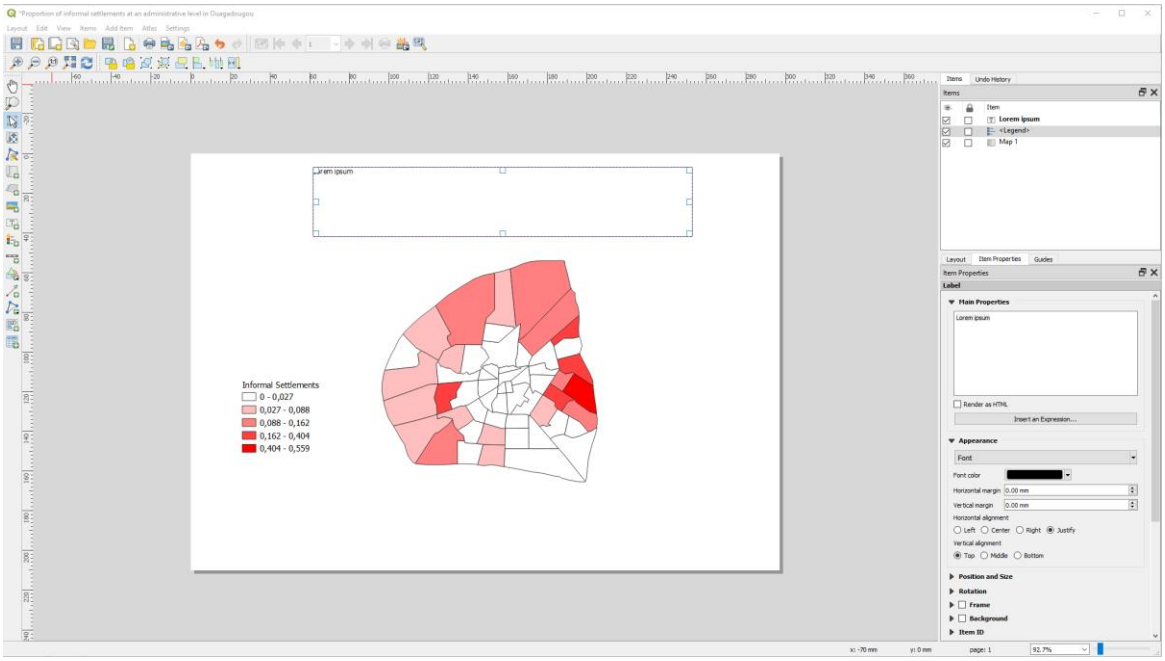

Figure 26. Creating the rectangle that the map title will be loaded in.

By doing this, the area that map title will appear is loaded but not the title itself. For this we need to type the desired title in the ***Map Properties*** section after we have selected the title Item (Figure 27).

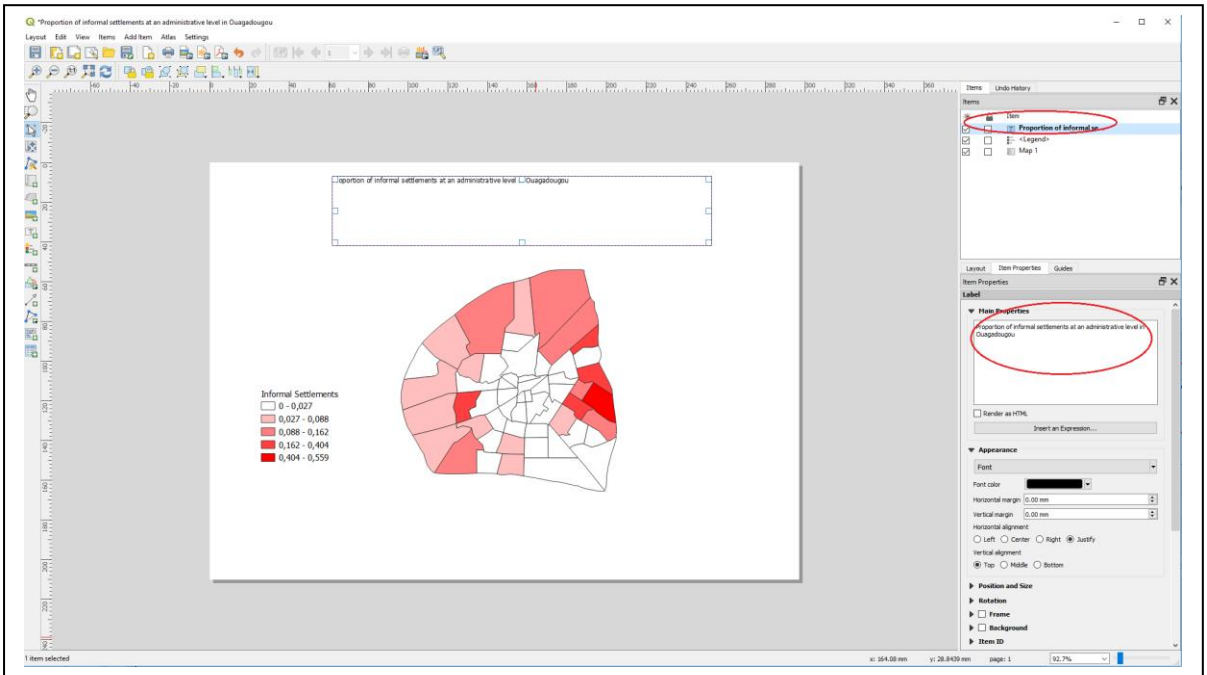

Figure 27. Naming the map title

For the title, we can change the font size by clicking on the **Appearance - *Font*** options and increasing the size (Figure 28).

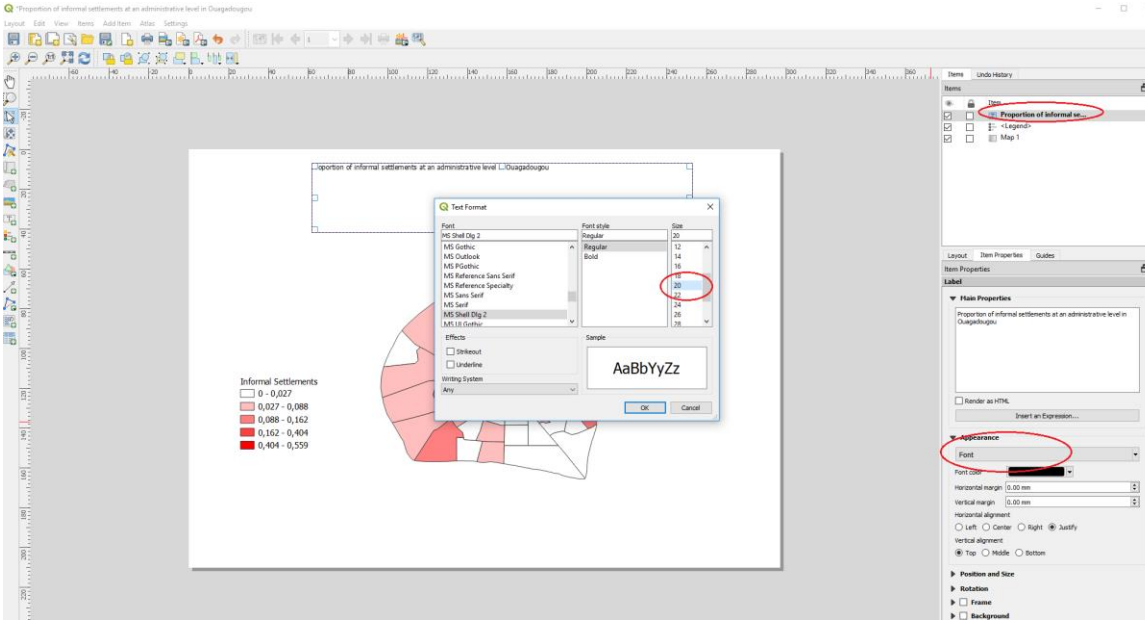

Figure 28. Changing the font size of the map title

Similarly, we may add scale bar by going to the respective option in the *Add Item* section as previously:

- **Add Item ► Scale Bar ► Draw a rectangle on the display to load the scalebar (Figure 29)**

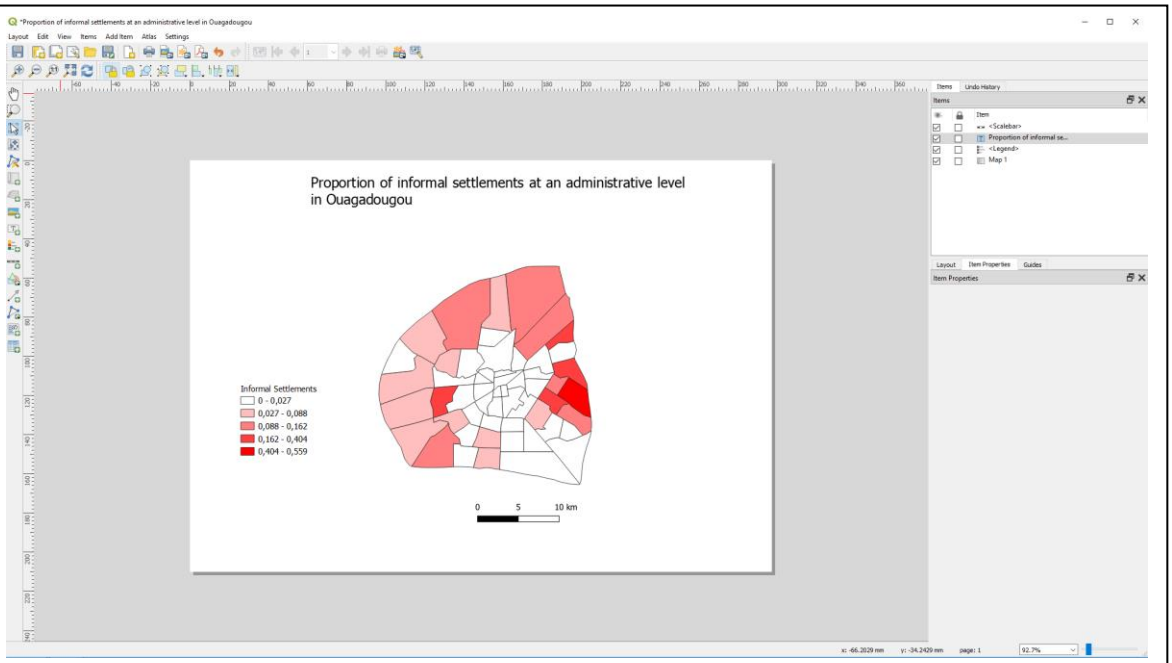

Figure 29. Adding a scale bar

When we are ready, we can export the map as an image by going to ***Layout – Export as Image***, select the path for the file to be saved and click ***Save*** on the window that pops.

Finally, you may save the current work as a project:

- **MENU Project ► Save as ► Type a fitting name for your project ►Save**

1.4.5 **Additional Work**

If you finished quickly or you would like to experiment more at a later time, try to do the same but this time, extract one of the classes of the land-cover product, such as the proportion of highly-elevated built-up areas (*class ID: 111*).

References

[1] https://zenodo.org/record/1290654#.Xhc3j0dKhPY

[2] https://zenodo.org/record/3238302#.Xhc3u0dKhPY

[3] https://docs.qgis.org/3.4/en/docs/

[4] https://www.qgistutorials.com/en/docs/making_a_map.html