

# QGIS - PostGIS

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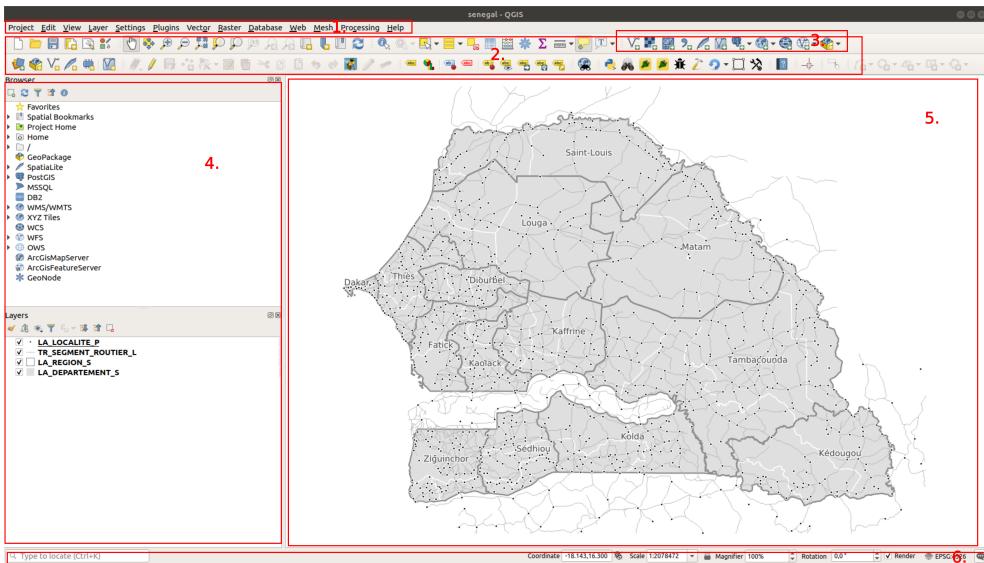


Figure 1 – The QGIS interface

## 1 Small hands-on on QGIS

### 1.1 Discover QGIS

#### 1.1.1 QGIS interface

##### 1. Menus

- Project : set up, open and save your current project
- Edit : Undo, Paste etc.
- View : Edit your map image such as zoom in and out, measure, etc.
- Map layers : add and manage
- Tools : General settings
- Plugins : install additional components
- Database : query databases
- Vector, Raster, Web, Meshes and processing : analysis tools
- Help : Documentation

**2. Toolbars :** The same as in the menus, but in the form of icons. To find out what a tool does, hover your mouse over it and read the tooltip. To add or remove toolbars, right-click anywhere in this area except on a disabled tool, and check or uncheck the desired toolbars.

**3. Layer Management Toolbar :** To easily add layers.

##### 4. Panels :

- The first one : the “Browser” which allows you to easily find a file opened by QGIS, a WMS stream, ...
- The second one : list of loaded layers, also called **table of contents** (TOC). If several layers are present, you can change the display order here. To make this area appear or disappear : View > Panels > Layers

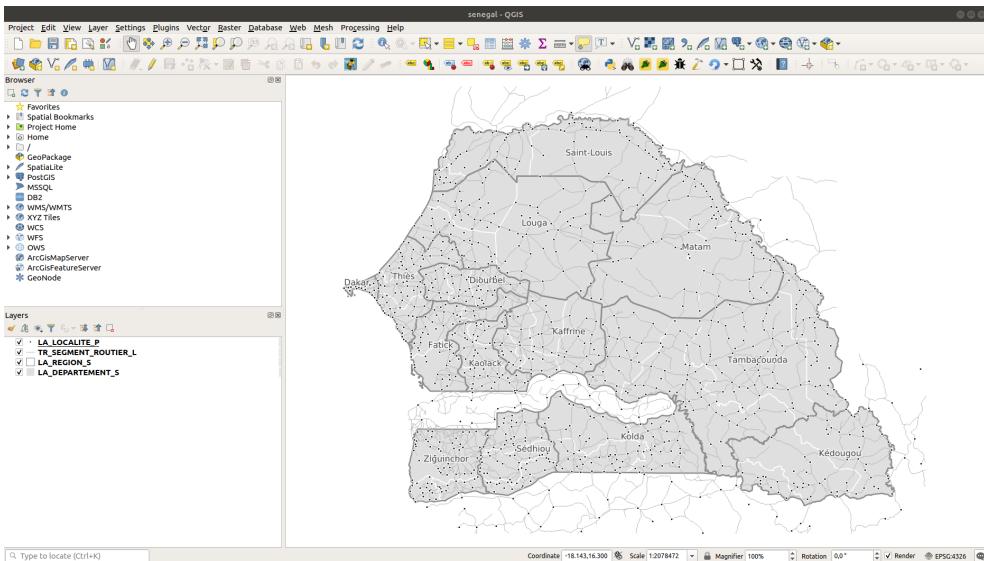


Figure 2 – QGIS Project

— To add panels, View > Panels

**5. View Area.** This area can be zoomed in or out.

**6. Status Bar.** Here you can find the coordinates of the point where the mouse is located, the scale...

### 1.1.2 A QGIS project

A project is a workspace. Saving a project is equivalent to saving the list of layers used, the style used for each layer but not the data!

For a layer the project only retains the path to the layer and not the data contained in the layer.

You can specify relative paths or absolute paths. The advantage of using relative paths is that you can share a file that contains the project and its layers.

### 1.1.3 Exercises

**Open a project** Open the project in the files received at the location “projects/part\_1/senegal.qgz”.

You can change the order in which the layers appear by clicking on them and dropping it lower or higher.

The order of the layers is important : QGIS displays the layers from bottom to top : it draws the layer at the very bottom, then the one just above it and so on. If you put the cities layer at the bottom of the list, it will be hidden by the regions layer.

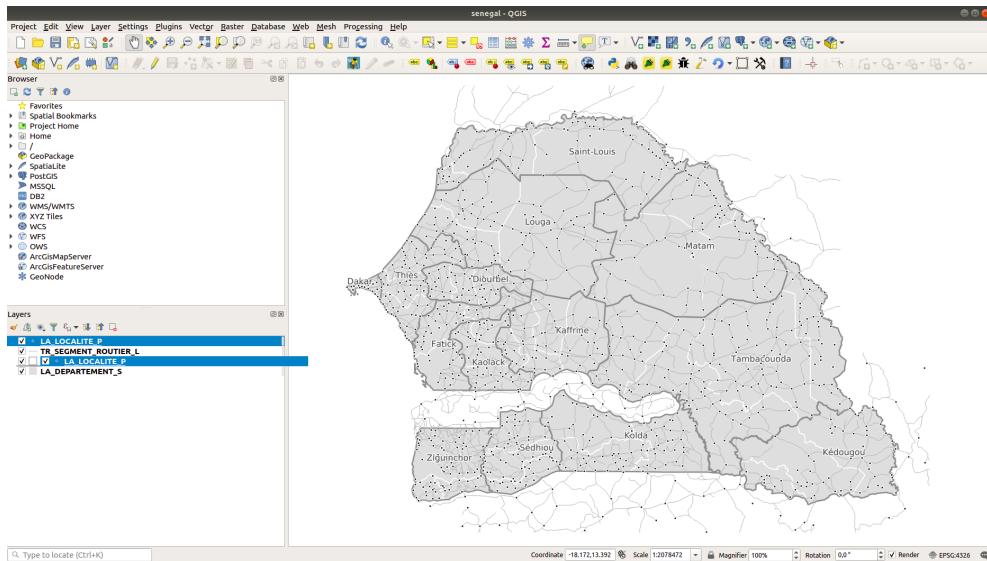


Figure 3 – QGIS Project - changing layer order

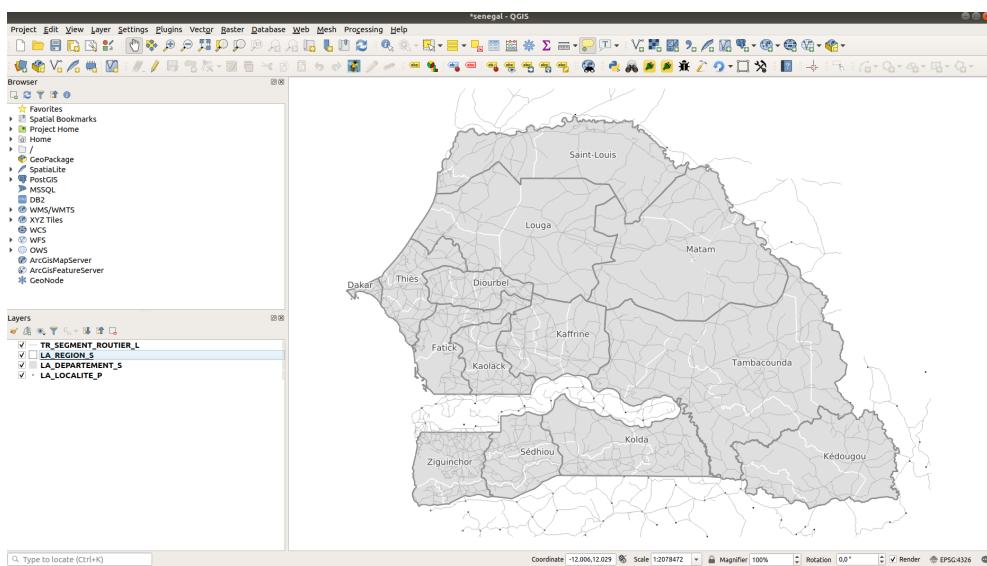


Figure 4 – QGIS Project - layer order changed

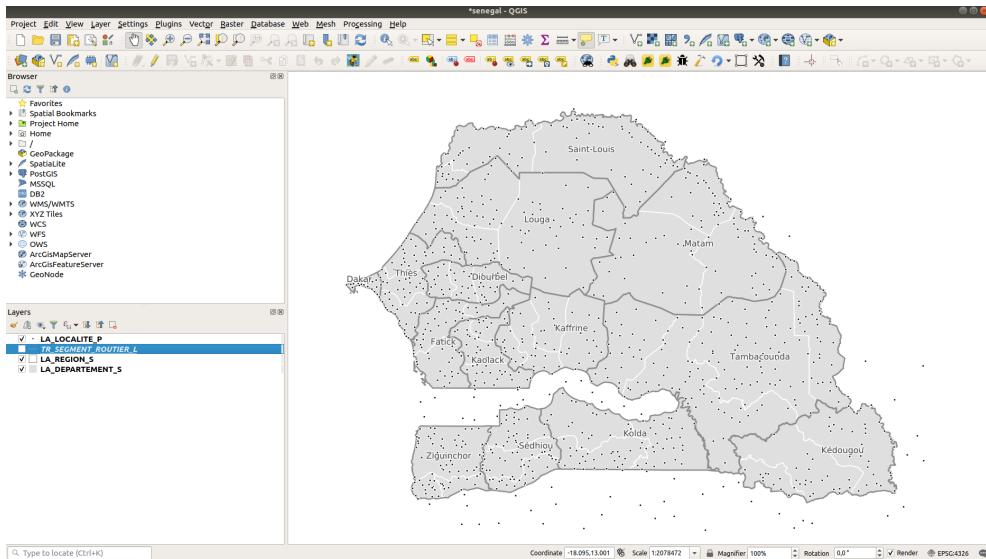


Figure 5 – QGIS project - hidden layer

The checkboxes in the “layers” panel allow to display or not a layer.

Warning, the project file we opened did not store the data that are displayed. It just records the path where this data is located. For example, if we look at the details of the LOCALITIES layer, we can see that the path to the data is “/...links-to-exercises.../LOCALITY\_P.gpkg”.

We can open this layer in another project : go to the directory ” /...links-to-exercises... /donnees/part\_1/” and click on the file “LA\_LOCALITE\_P.gpkg”.

We have another project that displays this data but in a different style!

**Open a vector file** First of all, we launch QGIS and choose an empty project. When we start QGIS, the software offers us to open recent projects. We can also choose a new project by going to “Project” > “New”.

We are going to open a “shapefile” which is one of the most common vector formats.

In the “layer” menu, click on “add layer”, then “add vector layer”.

A window appears. Choose the encoding (in general, we leave UTF8 by default).

Then choose the source. In this case you have to select the desired “.shp” file. For this exercise, open the file “donnees/part\_1/AD\_2\_Municipality.shp”. This data is generated by the IGN and is available in free access on the Belgian federal portal <https://www.geo.be/#!/catalog/details/fb1e2993-2020-428c-9188-eb5f75e284b9>

If all went well, the map of the municipalities of Belgium should appear.

An alternative way to open a vector layer is to use the “Add a vector layer” icon in the “Layer Management” toolbar.

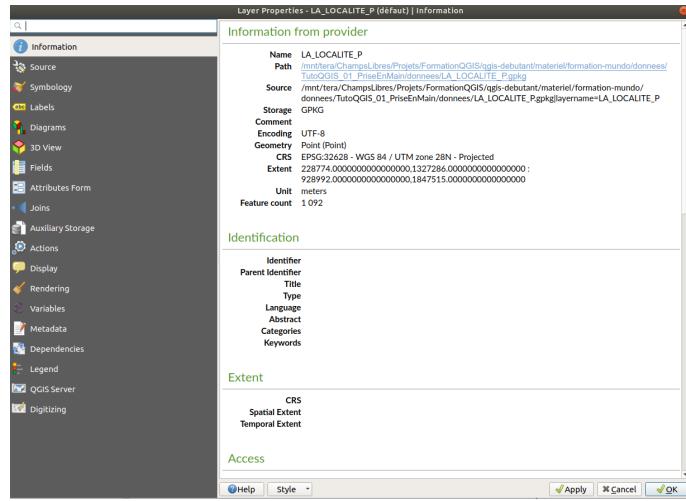


Figure 6 – QGIS Project - layer details

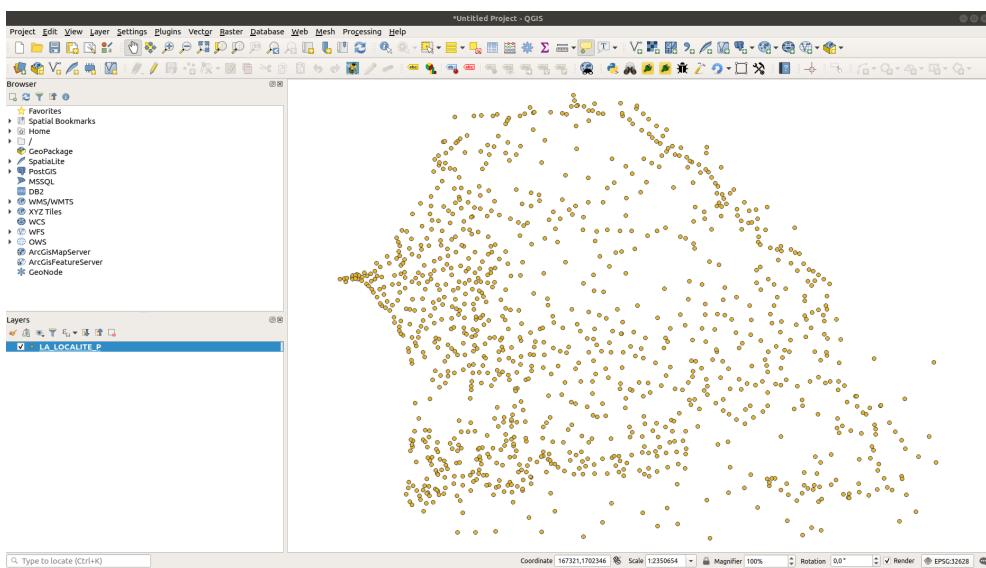


Figure 7 – QGIS project - opening the layer in a new project

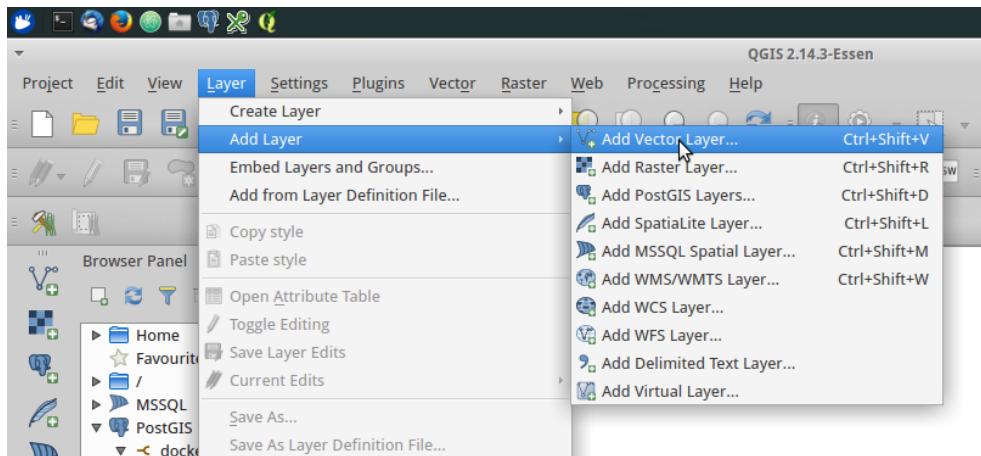


Figure 8 – Add vector layer

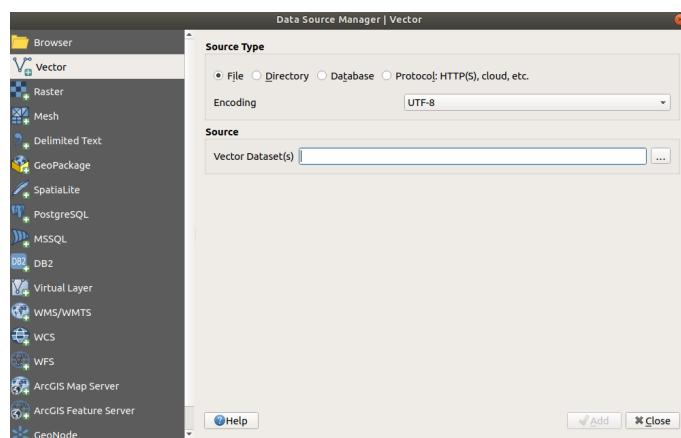


Figure 9 – Add a vector layer - choose the file

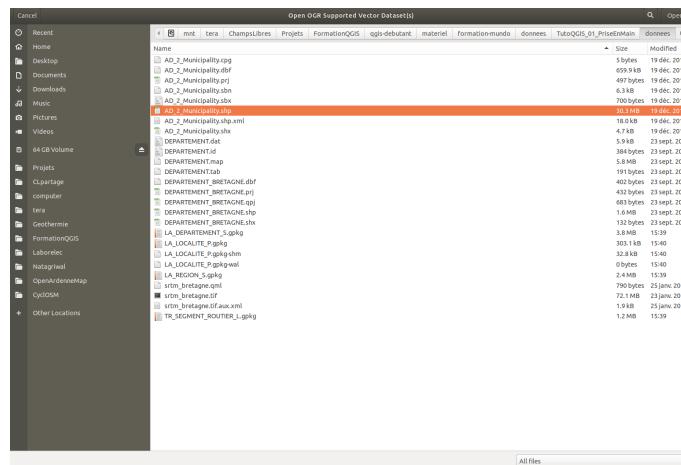


Figure 10 – Adding a vector layer - select file

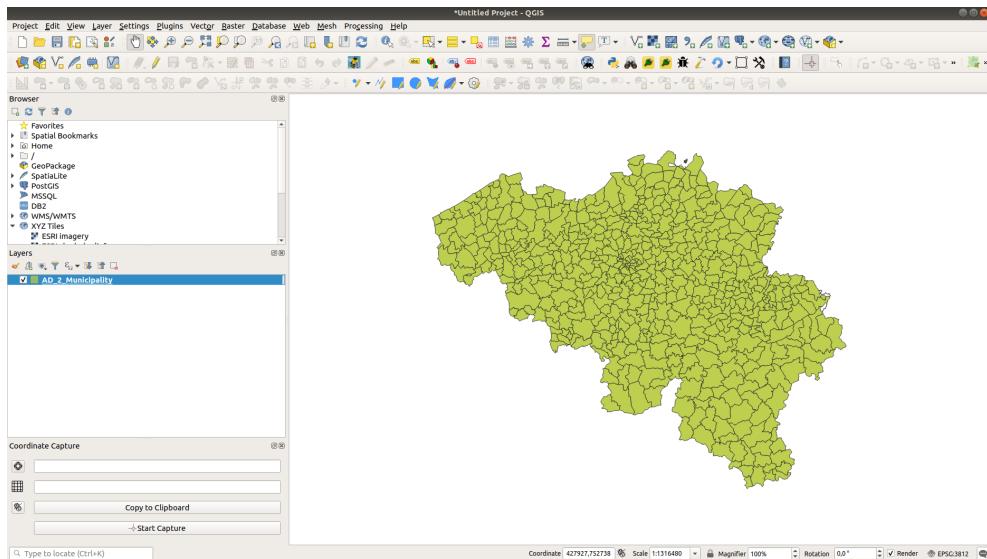


Figure 11 – Adding a vector layer - municipalities of Belgium

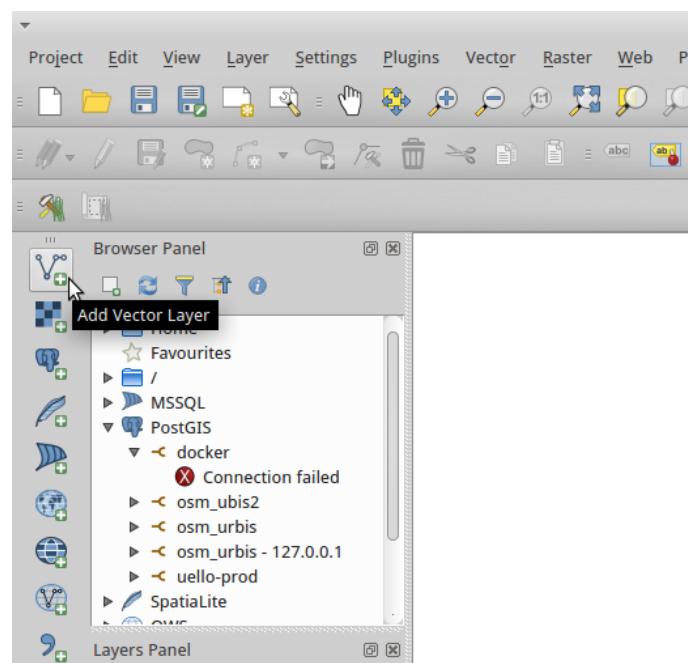


Figure 12 – Add a vector layer - via toolbar icon

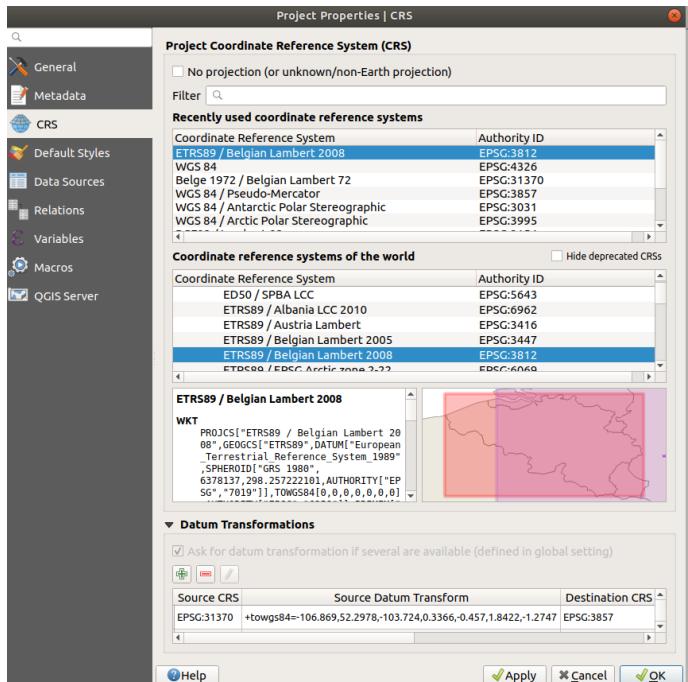


Figure 13 – Change project coordinate system

**Coordinate system** When a first layer is added to a QGIS project, the project automatically takes the projection system of this layer. Here, in the case of the municipalities layer, this is the Belgian Lambert 2008 coordinate system (EPSG :3812). You can see this information in the lower right corner of the project. Click on this button  , you will get a window to change the projection system.

You can test other coordinate systems via this window. The most commonly used coordinate systems in GIS are :

- WGS 84 (EPSG :4326) : projection system with longitude and latitude in decimal degrees. Sometimes called "GPS coordinates".
- WGS 84 Pseudo-Mercator (EPSG : 3857) : projection system based on the Mercator projection, with the metre as unit. Often in webmaps.
- In Belgium : Belgian Lambert 1972 (EPSG : 31370).

Do this test : adding the Belgium municipalities layer in the project "projects/part\_1/senegal.qgz" or in a new blank project does not render the same thing.

Do this other test : add the Belgium municipalities layer in a new project having deleted the projection file "AD\_2\_Municipality.prj" from its directory. What happens ?

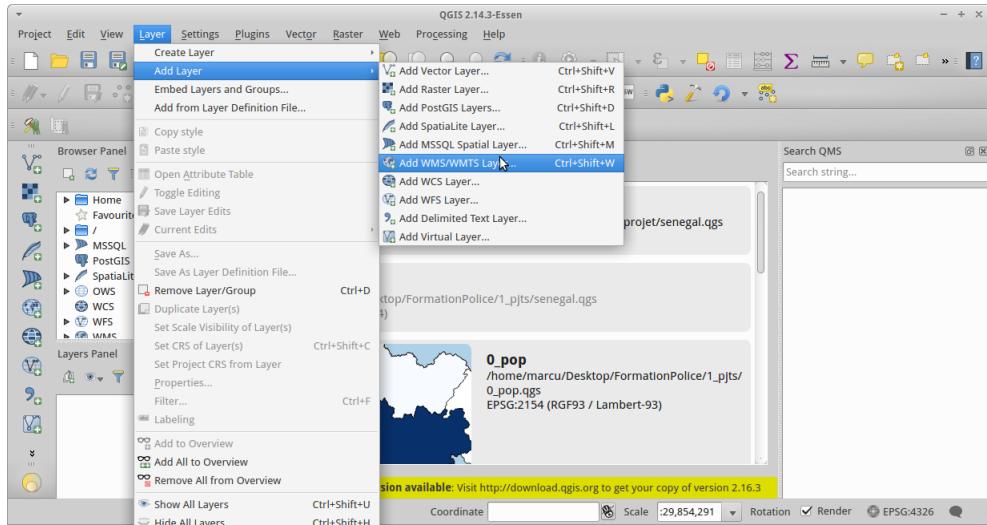


Figure 14 – Adding a WMS layer

#### 1.1.4 Open a WMS

As seen before, WMS streams are web services. Rather than downloading the whole data, we will access the data according to the location and the zoom level. Here, we will open a WMS service to view aerial images of the Walloon region, called “orthophotoplans”. The addresses of these WMS services are available on the Internet.

In the window that appears, click on “Load” to load the file of the connection which is in “data/part\_1/WMS-SPW-ortho2018.xml”.

Loading will bring up data in the drop down menu. Click on “connect” to list the layers provided by the service.

The layers appear in the white area. Click on “add” to add the selected layers to the project.

You should get this as a result :

**Open a WFS stream** Same procedure as for the WMS. Load the file “data/part\_1/WFS-BrusselsEnvironment.xml”.

Take some time to explore the layers in this WFS service and note the difference with the WMS service.

**Open XYZ tiles** It is also possible to add “tiled” data available on the Web. A common practice is to add an OpenStreetMap or a satellite imagery background to your QGIS projects in order to find your way in space.

These services are available in the “Browser” tab :

The OpenStreetMap server address is : <https://tile.openstreetmap.org/{z}/{x}/{y}.png>

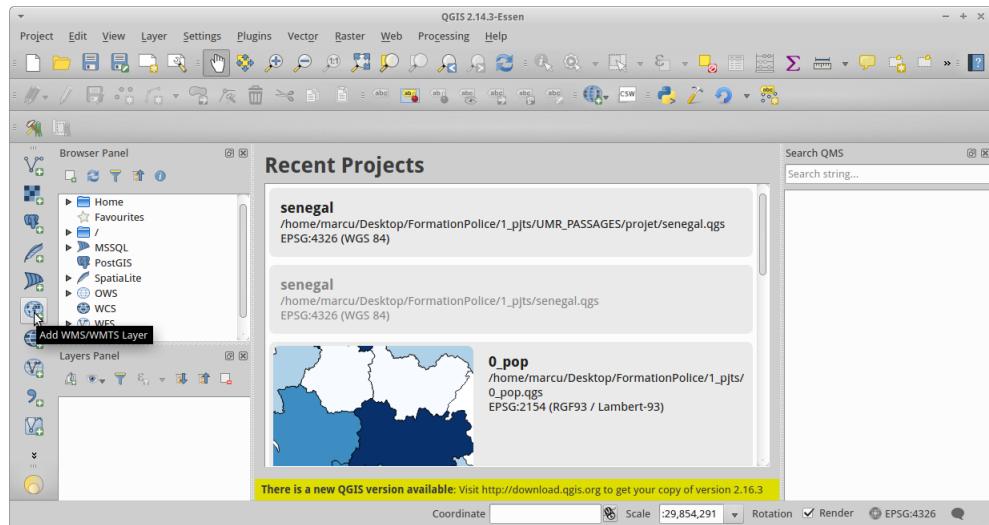


Figure 15 – Adding a WMS layer - toolbar icon

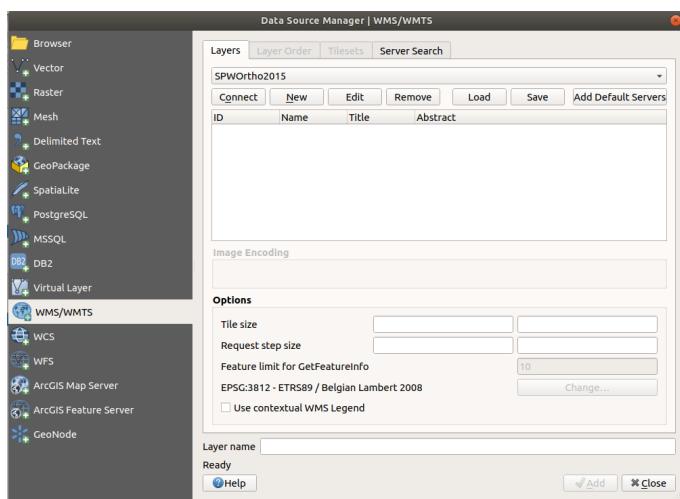


Figure 16 – Adding a WMS layer

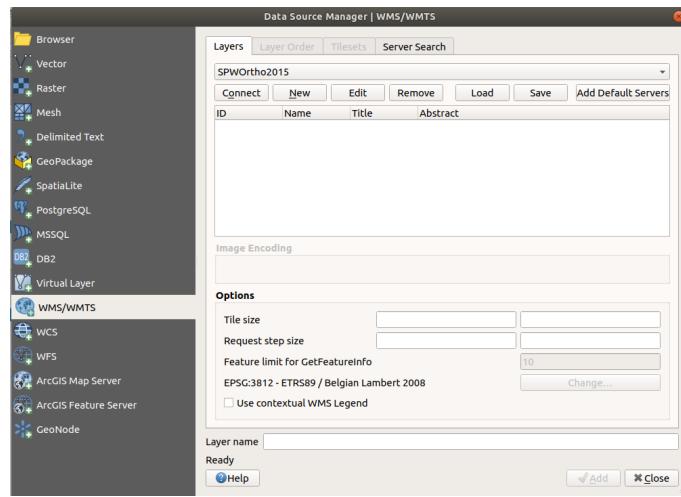


Figure 17 – Adding a WMS layer

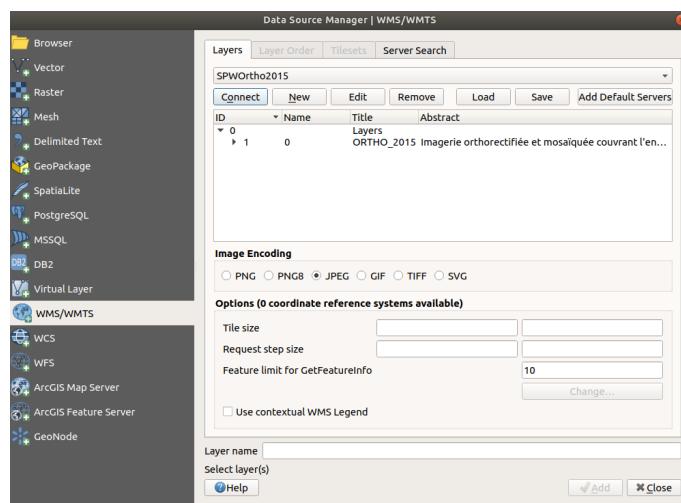


Figure 18 – Add WMS layer

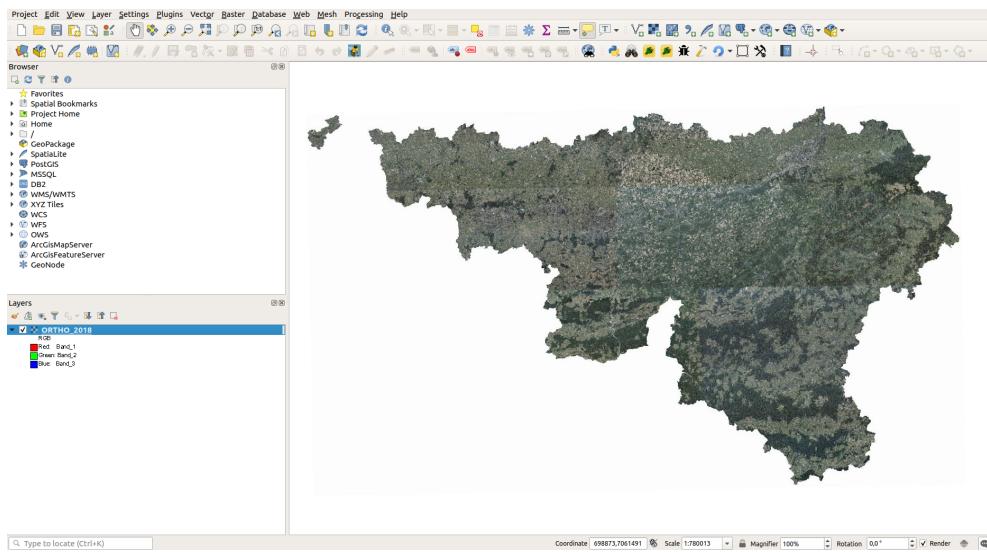


Figure 19 – Adding a WMS layer - Orthophotoplans

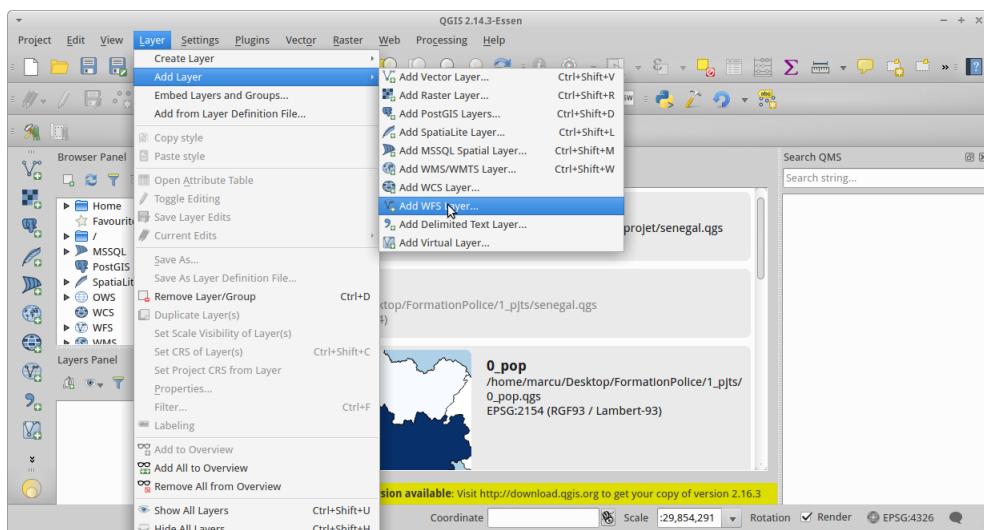


Figure 20 – Add a WFS layer

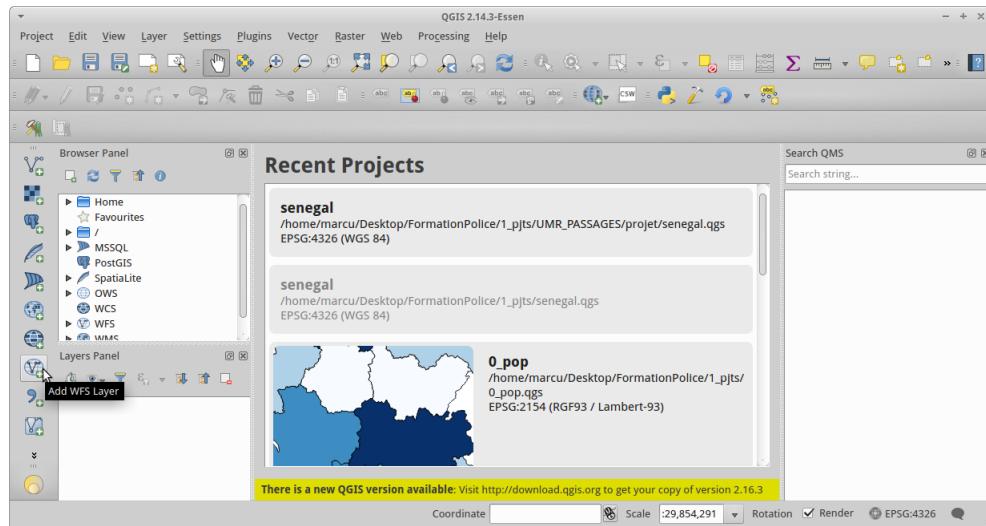


Figure 21 – Adding a WFS layer - toolbar icon

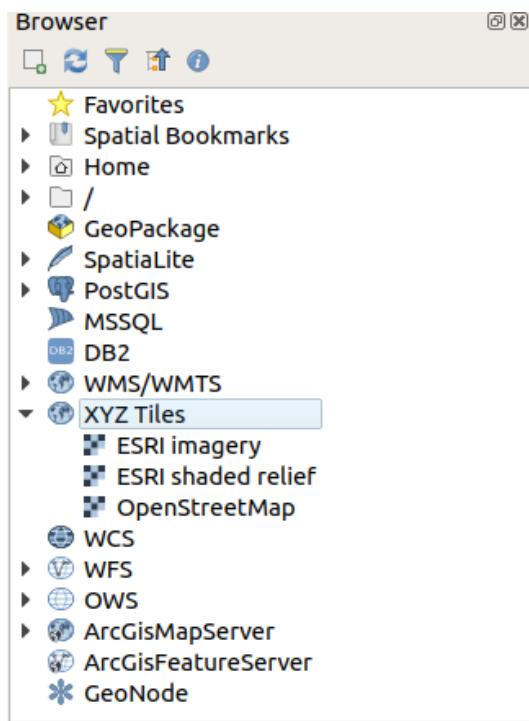


Figure 22 – Add a XYZ layer

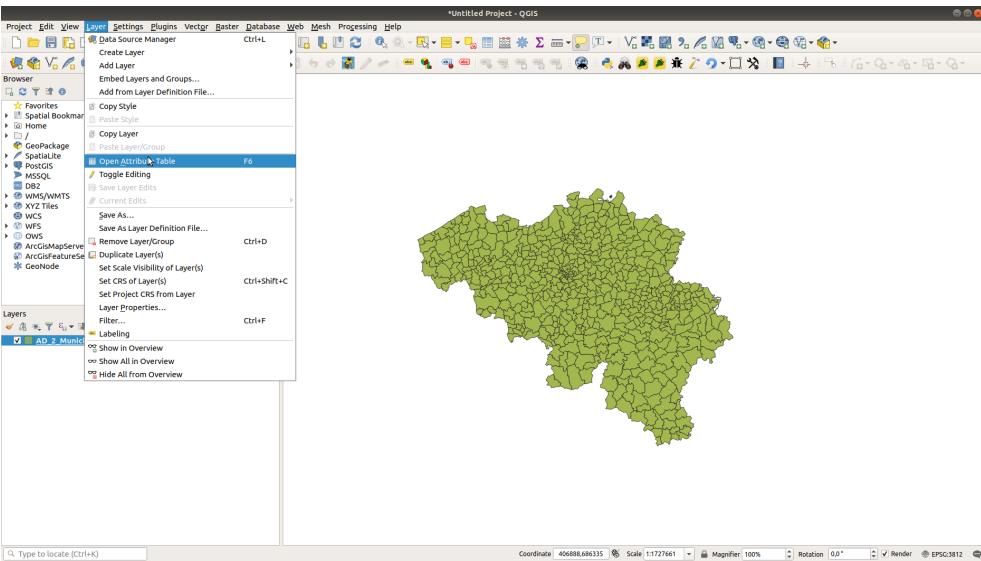


Figure 23 – Reading the attribute table

### 1.1.5 Open the attribute table

Open a new QGIS project. Add the vector layer “/donnees/part\_1/AD\_2\_Municipality.shp”

In the “Layer” menu click on “Open Attribute Table”.

Another way to access it : right-click on the layer name in the layer menu and the layer name in the layer menu and click on “Open Attribute Table”.

And the table appears.

**Selecting elements with the mouse** In the menu, click on the button.

You can select one or more elements on the map. They are highlighted in blue in the attribute table.

At the bottom of the attribute table window there are options for display options. Test them !

Test the other selection modes by clicking on the down arrow of the button :

## 2 Create a PostGIS layer from a Excel table

In this section, we will create a PostGIS layer from a table of point observations and save it as a Postgis layer.

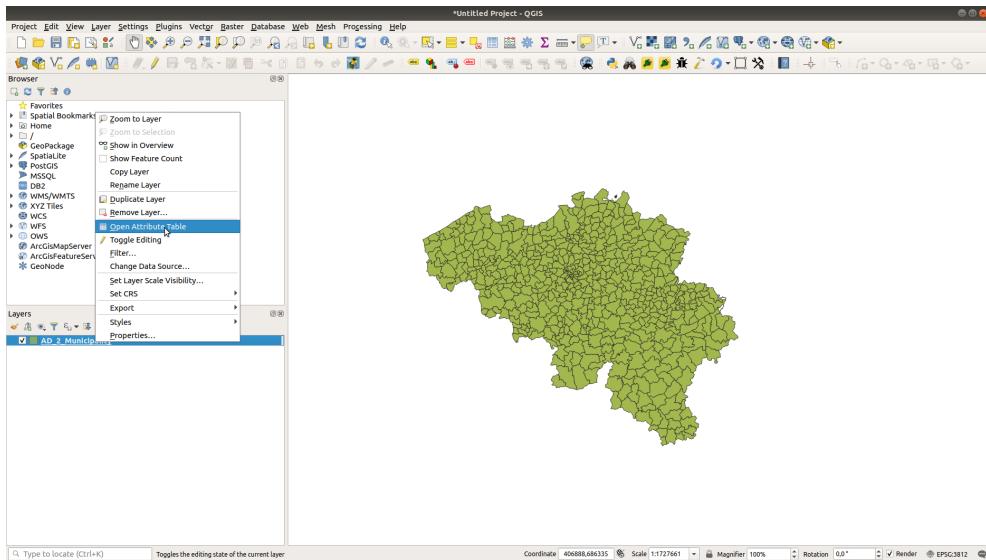


Figure 24 – Read Attribute Table

	ModDate	Cty	Language	Micode	DistrictC	ProvinceC	RegionCapl	CountryCap	Utlid	Shape_Leng	Shape_Area	NameDut.	NameFre	NameGer
1	2007-01-05	2	2	84000	0	0	0	0	0 [CA4A13B1...]	40489.629	50961554.11	Tellier		
2	2007-01-05	2	2	83049	0	0	0	0	0 [B319E8C1...]	58241.447	91945411.11	Tenneville		
3	2007-01-05	1	2	82003	1	0	0	0	0 [10F1D9E5...]	94383.578	172023851.11	Bastogne		
4	2007-01-05	1	1	71016	0	0	0	0	0 [C7A4B8C5...]	43668.938	87597345.11	Genk		
5	2007-01-05	2	1	24048	0	0	0	0	0 [B371F90E...]	23143.216	162326111.11	Kerberg		
6	2007-01-05	2	1	44043	0	0	0	0	0 [F77D09C3...]	35636.664	37001349.11	Merebeke		
7	2007-01-05	1	1	32030	0	0	0	0	0 [7F65F479...]	53195.653	63401243.11	Le-Priange		
8	2007-01-05	2	1	23050	0	0	0	0	0 [B379F772...]	31130.998	35099132.11	Mete		
9	2007-01-05	2	1	24014	0	0	0	0	0 [B4E55FC1...]	26218.366	18778792.11	Boostmeer		
10	2007-01-05	2	1	73107	0	0	0	0	0 [A451A1B9...]	55673.990	76499338.11	Maasmech		
11	2007-01-05	2	1	33096	0	0	0	0	0 [D243F184...]	45725.197	43228770.11	Zemel		
12	2007-01-05	2	1	44073	0	0	0	0	0 [7440E828...]	30990.811	346364992.11	Wichezeke		
13	2007-01-05	2	1	35011	0	0	0	0	0 [640DFB...]	50688.318	79048312.11	Middelkerke		
14	2007-01-05	2	2	25014	0	0	0	0	0 [F114B282...]	50836.155	52314551.11	Braine-l'All		
15	2007-01-05	2	1	43002	0	0	0	0	0 [498BF8E7...]	52558.826	87500150.11	Asseende		
16	2007-01-05	2	2	25119	0	0	0	0	0 [9329F89C...]	43388.166	47570314.11	Lasne		

Figure 25 – Attribute table



Figure 26 – Selection button

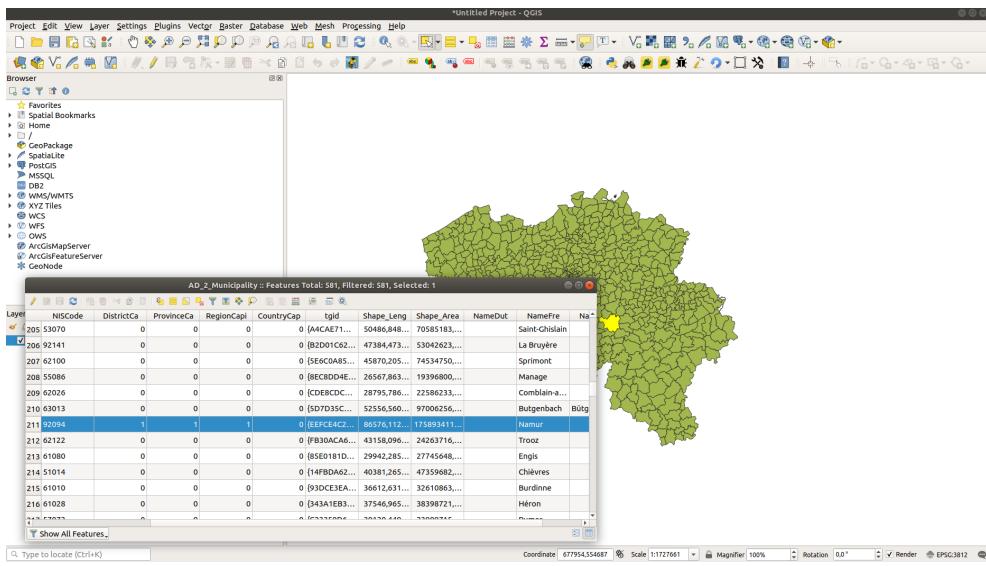


Figure 27 – Feature selection in the attribute table

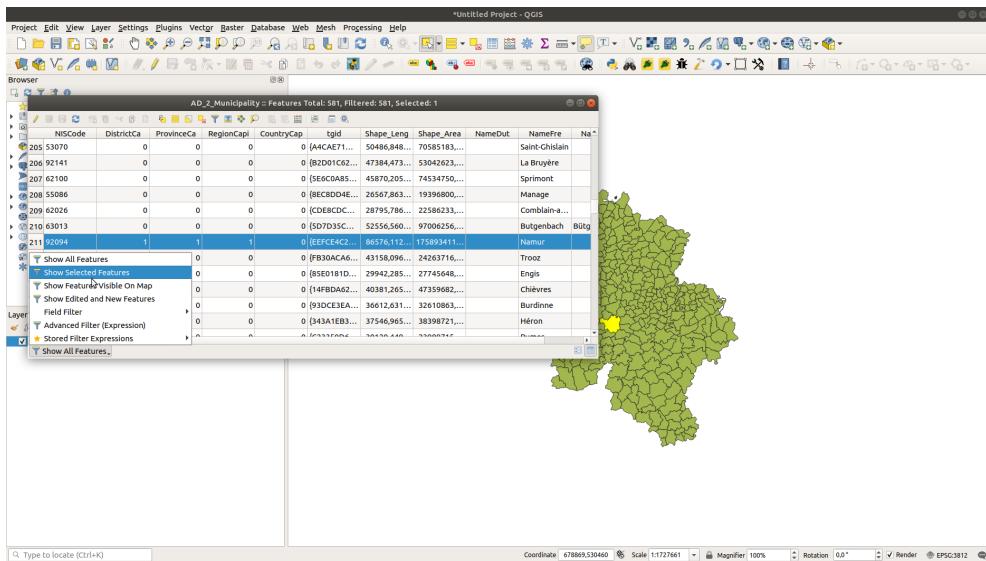


Figure 28 – Selecting items in the attribute table



Figure 29 – Selection button

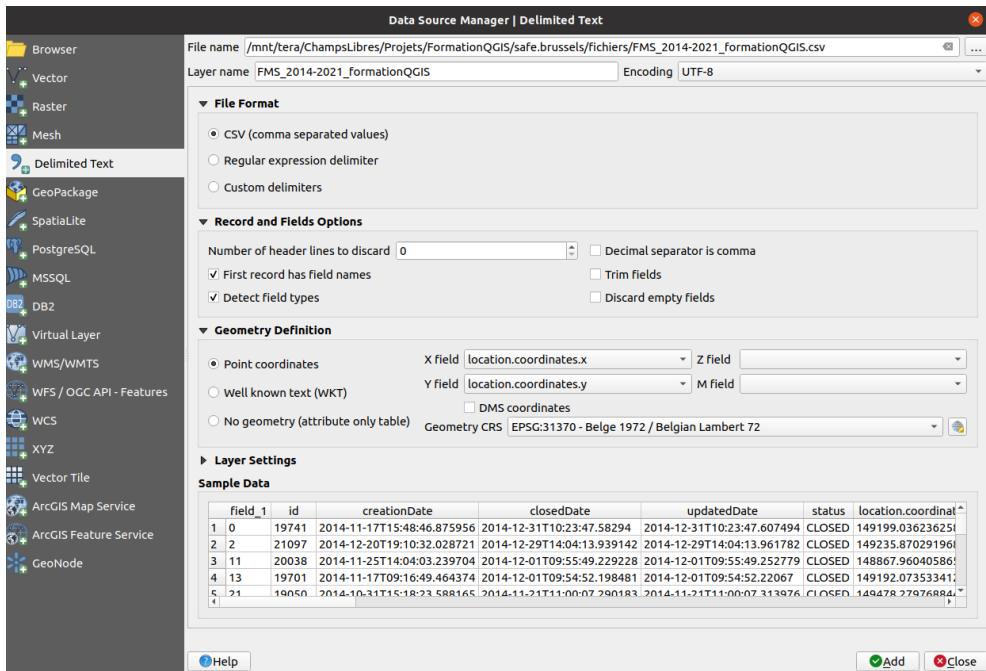


Figure 30 – Add delimited text dialog

## 2.1 Add the XY data to QGIS

We have an Excel file of point observations over Brussels, with coordinates of the observations in two columns (e.g., X and Y, or longitude and latitude) and we want to add it in our PostGIS database.

This is typically done by using the “Add delimited text” layer action in the layer menu which will add the table of observations and transform the coordinates columns into points on the map. This manipulation requires that we convert the Excel file to a “CSV” file first, which can be done in Excel or LibreOffice.

Open the Add delimited text layer dialog (Layer > Add Layer > Add delimited text layer ...) and browse to the csv file. The tool will automatically detect the coordinates columns based on their names (X, Y), but sometimes, you have to indicate the right columns for the coordinates. It is also important to choose a coordinate system (Geometry CRS) that is correct with respect to these coordinates!

Note : We can actually directly load the Excel file in QGIS and transform it into points without converting to the CSV format, but this may lead to a layer without column names, so it is not the preferred option. But you can try : drag and drop the Excel file directly in the layer browser of QGIS and then, use the tool “Create points layer from table” available in the “Processing toolbox”.

After using the tool, the points layer will be displayed on the map, as follows :

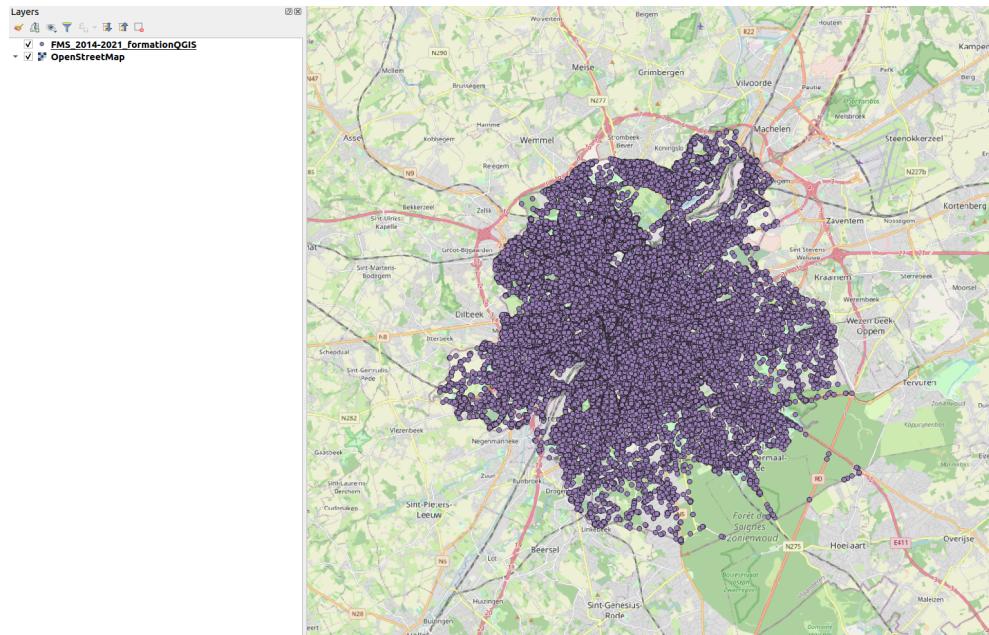


Figure 31 – Point layer displayed in the map panel

## 2.2 Save it as a PostGIS layer

Save this layer to a PostGIS database is trivial once you are connected to a PostgreSQL database with PostGIS enabled.

Open the DB manager (Database > DB manager). Browse on the left to the database and click on the third icon “Import Layer / File”. You can select the layer in the first field “Input”, and then choose in which table you want to store the database.

Important note! By default QGIS will propose to store the data in a new table with the same name as the layer, but please note that you will avoid several problems by choosing a name without special characters (spaces, “-”, “&”, etc.) and without capital letters! Although PostgreSQL tables *can* have complicated names and users can deal with that (by quoting the table names between “”), it is your responsibility as a GIS manager to avoid these issues by providing simple table names!

Tip : You'd better ticking the box “Create a spatial index”: though it will take a little bit more time to create the PostGIS table, an index will increase the performance (i.e. the speed) of reading the data for later use.

## 2.3 Make a spatial intersection

Now that the observations are imported in a PostGIS table, we can start making some spatial queries!

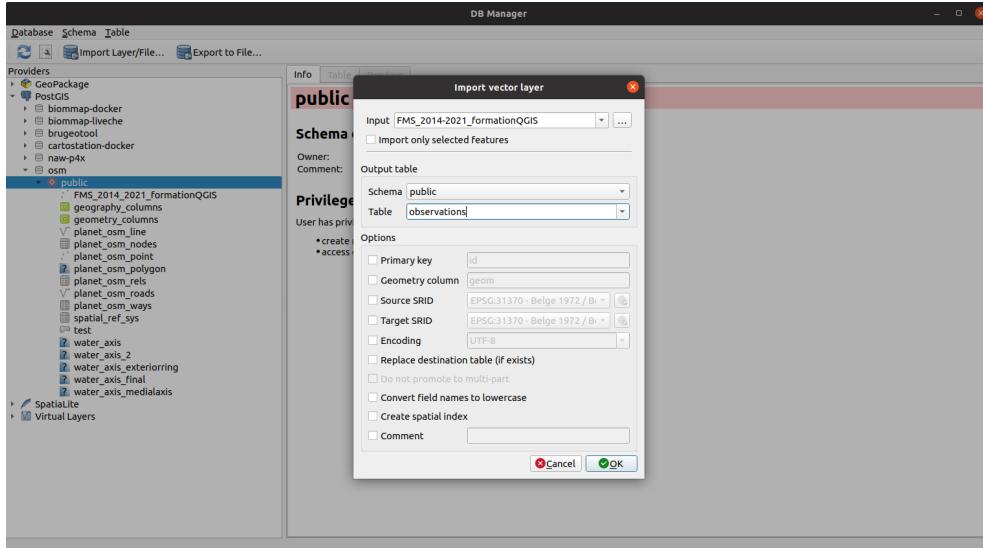


Figure 32 – Import a vector layer to the database

Please create a polygon in an area of interest. Here I've drawn a polygon around the central station in Brussels. I've imported it into the PostGIS table as seen previously. To create a polygon, you have to create a layer (Layer > Create Layer) and store it on your computer, or you may use the QuickDraw QGIS plugin which is rather useful to quickly create a layer from scratch.

Like any table, we can create a query on the observations table to filter the data. Using PostGIS functionalities, we can create some spatial queries.

To run a spatial query, open the DB manager (Database > DB manager), browse to your PostGIS database and click on the second icon to open the query builder. On the query builder, you can type some queries on your database. In this exercise, we want to filter all the points that falls into the polygon we drew.

### 2.3.1 A spatial intersection with the WHERE clause

There are actually 2 ways of making a spatial intersection : (1) using the WHERE clause and (2) using the JOIN statement. Here's the SQL statements to write with the WHERE clause. We use the [PostGIS function "ST\\_Intersects"](#) : this function returns "true" where there is a spatial intersection between two layers. There are other PostGIS functions for doing spatial intersection, such as ST\_Within, ST\_Contains, ST\_Disjoint, ... with some subtleties in their use.

```
SELECT observations.*  
FROM observations, gare_centrale  
WHERE st_intersects(gare_centrale.geom, observations.geom)
```

You can load the result of the query in the QGIS map panel by clicking on "Load".

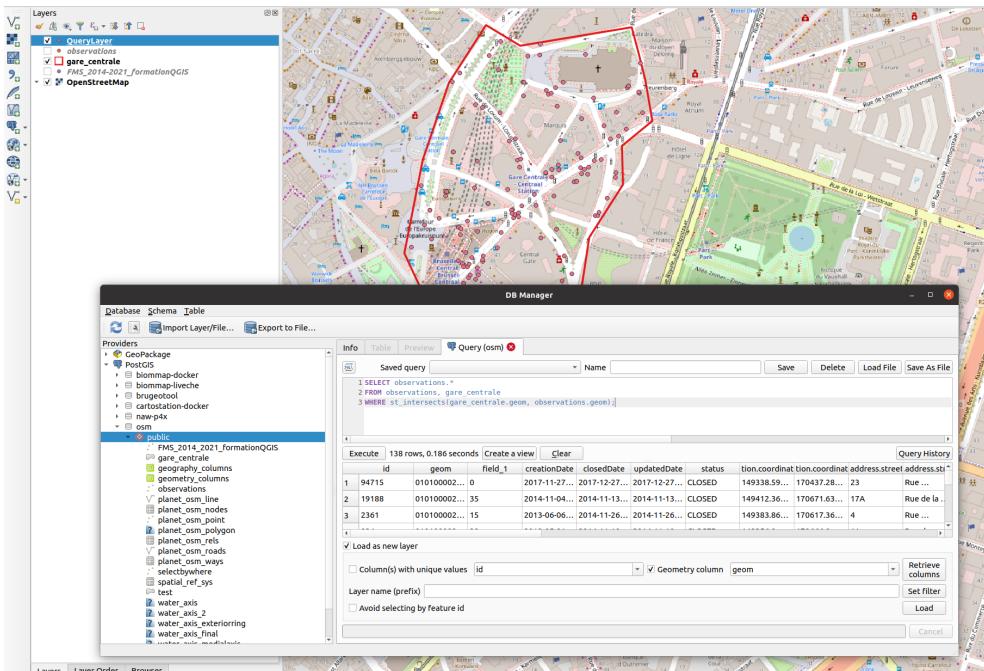


Figure 33 – Spatial query between 2 tables

### 2.3.2 A spatial intersection with JOIN

And here the statement using the (INNER) JOIN statement. Both queries results in the same outputs.

```
SELECT observations.*  
FROM observations  
INNER JOIN gare_centrale ON st_intersects(gare_centrale.geom, observations.geom);
```

To summarize, you learned how to make a simple spatial intersection with some PostGIS function!

Actually this could be done using QGIS tool (select by location), but doing it with the DB manager has some advantages :

- you can save your query as a SQL file to make a collection of SQL recipes to be used and shared across colleagues.
- more importantly, you can save the result of the query in a new view. A view is like a table for the end-users, except the data won't be duplicated and will evolve with the original table.

### 2.3.3 Exercise : expand the area of intersection with a buffer

Now, suppose that we want to expand a little bit the analysis by looking at all the observations that are within a buffer zone of 100 m around the central station polygon.

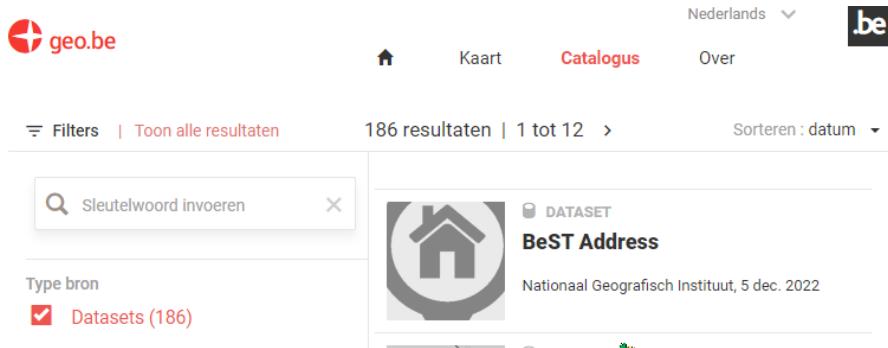


Figure 34 – geo.be

We could redraw a new polygon, importing it in PostGIS and re-do the manipulation, but there is a much simple way : we can modify the query by adding a buffer around the "gare\_centrale" geometry.

### 2.3.4 Exercise : Filter the observations based on the date of observations

We want to filter the observations based on the date of observations, keeping for instance only observations after the 01/01/2018.

## 3 Opendata : Free to use data sources

Many government agencies provide a opendata-site where you can download their free datasets.

Some provide services and others file formats.

### 3.1 government

#### 3.1.1 GEO.be (NGI/IGN)

Interesting datasets : - All Belgian addresses : [BestAdd](#) - All administrative divisions of Belgium (community, province, municipality) [Administrative units](#) - Postalcode area's : [Postal Districts](#) - Statistical divisions of Belgium : [Statistical sectors](#) -> Used a lot in statistical reporting - NGI WMTS-basemap : [Cartoweb](#) -> NGI does not provide base vectordata for free. - Land Parcels : [Land register plan](#) -> ownership info not included

#### 3.1.2 Statbel.fgov.be opendata (Statistics Belgium)

Various statistics of Belgium, like fiscal incomes, population, ...

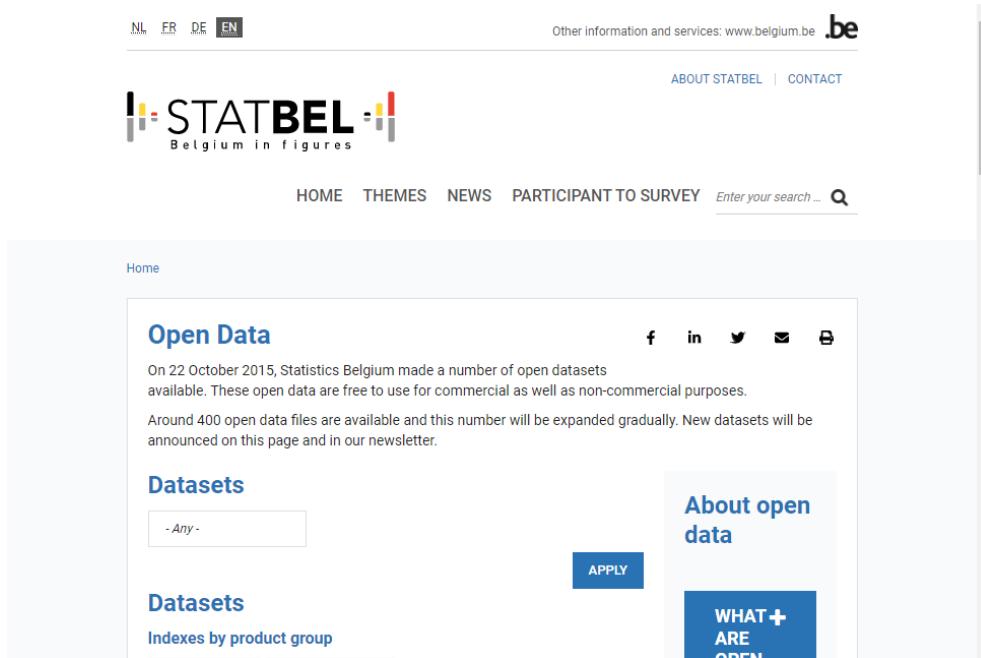


Figure 35 – Statbel.fgov.be

Mostly flat tables (.csv) or excel-files, usually reported on municipal or statistical sector level.

Using GIS-data from NGI/IGN you can join these tables to make maps with these datasets.

### 3.1.3 Others

- MIVB : <https://opendata.stib-mivb.be/store/data>
- De lijn : <https://data.delijn.be>
- Infrabel (trains) : <https://opendata.infrabel.be>
- Fluvius (energy) : <https://opendata.fluvius.be>
- Bosa : <https://data.gov.be>

## 3.2 Brussels

- Geoportal of the Brussels Capital Region [Geo.brussels](#)
- Brussels open data site [datastore.brussels](#)
  - useful to share with external contacts

## 3.3 Other regions

- Flanders :
  - [geopunt.be](#)

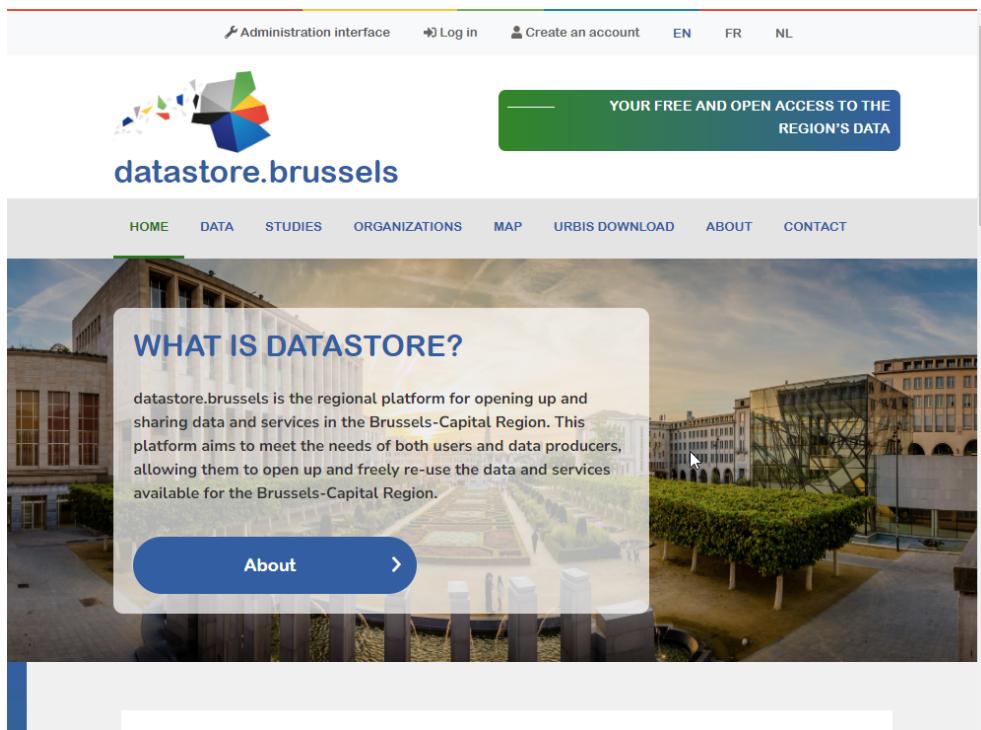


Figure 36 – datastore.brussels

- [provinces.incijfers.be](#)
- Walonia : [geoportail.wallonie.be](#)

## 3.4 World

### 3.4.1 Openstreetmap

Openstreetmap is a free base map of the world created by hobbyists. QGIS already includes this map under XYZ-tiles. This is only the rendered tiles, not the source data.

Retrieving the openstreetmap source data is quite complicated. The German company geofabrik provides downloads for each country, in the original opensourceformat (.osm.pbf) and in shapefile format, useful in QGIS if you need basic data from other countries.

The European downloads can be found here : <https://download.geofabrik.de/europe.html>

### 3.4.2 Natural earth

Natural earth contains the basis if you want to make maps on a global scale. It includes administrative boundaries, larger water bodies, etc.

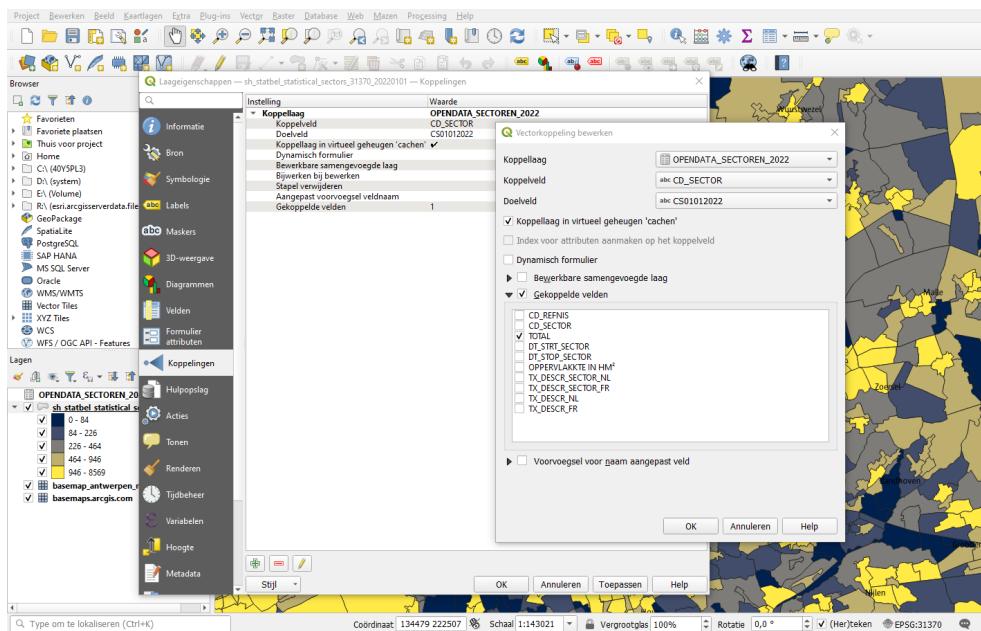


Figure 37 – Joins in QGIS

You can find the download here : <https://www.naturalearthdata.com/downloads/>

### 3.5 Exercise

- On the Statbel site <https://statbel.fgov.be/nl/open-data/>
  - Search and download the statistical sectors of Belgium as *shapefile (.shp)*
  - Extract the zip file and add it to qgis.
  - Search “Population by Statistical Sector” and download it as a text file.
  - Add it to qgis using the delimited text tool.
  - Connect both data sources using :
    - 1) Right-click on the Statistical Sectors layer
    - 2) Choose “Properties”
    - 3) Choose “Joins” and then click the plus sign
    - 4) Connect the sectors on field “CD\_SECTOR” Population on field “TOTAL” (=number of people) of population