



AWAY
from the
CROWD



Analyzing Nasa Nighttime Imagery with QGIS

Objective

This document has the objective of showing all the steps on how NASA Satellite data was acquired and processed with the objective of determining how night lights are related to population density, human activity and new Covid-19 cases.

Output

The data output of this process is a csv file which quantifies night lights data, containing coordinates of the brightest spots and assigning them to the respective counties.

1. Creating the QGIS Project for the State of São Paulo

1.1. Data acquisition

Shp files responsible for shaping the State were downloaded from IBGE's (*Brazilian Institute of Geography and Statistics*) website¹.

1.2. Creating State Map on QGIS

In QGIS toolbar: **Project → New** then **Project → Save as...** to create a new blank project.

Import .shp file downloaded through **Layer → Data Source Manager → Vector** in the Source box. This should create the shape of the State.

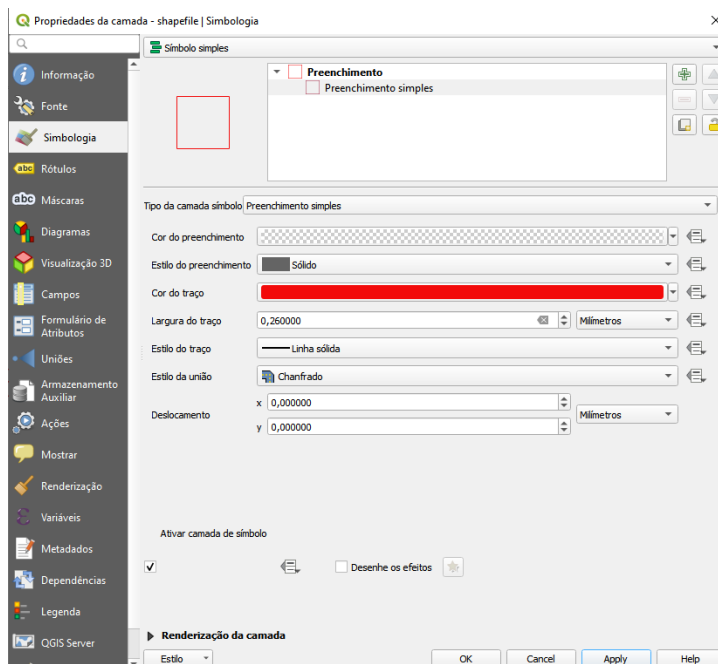
In the **Layers** window of the panels on the left, right click on the shp layer and choose **Export → Save features as...** Fill the file name in the project directory and check if it's in Shapefile format to save the

project's Shape File. Now Ctrl+D the original .shp to have the Shape File in the right directory.

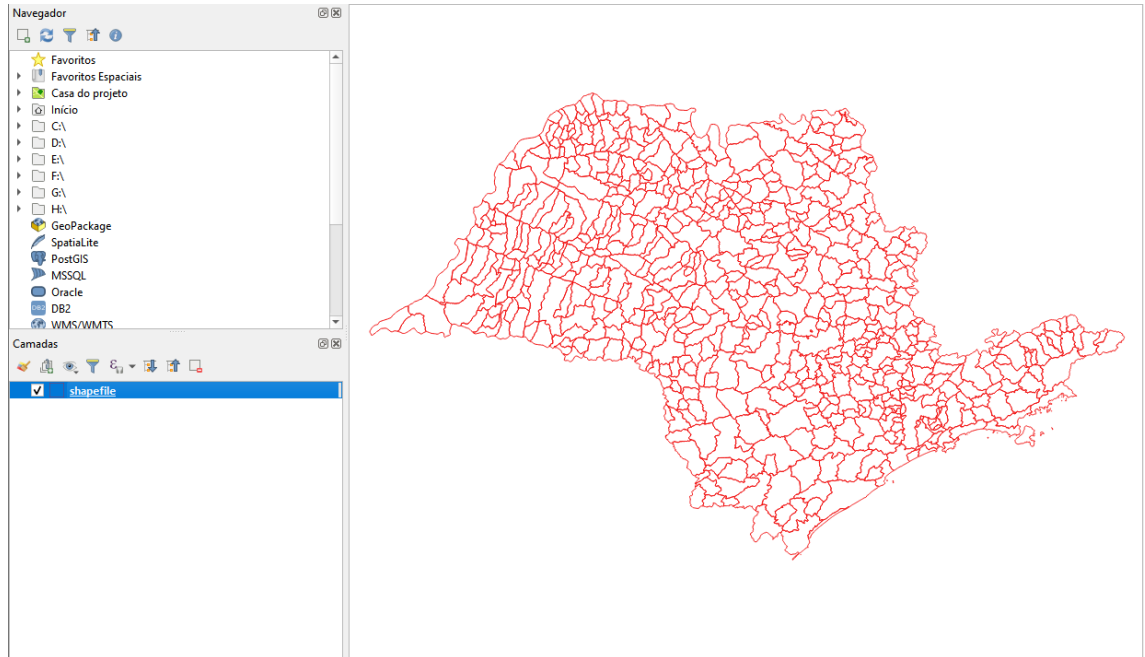
For São Paulo State, it should look like this:



Again in [Layer](#), right click on **shapefile** and choose [Properties](#). Go to [Symbology](#) and set as in the below image to have a transparent shape of the State. **Note:** Stroke color should be different from black, as it will not be shown when the tif file is added. Apply and OK.



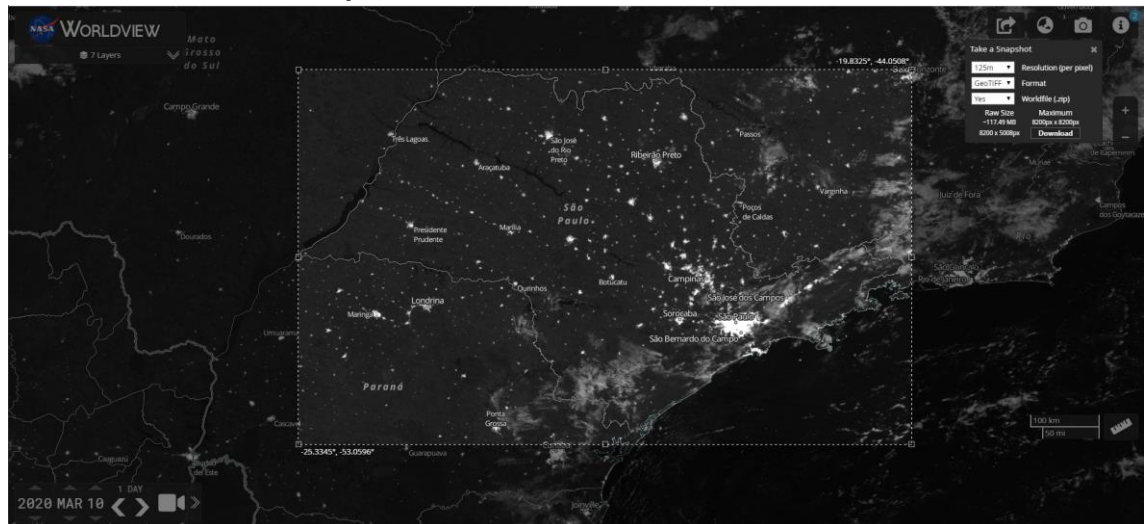
Now we have a transparent shape of the State:



2. Downloading Satellite data from NASA

2.1. Data acquisition

A snapshot from NASA worldview² was taken and turned into a GeoTIFF file of the analyzed state.

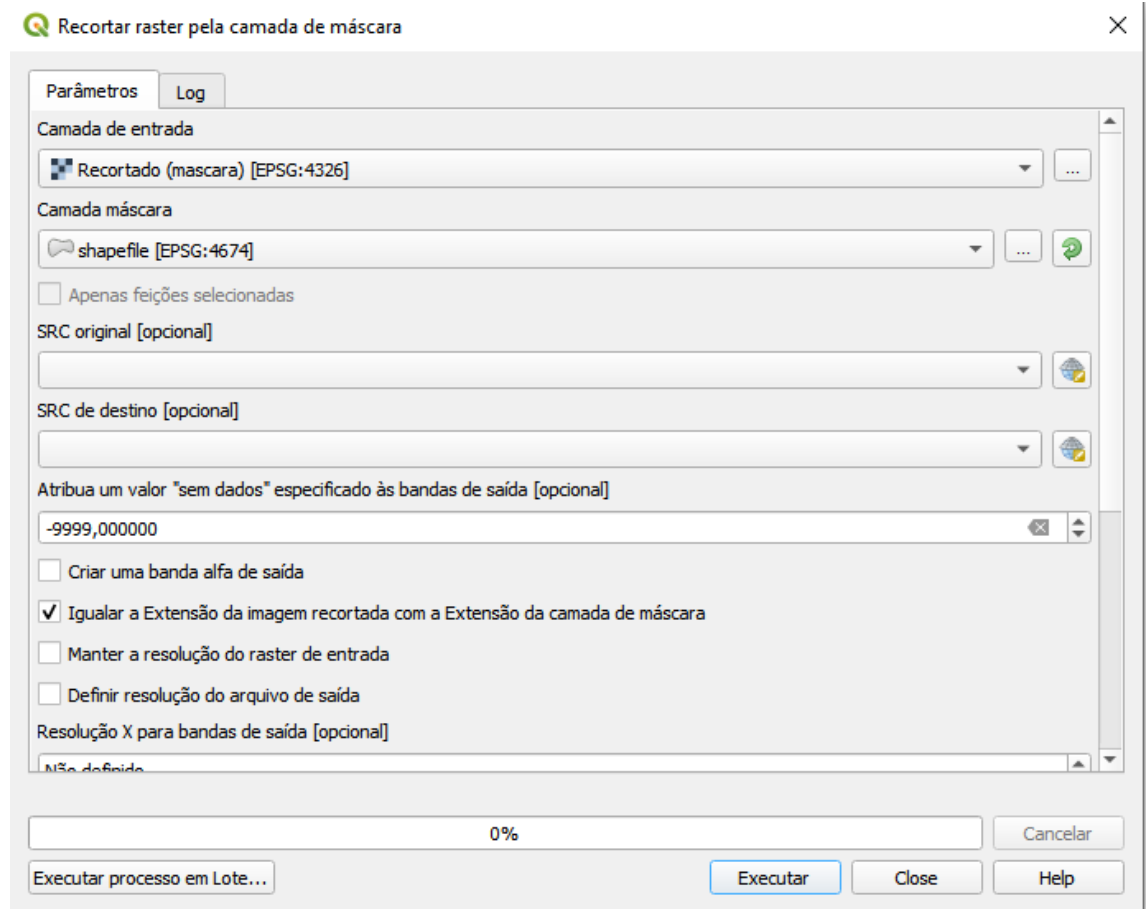


2.2. Adding a raster layer

In QGIS toolbar: **Layer** → **Add layer** → **Add raster layer** and select the downloaded .tif file to add a raster layer of the NASA data.

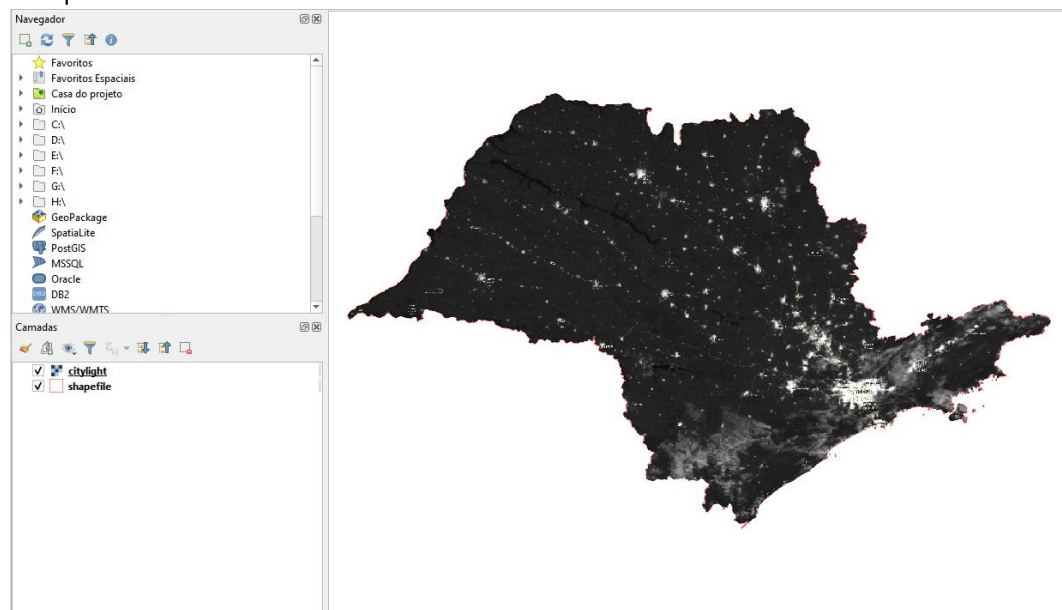
In QGIS toolbar: **Processing** → **Toolbox** and search for “**Clip raster by mask layer**”. Input Layer should be the Raster Layer and Mask Layer should be the Shape File. **NOTE:** set nodata value to -9999 to avoid a

black rectangle in the State surroundings.



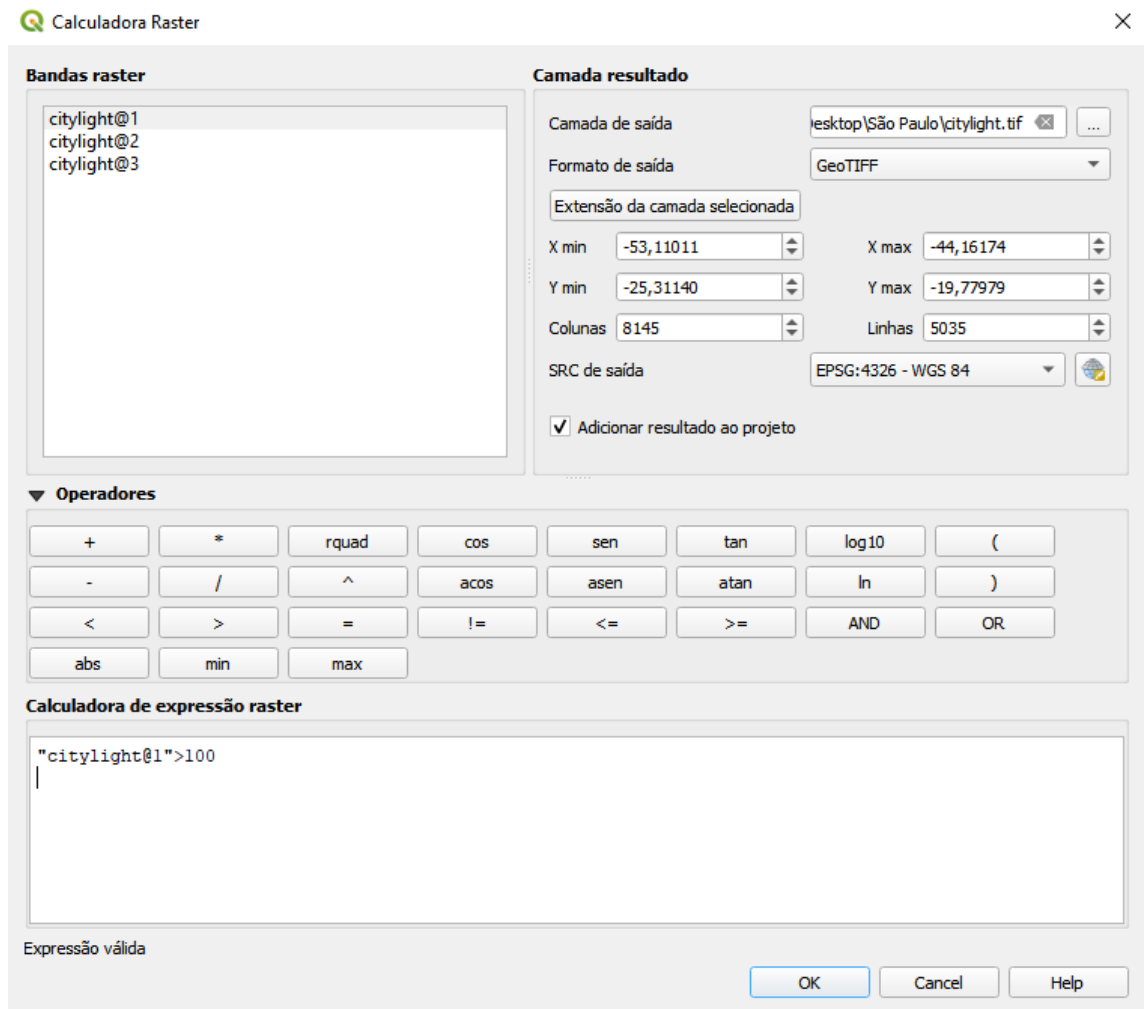
Export → Save as... the new raster layer and Ctrl+D all the raster layers except the new one.

The result is a cropped raster layer that is in accordance with the State shape



3. Processing the data

In [Layers](#) window: [citylight](#) → [Properties](#) → [Simbology...](#) and change the [Render type](#) to [Singleband Gray](#) and [Color Gradient](#) to [White to Black](#).
Now go to [Raster](#) → [Raster Calculation](#) and set “citylight@1”>100 in [Raster Calculator Expression](#)



The screenshot shows the 'Calculadora Raster' (Raster Calculator) dialog box in QGIS. The window has a title bar with a close button (X) in the top right corner.

Bandas raster (Raster Bands): A list box on the left contains three entries: 'citylight@1', 'citylight@2', and 'citylight@3'.

Camada resultado (Result Layer): This section on the right contains several fields:

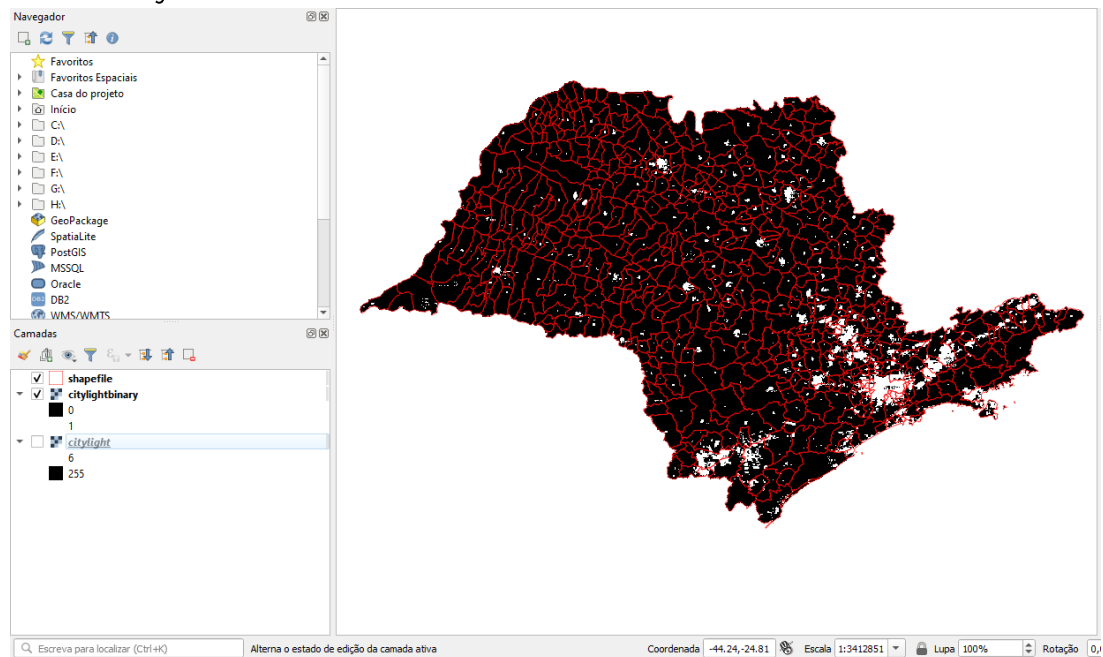
- Camada de saída** (Output Layer): A text field with the path 'C:\Users\user\Desktop\São Paulo\citylight.tif' and a browse button (...).
- Formato de saída** (Output Format): A dropdown menu set to 'GeoTIFF'.
- Extensão da camada selecionada** (Extent of selected layer): A button to define the extent.
- X min** and **X max**: Spinners for the horizontal extent, with values -53,11011 and -44,16174 respectively.
- Y min** and **Y max**: Spinners for the vertical extent, with values -25,31140 and -19,77979 respectively.
- Colunas** and **Linhas**: Spinners for the number of columns and rows, with values 8145 and 5035 respectively.
- SRC de saída** (Output Source Reference): A dropdown menu set to 'EPSG:4326 - WGS 84' with a globe icon.
- ☒ **Adicionar resultado ao projeto** (Add result to project).

Operadores (Operators): A grid of buttons for mathematical and logical operations, including '+', '-', '<', '>', '=', '<=', '>=', '<', '>', '^', '/', '*', '&', '!', '<=', '>=', 'AND', 'OR', 'abs', 'min', 'max', 'rquad', 'cos', 'sen', 'tan', 'log10', 'acos', 'asen', 'atan', 'ln', '(', and ')'. There are also buttons for 'abs', 'min', and 'max' at the bottom.

Calculadora de expressão raster (Raster Expression Calculator): A large text area containing the expression '"citylight@1">100'.

At the bottom left, it says 'Expressão válida' (Valid expression). At the bottom right, there are three buttons: 'OK', 'Cancel', and 'Help'.

The finished image has [shapefile](#) as top layer and [citylightbinary](#) as bottom layer

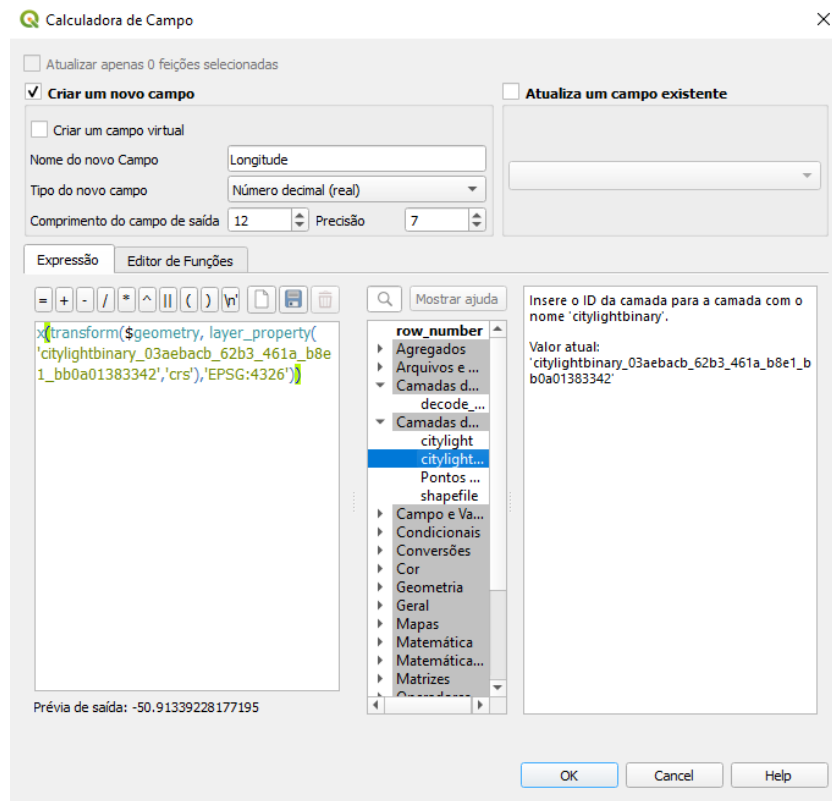


4. Getting the output file

In QGIS toolbar: **Processing** → **Toolbox** and search for “[Raster pixels to points](#)”. Run in order to convert the binary .tif file into vector points. On the generated [Vector points](#), go **Properties** → **Source**. In [Query Builder](#), set “VALUE”=1 in order to filter the city light points. Again on [Vector points](#), select **Toggle Editing**. For the third time on [Vector points](#), select **Open Attribute Table**. In there, click on **Open Field Calculator**.

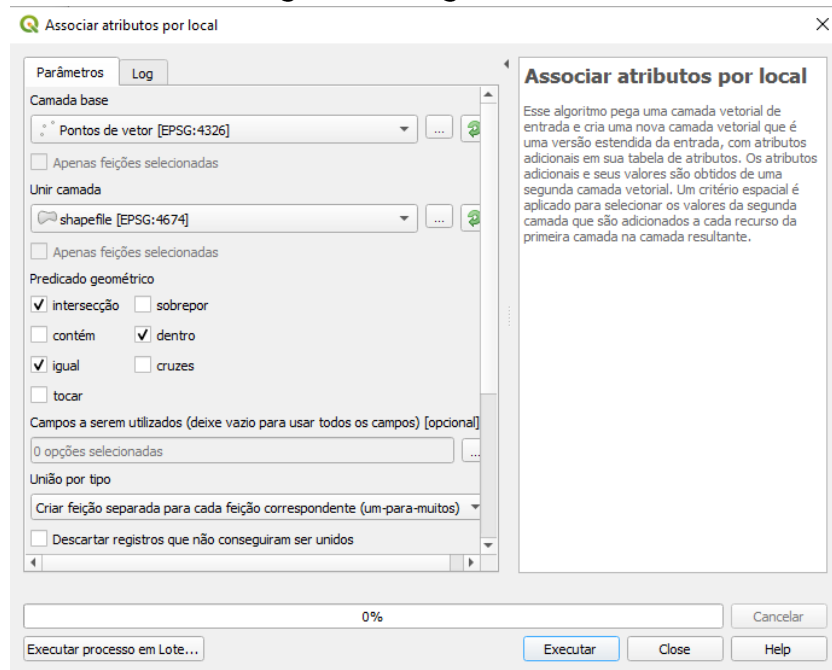
To add the **Longitude** field, on the search bar get current value of [citylightbinary](#) and write on the expression field
`y(transform($geometry,layer_property('currentvalue','crs'),('EPSG:4326'))`

To add **Latitude**, substitute y for x



Now the vector points table has **Longitude** and **Latitude** values, which will be joined with the shp file data to relate coordinates to counties

In QGIS toolbar: **Processing** → **Toolbox search** for “**Join attributes by location**” with the given configuration



In the Joined Layer in Layer window, select [Export → Save as...](#) and save the joined layer as CSV file

In our project, the output CSV file was saved as “NightIlluminationSP.csv”

This file quantifies in number of light pixels per county the intensity of the night light in each of these counties.

References

1. <https://www.ibge.gov.br/geociencias/organizacao-do-territorio/estrutura-territorial/15774-malhas.html>
2. [https://worldview.earthdata.nasa.gov/?v=-57.40996572126986,-26.859610619764453,-40.53496572126986,-18.624259057264453&t=2020-03-10-T18%3A00%3A00Z&l=Reference_Features,Reference_Labels,VIIRS_SNPP_DayNightBand_ENCC,Coastlines\(hidden\),VIIRS_SNPP_CorrectedReflectance_TrueColor,MODIS_Aqua_CorrectedReflectance_TrueColor\(hidden\),MODIS_Terra_CorrectedReflectance_TrueColor\(hidden\)](https://worldview.earthdata.nasa.gov/?v=-57.40996572126986,-26.859610619764453,-40.53496572126986,-18.624259057264453&t=2020-03-10-T18%3A00%3A00Z&l=Reference_Features,Reference_Labels,VIIRS_SNPP_DayNightBand_ENCC,Coastlines(hidden),VIIRS_SNPP_CorrectedReflectance_TrueColor,MODIS_Aqua_CorrectedReflectance_TrueColor(hidden),MODIS_Terra_CorrectedReflectance_TrueColor(hidden))

Relevant bibliography

Modeling population density based on nighttime light images and land use data in China

https://www.researchgate.net/publication/322191952_Modeling_population_density_based_on_nighttime_light_images_and_land_use_data_in_China