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*) website[1].

1.2. Creating State Map on QGIS

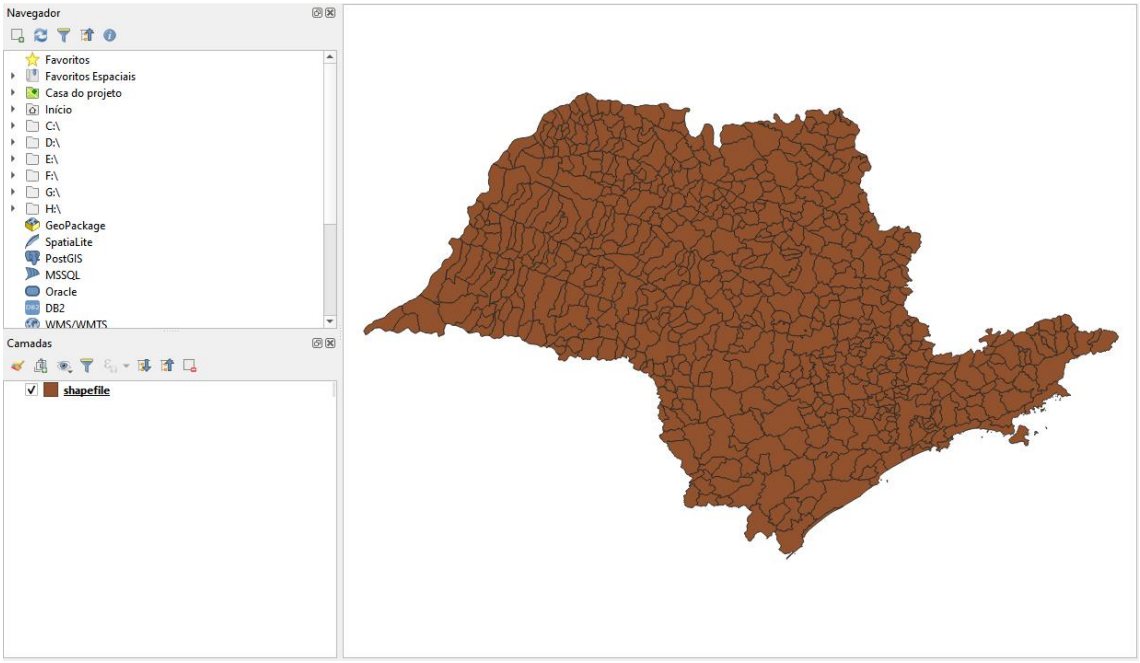
In QGIS toolbar: Project → New then Project → Save as... to create a new blank project.

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

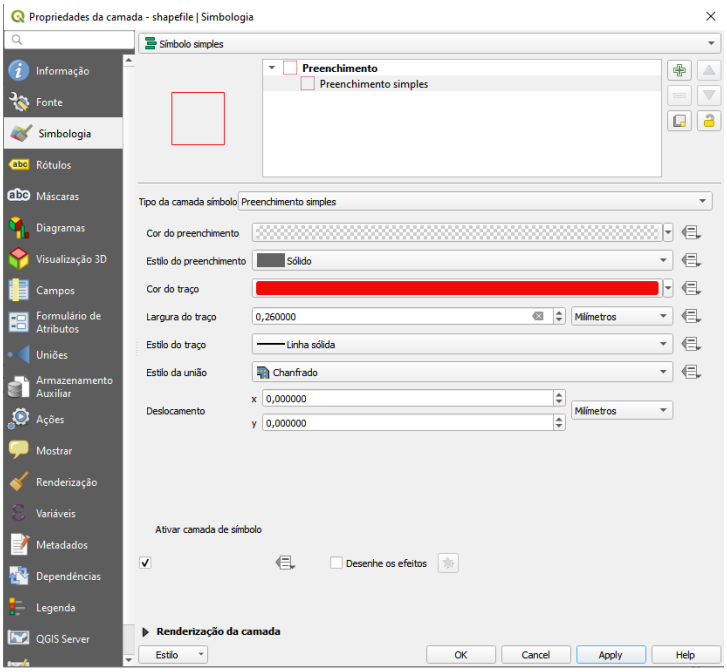
In the Layers window of the panels on the left, right click on the shp layer and choose Export → Save features as.... Fill the file name in the project directory and check if it's in Shapefile format to save the

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 Simbology 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.

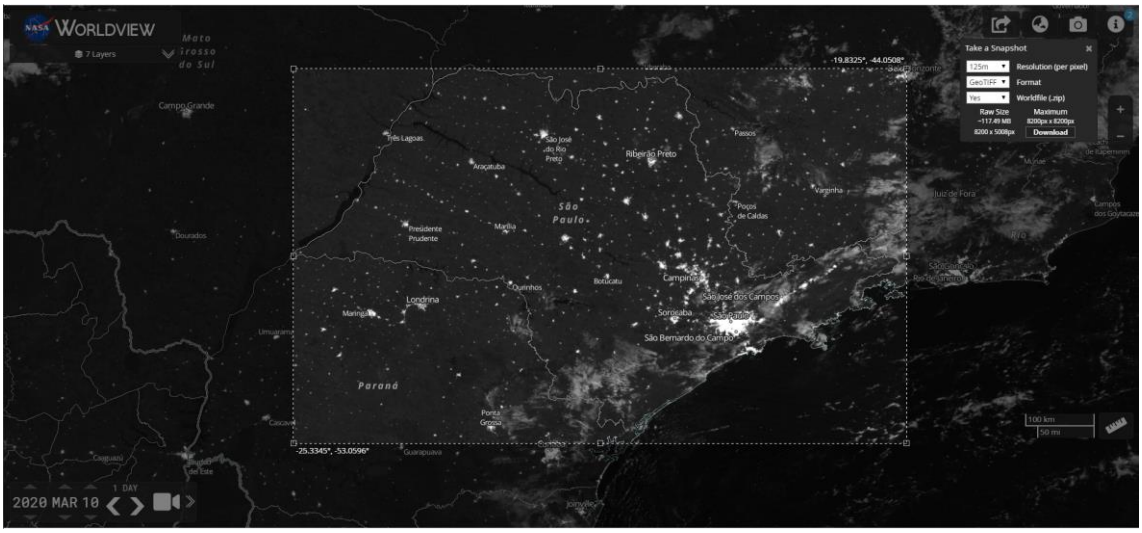


Now we have a transparent shape of the State:

2. Downloading Satellite data from NASA

2.1. Data acquisition

A snapshot from NASA worldview[2] was taken and turned into a GeoTIFF file of the analyzed state.

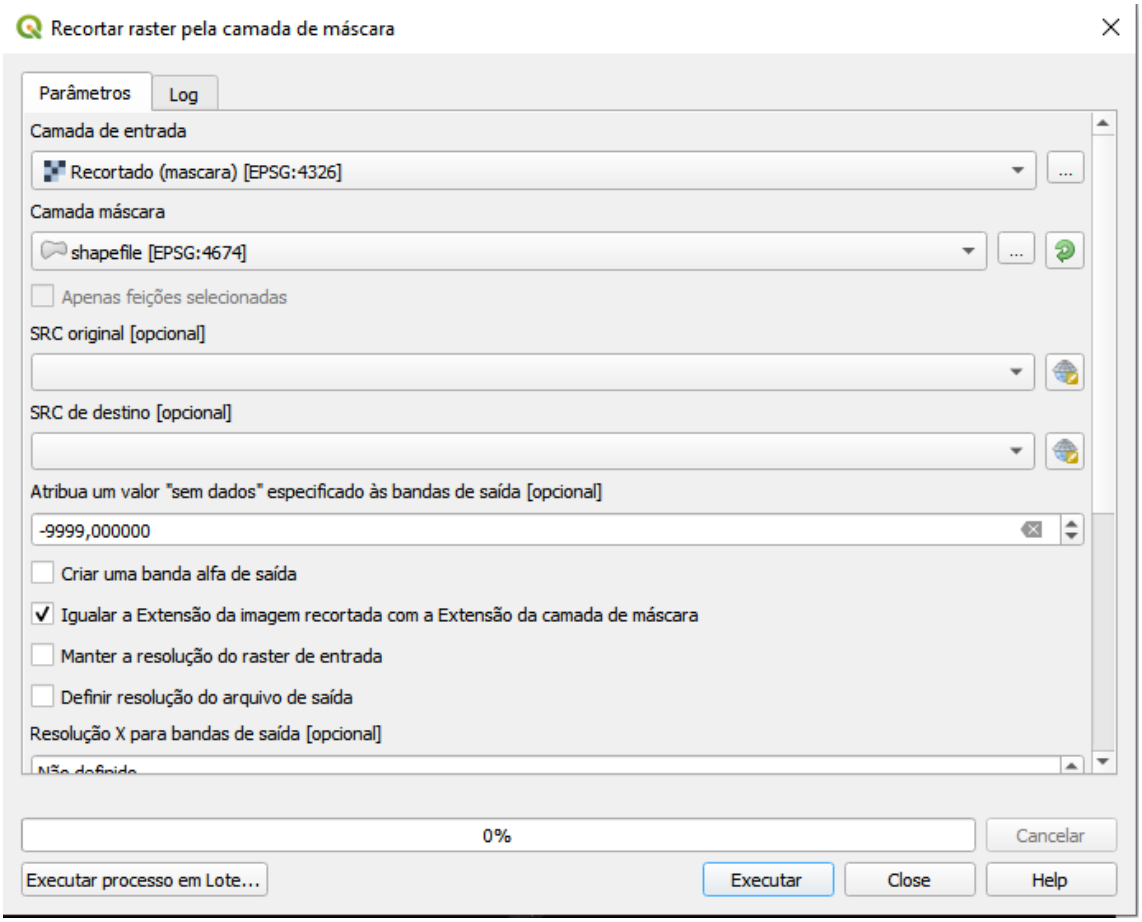


2.2. Adding a raster layer

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

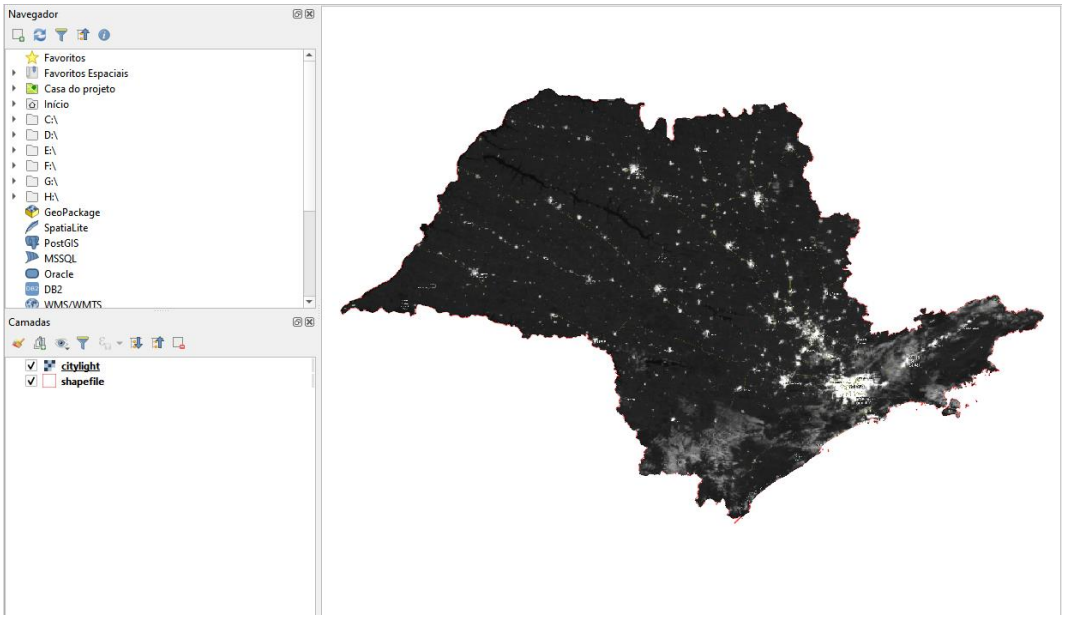
In QGIS toolbar: Processing → Toolbox and search for "Clip raster by mask layer". Input Layer should be the Raster Layer and Mask Layer should be the Shape File. **NOTE:** set nodata value to -9999 to avoid a

black rectangle in the State surroundings.



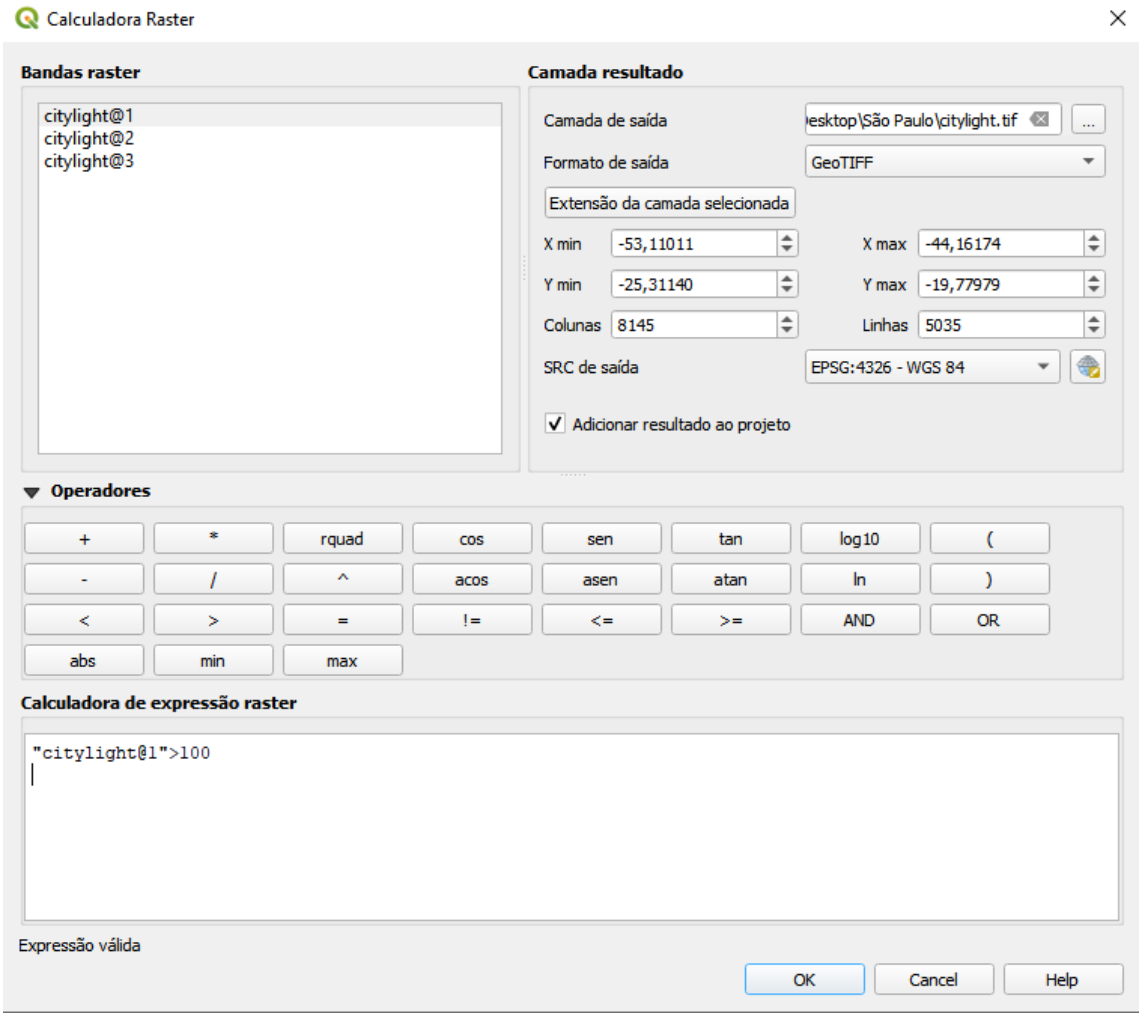
Export → Save as... the new raster layer and Ctrl+D all the raster layers except the new one.

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

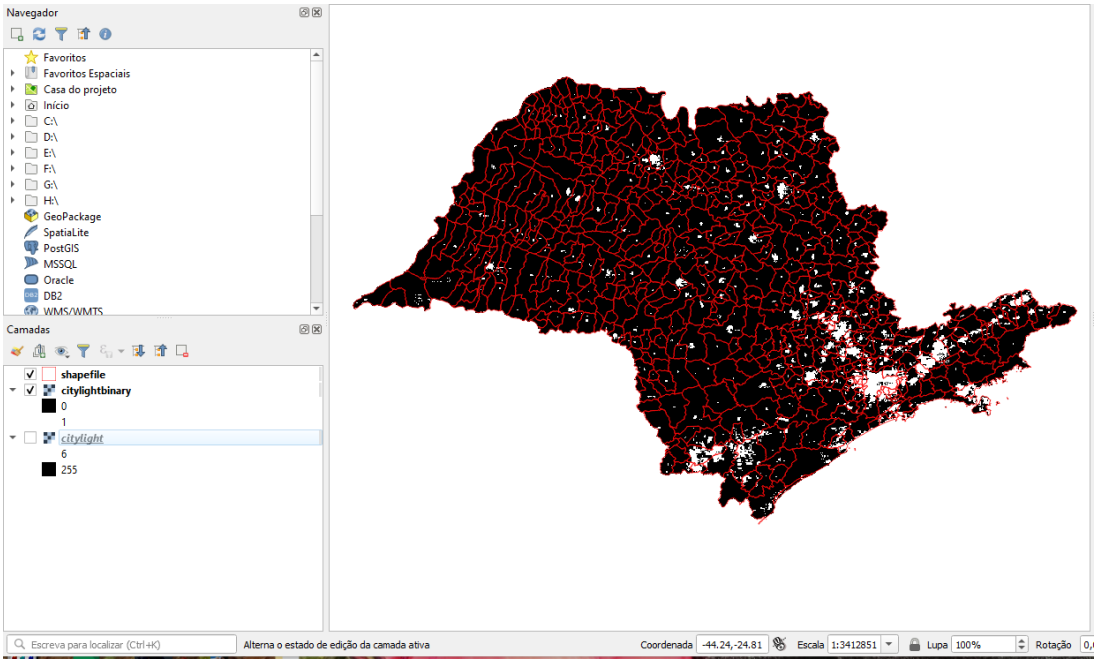


3. Processing the data

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



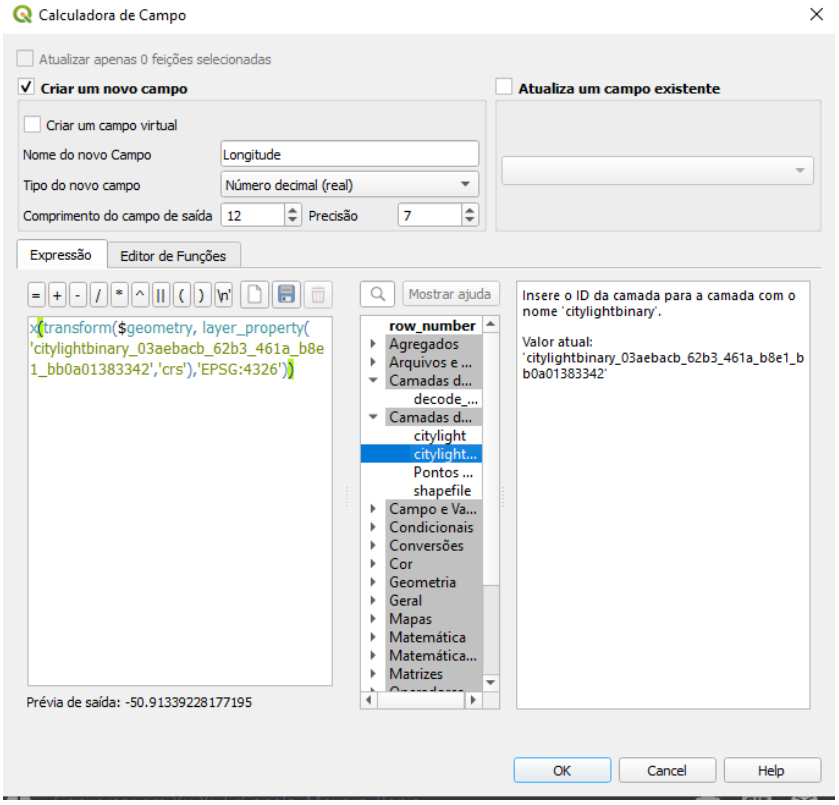
The finished image has shapefile as top layer and citylightbinary as bottom layer



4. Getting the output file

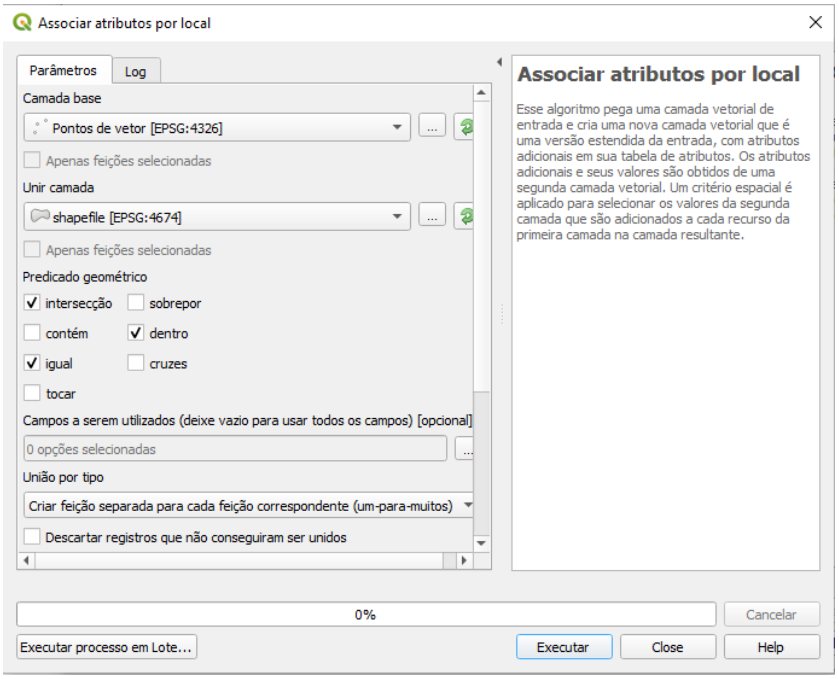
In QGIS toolbar: Processing → Toolbox and search for "Raster pixels to points". Run in order to convert the binary .tif file into vector points.
On the generated Vector points, go Properties → Source. In Querry Builder, set "VALUE"=1 in order to filter the city light points.
Again on Vector points, select 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)

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