Co-funded by the Erasmus+ Programme of the European Union

Project number: 2021-1-IE01-KA220-SCH-000027825

Energy Resources & Light Pollution Mitigation

Topic: Light Pollution Mapping

Lesson Plan for Teachers - Age Group 13-18

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Project Information

PROJECT: CliC-PoliT

PROJECT TITLE: Engaging students and the society in environmental and climate change activities to raise awareness and strengthen responsible citizenship.

ACRONYM: Climate Action and Light Pollution Threat

PROJECT WEBSITE: https://www.clicpolit.eu/

PROJECT NO.: 2021-1-IE01-KA220-SCH-000027825

PROJECT COORDINATOR: CIT Blackrock Castle Observatory, Cork, Ireland

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Module: Energy Resources & Light Pollution Mitigation

Topic: Light Pollution Mapping

Lesson Plan – Light Pollution mapping	
Duration: 2 lessons of 45 minutes	
Short Description of the Lesson	Students will gain an understanding of what light pollution is, how it impacts our environment, how we map light pollution and we can work with real data in order to identify changes as well as on how we can reduce and apply mitigation measures.
Learning Goals	• Describe different types of light pollution • To recognise some sources of light pollution and describe how these affect how we see stars in the night sky • To conduct an experiment to find out how artificial light can be directed and which materials and shapes would help do this
Green Competences Linked	• Knows that when human demand for resources is driven by greed, indifference and unfettered individualism, this has negative consequences for the environment. • Knows which aspects of personal lifestyle have higher impacts on sustainability and require adapting. • Can bring personal choices and action in line with sustainability values and principles. • Listens actively and shows empathy when collaborating with others to frame current and potential sustainability challenges.
Target Group	Secondary school students aged 12-18 years old
Educational Approach	Inquiry-based scenario
Link to School Curricula (if applicable)	Environmental education, Geography, Physics (Energy)
Facility/ Equipment	• Classroom • Internet access • Projector • White board • Personal computers
Tools/ Materials	• Sticky notes
Main Tasks	**Introduction to light pollution mapping and topics…….**

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Task 1: Light pollution monitoring and mapping (10 minutes)

You can ask students if we can see Light Pollution from space! Is this possible and how?

Now let's use an online Geographic Information Systems platform to monitor light pollution at a global scale!
You can use the Dark Site Finder app in the following link:

Dark Site Finder

Let the students to navigate on the map and identify different areas of increased light pollution.

Discuss with the students their thoughts and if any correlation exists between the sites of increased light pollution and the number of people live there (big cities, industrial areas, roads etc.). This map is real, however, is a little bit enhanced in terms of the light pollution distribution, spread and colours. What is next?
TO WORK WITH REAL DATA AND DIGITAL TOOLS! LET'S DO THIS!

Task 3: Light pollution in our area/city/region using real data and tools (30 minutes)

3.1 Introduction

Video: How one NASA image tells dozens of stories (5 min)
https://youtu.be/ZYGd-llxHJE

3.2 Case study - Implementation phase

see Annex I with all technical guidelines step by step (25 minutes)

3.3 Discussion - Explanation based on evidence (10 minutes)

Encourage your students to provide correct explanations for the topic(s) investigated. Describe ways and they can use to this end and give them directions how to discover them. You can start a conversation related to the results explanation by asking:

- What do you think that the minimum and maximum values indicate?
- Negative values point out a potential Light Pollution decrease?

On the contrary, increased positive values highlight a potential Light Pollution increase between 2012 and 2021?

3.4 Reflection - Communicate explanation (Homework)

Help the students to get familiarized and to become efficient in scientific writing or poster presentation.

Ask from students to write a short report by incorporating the scope of this Activity (the objective?), the data and the tools they used, what methodology (QGIS tools) and to present their results in the form of maps (images) by reporting the differences of Light Pollution levels between 2012 and 2021.

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	They can also report all potential adjustments they made (clipping areas) or any future research they want to consider (add Light Pollution data for year 2018, 2020 etc.). The report outline could be in the form of: Introduction, Study area and Data used, Methodology (tools), Results and Discussion. ----------

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ANNEXES

QGIS TUTORIAL FOR LIGHT POLLUTION ACTIVITY

Title: Light Pollution hunters

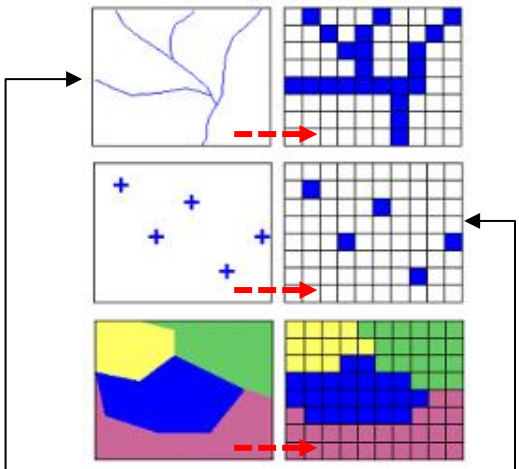
In order to better understand what type of data we will use and how we "translate" or model the Earth surface and processes, we have to discuss about spatial data structures (type of data and how spatial information is stored, data types etc.)

A short explanation:

https://www.youtube.com/watch?v=HwVFvHwuYJo

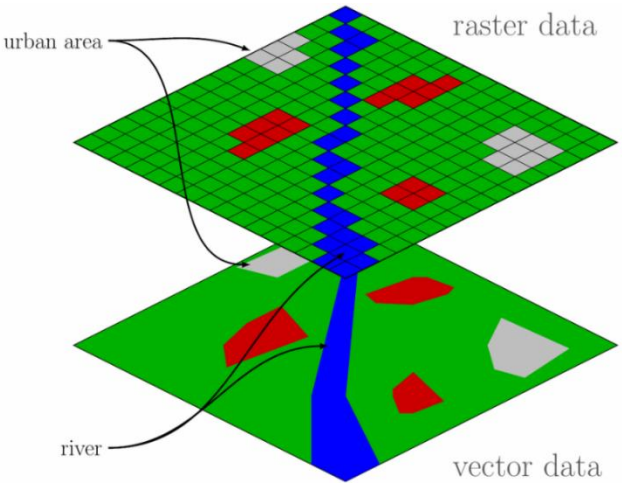
Vector and Raster data:

Some useful examples on how we can model a river, a mark on the map or an area using vector and raster data structures!



Vector data (Lines, Points, Polygons)

Raster data (as Lines, Points, Polygons)



An example

Support Material for Vector and Raster data: https://gisgeography.com/spatial-data-types-vector-raster/

WHY THIS IS IMPORTANT?

In order to understand spatial data structures, models' data inputs, data volume, spatial resolution, scale and other relevant terms and definitions.

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Explanation about raster data and satellite images:

https://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/what-is-raster-data.htm

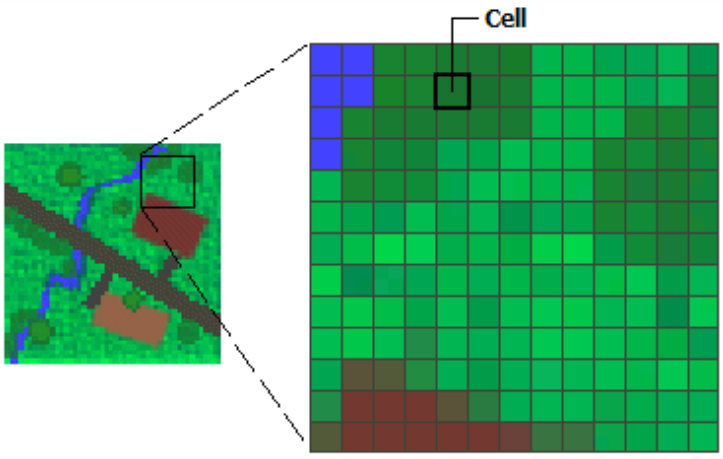

Figure 4: Indicative example of a raster dataset (i.e satellite image) expressed as a grid of multiple cells with different (or the same) pixel/cell values, for example, light pollution

How do we manage and process this type of data?

Using Geographic Information Systems (GIS) and specific GIS-based applications and platforms!

GIS definitions: https://www.esri.com/en-us/what-is-gis/overview

GIS software and platforms (see QGIS):
https://en.wikipedia.org/wiki/List_of_geographic_information_systems_software

Students can work in groups of two where each member of the group is responsible for:

1) Data collection (maps, spatial data etc.) and reporting
2) Data interpretation and analysis

Before we begin, students have to download and install QGIS platform!

QGIS Platform Download (version 3.18.1, file QGIS-OSGeo4W-3.18.1-1-Setup-x86.exe)

https://download.qgis.org/downloads/windows/3/3.18/

Download Light Pollution data

https://www.lightpollutionmap.info/#zoom=8.15&lat=38.2410&lon=23.9360&layers=B0FFFFFFFFFTFFFFFFFF

The selected resource (e.g., a simulation, an experiment, an animation, a graph, or other exhibit of similar nature) must provide students with an opportunity to collect evidence addressing the scientific questions presented in previous stages through direct or indirect observation.

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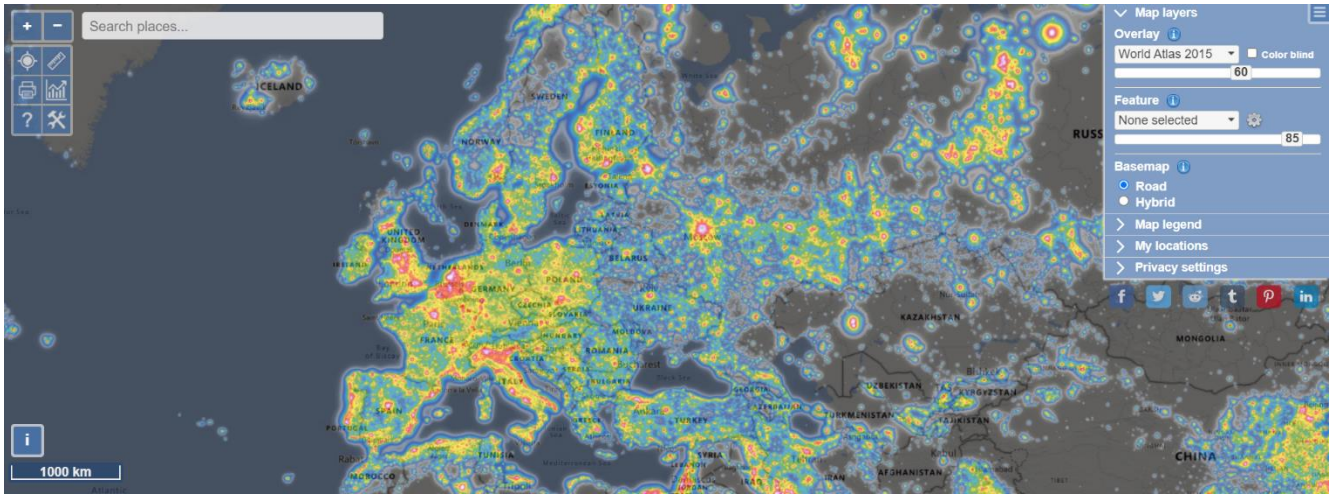
1. Light Pollution Map – Download Data

The first step of the activity is to navigate on an online light pollution mapping Web-GIS platform and download data (raster data). To succeed this, visit the following link:

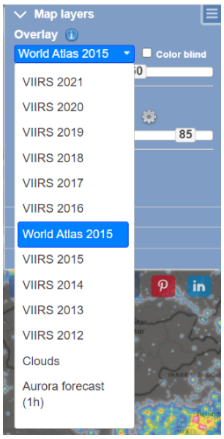
Light Pollution Web-GIS platform

You can see the platform's interface below!



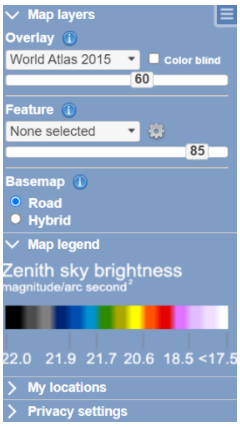
In the platform you can see the light pollution levels at global scale. In particular, you see the **radiance levels at night**, as seen from the satellites.

On the right corner you may select different light pollution maps per year (i.e. from 2012 - 2021), you can change the basemap layer, change the transparency level, see the map legend or even to save different locations around the world.



Select year based on the VIIRS satellite mission data

See map's legend, change basemap or select point features with actual measurements.



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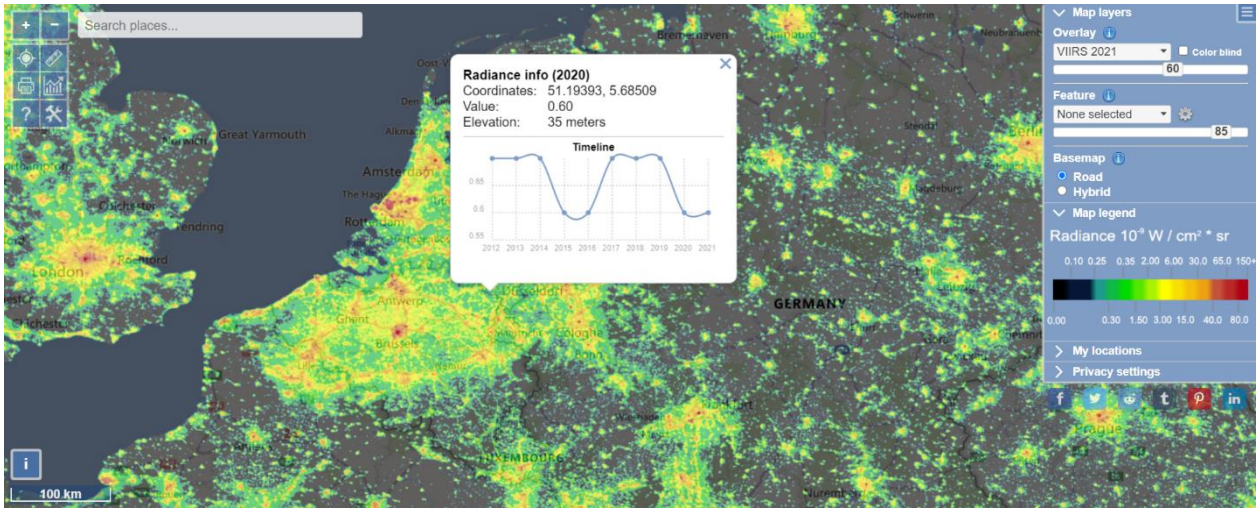
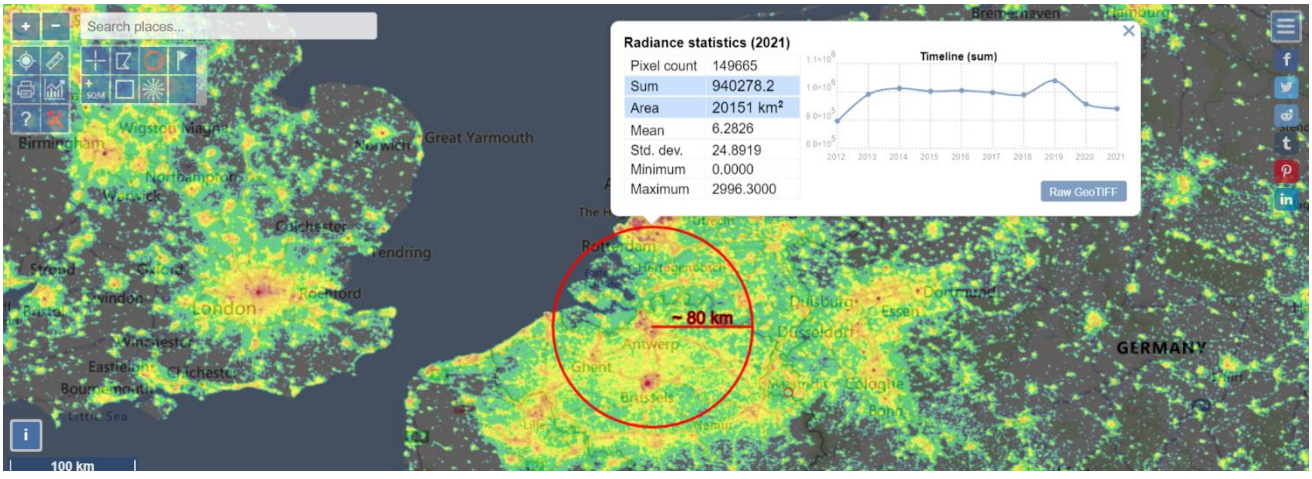
While you select one of the VIIRS mission rasters (maps), you can zoom in wherever you want and you can left-click a specific area (pixel). Then a graph appears showing the temporal changes on Light Pollution levels from 2012 – 2021, the exact coordinates and the elevation as shown below.



In case you want to download data or see further information and statistics at a country level, you can use the toolbar on the left as shown below:

In order to download data, you select the tools icon (bottom right) and then you click on the circle to select a specific area based on the circle's radius as shown below:



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While you select the circle's radium you left click and a pop-up window appears with all descriptive characteristics for this area and the option to download the data in GeoTiff format (bottom right corner).

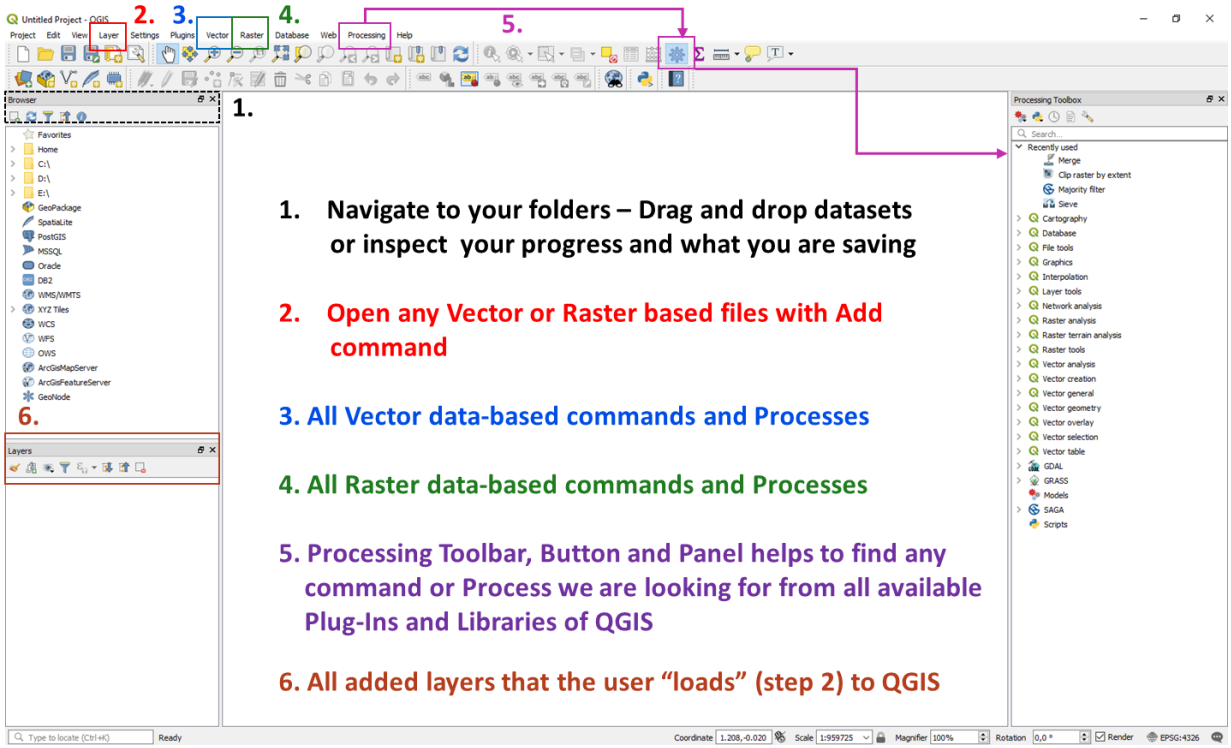
Repeat the above mentioned process for both the VIIRS 2014 AND VIIRS 2021 images using always the same circles center and radius.

NEXT STEP CONSISTS OF LOADING AND PROCESSING THE IMAGES IN QGIS PLATFORM!

2. QGIS Interface

Some technical guidelines considering the tools (QGIS Platform) we will use during this Activity!

Load data: In general, data can be loaded in four ways. The first way (see Figure below, selection 2) is to use the ***Layer > Add Layer menu*** and select the appropriate type of data you wish to load. The second way (Figure-selection 1) is to ***open the Browser panel, navigate to the data you wish to load, and then drag the data on to the map display***, or on to the Layers panel. The third way (Figure -selection 6) to load data is to ***enable the Manage Layers toolbar and click on the button representing the data type you wish to load***. The fourth way is to locate the data in ***QGIS Browser, drag to the data, and drop it onto the QGIS Desktop Map Display*** or Layers panel (Source: https://www.gislounge.com/loading-data-mastering-qgis/).



Step 1: Install the Plugins needed to run the activity (QuickMapServices)

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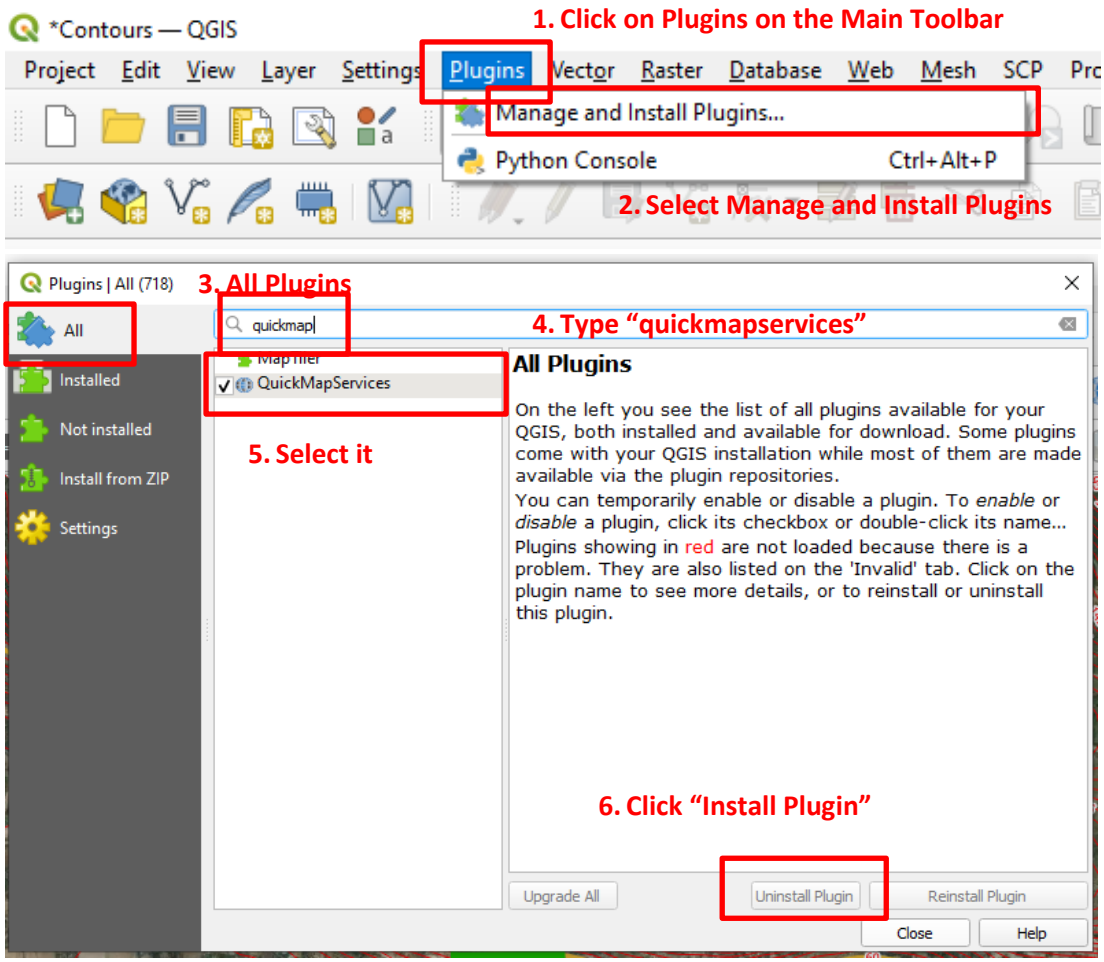
To begin using plugins, you need to know how to download, install and activate them (Figure 6). To do this, you will learn how to use the **Plugin Installer** and **Plugin Manager**. But what a Plugin is?

Plugins in QGIS add useful features to the software. Plugins are written by QGIS developers and other independent users who want to extend the core functionality of the software. These plugins are made available in QGIS for all the users (Source: QGIS Tutorials).



*You can load the Basemap using the Main Toolbar on top: **Web > quickMapServices > OSM > OSM Standard. The result is shown below!***

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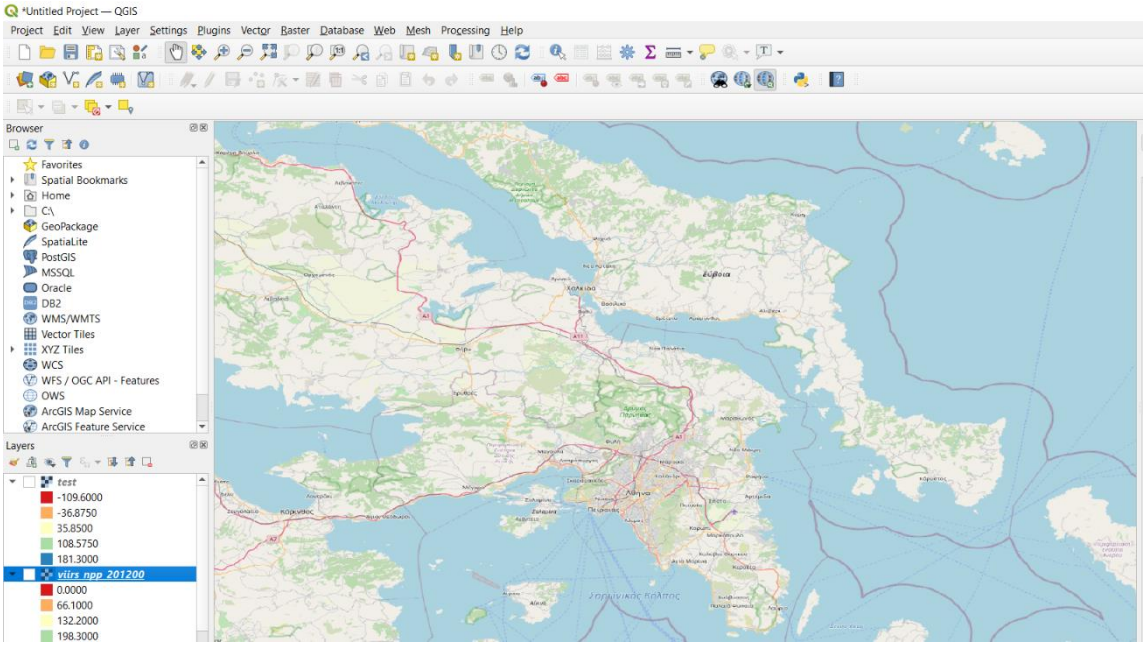
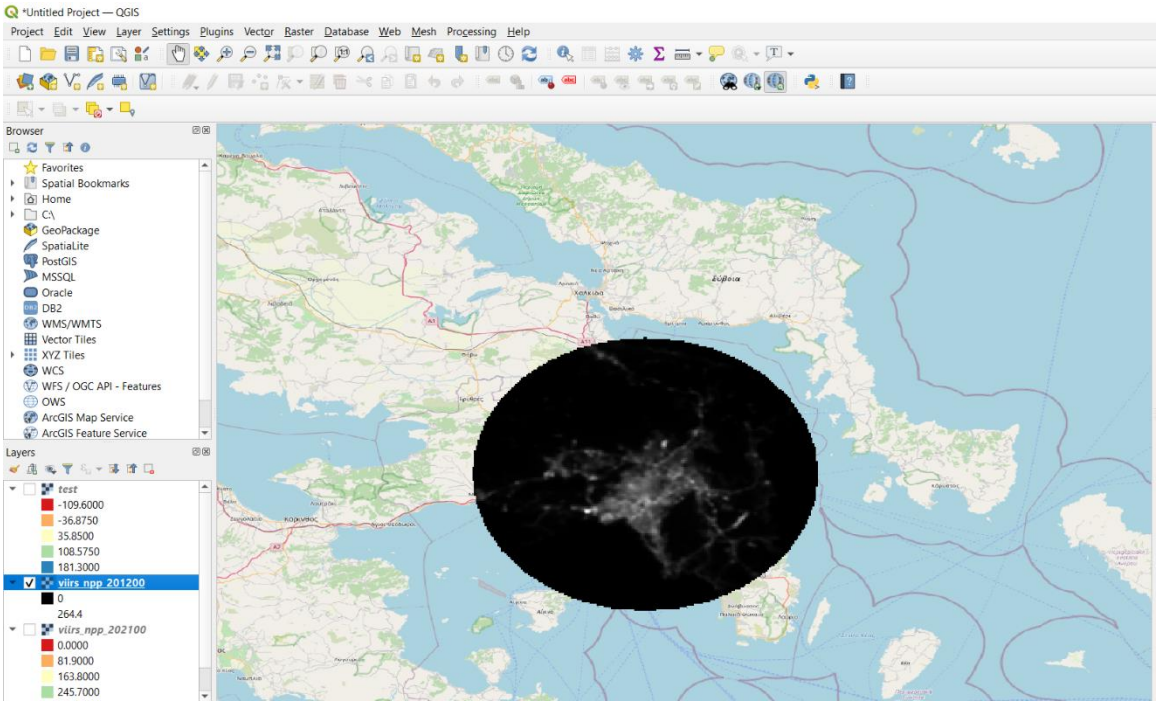


Step 2 - Based on the above-mentioned instructions you can start with:

1. *During the first step of the Activity, load the Light Pollution files you have downloaded (VIIRS 2012 and 2021) on the QGIS platform.*
2. *Use the Main toolbar (top of the screen) -> Layers -> Raster Layer -> Navigate to your folder and select* ***viirs_npp_201200.tif*** and ***viirs_npp_202100.tif***

The results on the map will look like this, having only black and white colors for both images:



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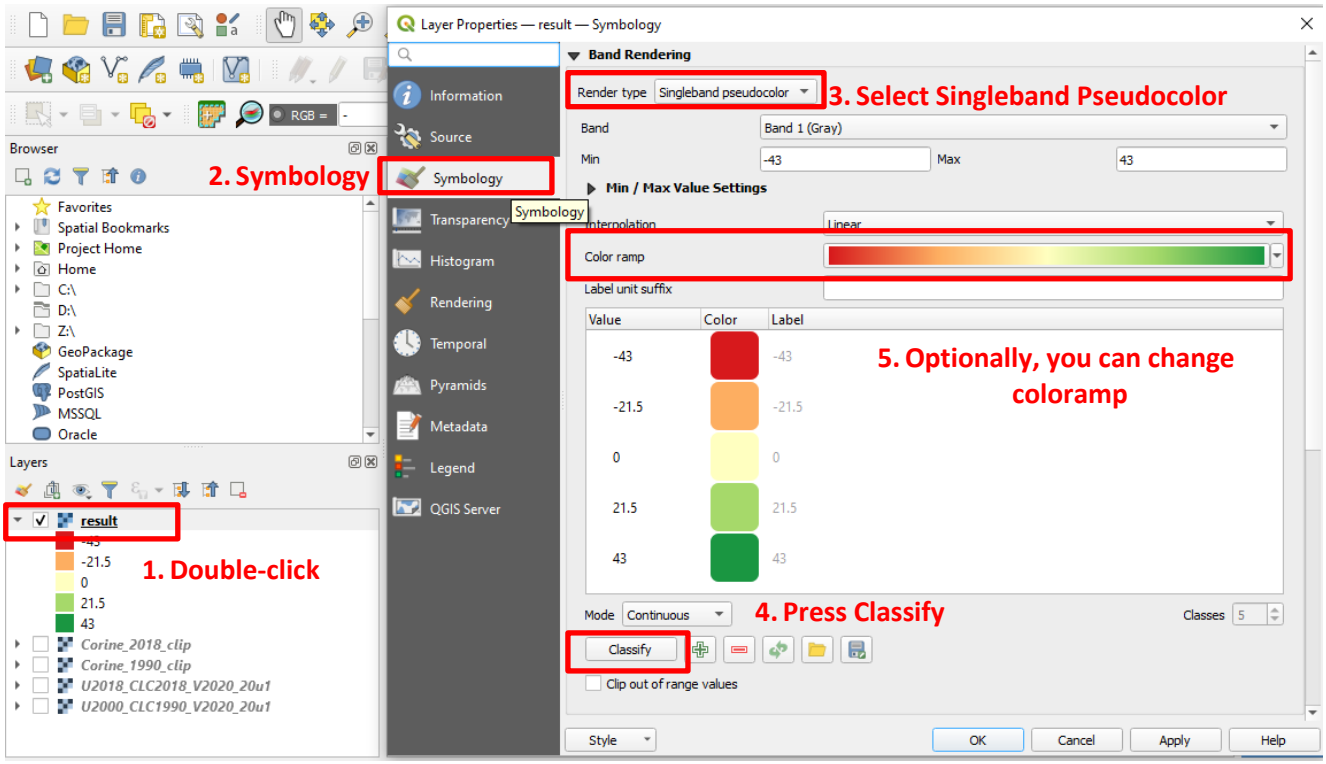
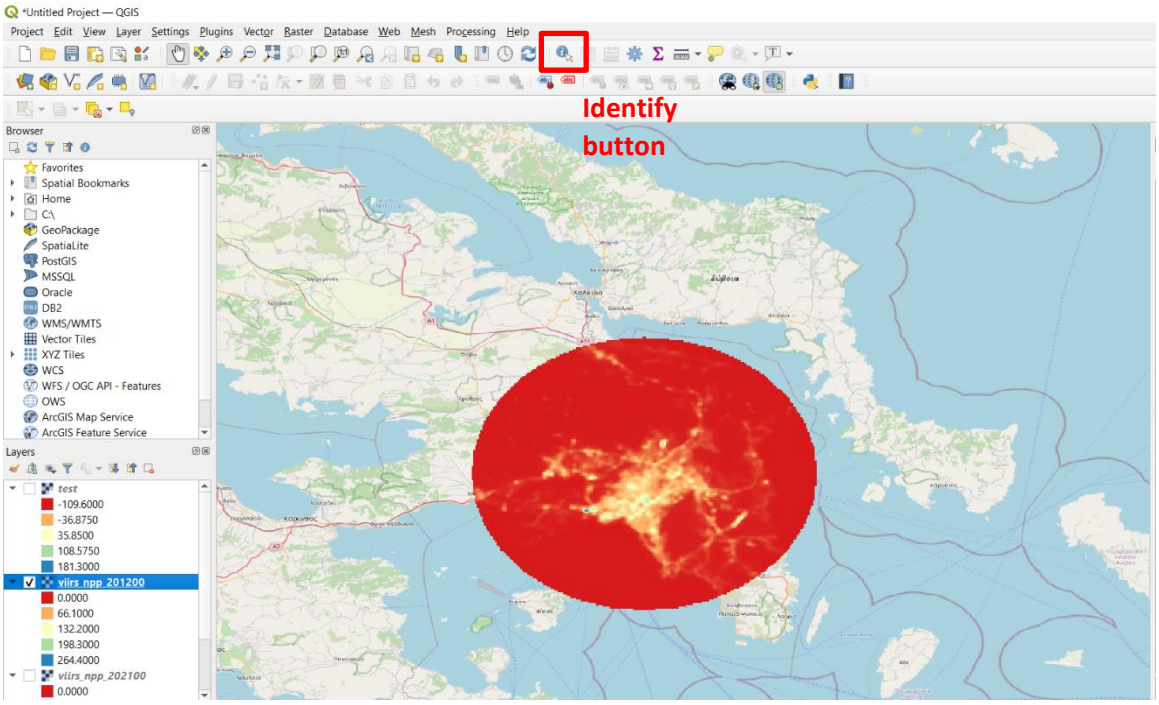
3. *Change layout colors using Layer Properties (double-click on the .tif image you have loaded)* ***-> Symbology -> Single-band Pseudocolor -> Classify****. See image below!*





4. *Identify areas of increased light pollution (blue and yellow colors) or the differences between 2012 and 2021 by checking and un-checking each map on the Layers panel. Alternatively, you can use the*

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identify button (see the image above) in order to extract the exact light pollution values (in terms of illumination levels).

BUT HOW WE QUANTIFY THE DIFFERENCES AND THE DIFFERENCES TO LIGHT POLLUTION LEVELS AMONG DIFFERENT YEARS???

Step 3 – Quantify changes of Light Pollution levels

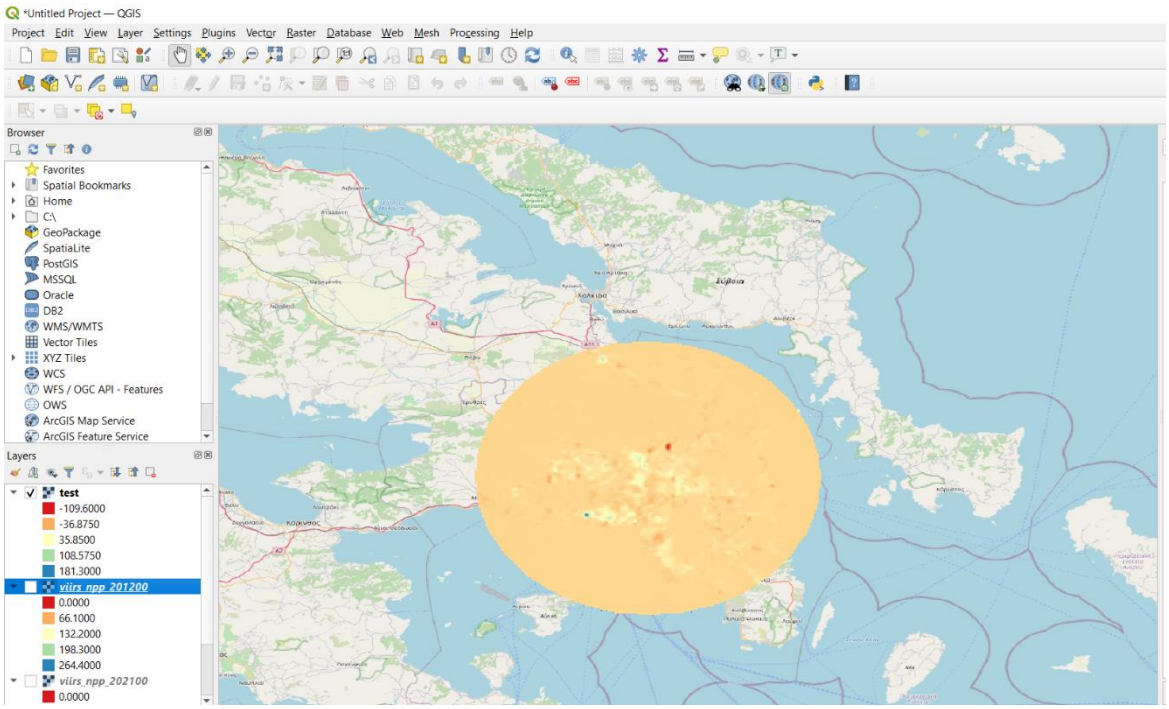
We have to simply compare each pixel's value from ***viirs_npp_201200.tif*** and ***viirs_npp_202100.tif*** and we have to do this for all pixels! To succeed that, we need a specific tool called ***"Raster Calculator".*** Using this tools we can run through different math operations and conditional statements between different rasters (images).

A simplified measure to compare pixels' values is by subtracting the pixel values of *viirs_npp_202100.tif* from *viirs_npp_201200.tif*!

Hence, open Raster Calculator via the main toolbar > Raster > Raster Calculator and type:

```
"viirs_npp_202100@1" - "viirs_npp_201200@1"
```

Save your file as 'Final' as you see below!



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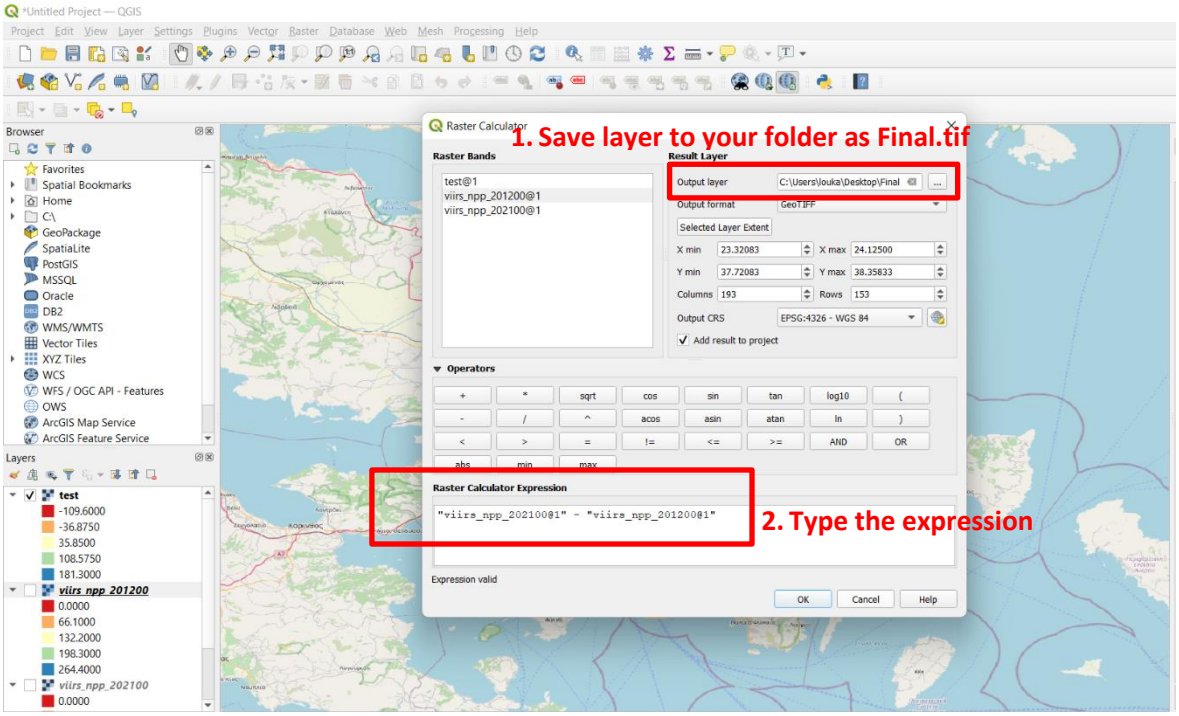

You can change the map colors as previously by selecting the properties of the Layer Final > Symbology > Single band pseudocolor. The results is shown on the last map.

Inspect your results, the colors and the min-max values!

References:

ESRI Overview: What is GIS

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