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Climate Action and Light Pollution Threat



Earth Observation & Light Pollution monitoring in your classroom

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Workshop outline

- ▶ Educational activity description
- ▶ General objectives
- ▶ Lesson Plan template
- ▶ Using digital tools to monitor Light Pollution
- ▶ Case Study
- ▶ Outcomes

Description



- ▶ Students will gain an understanding of **what light pollution is, how we map light pollution** and **how we can work with real data** in order to **identify changes in light pollution patterns.**
- ▶ How we are using satellite **data to map spatial – temporal patterns.**
- ▶ **What digital tools are needed** in order to analyze and visualize this type of data.
- ▶ **Students will also analyze and present their findings** using short reports or poster presentation in order to communicate their explanations.



GENERAL OBJECTIVES

- ▶ Describe what light pollution is along with the 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 light pollution patterns are changing.
- ▶ Use the scientific method and structures to analyze your data and validate your results.

QUESTION ELICITING ACTIVITY

Task 1: Introduction to Light Pollution (45 minutes)

1.1 Eliciting questions and Background Exploration (20 minutes)

Start by leading a brainstorm about how we use light in our daily lives.

Video: Light Pollution explained (1 min and 16 sec.)



QUESTION ELICITING ACTIVITY

1.2 Light pollution monitoring and mapping (20 minutes)

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

Video: Light Pollution mapping (2 mins and 25 sec.)

► Now let's use an online Geographic Information Systems platform to monitor light pollution at a global scale!

[Dark Site Finder](#)

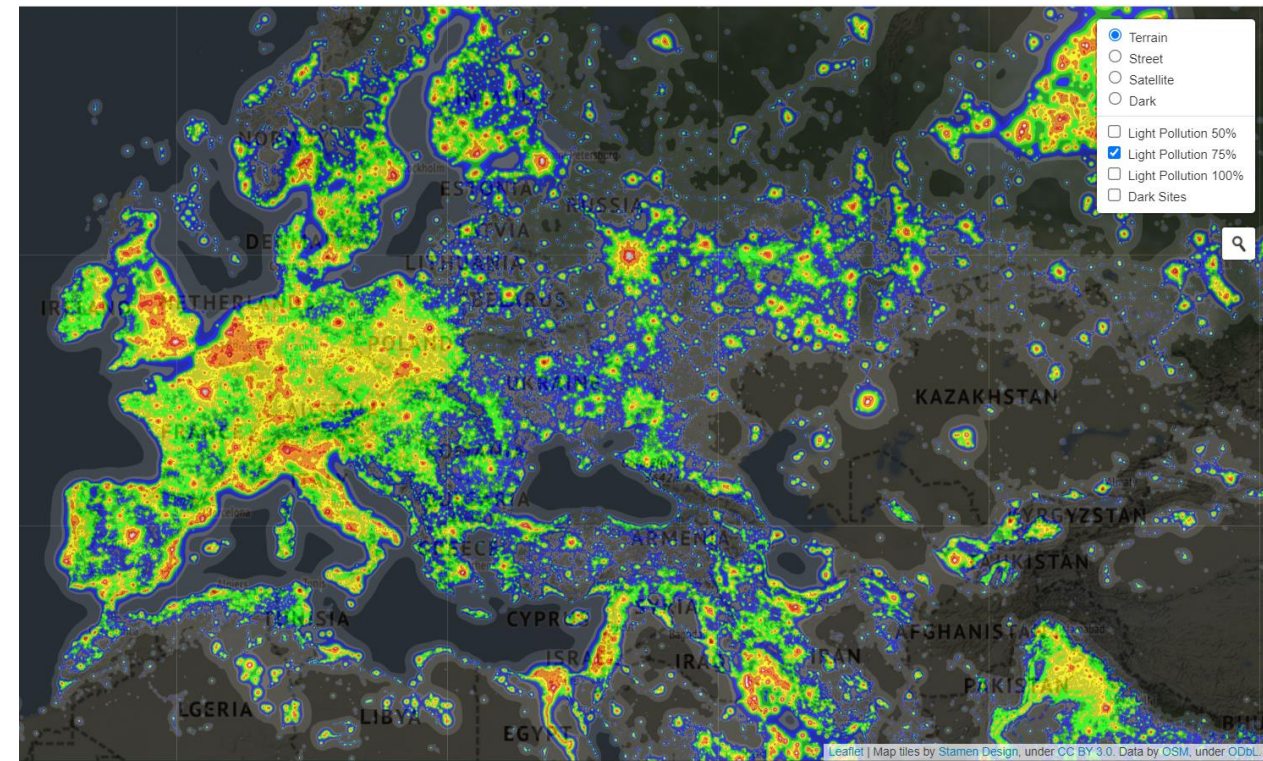


EXPLORE PREVIOUS KNOWLEDGE

- 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!



CASE STUDY

- 1.3 Light pollution in our area/city/region using real data and tools (45 minutes)
- Introduction (Video)
- How can we quantify these changes using real data?



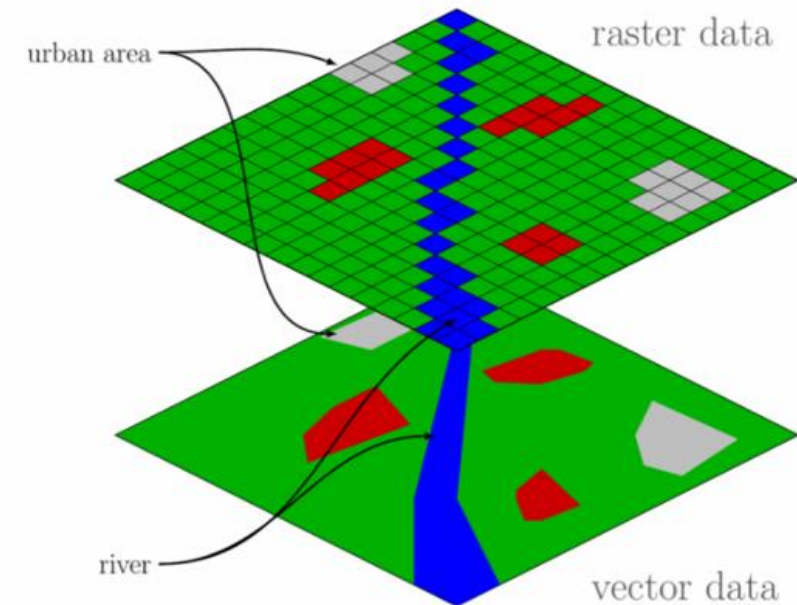
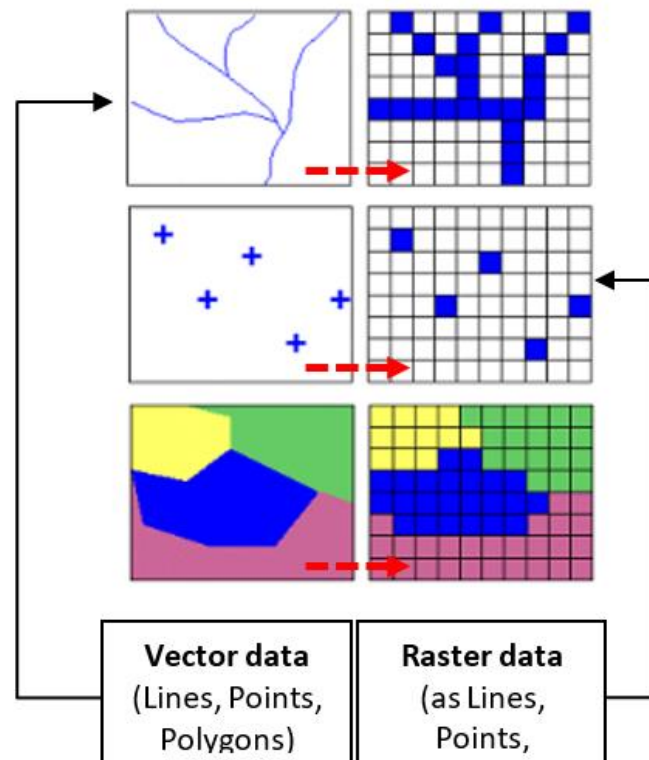
Case Study Background information



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 first about spatial data structures** (type of data and how spatial information is stored, data types etc.)

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!



An example

Case Study Background information



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 density

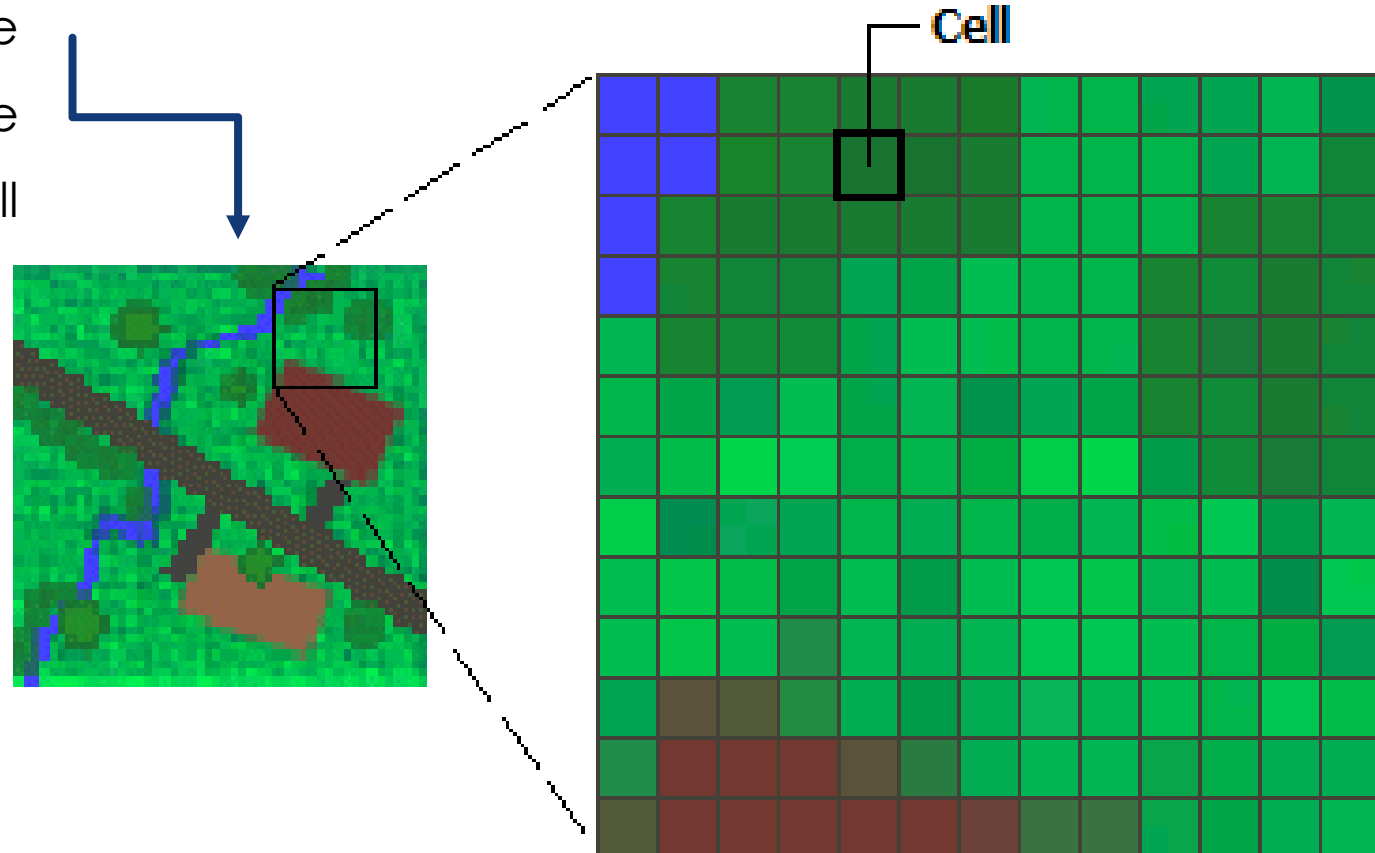
How do we manage and process this type of data?

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



Case Study- Download tools



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

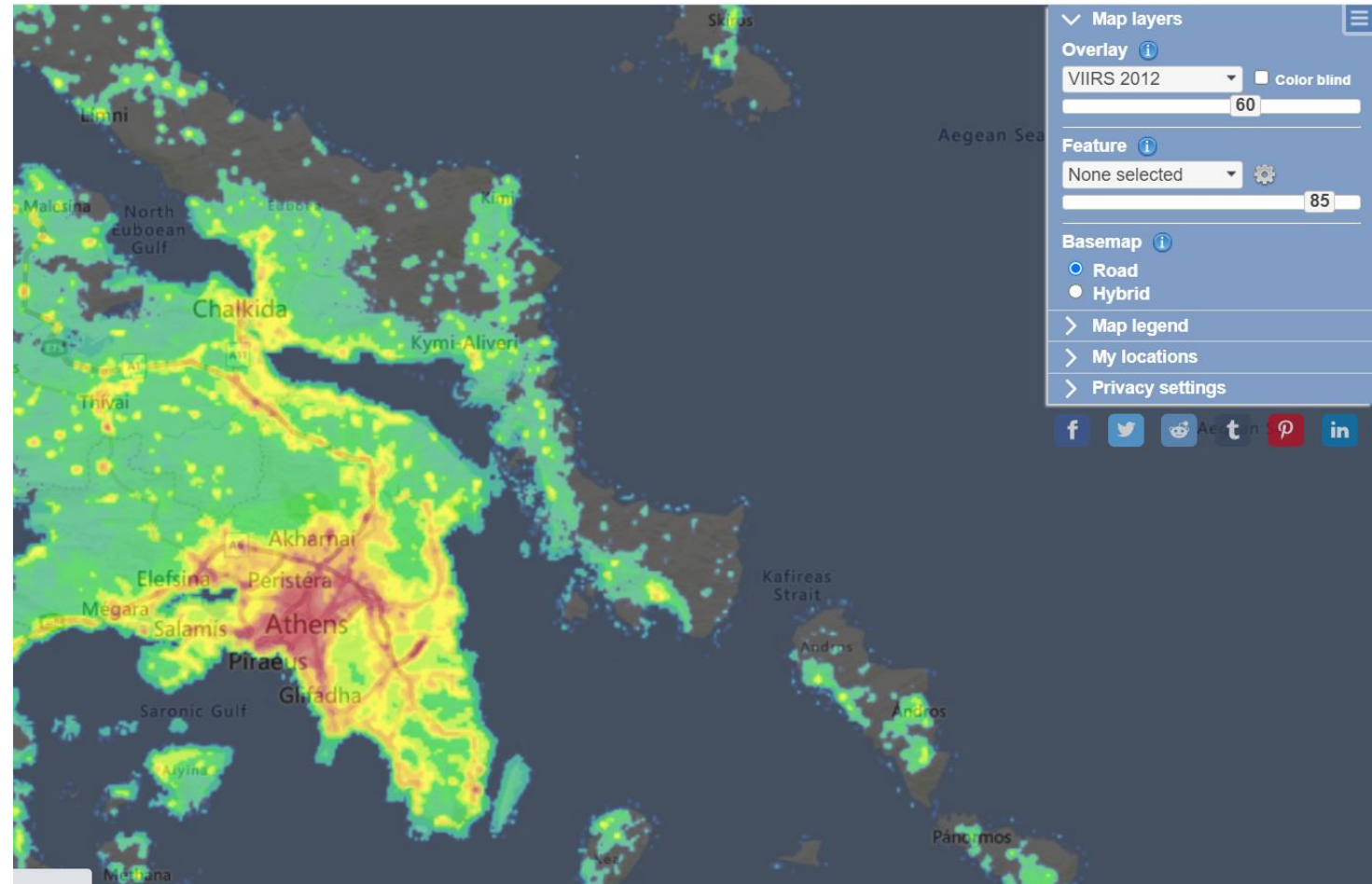
[QGIS Platform](#) Download (version 3.18.1)

Download [Light Pollution data](#)



What's the difference with the Dark Sky Finder app?

Now we can download spatial data (i.e. on each cell we know the light pollution impact and not a colour value)!



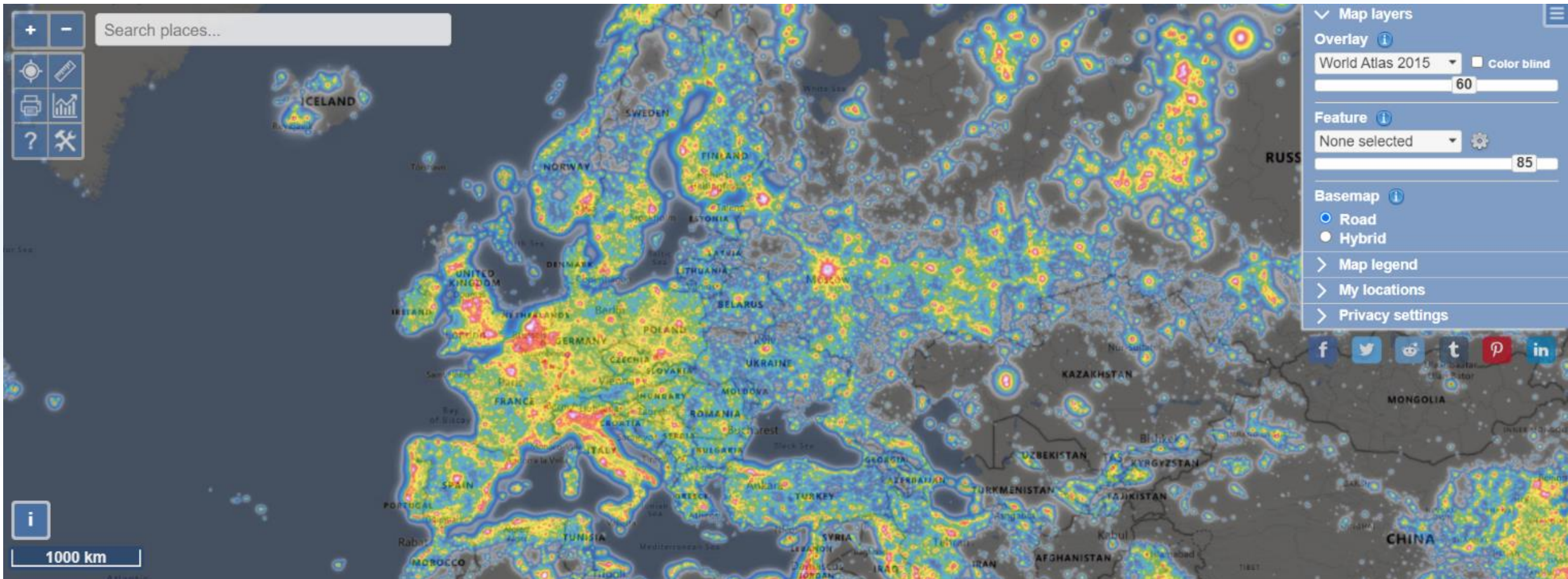
Case Study- Platform overview



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.

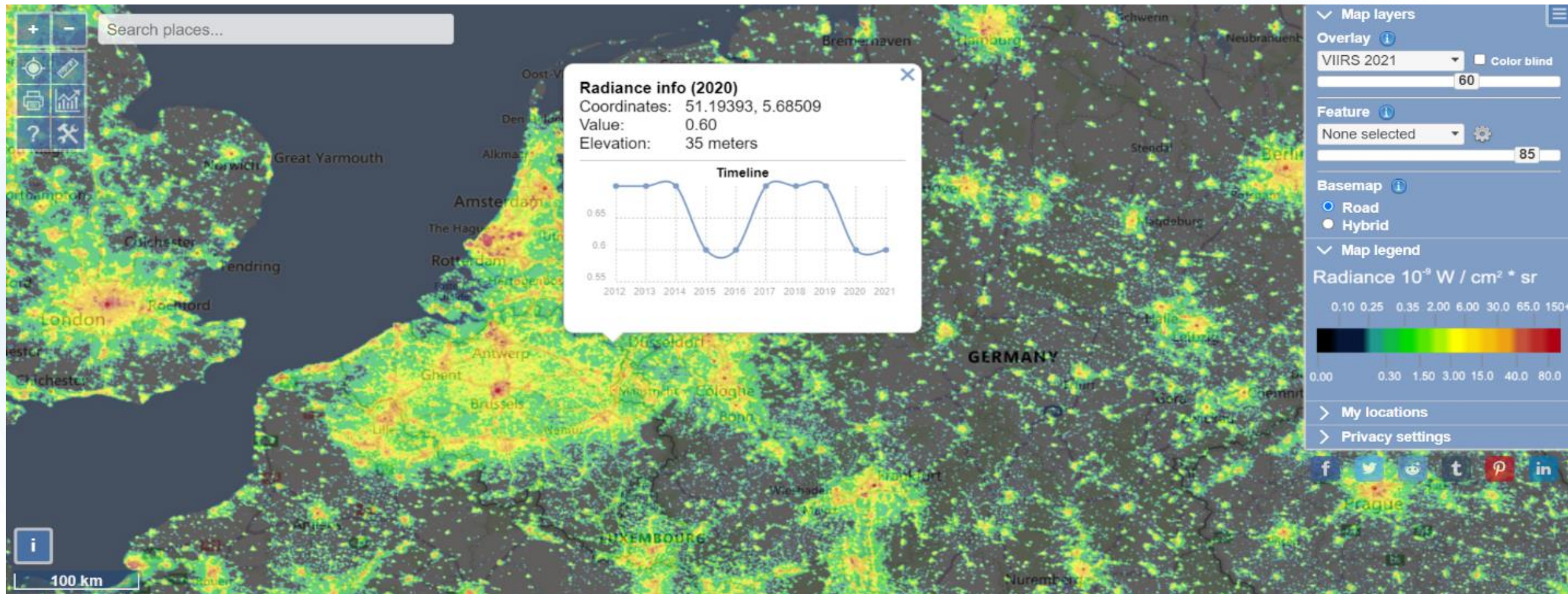
On the right corner you may select different light pollution maps per year (i.e. from 2012 - 2021), you can change the basemap layer, change the transparency level, see the map legend or even to save different locations around the world.



Case Study- Platform overview



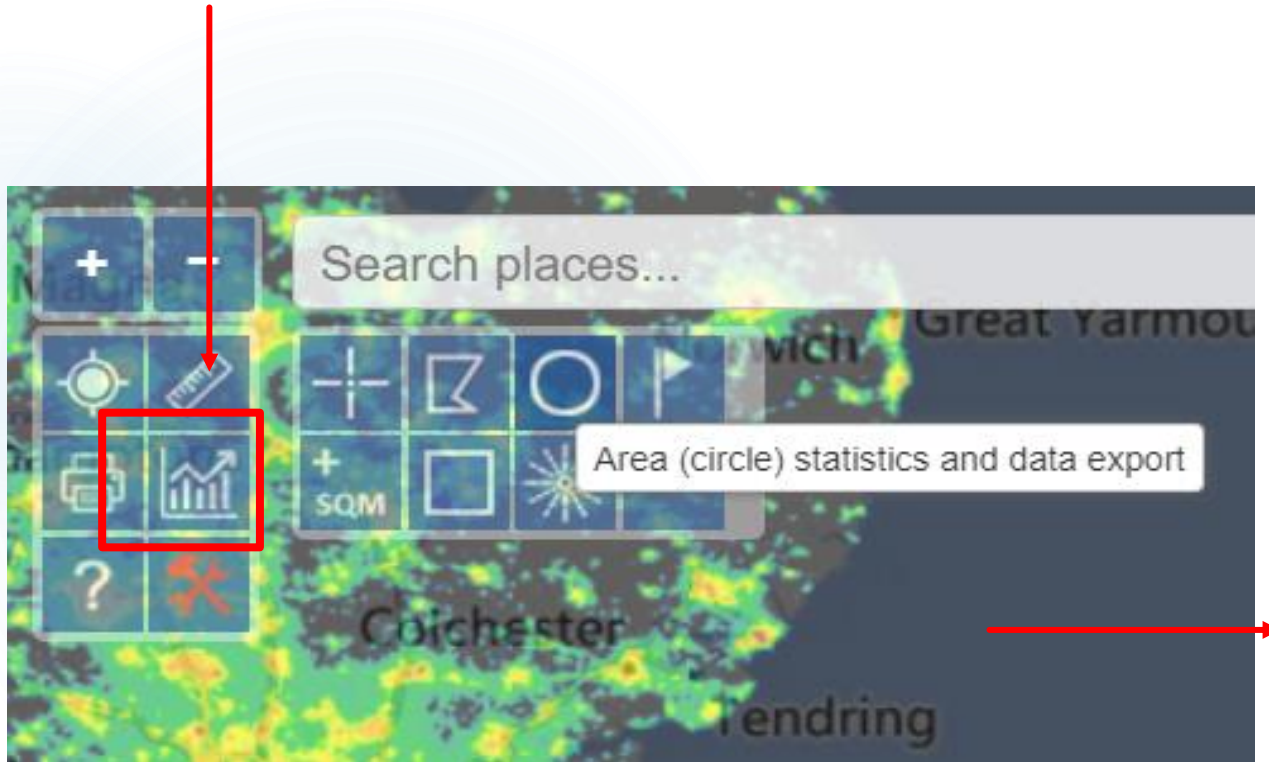
While you select one of the VIIRS mission rasters (maps), you can zoom in wherever you want and you can left-click a specific area (pixel). Then a graph appears showing the temporal changes on Light Pollution levels from 2012 – 2021, the exact coordinates and the elevation as shown below.



Case Study- Platform overview



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:



ALL COUNTRIES
 OECD
 EEA +UK +CH
 G20

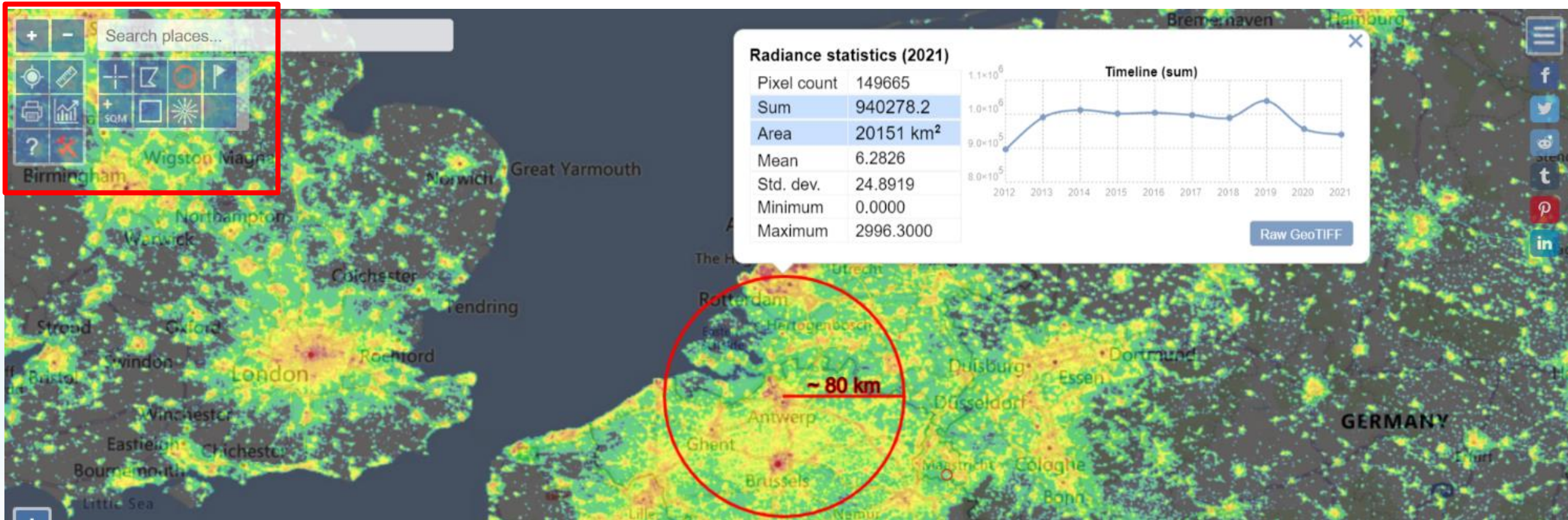
Country ▾	Population	Area (sq. km)	Avg. Sum	Trend	Rad./1k pop	Avg. Mean
Austria	8,869,537	83,859.51	253,137	+0.30 %	28.5	0.649
Belgium	11,473,875	30,790.18	678,162	-0.15 %	59.1	4.740
Canada *	37,553,100	10,133,038.69	2,595,954	-1.78 %	69.1	0.225
Denmark *	5,811,413	48,270.28	156,676	+1.17 %	27.0	0.698
France	67,009,000	554,494.12	3,508,310	-3.15 %	52.4	1.361
Germany	83,019,200	360,625.87	1,880,617	-0.27 %	22.7	1.122
Greece	10,741,165	144,280.45	763,727	+0.14 %	71.1	1.139
Ireland	4,857,000	74,321.77	200,591	-2.55 %	41.3	0.581
Italy	60,359,546	307,441.81	4,541,647	-0.28 %	75.2	3.178
Luxembourg	613,894	2,581.40	43,896	+0.93 %	71.5	3.660
Netherlands	17,332,500	38,586.10	941,819	-1.09 %	54.3	5.251
Norway *	5,334,762	351,481.18	448,615	-0.06 %	84.1	0.490
Portugal	10,276,617	93,928.59	1,046,697	-1.85 %	101.9	2.397

Aurora may interfere in * countries. Read Help on how statistics are calculated.

Case Study- Platform overview



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:



While you select the circle's radius 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.

Case Study- QGIS Platform overview



1. **Navigate to your folders – Drag and drop datasets or inspect your progress and what you are saving**

2. **Open any Vector or Raster based files with Add command**

3. **All Vector data-based commands and Processes**

4. **All Raster data-based commands and Processes**

5. **Processing Toolbar, Button and Panel helps to find any command or Process we are looking for from all available Plug-Ins and Libraries of QGIS**

6. **All added layers that the user “loads” (step 2) to QGIS**

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.

Case Study- QGIS Platform overview



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

Click on Plugins on the Main Toolbar

Manage and Install Plugins...

Python Console Ctrl+Alt+P

Select Manage and Install Plugins

Plugins | All (718)

All Plugins

All

quickmap|

Type "quickmapservices"

MapTiler

QuickMapServices

Select it

All Plugins

On the left you see the list of all plugins available for your QGIS, both installed and available for download. Some plugins come with your QGIS installation while most of them are made available via the plugin repositories. You can temporarily enable or disable a plugin. To *enable* or *disable* a plugin, click its checkbox or double-click its name... Plugins showing in **red** are not loaded because there is a problem. They are also listed on the 'Invalid' tab. Click on the plugin name to see more details, or to reinstall or uninstall this plugin.

Click "Install Plugin"

Upgrade All Uninstall Plugin Reinstall Plugin Close Help

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

Untitled Project — QGIS

Project Edit View Layer Settings Plugins Vector Baster Database Web Mesh Processing Help

Browser

- Favorites
- Spatial Bookmarks
- Home
- CA
- GeoPackage
- SpatialLite
- PostGIS
- MSSQL
- Oracle
- DB2
- WMS/WMTS
- Vector Tiles
- XYZ Tiles
- WCS
- WFS / OGC API - Features
- OWS
- ArcGIS Map Service
- ArcGIS Feature Service

Layers

- test
- 109.6000
- 36.8750
- 35.8500
- 108.5750
- 181.3000
- vltms_npp_201200
- 0.0000
- 66.1000
- 132.2000
- 198.3000

Case Study- QGIS Platform overview

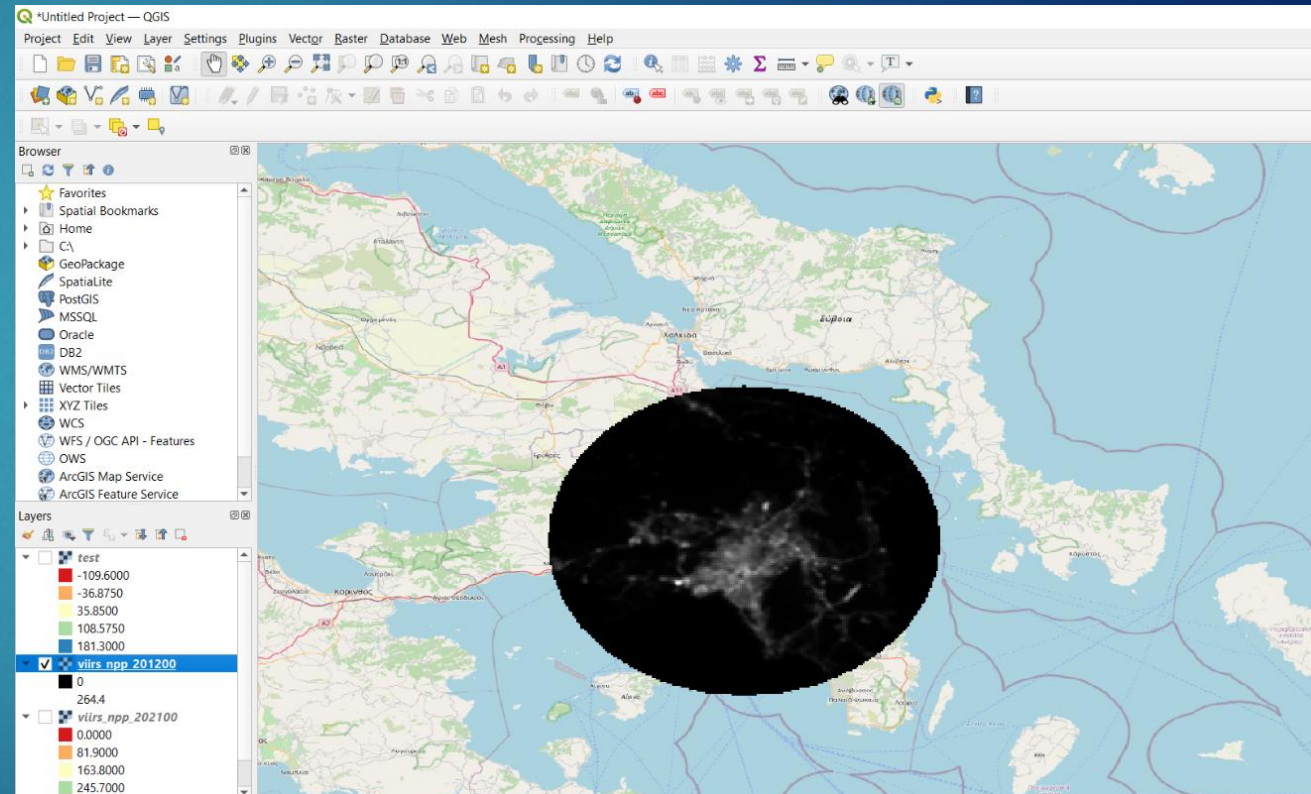


Step 2 - Based on the above-mentioned instructions you can start with:

During the first step of the Activity, load the Light Pollution files you have downloaded (VIIRS 2012 and 2021) on the QGIS platform.

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 colours for both images:



Case Study- QGIS Platform overview



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

The screenshot shows the QGIS Layer Properties dialog for a layer named 'result'. The 'Symbology' tab is active, and the 'Render type' is set to 'Singleband pseudocolor'. The 'Band' is 'Band 1 (Gray)'. The 'Min' value is -43 and the 'Max' value is 43. The 'Interpolation' is set to 'Linear'. A color ramp is displayed, ranging from red to green. The 'Classify' button is highlighted. The 'Layers' panel on the left shows the 'result' layer selected. The 'Symbology' panel on the right shows the 'Symbology' tab selected.

Select Singleband Pseudocolor

Double-click

Optionally, you can change colorramp

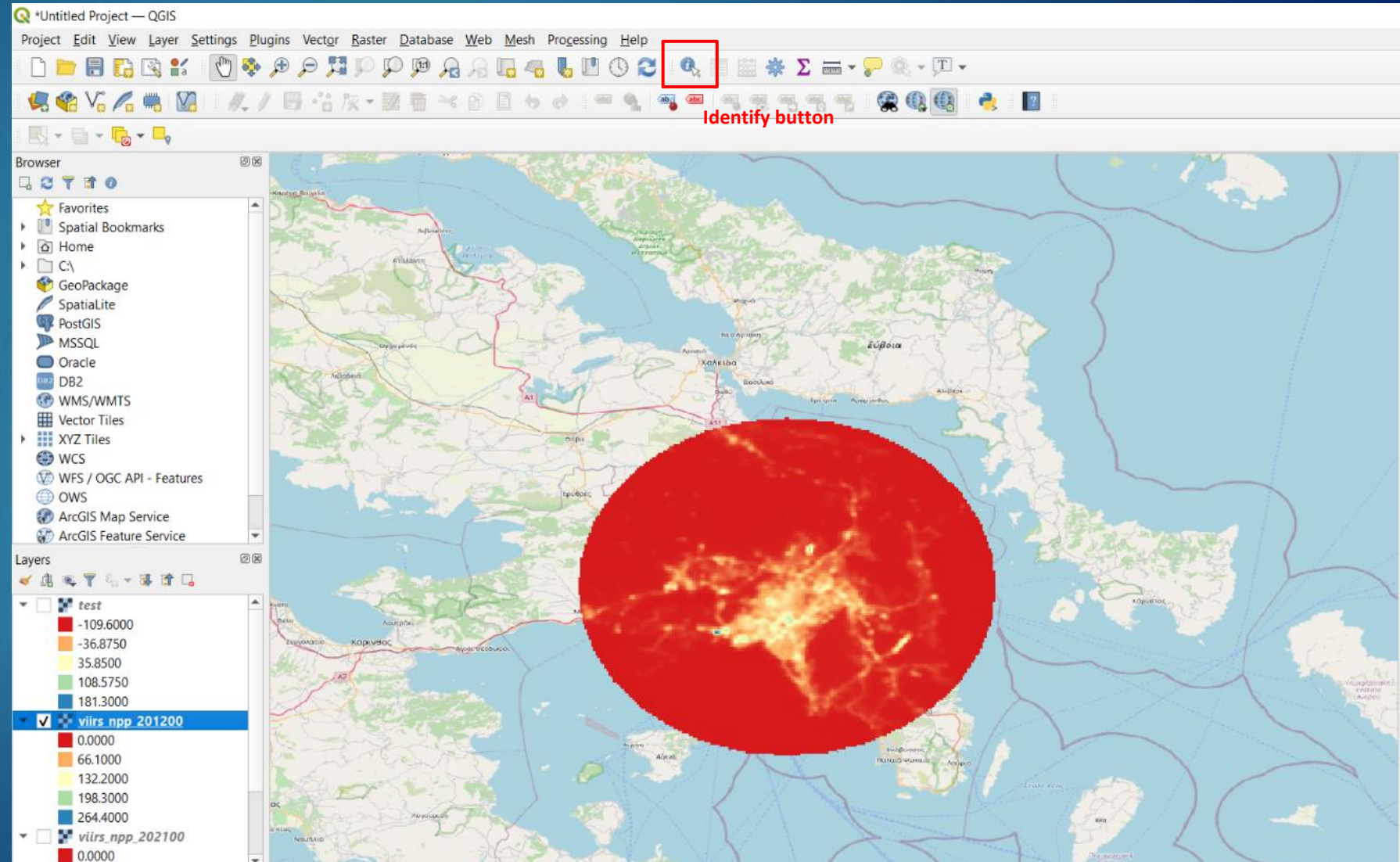
Press Classify

Value	Color	Label
-43	Red	-43
-21.5	Orange	-21.5
0	Yellow	0
21.5	Light Green	21.5
43	Dark Green	43

Case Study- QGIS Platform overview



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



Case Study- QGIS Platform overview



1992



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

Case Study- Quantify differences



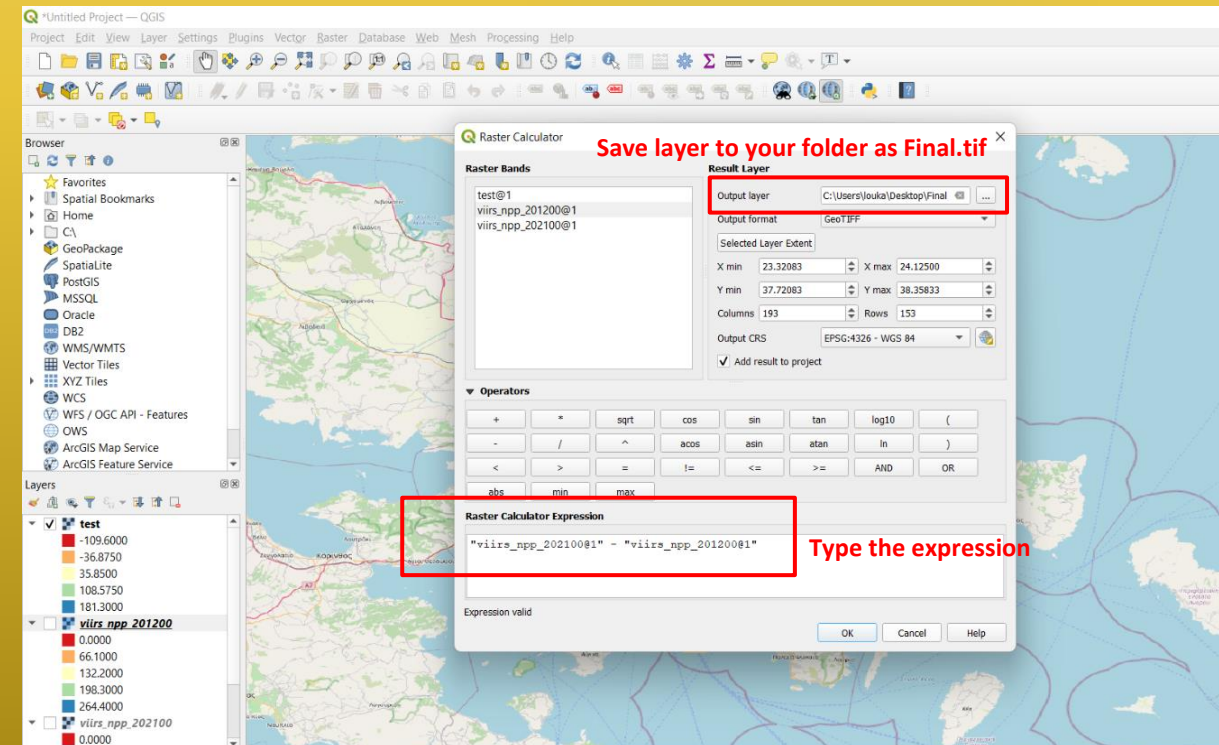
Step 3 – Quantify changes of Light Pollution levels

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).

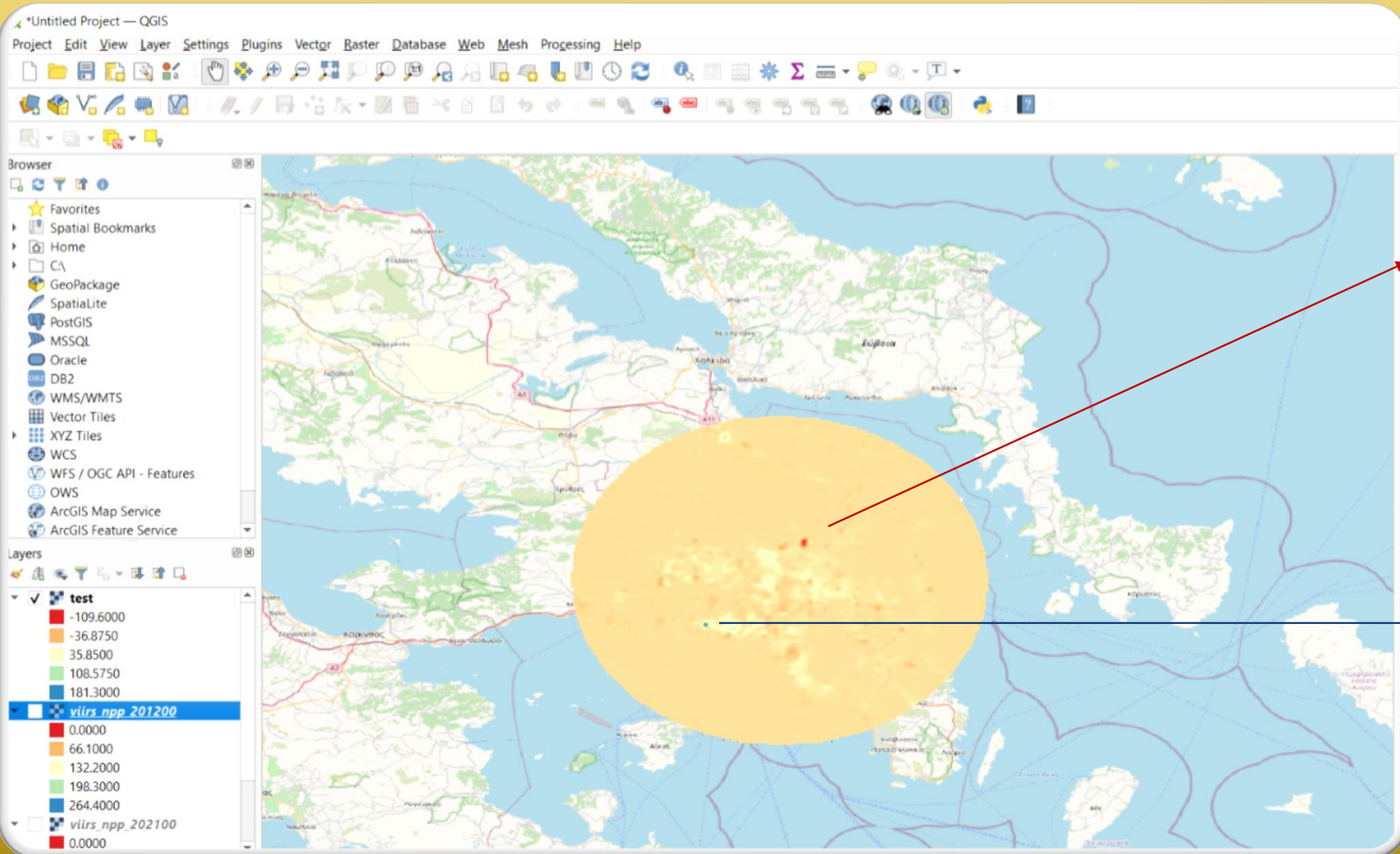
A simplified measure to compare pixels' values is by subtracting the pixel values of `viirs_npp_202100.tif` from `viirs_npp_201200.tif`!

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

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



Case Study- Map differences



Red areas indicate a reduction of light pollution levels between 2012 and 2021 (Athens airport – COVID-19)

Blue areas indicate that light pollution levels increased between 2012 and 2021 (Piraeus port and Cosco investments)


Results



Present your results and communicate your findings.

Create a scientific poster


DARK SKIES & LIGHT POLLUTION




Outdoor lighting uses 120 terawatt-hours of energy

=


10 million tons of oil






Unshielded lights waste about 30% of outdoor lighting

Equivalent to: \$3.3 billion or \$10 for every man, woman, and child in the U.S.



Waste from bad lighting releases as much CO₂ as:


3 million passenger cars



We would need to plant 875 million trees every year to offset the waste


Source: DarkSkies.org


Create a flyer or a leaflet to start a campaign



LIGHT POLLUTION: WHAT IS IT AND WHY IS IT IMPORTANT?

RAKIBUL SHOGIB and JAMIE SPINNEY
DEPARTMENT OF GEOGRAPHY
SOUTH DAKOTA STATE UNIVERSITY





WHAT IS IT?

Most people are familiar with air, water, and land pollution, but did you know that light can also be a pollutant?

The International Dark Sky Association (n.d.), an organization that combats light pollution worldwide, defines light pollution as...

The inappropriate or excessive use of artificial light – known as light pollution – can have serious environmental consequences for humans, wildlife, and our climate.

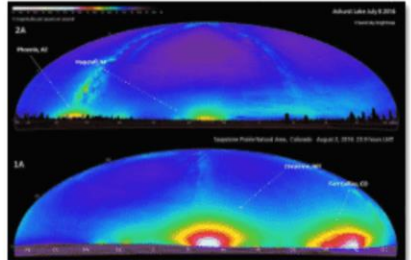

TYPES OF LIGHT POLLUTION

Urban Sky Glow - the brightening of the night sky over inhabited areas.

Light Trespass - light falling where it is not intended, wanted, or needed.

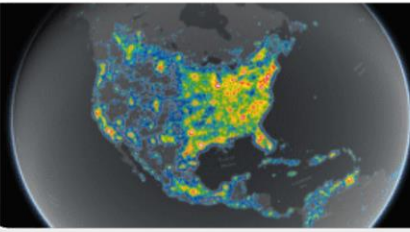
Glare - excessive brightness causes visual discomfort and high levels of glare can decrease visibility.

Clutter - bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas. The proliferation of clutter contributes to urban sky glow, trespass, and glare.

WHY IS IT IMPORTANT?

The Milky Way is hidden from a third of all humans



Scientific evidence suggests that light pollution:

- Interferes with normal circadian rhythms and, thus, negatively impacts human health and immune function;
- Adversely impacts behavior in insects and animals;
- Decreases quality and safety of nighttime environments;
- Wastes energy, which is expensive and it also contributes to climate change; and,
- Obscures our view of the wondrous night sky.

CONCLUSION

Light pollution affects every citizen. Light during darkness is a potentially threat to our environment, wildlife, human health, and other organism as well. Each of us can implement practical solutions to help combat light pollution locally, nationally, and internationally.

REFERENCES

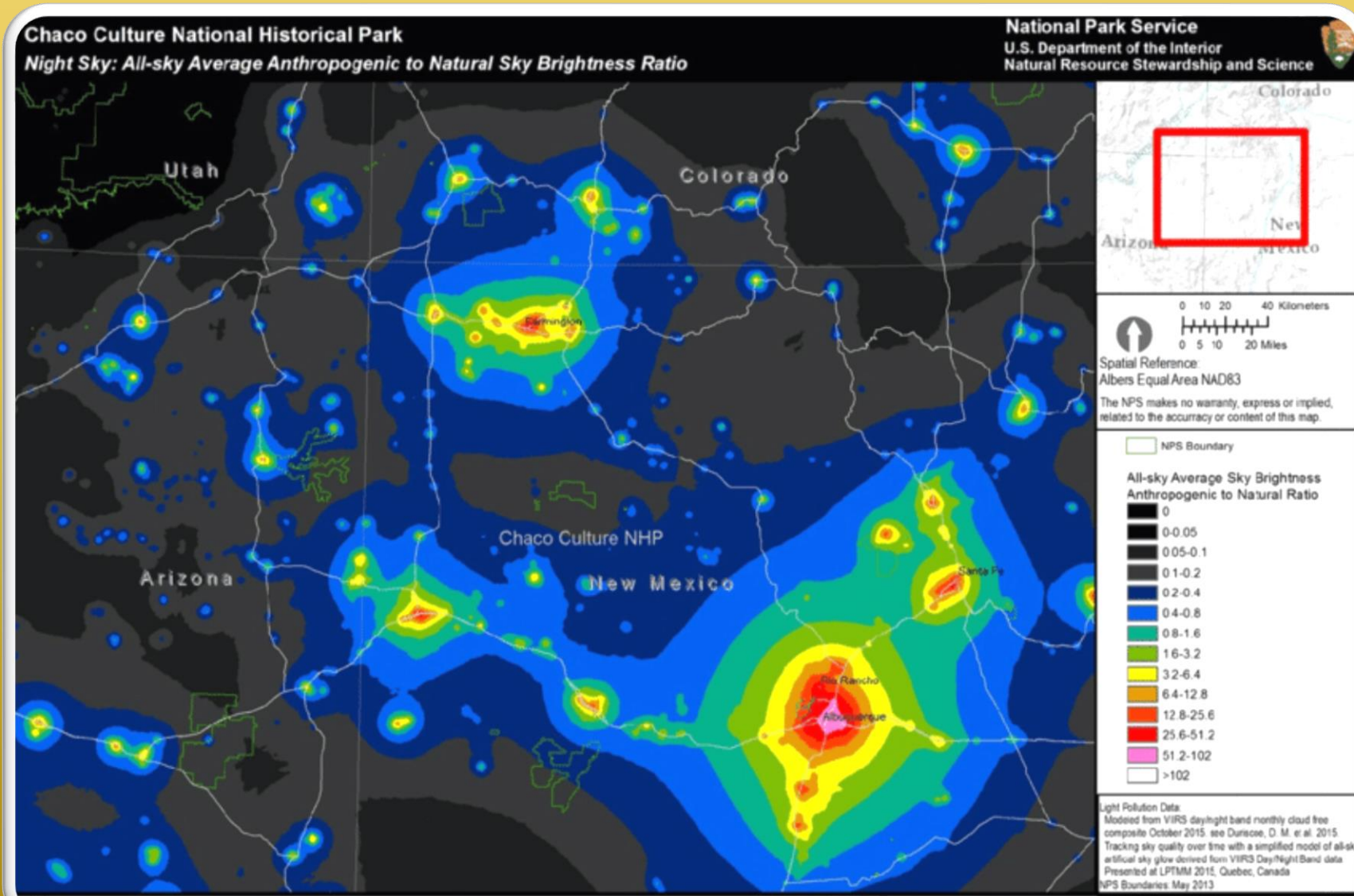
Cherpejak, R. (2009). Missing the Dark: Health Effects of Light Pollution. *Environmental Health Perspectives*, 117(11), A20-A27.

International Dark Sky Association. The natural night sky is our universal heritage. Retrieved from <http://www.darksky.org/> on March 12, 2018.

Results (2)



Present your results and communicate your findings.



Create a map (or set of maps) demonstrating light pollution differences in different areas and timescales.



Thank you!

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