



Project number:

2021-1-IE01-KA220-SCH-
000027825

Earth Observation & Light Pollution

Age: 12-14

Topics: Light Pollution, Understanding, Mapping, Satellite Data, Spatial-Temporal Patterns, Data Analysis, Visualization, Digital Tools, Student Learning, Q-GIS Introduction.

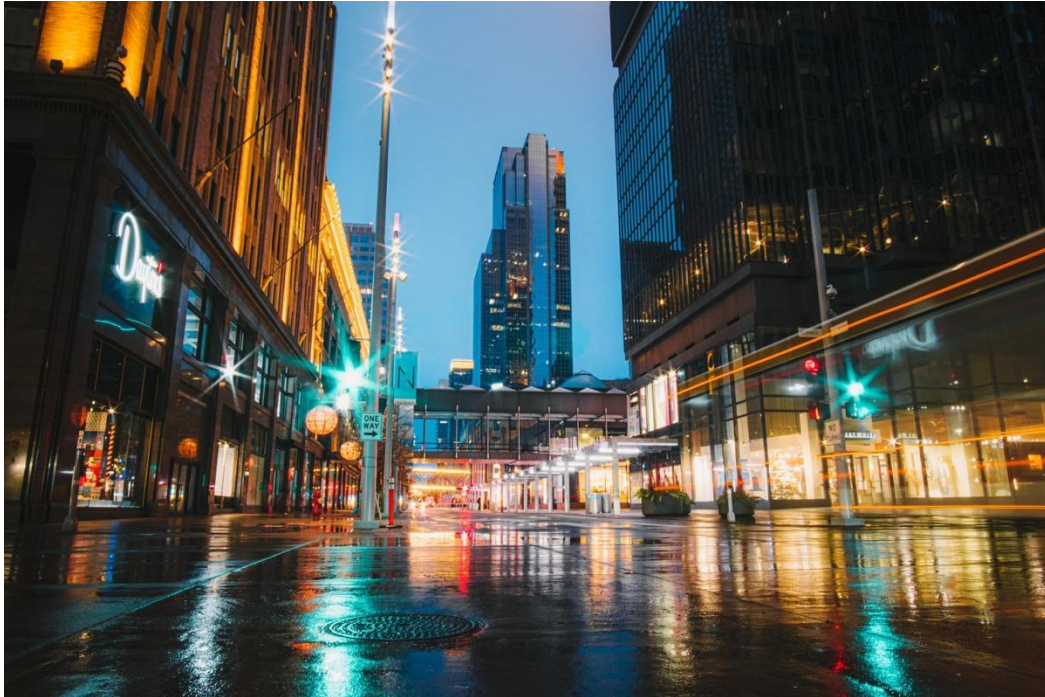
Resources: Dr. Loukas Katikas (EA)

Authors: Dr. Seda Özdemir-Fritz, Dr. Lothar Kurtze
(FTP-Europlanet)

Understanding of Light pollution, observation and detection methods by using digital mapping strategy

OBJECTIVES

- Define and Explain Light Pollution
- Identify Various Types of Light Pollution
- Recognize Sources of Light Pollution
- Describe Impact of Light Pollution on Night Sky Visibility
- Conduct Experiment on Changing Light Pollution Patterns
- Apply Scientific Method to Data Collection and Analysis
- Utilize Structured Approach to Validate Results



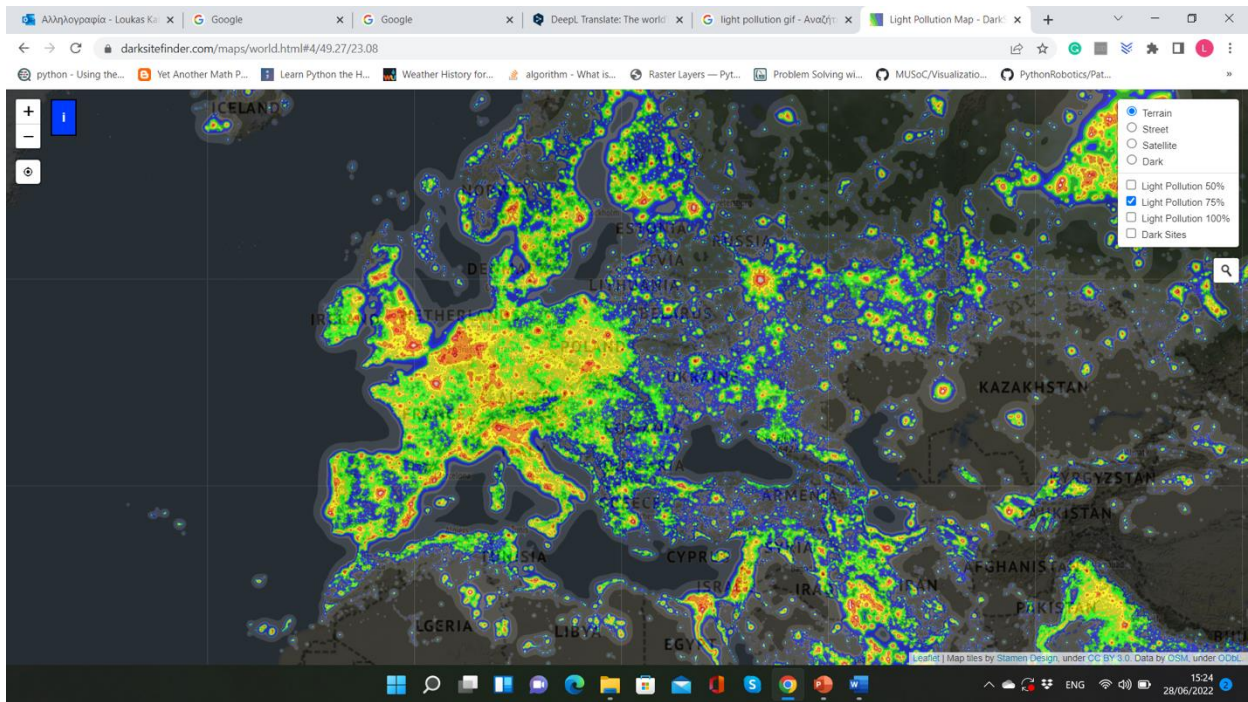
1.Pre-ACTIVITY: Introduction to Light Pollution (45 minutes)

Presenting Questions and Background Exploration (20 minutes):

- Begin with a brainstorm session to explore how light is used in daily life.
- Initiate a discussion on the various ways we rely on light.
- Show a concise 1m. video *explaining light pollution*.

Light Pollution Monitoring and Mapping (20 minutes):

- Pose the question: Can we see Light Pollution from space? Discuss possibilities.
- Present a video (2 mins) about Light Pollution mapping.
- Introduce the online Geographic Information Systems (GIS) platform - Dark Site Finder (<https://darksitefinder.com/maps/world.html#7/40.591/22.634>).
- Guide students to navigate the map and identify areas with high light pollution.
- Engage in discussions about correlations between light pollution and human activity.



⇒ Note to Teachers:

- The map is authentic but slightly enhanced for clarity.
- Prepare for the next step - Working with real data and digital tools!

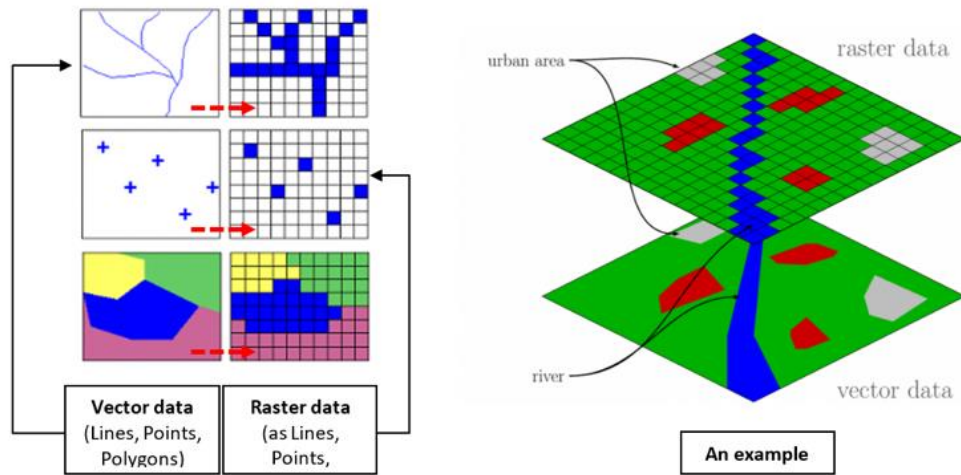
2. Activity: Exploring Light Pollution Patterns Using Real Data and Tools

2.1 Introduction and Data Quantification (Video):

- Start with a brief video introduction.
- Explore how we can measure changes in light pollution using real data.
- Provide a case study background to contextualise the activity.

2.2 Understanding Spatial Data Structures and Modelling:

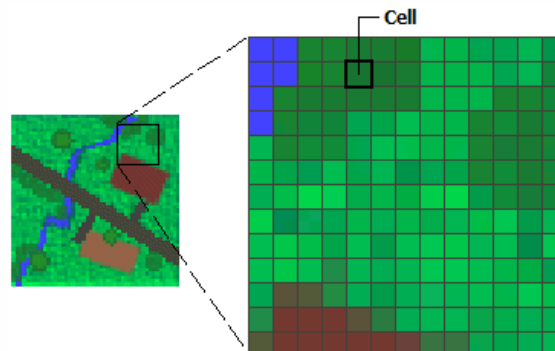
- *Discuss spatial data structures* and their significance.
- *Introduce raster datasets* with an example, like a satellite image depicting light pollution density.
- Define the difference between Vector and Raster Data set (i.e. satellite image) by using the examples e.g. river marks



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

2.3 Managing and Processing Data with GIS:

- Explain the role of Geographic Information Systems (GIS).
- Provide definitions and references for GIS concepts.
- Introducing QGIS software as a tool for analysis.

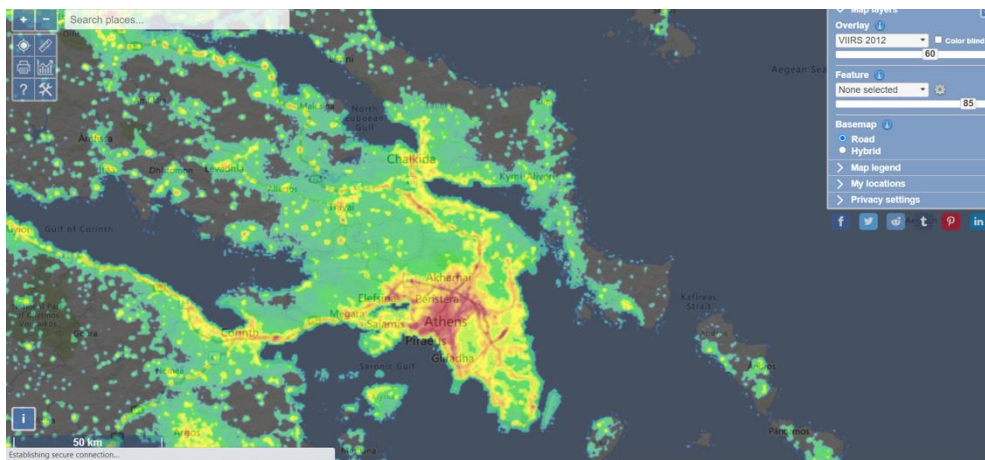


2.4 Case Study Setup - Data Download and Tool Installation:

- Guide students to download QGIS version 3.18.1. (<https://qgis.org/downloads/>)



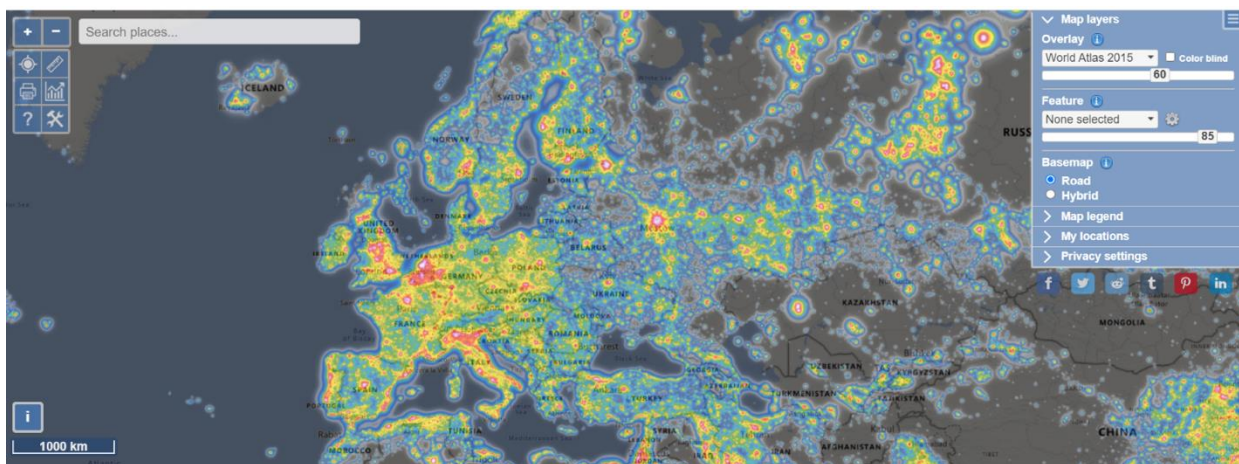
- Instruct students to download light pollution data.
 (<https://www.lightpollutionmap.info/#zoom=8.15&lat=38.2410&lon=23.9360&layers=B0FFFFFFFFFTTTTTTTTT>)



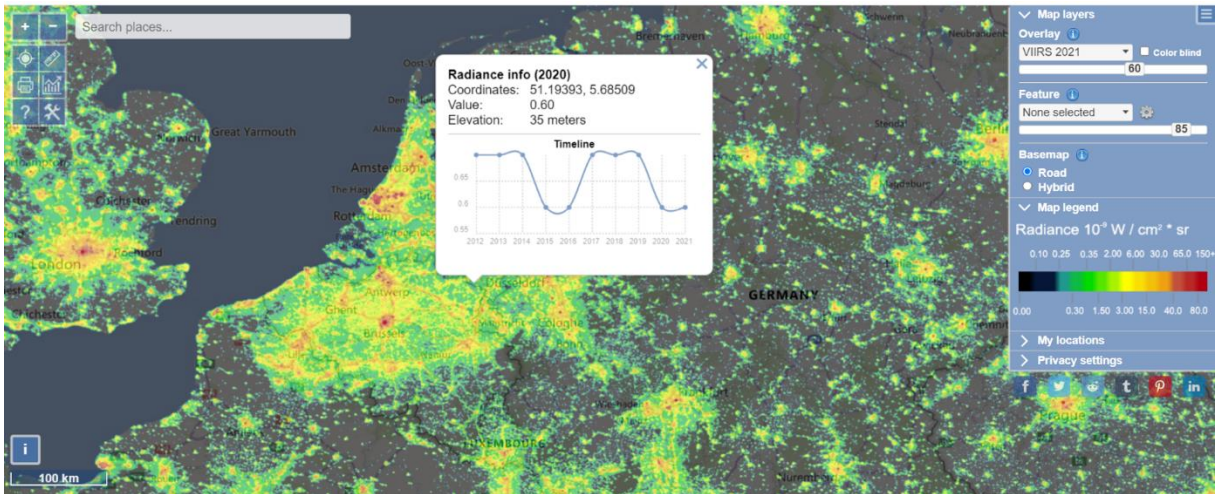
- Highlight the difference between data sources, like the Dark Sky Finder app.

2.5 Exploring the Platform: Light Pollution Mapping (www.lighpollutionmapping.info):

- Give an overview of the platform's capabilities.
- Demonstrate accessing global light pollution levels.
- Explain how to customize views (year, basemap, transparency, etc.).



- Show how to select specific areas and view temporal changes.
- Example: Display the graph of light pollution levels from 2012 to 2021.



2.6 Data Download and Analysis:

- Describe how to access detailed statistics and country-level data (click the statistics sign in the toolbar-shown with red rectangle).
- Instruct on downloading data for analysis (GeoTiff format).



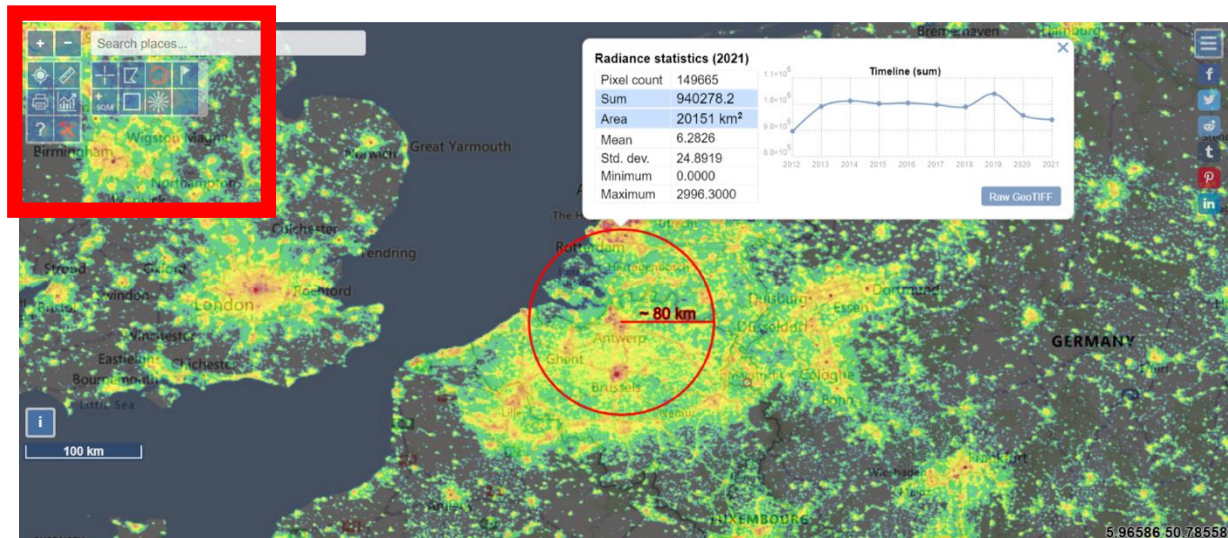
VIIRS Country statistics

○ 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.

- Download the data by selecting the Tools icon (bottom right and click on the circle to select the respective area)



- Select the circle's radius and left click, the pop-up window presents all descriptions and data of the selected area.
- Guide students to repeat the process for different years (VIIRS 2014 and VIIRS 2021).

⇒ Note to Educators:

- This activity empowers students to explore light pollution using real data and GIS tools.
- Encourage thorough data analysis and interpretation.

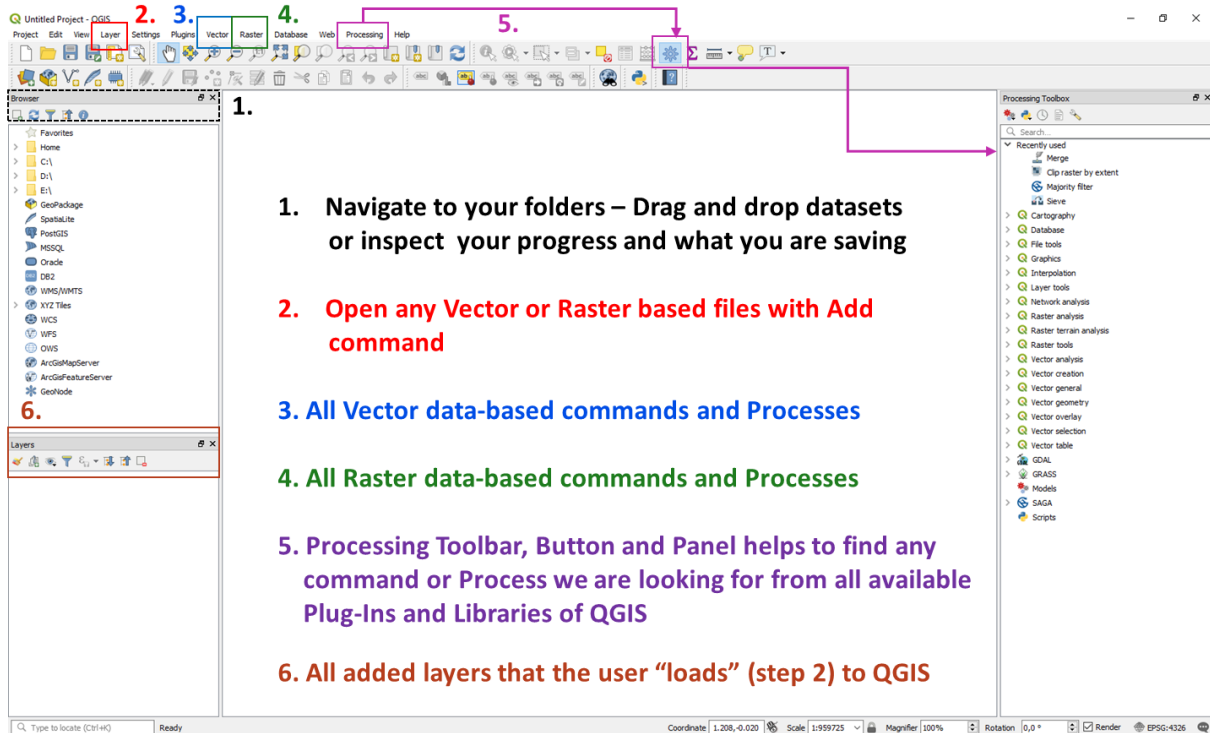
⇒ Concluding Remark: This activity encourages students to delve into practical applications of data analysis and spatial tools to gain insights into light pollution patterns within their region.

Enjoy facilitating these engaging activities!

3. QGIS PLATFORM OVERVIEW and TECHNICAL GUIDELINES

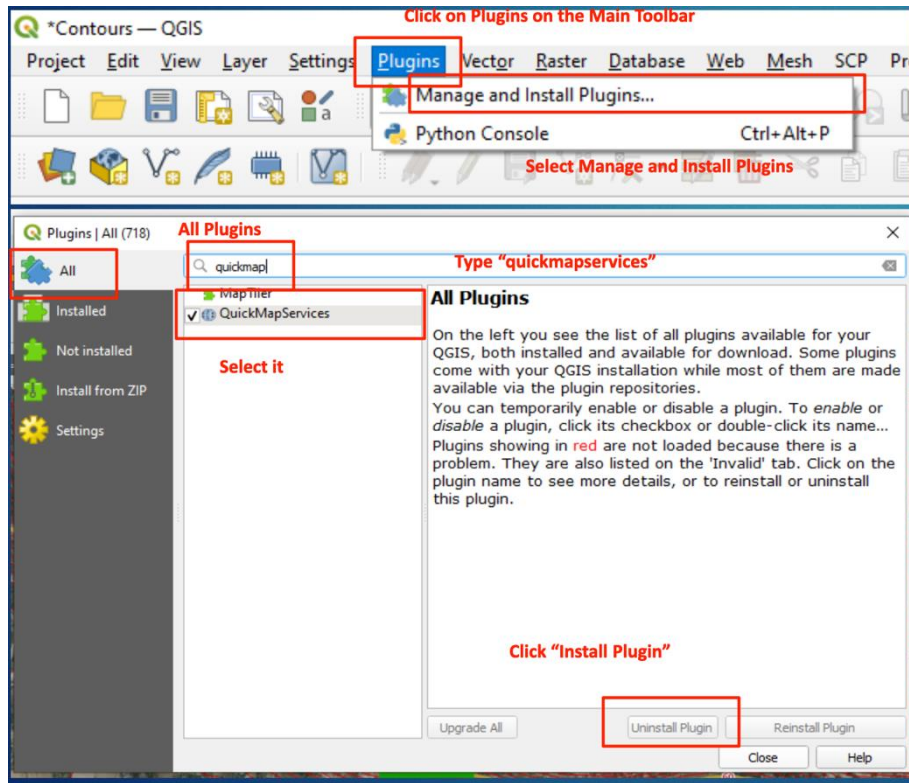
Step 1

- Loading Data: Data can be loaded in four ways (shown on image)

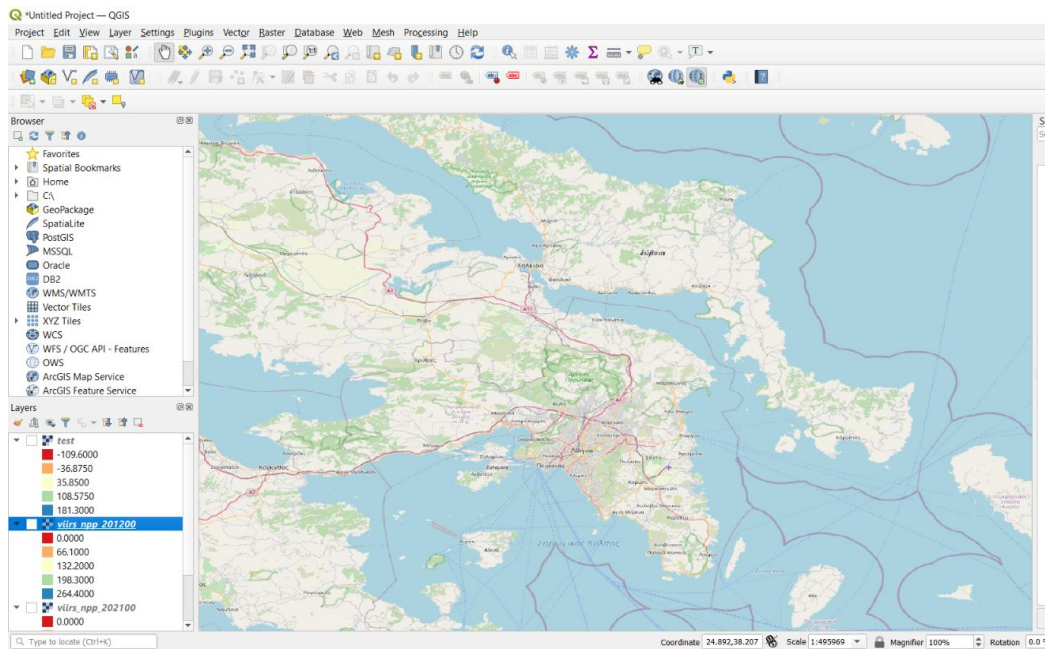


- 1. Navigate to your folders – Drag and drop datasets or inspect your progress and what you are saving**
- 2. Open any Vector or Raster based files with Add command**
- 3. All Vector data-based commands and Processes**
- 4. All Raster data-based commands and Processes**
- 5. Processing Toolbar, Button 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**

- Install required plugins :



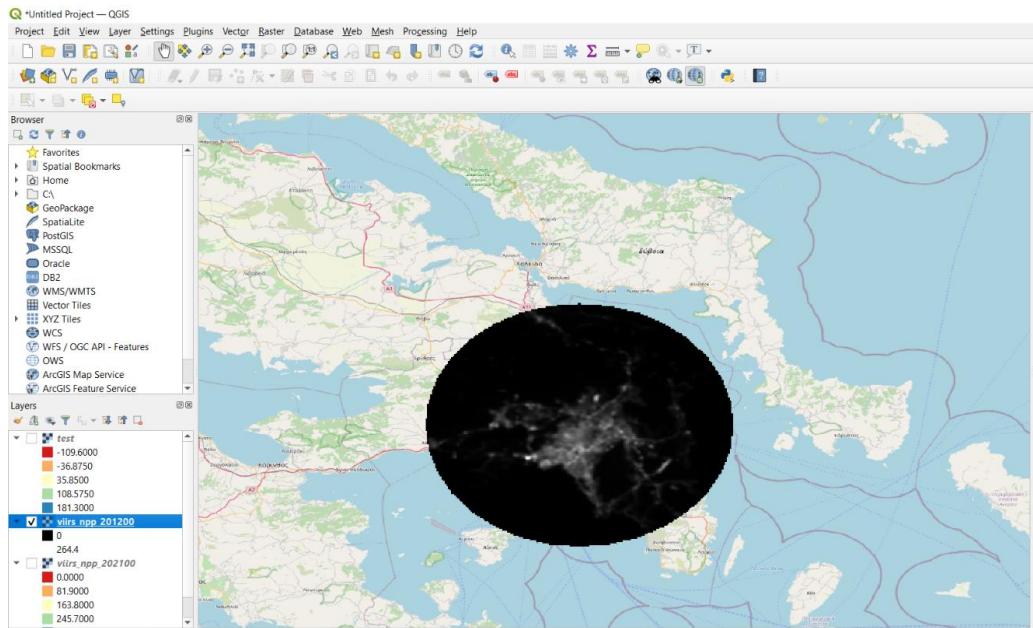
- Basemap Loading: Load Basemap using Main Toolbar: Web > quickMapServices > OSM > OSM Standard.



Step 2

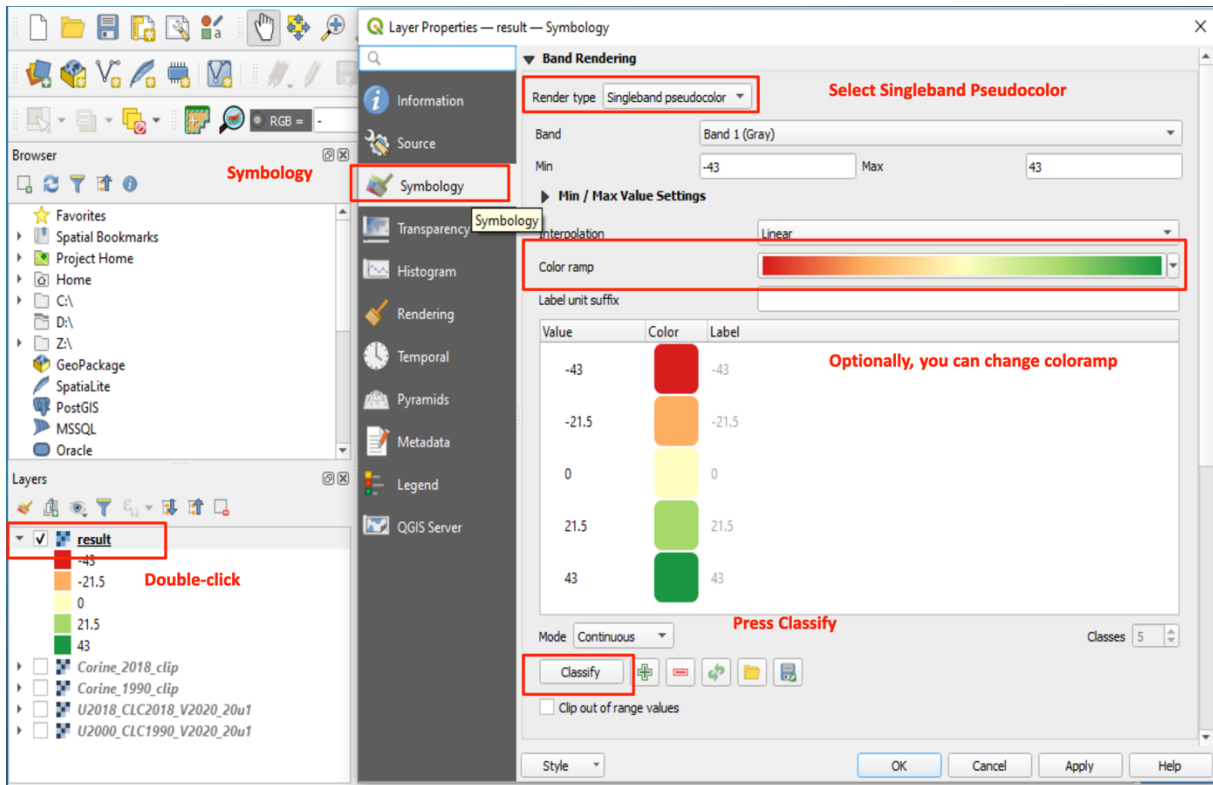
Starting the Activity:

- In the initial step, load downloaded Light Pollution files (VIIRS 2012 and 2021) onto QGIS.
- Main toolbar: Layers > Raster Layer > Navigate to folder > Select viirs_npp_201200.tif and viirs_npp_202100.tif.
- Initial map display will be black and white for both images.

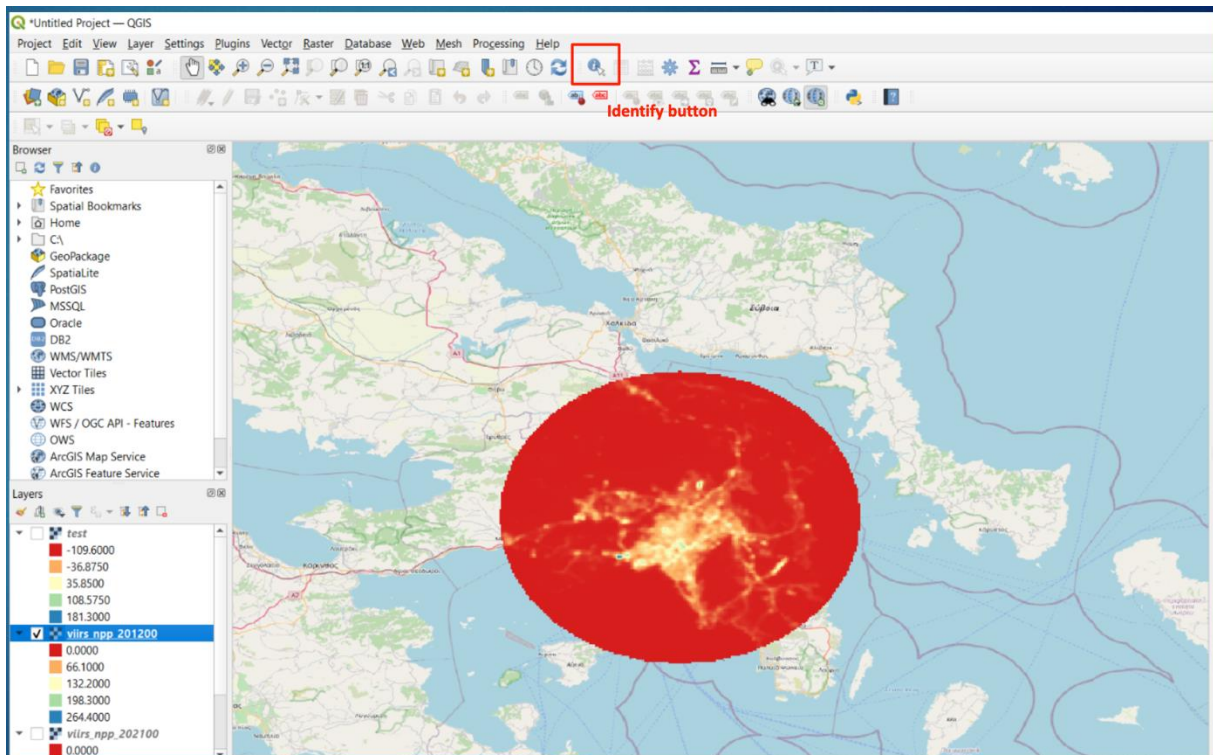


Color Layout Adjustment:

- Modify layout colors using Layer Properties.
- Double-click on .tif image > Symbology > Single-band Pseudocolor > Classify.



- Identify areas of increased light pollution or differences between years by checking/unchecking maps or using the identify button.

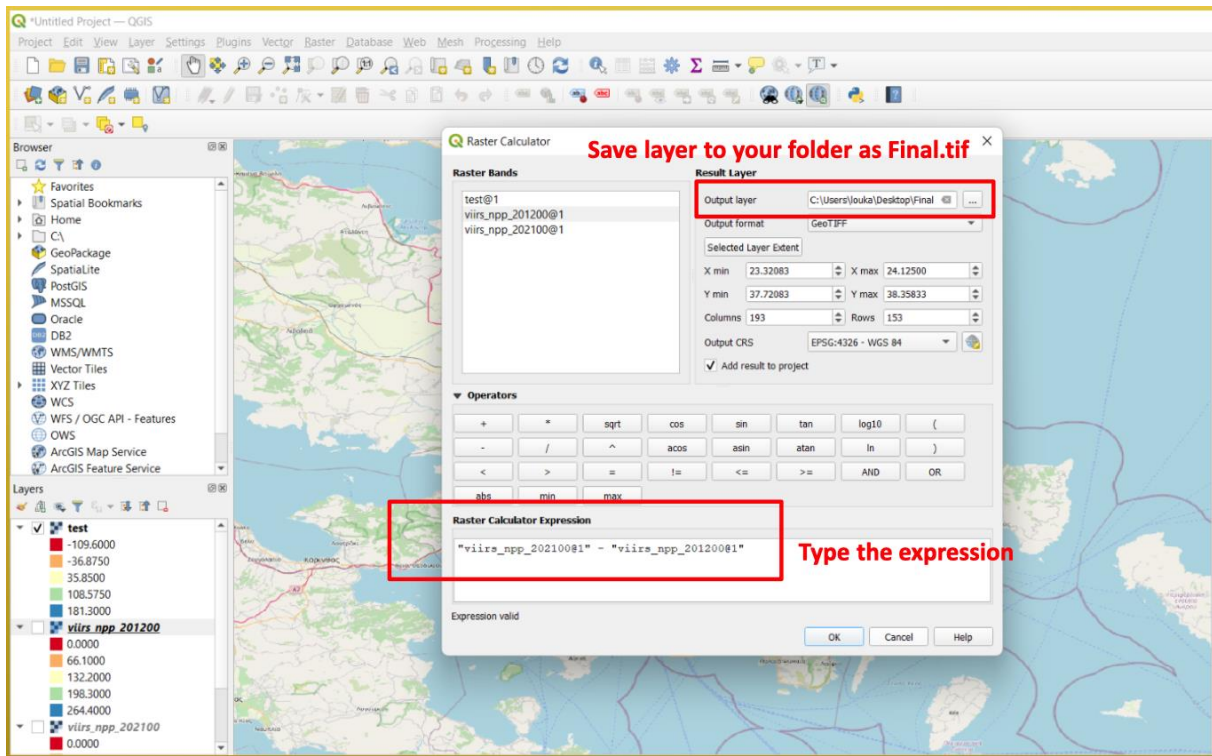


Step 3: Quantifying Changes of Light Pollution Levels

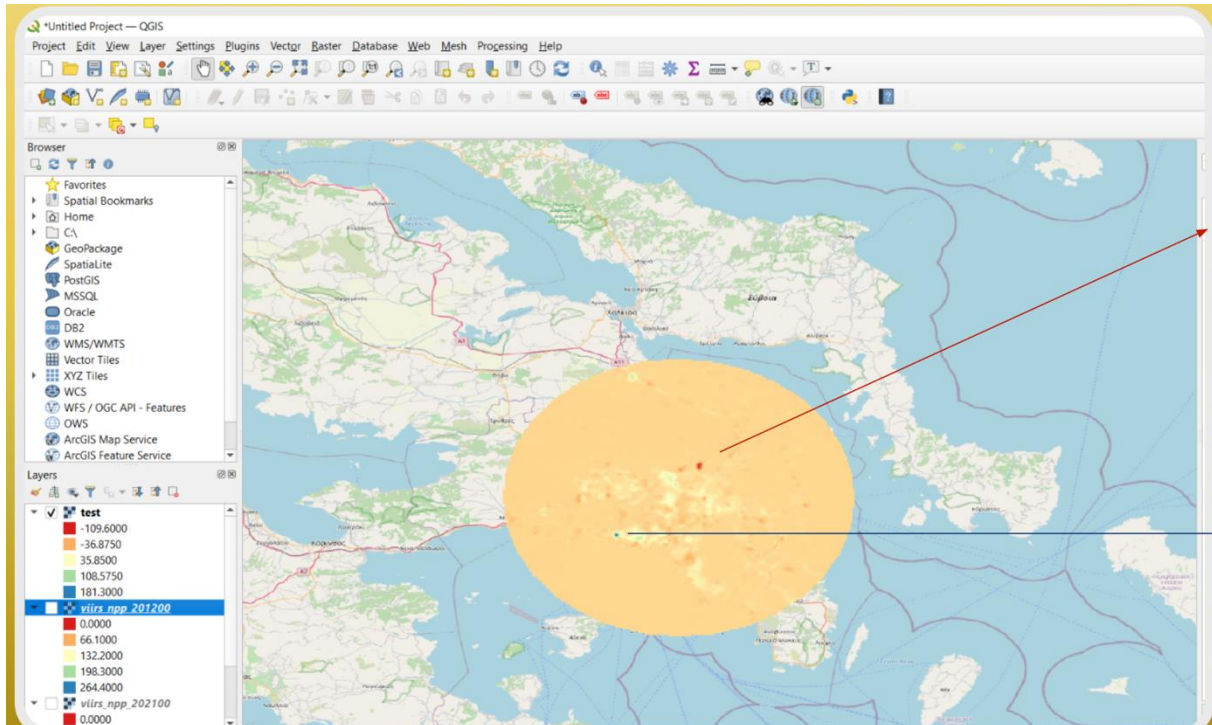
- Compare each pixel's value from viirs_npp_201200.tif and viirs_npp_202100.tif.
- Use the "Raster Calculator" tool for mathematical operations and conditional statements between rasters (images).

Simple Comparison Measure:

- Subtract pixel values of viirs_npp_201200.tif from viirs_npp_202100.tif.
- Open Raster Calculator via Main Toolbar: Raster > Raster Calculator.
- Enter: "viirs_npp_202100@1" - "viirs_npp_201200@1".



- Red areas indicate reduced light pollution levels (2012-2021) – Athens Airport -COVID-19.
- Blue areas indicate increased light pollution levels (2012-2021) – Piraeus port and Cosco investments.



Results Presentation

- Communicate findings from the analysis.
- Share insights on areas with decreased and increased light pollution.
- Discuss observed changes, such as implications of COVID-19 on light pollution levels.

STUDENT TASKS

⇒ Create a flyer to start a campaign or 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

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 (i.d.s.), 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.

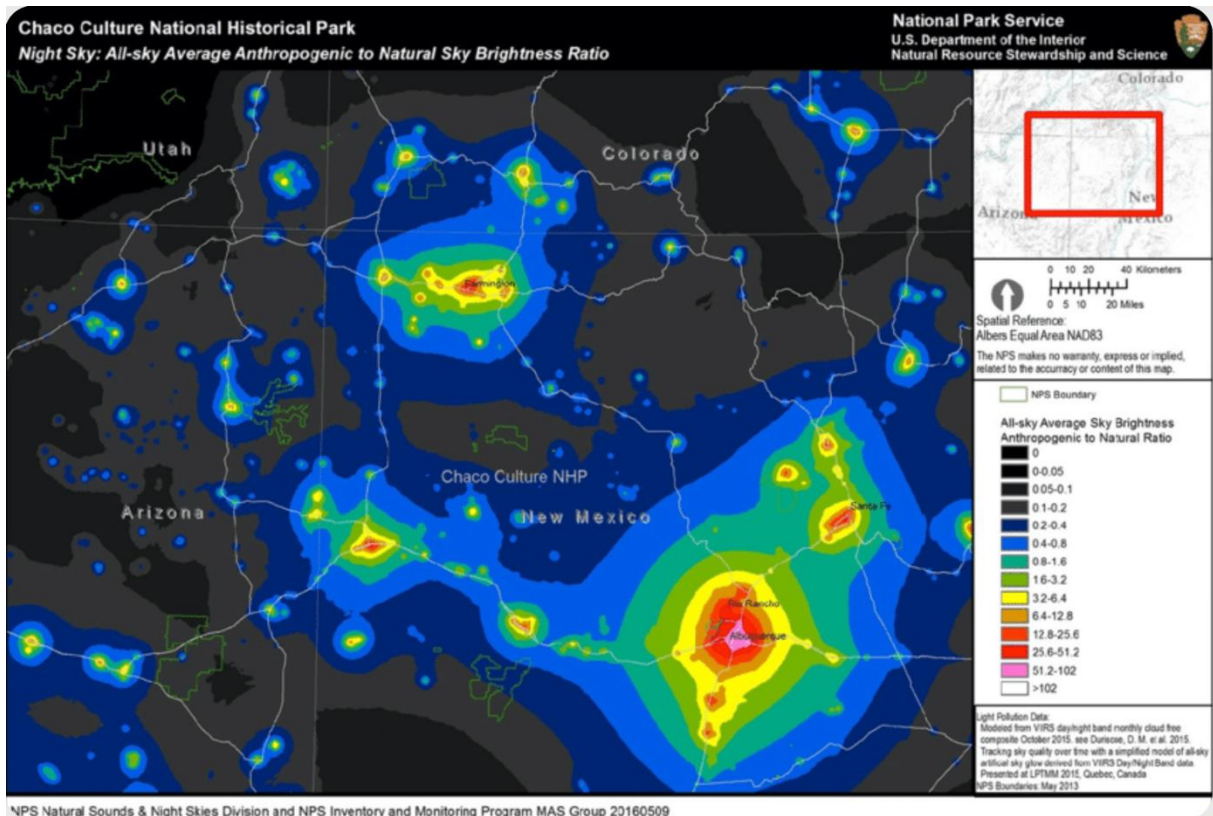
CONCLUSION

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

Cheremisin, R. (2008). *Missing the Dark: Health Effects of Light Pollution*. Environmental Health Perspectives, 116(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.

⇒ Create a map demonstrating light pollution differences in multiple areas and timescales.



⇒ Educational Note:

Utilizing the QGIS platform and associated tools, students engage in meaningful analysis and interpretation of real-world spatial data, gaining valuable insights into changing light pollution patterns.

ENJOY THE ACTIVITIES!