

Project number:
KA220-SCH-A710136B



Climate Action and Light Pollution Threat



Presenting the CLiC – PoLi educational toolkit

Dr. Loukas Katikas
Ellinogermaniki Agogi
Summer School, July 11, Marathon, Greece

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Project No.KA220-SCH-A710136B

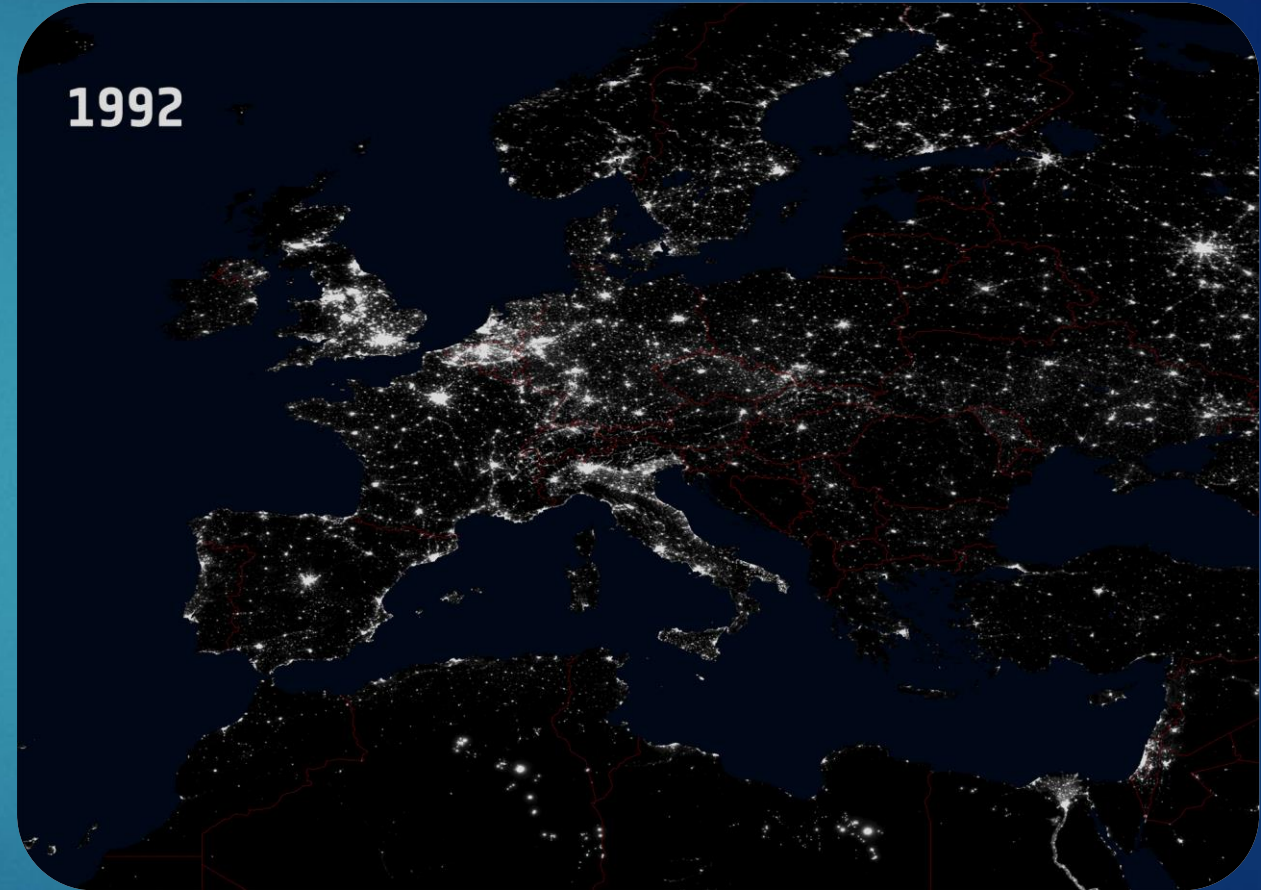


Co-funded by the
Erasmus+ Programme
of the European Union

Outline



- ▶ CliC – PoLiT educational toolkit in a nutshell
- ▶ Background information & Teacher's Handbook
- ▶ Ideas to support school & out of school activities
- ▶ Guidelines, manual & support material
- ▶ Pedagogical Framework





TOOLKIT MATERIALS

1.

- Teacher's handbooks

2.

- Students' presentations

3.

- Lesson Plans

4.

- Assessment tools

Description (Intro)



1. As part of the support offered to the schools, teachers and students that will be involved in the implementation process, the project team will **identify and develop a collection of guidelines and support materials in the form of a toolkit.**
2. This toolkit will employ transdisciplinary activities targeted at **Upper Primary and Secondary students (ages 9 - 15)**, relating **light pollution with Sciences, Arts, & Humanities.**
3. The use of **new technologies and digital tools** will be encouraged in all activities. These instruments will assist students and teachers in making their own discoveries and share them with their communities, thus developing their **problem-solving, communication and collaboration competences** (project-based activities, outdoor experimentation, real – world problem solving).

Description (Content)



The CliC-PoLiT toolkit will provide support that covers the following aspects that are crucial to enable successful piloting in schools:

- ▶ **Background information** on Light Pollution, its effects on the environment, and its connection to Climate Change;
- ▶ Ideas and help to **support classroom activities**;
- ▶ **Connections between the toolkit activities and the pedagogical framework**, and **suggested ways of implementation**;
- ▶ **A how-to guide to introduce the selected digital resources.**
- ▶ **Professional Development and Assessment Toolkit**



Description (Timeline)

The work of the educational toolkit is divided in the following tasks:

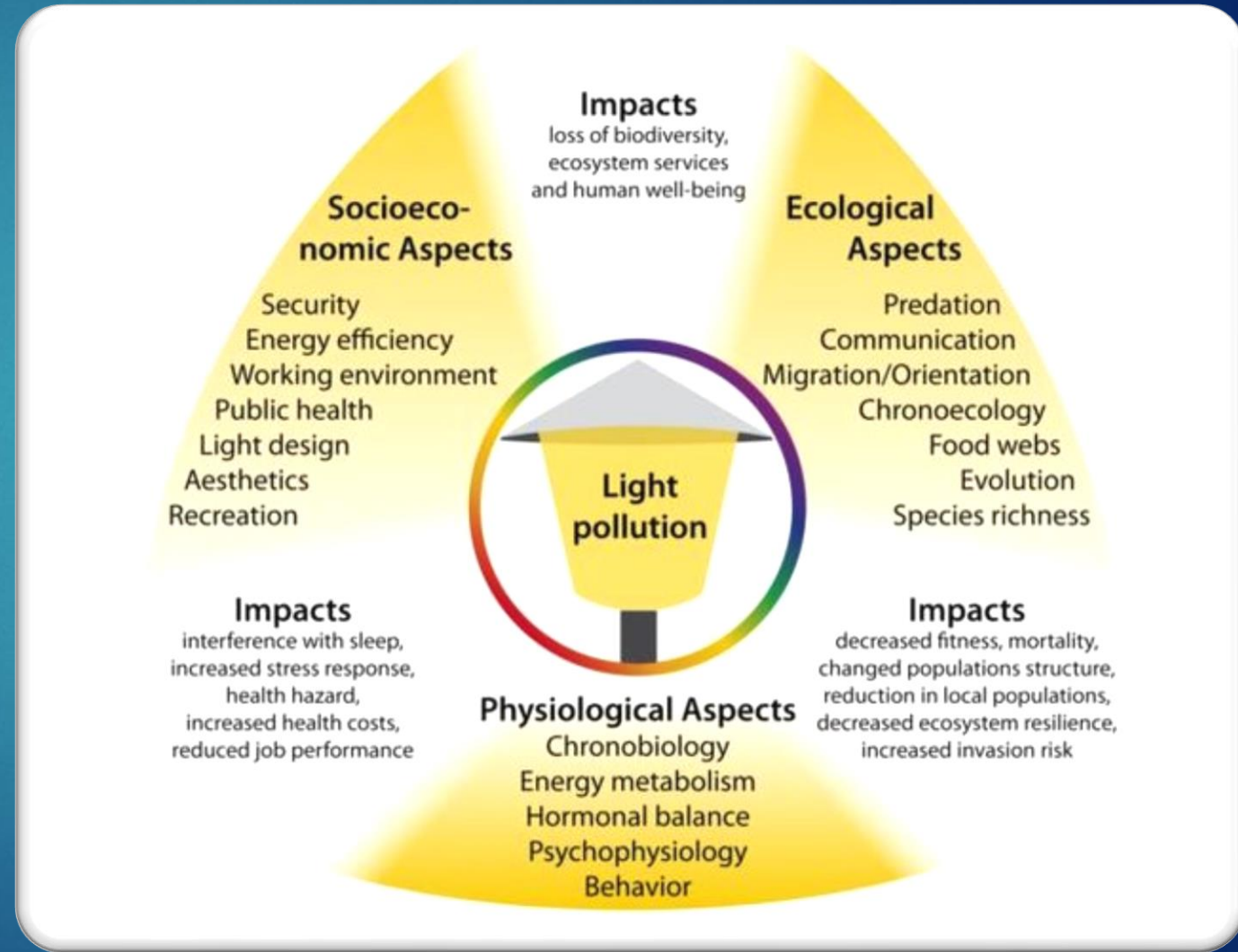
1. **Preparation of the first version of the toolkit**, including a **preliminary study of each country's curricular components**, **collection of educational resources** from all partners, and **testing during the CliC – PoLiT Summer School**.
2. **Implementation of suggestions**, design of the revised toolkit version, and implementation in participating schools.
3. **Evaluation of first year of implementation results**, applying changes, design and implementation of the final toolkit version.
4. **Final evaluation of results**.

Background information



Definitions, Glossary and Examples

- What Is Light Pollution?
- Causes and types of Light Pollution
- Effects of Light Pollution
- Light Pollution monitoring and mitigation
- How can we reduce light pollution?
- Fun facts (or maybe not) about Light Pollution!



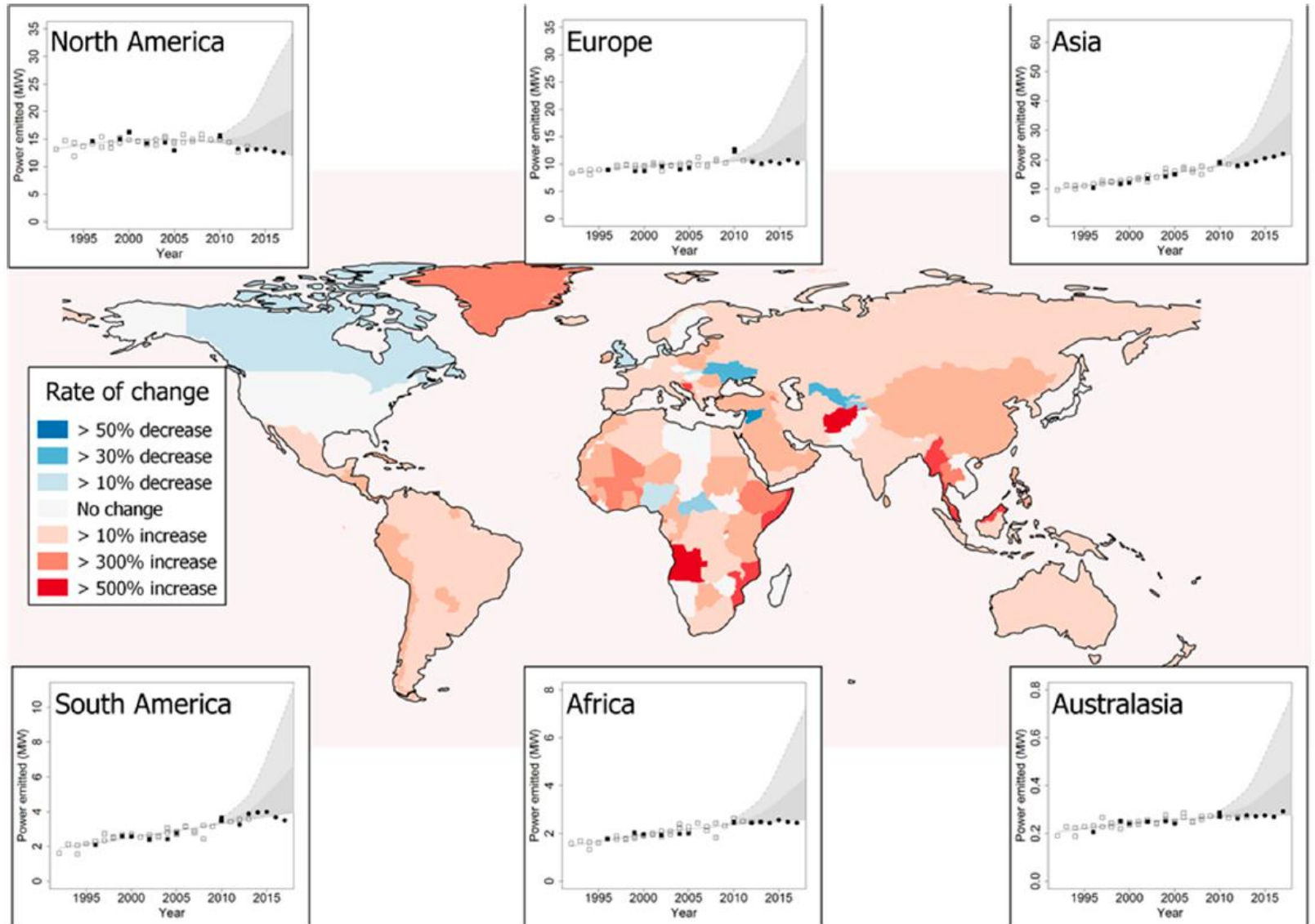
Background information (2)



Monitoring light pollution (geospatial skills)

- **How to work with satellite images** of the Earth at night strikingly that illustrate the extent of the distribution of artificial light sources associated with human settlement, industry and transport links, across its surface.
- **How satellites work and measure the quantity of artificial light** that includes a mixed signal of direct emissions from outdoor lighting that is not vertically shielded, as well as reflected light from the ground, buildings and vegetation, and light scattered within the atmosphere.
- **Importance of monitoring and mapping artificial light.** These signals have been increasingly used as an important indicator of urbanisation, industrial activity and economic development. It has also been used as a measure of light pollution, which has long been a concern of astronomers but has more recently been proposed as an emerging major threat both to public health and natural ecosystems.

Background information (2 - Analyzing patterns)

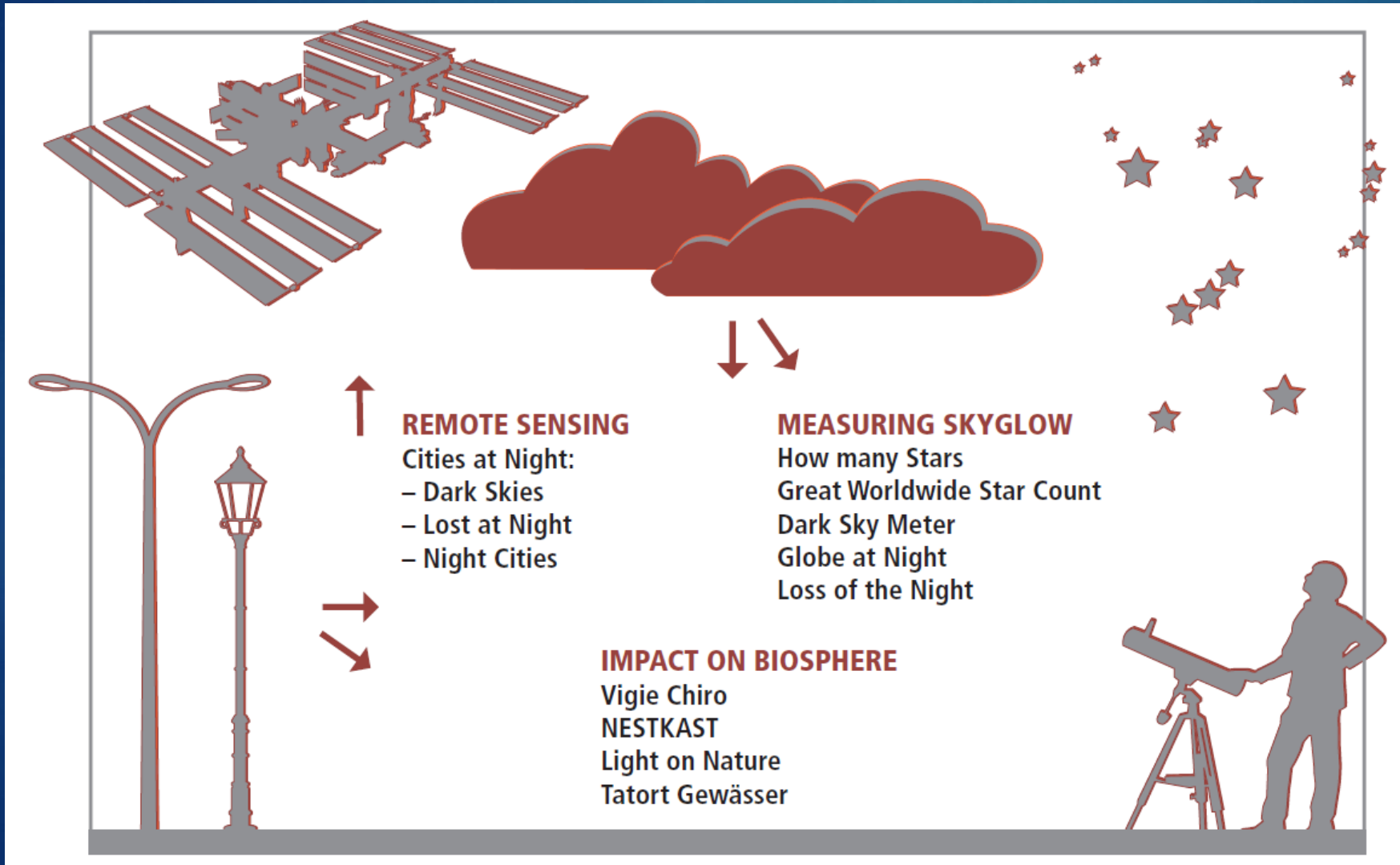


Graphs, charts & maps (examples)

Rate of change in artificial light at night represented as power output detectable by satellites from 1992 to 2017

Source:
Sánchez de Miguel et al. 2021

Background information (Citizen Science)



Citizen Science & Light Pollution tracking and mitigation

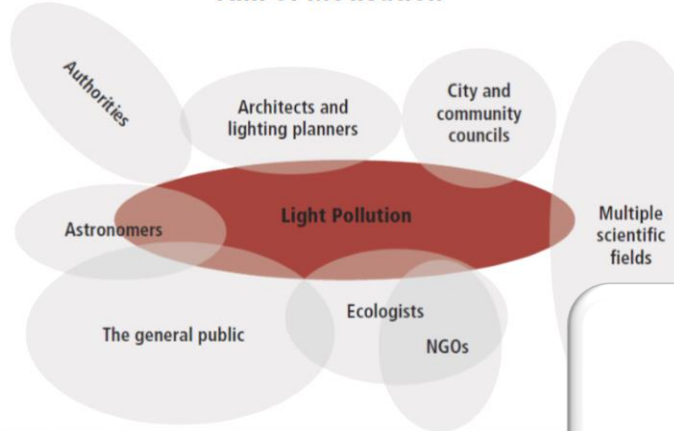
List and ideas for citizen science projects focusing on artificial light at night and changes of nightscapes.

Source:
Schroer et al. 2018

Background information (Citizen Science)

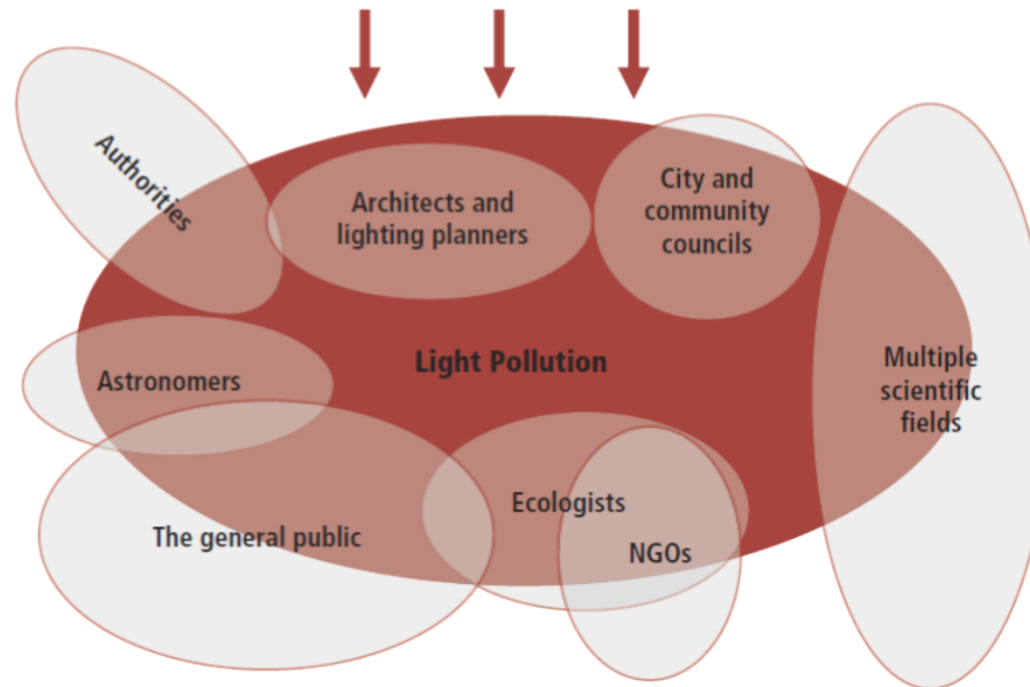


Aim of Motivation



Light Pollution and Citizen Science scientific fields

Citizen Science



Motivation aim to transfer the relevance of light pollution to a broader field of stakeholders

Source:

Schroer et al. 2018

Background information (Sustainable Development)



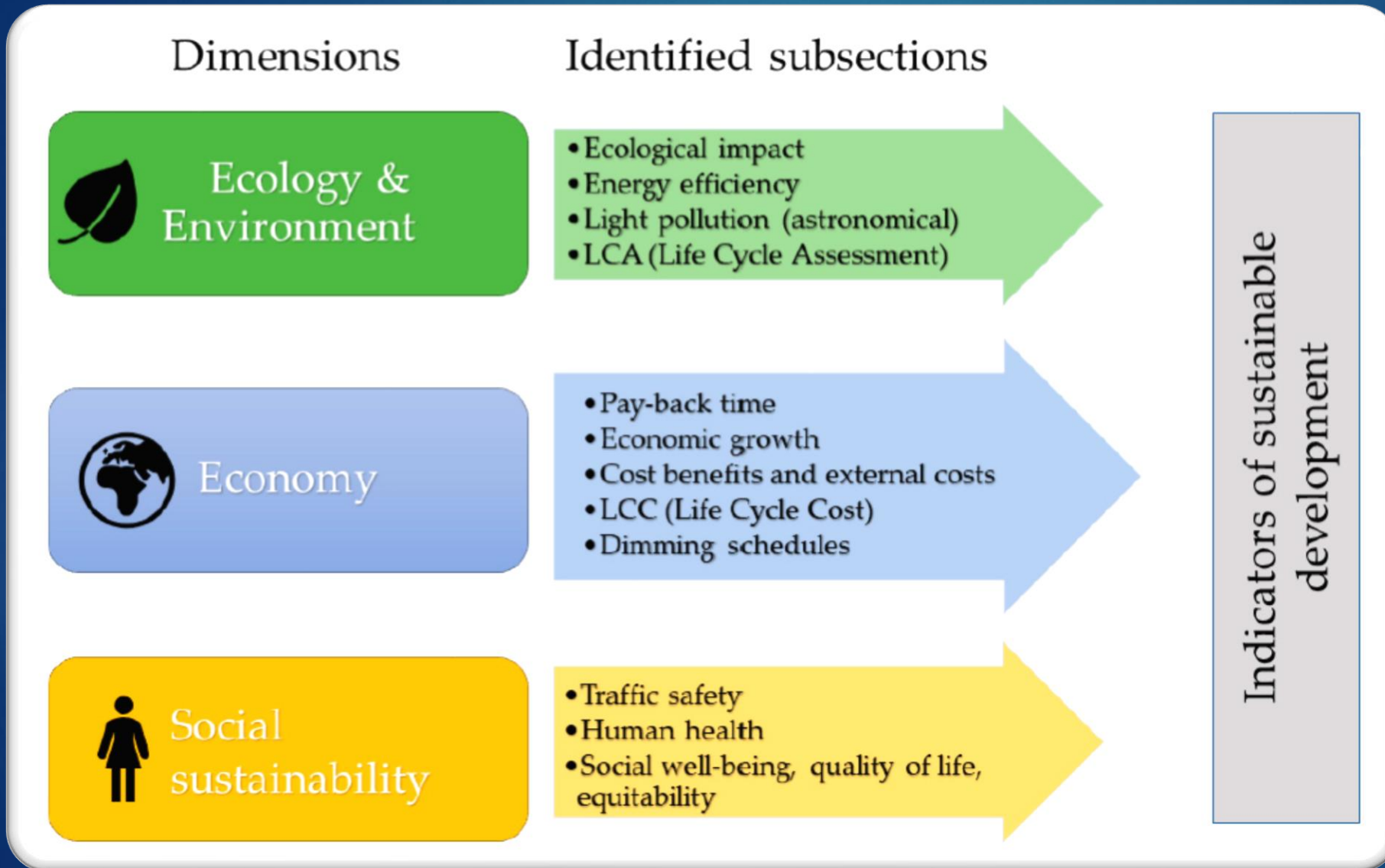
Energy Performance Variables	Aspect	Indicator	Type
Energy consumption in an area	Energy consumption for an area	Number of luminaires/area New luminaires in non-lit areas	System System
Rebound effects	Predicted energy savings will be underestimated	Percentage (rebound effect)	System
Energy efficiency	Energy efficiency based on energy and light per km road (per year)	W/lx per km road W/(cd·m ²) per km road	Energy efficient
Energy performance indicators in accordance with EN 13201-5	Annual energy consumption indicator (AECI)	Wh·m ⁻²	Energy efficient
	Power Density Indicator (PDI)	W/(lx·m ²)	Energy efficient
Luminous efficacy	Increase energy to light output	lm/W	Energy efficient
Luminous efficiency	Increase energy to light output compared to 100%	%	Energy efficient
Mesopic design or spectral distribution of the light source	Maximize visual performance and energy savings	S/P ratio	Energy efficient
		Correlated color temperature, degrees Kelvin (K)	Energy efficient
Light loss factor and lamp lumen depreciation	Minimize energy waste in the design and use stages (by accurate values of LLF or LLD)	Light loss factor (LLF), lamp lumen depreciation (LLD) or maintenance factor constant light output (CLO)	Energy conserving Energy conserving
Controlled dimming or adaptive/smart/dynamic systems	Energy savings in accordance with demand or schedule	Percentage savings (kWh/year)	Energy conserving
Surface luminance	Energy savings through increased luminance by changing the surface characteristics or adapting light levels to changed surface conditions	Percentage savings (kWh/year) due to intelligent lighting compensation for surface characteristics	Energy conserving
Legislation or regulations	Restrict the use of light sources, or spatial or temporal distribution of light	For example, implementing principles of "as low as reasonably achievable" (ALARA) or requirements on energy efficiency labelling	System, energy efficient or energy conserving
Optimized lighting design	Different implementations of optimization in the design process	For example, adaptation to current conditions or settings, or digital optimization	System, energy efficient or energy conserving

Linking Light Pollution to the EU Green Deal and SD goals.

Energy performance variables, aspects, indicators, and type. Energy performance, consumption, efficiency, or energy conservation examples.

Source: Calluna et al. 2020

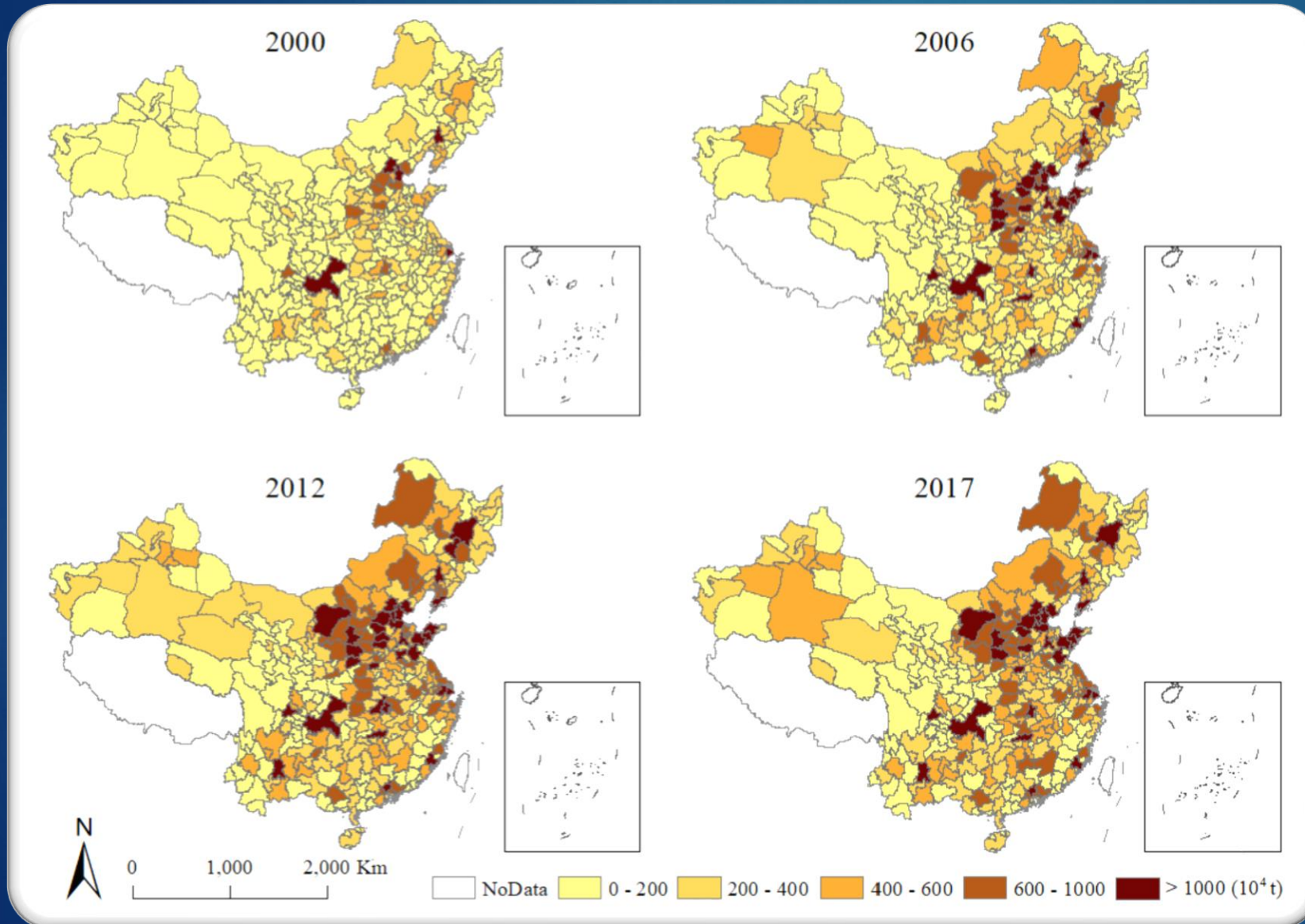
Background information (Sustainable Development)



Overview of the dimensions and identified subsections in the framework of indicators of **sustainable development for exterior lighting.**

Source:
Calluna et al. 2020

Background information (Climate change)



Spatial distribution of carbon emissions at the city level for the periods 2000–2017. Correlating Light Pollution & Air Pollution.

Source:
Sun et al. 2020

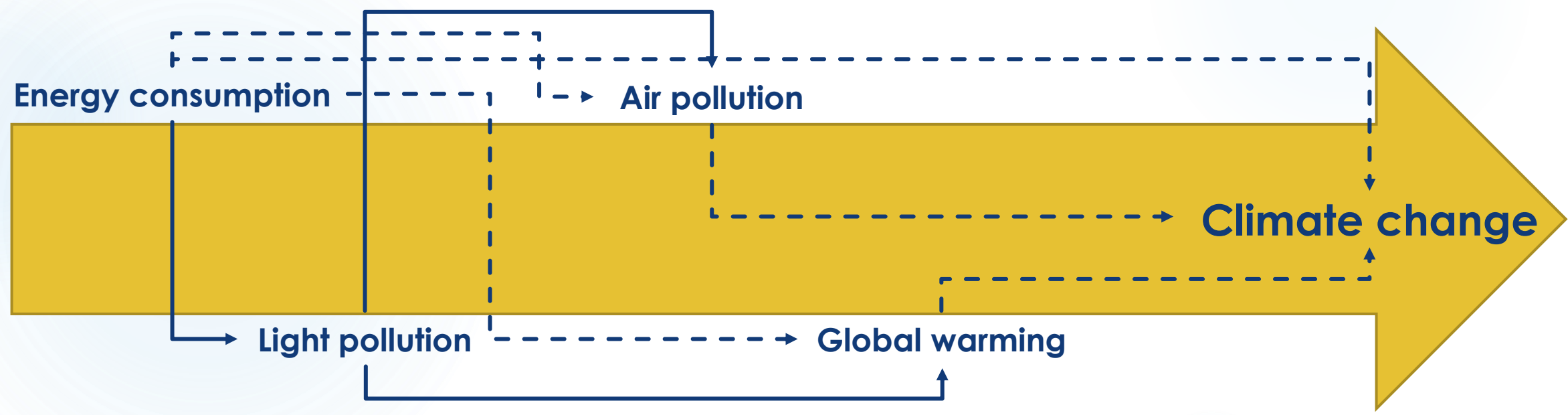


Light Pollution and Climate change

There are two ways for light pollution to affect climate change;

Direct Way : With the destruction of nitrate radicals (which cleanse our air)

Indirect Way : Wasting resources (energy consumption) that pollutes air



Background information (Biodiversity)



► Effects of Light Pollution

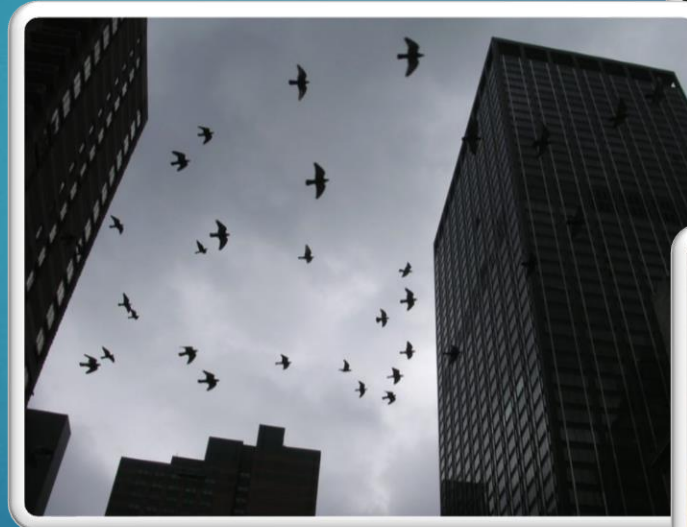
Light pollution disrupts ecosystems, from nocturnal to diurnal species: Nocturnal species are adapted to primarily be active at night -- from hunting for food, to reproduction, to pollination, to regulating body temperature. Diurnal species are adapted to primarily be active during the day. Diurnal species also require darkness to develop, navigate and survive.

Source: [International Dark Sky Association](#)

NUCLIO
NÚCLEO INTERATIVO DE ASTRONOMIA
E INOVAÇÃO EM EDUCAÇÃO



Light Pollution is Contributing Significantly to Insect Apocalypse



Light Polluted Cities are Deadly for Birds



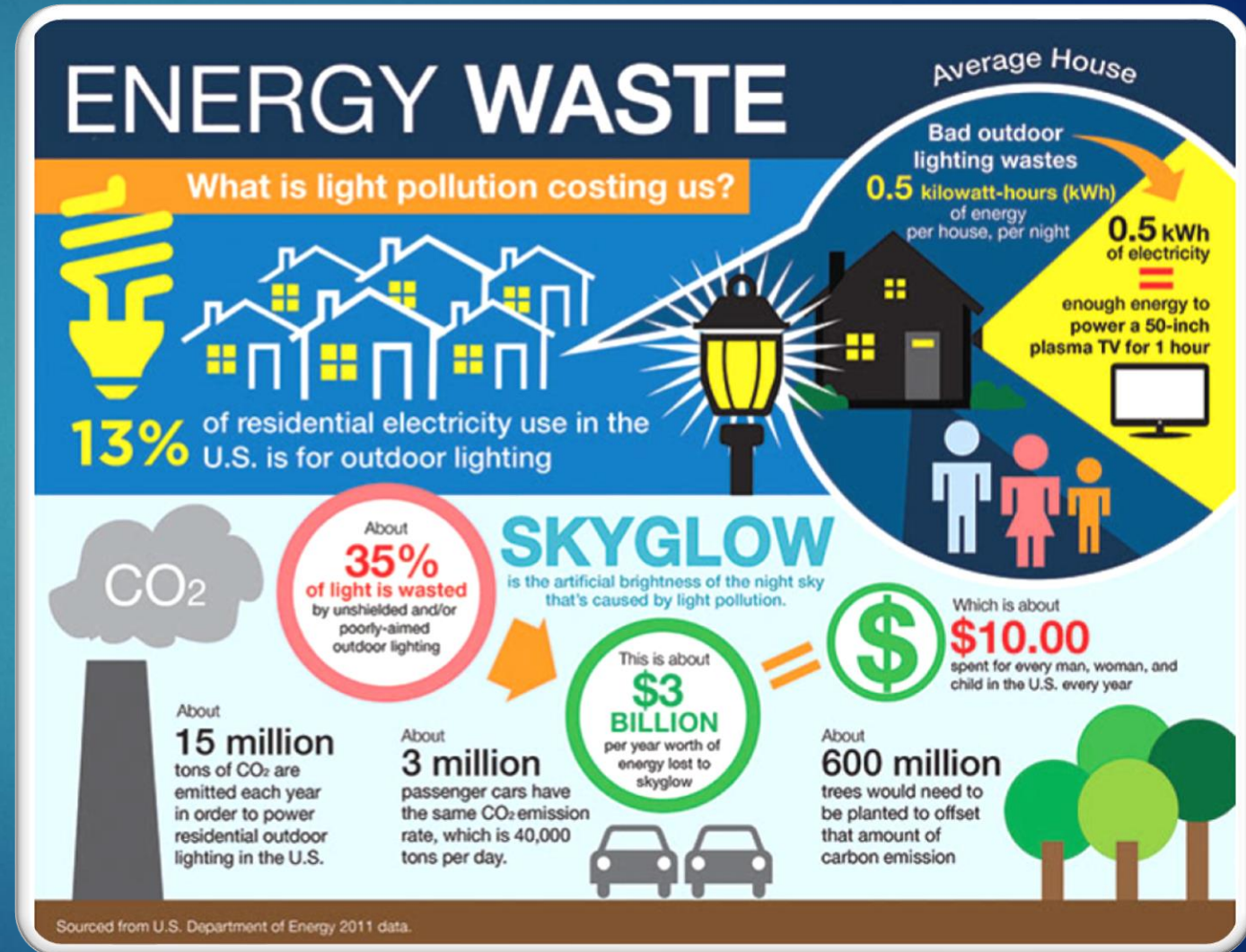
Bright Lights Disorient Sea Turtle Hatchlings

Background information (Energy consumption)



► Effects of Light Pollution

Light pollution wastes energy: Light pollution wastes a lot of energy. 40,000 tons of carbon dioxide enters the atmosphere -- every day -- to produce the energy for unnecessary outdoor light. 600 million trees would need to be planted to offset that amount of CO₂!



Source:

Source: <https://www.caro.ie/projects-research/case-studies/improving-public-lighting-energy-efficiency>

Background information (Energy efficiency)



	Annual Energy (kWh)	Annual costs (Euro)	Annual CO2 (kg)
Before project	1,091,873	148,713	580,876
After project	346,300	47,166	184,231
Savings	745,573	101,547	396,645
% saving	68%	68%	68%

Source:

<https://www.caro.ie/projects-research/case-studies/improving-public-lighting-energy-efficiency>

Environmental

The **energy-efficient lighting project achieved 68% savings** in energy spending and has made a significant contribution to energy efficiency target of 33% by 2020 relative to 2009 energy usage.

Is LED lighting systems a viable option towards light pollution mitigation?

Social

The **social benefits of a LED** lighting system include providing a safer environment, helping to lessen street crime and the fear of crime, and reducing the number and severity of night-time accidents.

Background information (LED or No LED?)



Egypt is one of the places on the planet where the massive use of high-intensity white LED street lighting.

The contrast with the areas of Cairo that still have orange street lights speaks for itself.

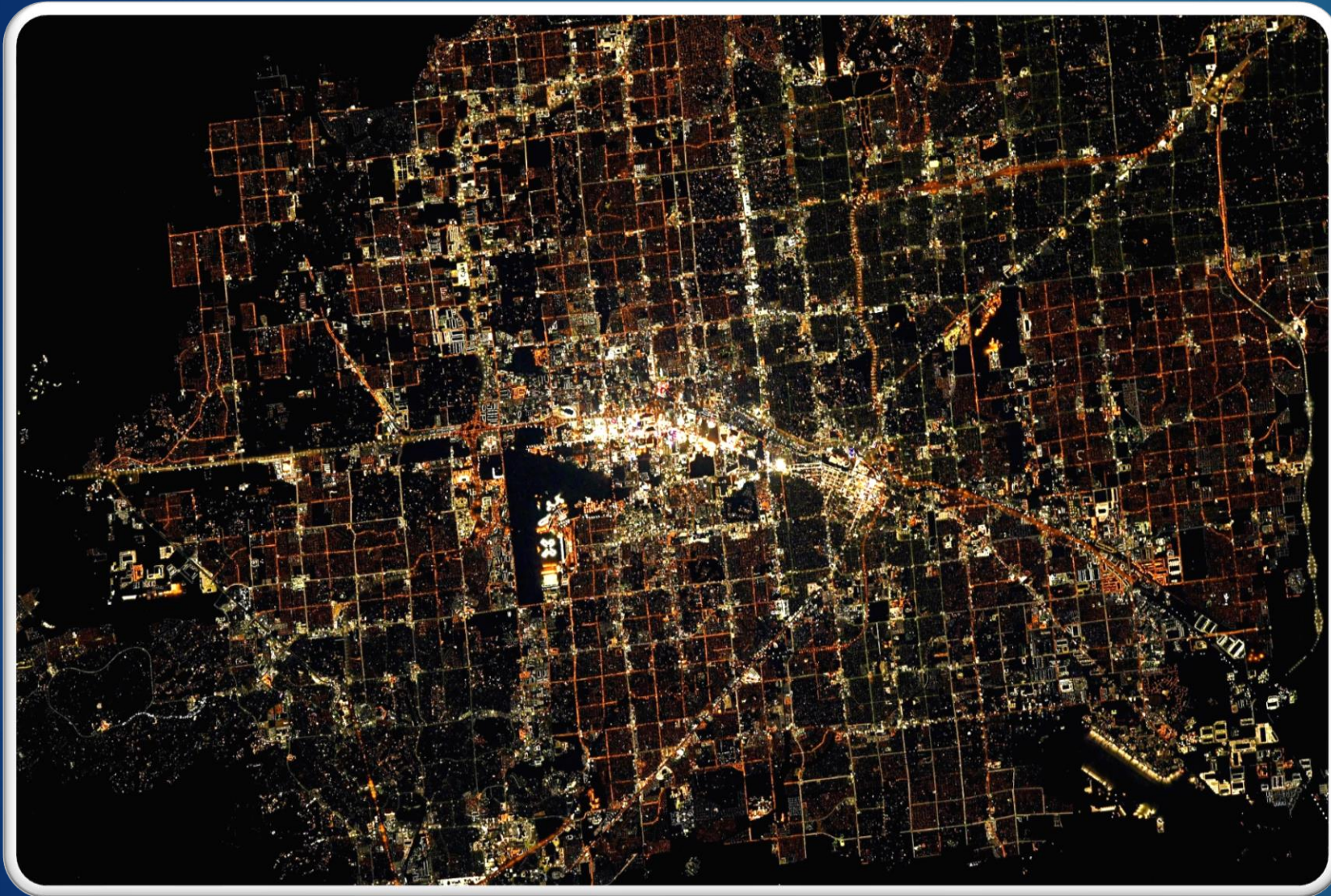
Cairo, 5 May 2021.

LED or no LED? LET'S DEBATE!

Source:

<https://www.equaltimes.org/light-pollution-the-white-light?lang=en#.Yr6SmXZBzi2>

Background information (LED or No LED?)



Seen from space, Las Vegas looks like a strip of incandescent light, mostly white in colour. In terms of light pollution, **it is clear that what lights up Las Vegas does not stay in Las Vegas.**

Source:

<https://www.equaltimes.org/light-pollution-the-white-light?lang=en#.Yr6SmXZBzi2>

Is this sustainable development?

Ideas to support school activities



Wildlife Workbook (includes games or activities about wildlife and light pollution)

- [Workbook for ages 5-9](#)
- [Workbook for ages 6-12](#)

Individual Activities and Games from the Wildlife Workbooks

Ages 5-9

- [Animals of the Night Word Search](#)
- [Lost Moth Dot to Dot](#)
- [Save the Stars Ages 4-8](#)

Ages 5-12

- [Owl Coloring page](#)
- [Sleep Tight Maze](#)
- [Turtle Maze](#)

Ages 6-12

- [Light Pollution and Wildlife Crossword Puzzle](#)
- [Wildlife Word Search](#)

Existing material

- [Wildlife Connect the Dots](#)
- [How can schools fight light pollution?](#)
- [Diorama of the Night Art Project Ages 6-12](#)
- [Protect our Night Sky/Reduce Light Pollution Ages 11-15](#) (12-page PDF of information and activities from the Bush Telegraph, published by the nonprofit [NaDeet](#), the educational core of [NamibRand International Dark Sky Reserve](#), Africa's first International Dark Sky Reserve)
- [Mini Page on Light Pollution Ages 8-10](#) (4-page PDF about light pollution and good lighting)

Ideas to support classroom activities



Existing material

► How can we reduce light pollution?

LET'S START A CAMPAIGN!

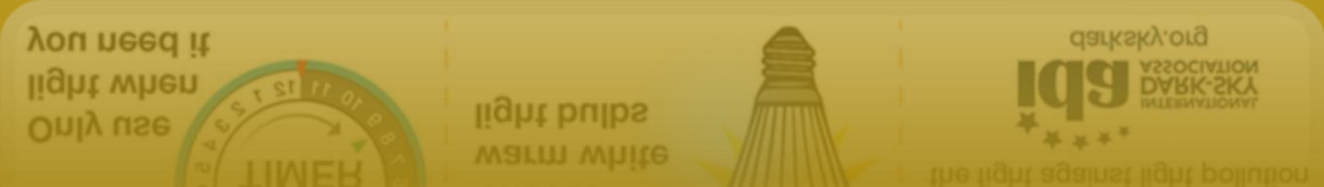
LET'S TRY THIS GAME!



[Light Pollution Simulator](#)

Protecting the night sky starts with YOU!

<p>1 Light only what you need</p> 	<p>2 Use energy efficient bulbs and only as bright as you need</p> 	<p>3 Shield lights and direct them down</p> 
<p>4 Only use light when you need it</p> 	<p>5 Choose warm white light bulbs</p> 	<p>6 Join IDA!</p> <p>We need your help to continue the fight against light pollution</p> 

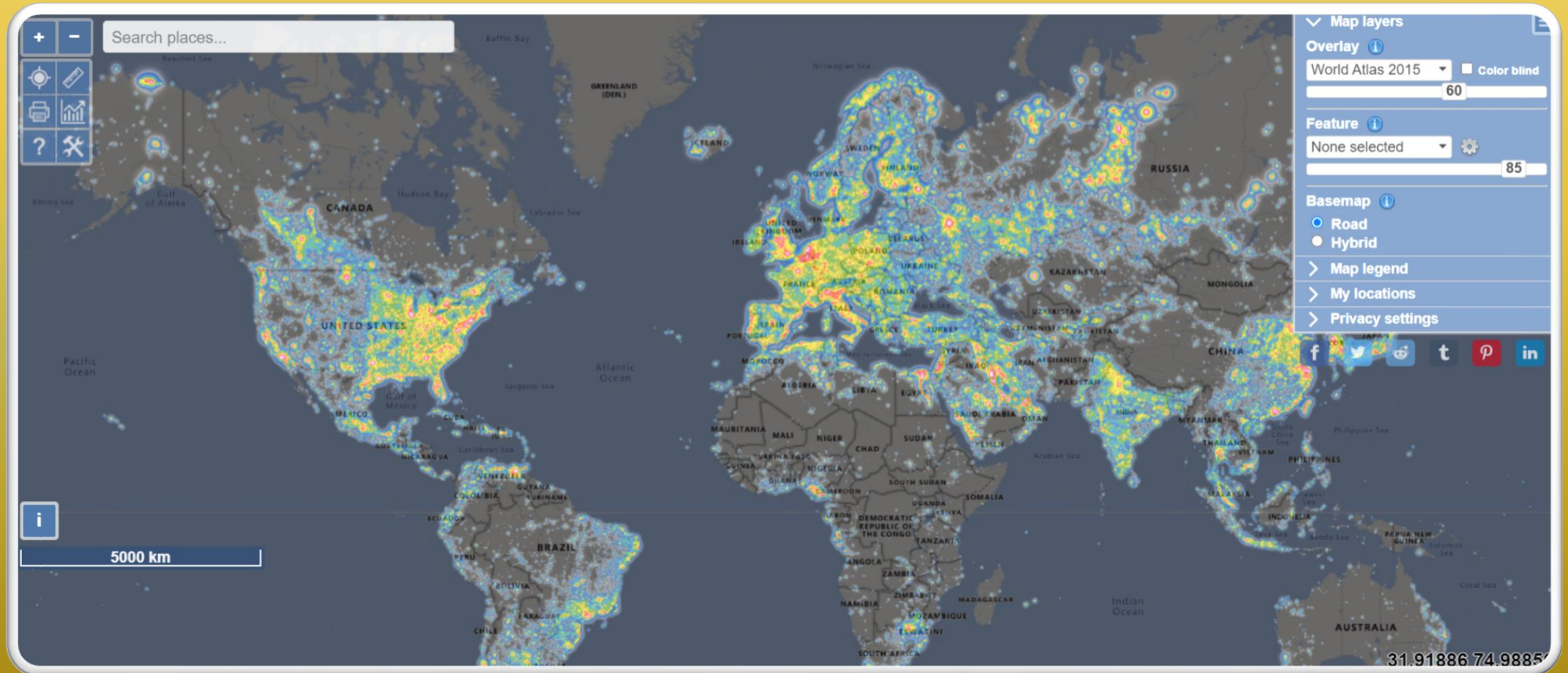


Ideas to support classroom activities



Create new material – Analyze data

Let's track Light Pollution from space! Click on the image below.

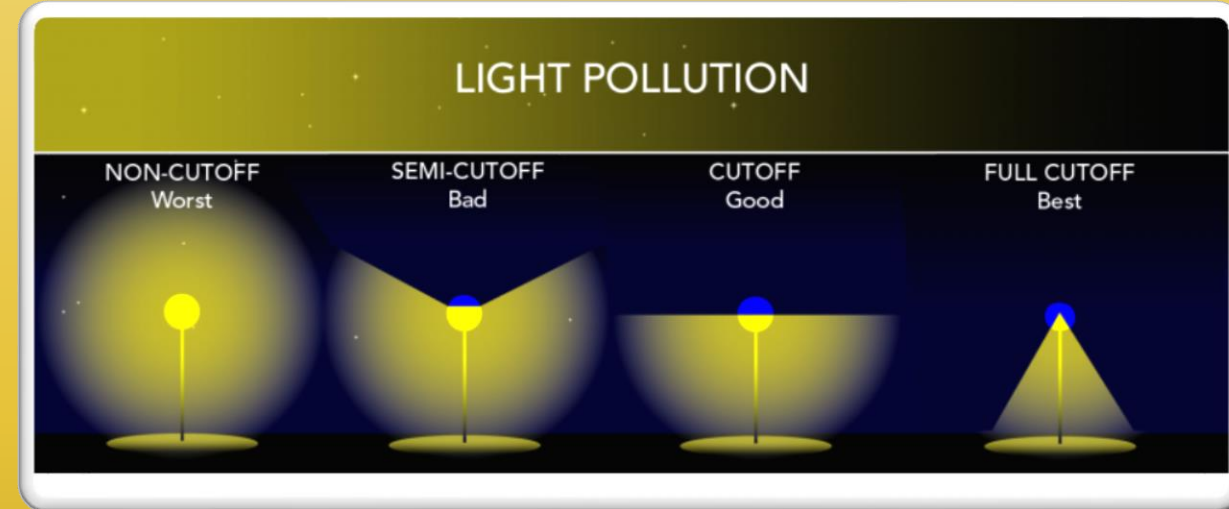


Ideas to support out of school activities



► How can we reduce light pollution?

1. First, you can turn off your lights at night, or close the curtains.
2. Then look at the lights outside your house. Can they be turned off?
3. Or can motion sensors be installed so they only come on when needed?
4. Glare from outdoor lighting can be reduced by shielding light fixtures. You can talk to friends, family, and guardians about making some of these changes at home!
5. LED lights are often used outdoors. But LEDs can harm humans and animals. It's safer to use lights and filters that are coloured red or yellow.



6. Make your contribution and convince others!

Guide to introduce digital resources



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

Click on Plugins on the Main Toolbar

Project Edit View Layer Settings **Plugins** Vector Raster Database Web Mesh SCP Pro

Manage and Install Plugins...
Python Console Ctrl+Alt+P

Select Manage and Install Plugins

Plugins | All (718)

All Plugins

quickmap|

Type "quickmapservices"

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.

Select it

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 Raster Database Web Mesh Processing Help

favorites Spatial Bookmarks Home C:\ GeoPackage Spatialite PostGIS MSSQL Oracle DB2 WMS/WMTS Vector Tiles XYZ Tiles 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

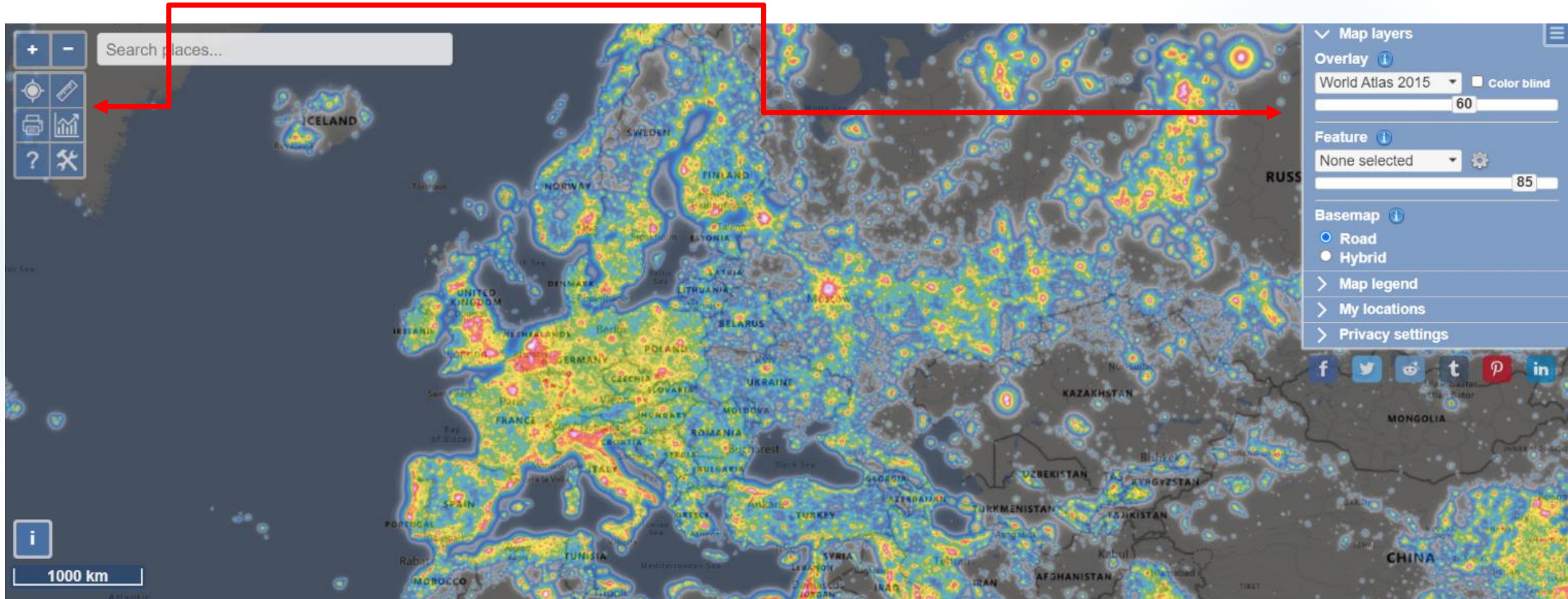
Guide to introduce digital resources



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.



Guide to introduce digital resources



Using NASA WorldView to download real light pollution satellite images.

The image shows a screenshot of the NASA WorldView web application. The interface is divided into several sections. On the left, a 'LAYERS' panel is highlighted with a red border. It contains three main sections: 'REFERENCE' with 'Place Labels', 'Coastlines / Borders / Roads', and 'Coastlines'; 'EARTH AT NIGHT' with 'Black Marble Nighttime At Sensor Radiance (Day/Night Band)'; and 'BASE LAYERS' with 'Corrected Reflectance (True Color)'. Below these are buttons for '+ Add Layers' and 'Start Comparison'. The main map area shows a satellite view of Bulgaria and North Macedonia at night, with city lights visible. Labels for cities like Sofia, Plovdiv, and Thessaloniki are present. The bottom of the interface features a 'TIMELINE' section, also highlighted with a red border, showing a date range from May 2022 to July 2022, with navigation arrows and a 'DAY' button.

Guide to introduce digital resources



Changing the levels of light pollution in Stellarium

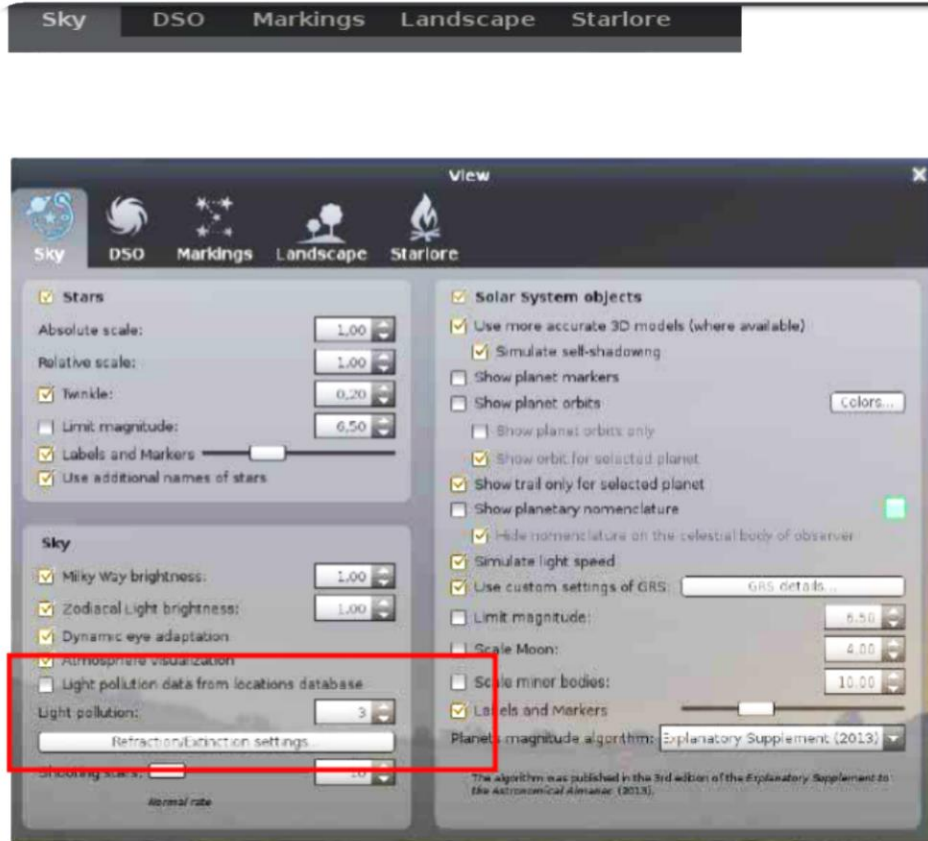


Fig. 7 Adjusting light pollution level in the View dialog box.

Stellarium simulates light pollution and is calibrated to the Bortle Dark Sky Scale where 1 means a good dark sky, and 9 is a very badly light-polluted sky. The box for 'light pollution data from location database' should remain unchecked to allow the user to increase or decrease levels of light pollution.

The dialogue box can be closed by 'x' on right hand side.

There are of course so many other possibilities of learning using Stellarium and one is encouraged to explore freely or research the User Guide PDF on stellarium.org



To Quit Stellarium click the  button or Ctrl + Q .

To Quit Stellarium click the  button or Ctrl + Q .

Pedagogical framework



Why Light Pollution and overall, Climate change topics are important for DBR?

- ▶ **Design Based Research (DBR)** integrates two endeavours – **development and research** – in the process of designing artefacts (teaching materials, learning strategies, curricula, etc.) for school practice.
- ▶ **Light pollution** provides a number of aspects going beyond mere physics subject matter and **involves social, environmental and health issues**.
- ▶ In addition, it is a relatively **new research field** (past two decades). This is usually an interest **generating momentum for students as they get the feeling of involvement in current research**.

Pedagogical framework



Adopting the Design For Change (DFC) Process, a standard four-step process to guide students to develop their projects is proposed:

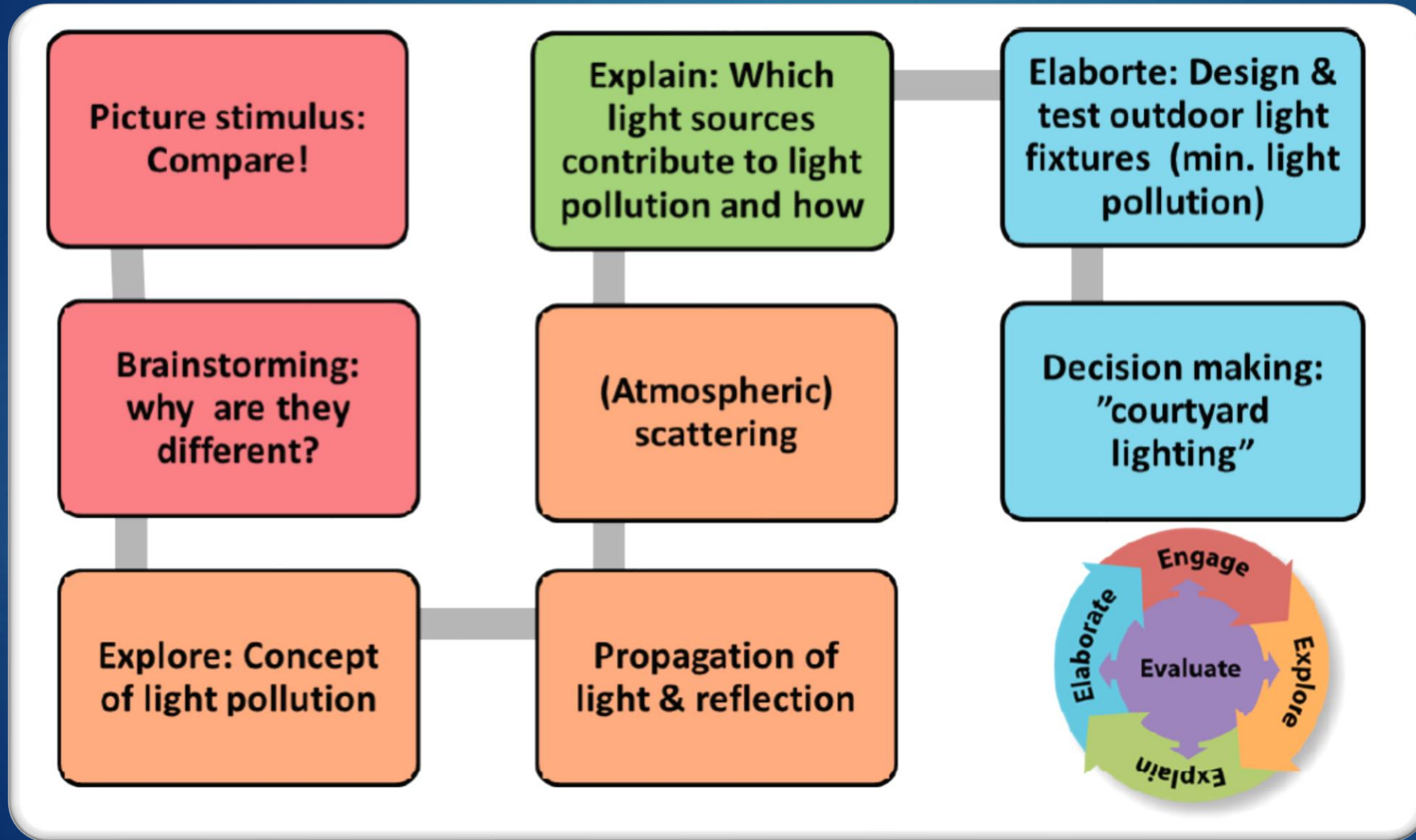
- ▶ **Feel:** Students identify problems or challenges in their local communities. Students observe problems and try to engage with those who are affected, discuss their thoughts and ideas of solution in groups, and plan of action, based on scientific evidences.
- ▶ **Imagine:** Students envision and develop creative solutions that can be replicated easily, reach the maximum number of people, generate long-lasting change, and make a quick impact. They are meeting external actors, they are looking for data to support their ideas and they are proposing a series of solutions.
- ▶ **Create:** Students are implementing the project and they are interacting with external stakeholders to communicate their findings.
- ▶ **Share:** Students share their outcomes through posters, scientific papers, text, photos, video, or slideshows as members of the Dark Sky Rangers community.

Pedagogical framework (Inquiry-based approaches)



- ▶ **Use constructivist approaches** to learn in general as well as an emphasis on a context-oriented or competence – oriented structure of the learning path.
- ▶ Provide the **engage-phase to grasp the phenomenological aspect of light pollution and problems connected to its existence**. Only after this cognitive activation and the generation of problem awareness, students are supported to acquire relevant scientific knowledge to identify questions and to draw evidence-based conclusions.
- ▶ For structuring the learning paths in such a way, **inquiry-based approaches will be used** (5E-Model - engage, explore, explain, elaborate, evaluate).

Pedagogical framework (Inquiry-based approaches)

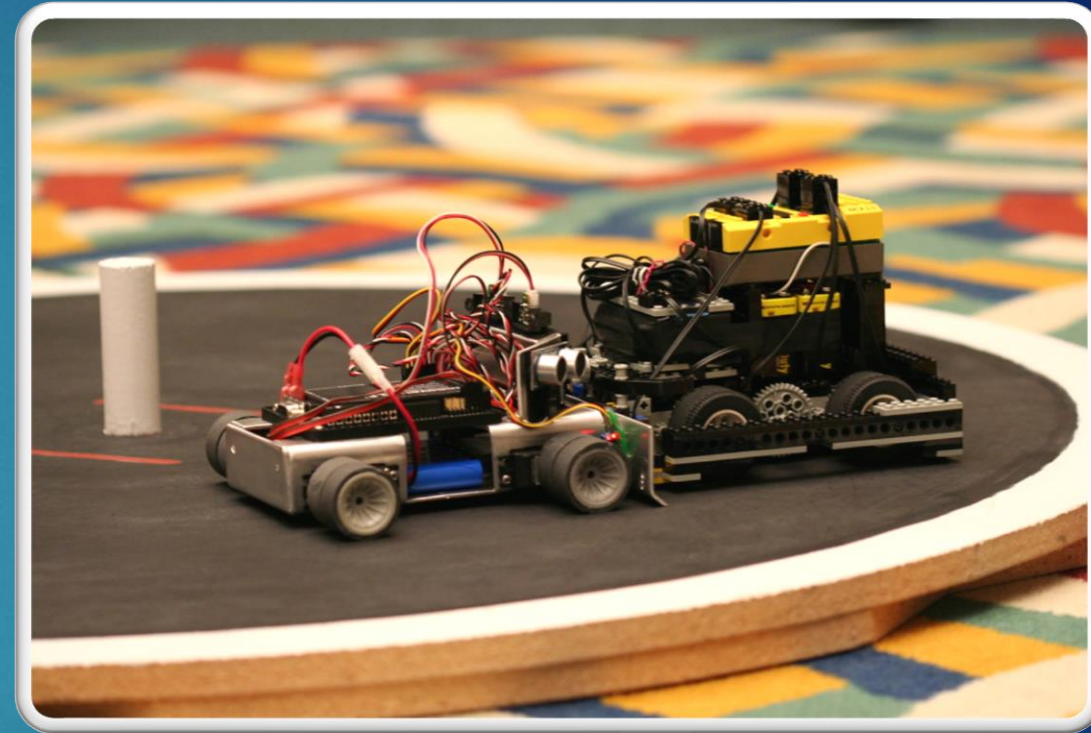


Source:
Haagen-
Schützenhöfer and
Kopper, 2019

Pedagogical framework (Engineering approaches)



1. **Define:** Explore, discuss, and build understanding of the problem (4 hours).
2. **Deeper investigation** about the problem (4 hours)
3. **Devise:** Create a plan to solve the problem (3 hours)
4. **Select** the best possible solution (1.5 hours)
5. **Code** implementation or **prototype** co-creation (5 hours)
6. **Solutions** test and evaluation – Review and Revise (2 hours)
7. **Communicate** results (2 hours)



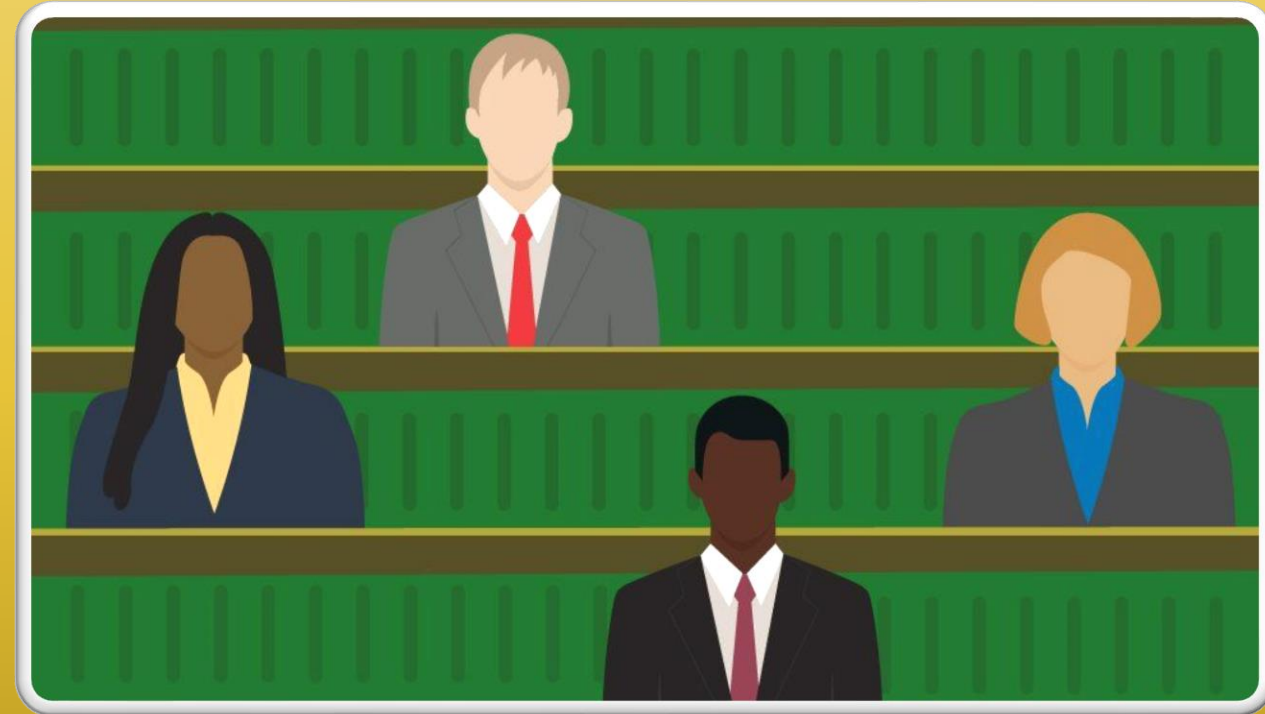
**Robotics Competitions –
Coding and Engineering skills**

Pedagogical framework (21st century skills)



► Debate science & 21st century skills

1. Develop critical thinking skills
2. Demonstrate collaboration, consensus building and cooperation
3. Apply skills in oral, visual and written literacy
4. Synthesize and communicate information
5. Develop media literacy skills
6. Demonstrate decision-making and problem-solving skills



Students' Parliament

Pedagogical framework (Green skills)



GreenComp: The European sustainability competence framework by JRC

12 competences organised into the four areas below:

- **Embodying sustainability values, including the competences**
 - valuing sustainability
 - supporting fairness
 - promoting nature
- **Embracing complexity in sustainability, including the competences**
 - systems thinking
 - critical thinking
 - problem framing
- **Envisioning sustainable futures, including the competences**
 - futures literacy
 - adaptability
 - exploratory thinking
- **Acting for sustainability, including the competences**
 - political agency
 - collective action
 - individual initiative





Thank you!

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