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Theme: Measurement and Modeling

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How the erosion of natural darkness affects tree-covered urban areas worldwide

Our approach
Background

Light pollution significantly impacts urban green areas › affecting ecosystems and people who use these spaces for recreation and nature connection.

The 2021 G20 summit proposed planting 1 trillion trees by 2030 to restore urban nature › emphasizing urban forests' roles in carbon absorption, biodiversity conservation, heat island mitigation, and water cycle regulation.

ALAN interferes with natural tree cycles › reducing carbon sequestration and increasing vulnerability to environmental stressors.

Public lighting enhances perceived safety, walkability, and inclusivity in urban green spaces, with significant gender-related differences › highlighting the complex interplay between street lighting, vegetation, and the balance between ecological and social needs

While research on ALAN's effects on plant physiology and phenology is growing, studies remain limited › compared to those on humans and wildlife, highlighting the need for more research in urban, suburban, and natural settings.

Most studies on the ecological impact ALAN on plants are conducted in laboratory or field settings › highlighting the importance of exploring remote sensing technologies to assess these effects on a broader, scale.

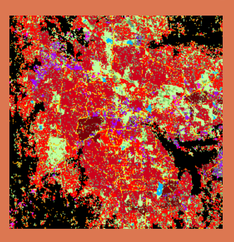
The challenge of light pollution in urban green areas: **mapping hotspots and coldspots**

Light pollution increasingly disrupts urban green spaces, impacting ecological processes essential for tree health, biodiversity, and carbon sequestration. While urban forests are key to sustainable cities—offering climate regulation, biodiversity support, and social benefits—ALAN alters natural cycles and threatens these functions globally. This study uses **remote sensing data**, combining Copernicus urban mapping and ESA tree cover datasets, with NASA satellite night-time light imagery from 2013 to 2023 **to assess global trends in light pollution over tree-covered urban areas**. Results reveal a general increase in light pollution, especially in Asia, while Europe shows a decreasing trend. These findings highlight the urgent need for integrated urban planning that balances ecological integrity and social safety in urban green infrastructure.

Method
Dataset and Workflow

Google Earth Engine

1 Identify cities



GHSL Data Package 2023
Build-up surface
Building height
Build-up volume
Settlement characteristics
Population

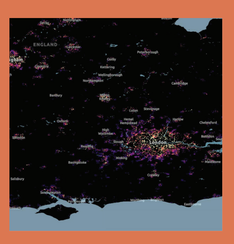
Class 30 «Urban centre»
A 500 m resolution map was produced to identify urban areas. Regions with at least 20% urban classification (from the Copernicus Global Human Settlement Layer) were marked as cities. Areas smaller than 10 pixels (2.5 km²) were excluded, and small non-urban gaps within cities were reclassified as urban.

2 Identify urban forests

ESA WorldCover 10m 2020 -2021
Based on Sentinel-2 and Sentinel-1 constellations
10 land cover classes + mangroves
10m resolution
77% overall accuracy

Class 10 «Tree cover»
tree-covered areas were identified using the ESA World Cover dataset.

3 Light pollution trend 2013-2024

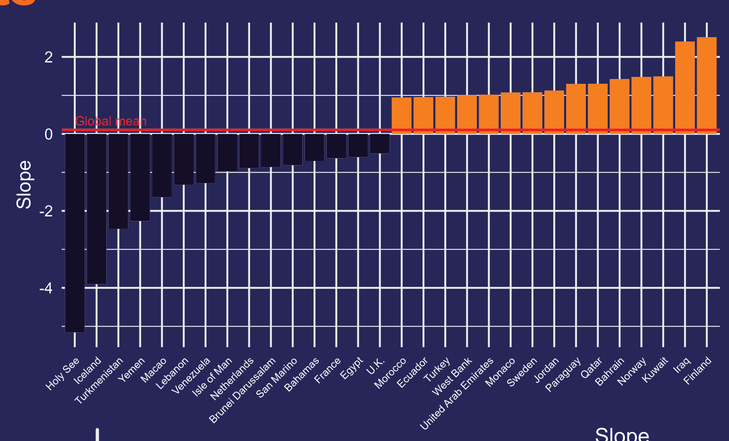


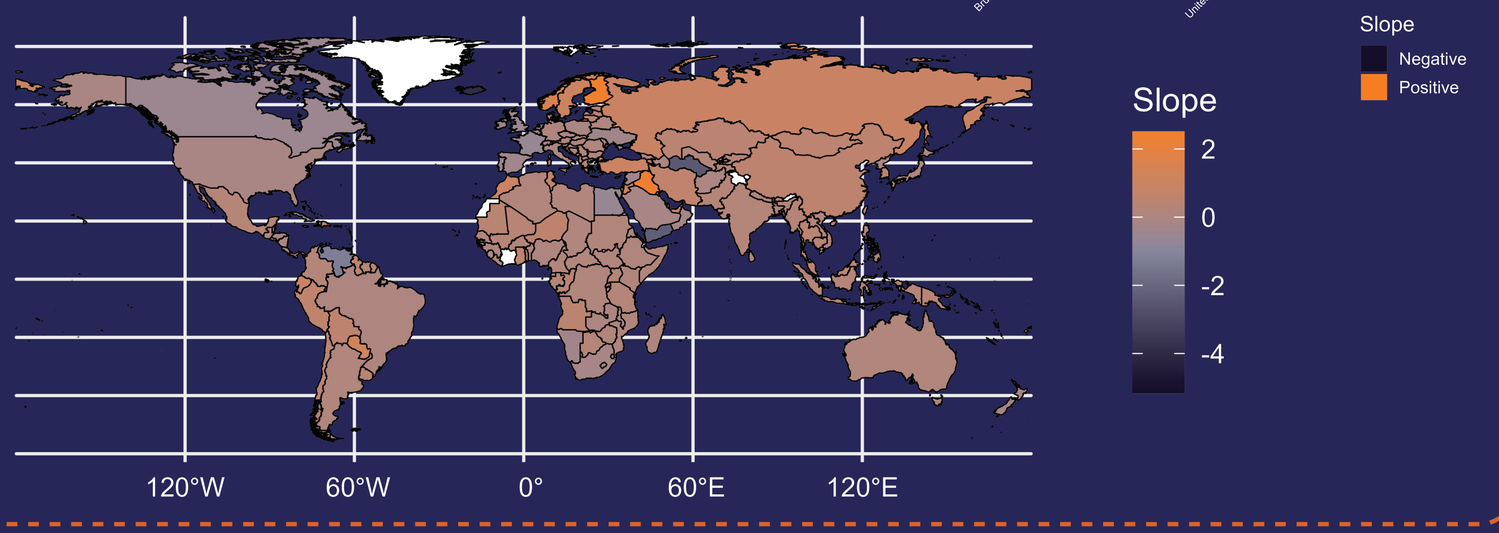
Suomi NPP VIIRS DNB Annual VNL V2.2 – 2022
Global coverage
15 arc second (~500m at the Equator)
EPSG:4326
Cloud-free average radiance [nW/sr/cm2/]
Masked* (sunlight, moonlight, clouds, fires, aurora, background)

500m Slope
A time series from 2013 to 2023 was analyzed using linear regression to assess changes in light intensity for each pixel, with trend reliability evaluated through p-values and the Pearson correlation coefficient.

Global trend of light pollution in urban green areas (2013-2023): **preliminary results**

Preliminary results show that **the average trend** (i.e., the slopes of the linear regression), **is growing globally in the studied period (0.103)**, with **the biggest increasing trend in the Asian continent (0.216)**, led by Western Asia region. The **opposite trend was observed for the European continent (-0.104)**, where Southern Europe region registered the largest decreasing trend in light pollution (-0.378), especially in smaller states. In detail, at the country level, the **top five increases are recorded in Finland, Iraq, Kwait, Norway and Bahrain** (from highest to lowest). On the opposite, **the five countries recording the largest decrease are** – in order – **Holy See, Iceland, Turkmenistan, Yemen and Macao**. Overall, half of the investigatedcountries reported a trend above the global average value.





Possible key applications

- Multiscale approach
- Multitemporal data integration
- Comprehensive urban green mapping
- Support for Nature-Based Solutions (NBS)
- Species selection guidance, urban green planning
- Cross-pollutant analysis
- Adaptive lighting strategies
- Policy relevance
- Predictive analysis for future light pollution trends and ecological impacts

10 years of ALAN in Westport

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