Mitigating Light Pollution: LED street lighting and public demonstration

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Introduction

Light pollution is a **key environmental issue** with wide-ranging effects on human health, animal habitat, and observational power. Commonly used LED street lighting is energy efficient but contributes greatly to ALAN (Artificial Light At Night), which has increased by **10% annually** in recent years [1].

Skyglow is caused by light dispersing upwards into the atmosphere and obscuring dark sky features [2]. Ways to mitigate skyglow caused by LED sources are investigated.

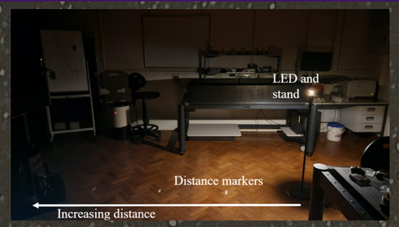
Public awareness studies have not focused on addressing laymen opinions [3]. A **public demonstration** of light pollution against a projected dark sky image is performed and its effectiveness tested.

Full research report

Part 1: LED source to mitigate skyglow

Methodology

LED source illuminance is measured, as it adjusts for human vision. The following are varied: a) size of 8 **model hoods** placed over the source, and b) **light color**, quantified by wavelength. The model hoods aim to **block light dispersion**, with illuminance measured at parallel height to and above source.

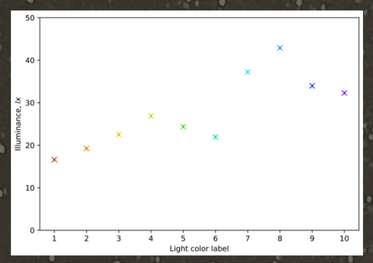




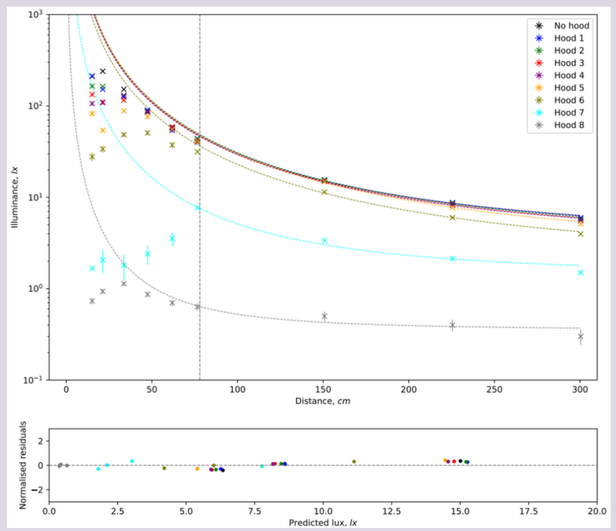
LED source findings

Flat disc-shaped hoods reduce average illuminance by 5% - 12% at parallel height. The largest hood, covering ~80% of the source, **reduces average illuminance by 96%** at parallel height and **reduces upwards dispersion** for all distances, remaining below 5lx.

Blue colors measure **5lx to 20lx higher** illuminance than red-orange colors.



Recommended LED source uses the **largest hood** and **orange light** to reduce upwards light dispersion and perceived brightness to humans, mitigating skyglow.



Part 2: Public light pollution demonstration

Methodology

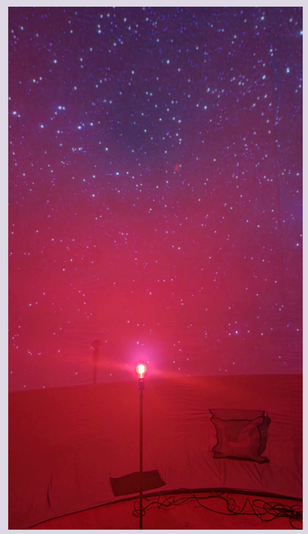
Participants are **surveyed** before and after the demonstration. LED sources of varying colors and hood sizes are placed against a projected local dark sky image. Participants use a scoring system to note how far each source changes image visibility. After, they provide Likert-scale statements about demonstration effectiveness.





Demonstration findings





Research questions:

RQ1. Does exposure to a light pollution demonstration change people's awareness, concern, or attitudes towards light pollution?

RQ2. How closely do percieved visibility scores match the trend for the same sources in Part 1?

RQ3. How effective and realistic is the demonstration method in simulating visual light pollution?

Outcomes:

RQ1: Wilcoxon effect sizes indicate potential for change with a **larger sample size**.

RQ2: Visibility scores **strongly agree** with illuminance data.

RQ3: 89% of participants agreed that the demonstration was **engaging** and 67% that it increased their awareness of the effects of light pollution.

Conclusions and References

Investigating illuminance reduction in LED sources shows that large hoods covering >75% of the source reduce upward flux and light dispersion by up to 96%. Orange-yellow light reduces perceived brightness by 5lx to 20lx. Demonstration method is found to be effective as a small-scale simulation of light pollution due to 89% participant satisfaction and agreement with illuminance data, though inconclusive Wilcoxon tests suggest insufficient sample size. Future studies should be repeated using color temperature to quantify results, larger datasets and larger participant sample size.An educational approach is suggested, with the demonstration used as an illustrative method.

[1] Falchi, F., et al. (2023); [2] K. J. Gaston., et al. (2012); [3] Lyytimaki, J. (2013). Night sky image, Methodology section: Dan Monk, Kielder Observatory.

Full research report: Laidlaw Scholars Network, Katarina Božić. Digital poster: LinkedIn, Katarina Božić.