Product-Based Light Pollution Mitigation Through Local Streetlights

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In what ways can light pollution be mitigated through preexisting outdoor light sources in cities?

Abstract

The purpose of my research is to provide a product to reduce light pollution that requires minimal to no effort for businesses or cities to implement. My specific goal is to develop an easily implementable, sustainable and adaptable outdoor light cover that reduces the light emitted upwards on common streetlights throughout cities, neighborhoods, and other communities. My chosen research method is a mixed-method study revolving around the light emitted by streetlamps in downtown Alpharetta. Developing a solution to outdoor light pollution that can be easily implemented without requiring lengthy discussions of why light pollution matters can change the way others approach light pollution, reducing its damage quickly and easily.

Background

The topic of my research is light pollution, specifically skyglow, a recently discovered effect of Artificial Light at Night (ALAN) that results in a very bright night sky with almost zero stars visible. Skyglow is an incredibly widespread type of pollution, with around only 19% of the entire population left unaffected (Mehmedinović and Heffernan). ALAN has serious impacts on the environment, disrupting the circadian rhythm of animals in the wild and severely impacting animals who rely on a biological cycle, causing them to develop disorders involving sleeping, finding food, reproducing, hibernating, or migrating (Górniak-Zimroz et al. 4). Animals are not the only organisms to be affected by these issues, as many humans can suffer from a suppression of the production of melatonin which may cause obesity, diabetes, and even breast cancer (Górniak-Zimroz et al. 4) (Mehmedinović and Heffernan). My project aims to target the lack of awareness surrounding this issue through a simple and easy to implement solution.

Górniak-Zimroz, Justyna, et al. “Light-Pollution-Monitoring Method for Selected Environmental and Social Elements.” Remote Sensing, vol. 16, no. 5, Jan. 2024, p. 774, https://doi.org/10.3390/rs16050774.

Mehmedinović , and Heffernan. “SKYGLOW - Light Pollution Awareness Project in Collaboration with International Dark-Sky Association.” SKYGLOW, skyglowproject.com/.

Materials & Methods

Materials

The materials used for this project included a lux meter, which measures light in lux units, tripod stand, ladder, and a 3D printer. Each light fixture was measured three times due to an inaccuracy in the first method I was utilizing to measure them, and the ladder and tripod stand provided additional reach for me to achieve adequate measurements. Alongside this hardware, I utilized the software SolidWorks and Microsoft Word. SolidWorks allowed me to create the models.

Method

My procedure for my research involved collecting data and developing a prototype for an adaptable light cover that will successfully work to reduce light pollution on nearly every common streetlamp design available. I began by utilizing a lux meter to measure the light emitted upwards by several streetlamps in downtown Alpharetta in lux units, standing on the ladder and attaching the tripod to the lux meter to supplement the height needed to reach the top of the street light. The gathering of this data was done with express clearance from the city. Once I collected and analyzed this data, I utilized SolidWorks to develop CAD model prototypes of light covers. These models were specifically built to be adjustable and adaptable to the specific light. These designs were tested by simulating the environment and the fixture dimensions in which the data was taken. Any prototypes that failed to provide any reduction or increased the amount of lux levels emitted upwards were eliminated. The prototypes were improved with each iteration of the design until a final, optimal prototype design was reached. This final prototype was tested in a similar environment to where the original data was gathered, and its lux level reduction was noted. The first values were compared to the new values, and the success of the project was determined based on the values obtained from the final test.

Data

	Maximum Lux Level
Light 1	1258
Light 2	1387
Light 3	1516
Light 4	1421
Average	1395.5

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Results

The final prototype is displayed. I spent time refining the final model and went through several iterations, implementing the advice I was given by astronomer John Barentine and focusing on the adjustment aspect of the project. I ended up with a functional model that effectively reduces lux levels with its design structure, and is modular and can be adjusted with future iterations. The angle of the shade can be adjusted on a ball joint, and the attachment piece is a screw that snaps onto the top point of the streetlight, allowing the ball joint to be screwed on to ensure a secure hold. The curved pieces of the shade attach on a modular scale, and different sized shades can be attached to fit the needs of the consumer. The potential implementation of this product around downtown Alpharetta could involve contracting with a manufacturing company before selecting the size of the base and the shade that they need, which could be mass produced to fit all streetlights specifically. Ideally, this design would be made of stainless steel, which has adequate heat resistance for a streetlight. The implementation of this product would be simple. Manufacturing costs would be elevated if stainless steel were used, but the longevity of the product earns this loss back. The product screws on easily to the light posts, leaving an easy installation for those looking to employ it.

Future

This research project resulted in a proof of concept prototype. However, during the development of this prototype, limitations were encountered that included a lack of access to the full blueprints of the city’s streetlights and the inability to access the modeling software off campus. This prototype could be further developed if access to the specific blueprints of Downtown Alpharetta’s streetlights was obtained, as it would allow for more specific modeling and adjustment of the original design. Additionally, more expansive access to the modeling software used for this project would allow development to happen much quicker, and would aid in producing quicker iterations of the prototype. Further solutions to light pollution exist in many places, and the city is just one place to begin. Restricting planned lights in building designs, reducing the amount of light turned on at night, and lowering the base brightness of car headlights are all steps that could be taken in the future to aid in reducing light pollution. This new type of pollution does not have to block out the sky, but can be easily regulated and reduced with the help of supporters everywhere.