PROPOSAL

It is our primary goal to comprehend the dark night sky as a common pool resource, as this may lead to unexpected solutions.

In economic terms, a common-pool resource (CPR) is defined as a good that exhibits characteristics of both a private and public good.

Importantly, a CPR is both rivalrous in consumption and non-excludable.¹

To be rivalrous means that when someone consumes a unit of the good, this good is no longer available for someone else's consumption. Secondly, a good is considered non-excludable when individual consumers are unable to prevent others from also consuming the good.¹

The key to CPRs is that they provide diminished returns to the group of individuals who use the resource for their own self-interest. This often leads to what is called the tragedy of the commons. This tragedy is often best portrayed through the parable of two herders grazing their respective cattle in a common lush pasture. In summary, the thinking for the rational herder is clear: "each herder receives a direct benefit from his own animals and suffers delayed cost the deterioration of the commons when his and other's cattle graze."² work to explore how this way of thinking allows for city planners, designers, architects, and the community to understand the issues surrounding light pollution as a type of appropriation – most evidently, the consumption of the night sky.

The night sky is rivalrous because illumination (the opposite of darkness) is additive. A dark environment (resource unit) is what allows for nighttime illumination, whether it is for façade lighting, sports lighting, or digital advertising. Light pollution is the additive effect of spill light illuminating the sky and has a subtractive effect of our view (consumption) to the night sky. This is most readily evident in urban areas with little lighting control, a prime example of the tragedy of the commons realized.

Importantly, the night sky is not historically scarce; however, with advancing lighting technologies, cheap electrical energy, and more construction, it is now reasonable to consider it



In short, by each herder acting in his or her own self-interest, the pasture will eventually be completely devoured; hence, there is nothing left for the herds.

In what follows, we will claim that the night sky should be considered a CPR. While this may seem abstract at first, it is the intent of this scarce (see next section).

The night sky is non-excludable because anyone can look upwards and no one individual can prevent another from consuming (viewing) the dark sky and stars.

To think of the night sky as a CPR means thinking of it not as something to overcome but instead consumed for our own self-interest via light pollution.

RESEARCH

Research highlights the impact of light pollution and its relation to climate change, biodiversity, environmental equity, and our ethical connection to the natural world.

GREEN NEW DEAL SUPERSTUDIO



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AIR QUALITY is directly impacted by the presence of nighttime light and its unwanted suppression of the nitrate radical, a key factor in cleansing the nighttime air of emissions, smog, ozone pollution, and irritants.³ These radicals require darkness to perform their processes.

ENERGY usage from light power consumption and fabrication accounts for 15% of global electricity consumption and 5% of worldwide greenhouse gas emissions.⁴ LEDs have doubled the amount of carbon dioxide emitted making tech-heavy fixtures, controls, and sensors.⁵





Photo by Blair Witherington. Source : https://variancelighting.com/led-to-reduce-the-impacts-of-artificial-light-on-wildlife/



NATURAL life cycle processes such as bird migration, turtle orientation, plant cycle growth, and insect populations which have traditionally relied on moonlight and starlight have now become confused and negatively impacted by light pollution.⁶

ETHICAL REFLECTION has lead theorists to consider the impact of losing our sense of connection with the night sky. In fact, 99% of people in the USA and Europe cannot see the Milky Way and most Americans will never experience true darkness where their eyes fully adjust.⁷

JEDI research has uncovered social inequities in light pollution exposure across urban-rural areas. Low-to-mid socioeconomic residential areas and groups of varied ethnic backgrounds are exposed to more night light, which could lead to environmental influences on health disparities.⁸

NIGHT SKY AS A COMMON POOL RESOURCE



Photo by Cestomano via Flickr (CC)

GREEN NEW DEAL SUPERSTUDIO PA | H () R () R () A

Generate potential solutions to overcome the tragedy of the commons, utilizing both regulation and collective action.



DESIGNERS



BUSINESS

Light pollution applies at many different scales – urban and residential – and across many market sectors – sports, advertising, architecture, and transportation infrastructure.

Both Garrett Hardin and Elinor Ostrom are well-known for their proposed solutions to the tragedy. Hardin proposed central agency regulation or the "Leviathan" way as well as the privatization or private property rights way. Regulation is "top-down government regulation or direct control of a common-pool resource. Regulating consumption and use, or legally excluding some individuals, can reduce over-consumption..." Privatization is when private property assignments are made on said CPRs, effectively converting a common-pool resource into a private good.¹

Ostrom pointed out how optimally achieved regulation is based on assumptions "concerning the accuracy of information, monitoring capabilities, sanctioning reliability, and zero costs to the administration...without valid and reliable information, a central agency could make several errors."² Privatization suffers from similar issues and is challenged to delineate rights on nonstationary resources² or hard-to-define boundaries such as the night sky.

Ostrom proposed an alternative solution through collective action in her seminal book Governing the Commons. Through collective action, "individuals making binding contracts to commit themselves to cooperative strategies that they themselves will work out."2 There is much to be learned and investigated here in regards to light pollution.

Night Sky

Public and private institutions are intermeshed and depend on one another, therefore we must carefully investigate the structures of the system and all parties involved.

COLLECTIVE ACTION: CITY NIGHT SKY "RATING"



Education and garnering an invested interest in the night sky is the first step towards collective action. Translate existing metrics such as the Bortle scale, which is well understood by scientist and astronomers, into a metric that is easily accessible and comprehensible by the public. Adopt these into location "scores" via web apps.



COLLECTIVE ACTION: PRODUCT DEVELOPMENT



Streetlight illumination can account for approximately 14-20% of the urban sky glow.9 Manufacturers and designers should produce and specify streetlights that create an infrastructure to proactively preserve the dark night sky. This conceptual prototype



Distance to travel to see Big Dipper: 45 miles Distance to travel to see Milky Way: 100 miles

WHAT IS MISSING FROM

PUBLICLY AVAILABLE CITY DATA

C-

streetpole utilizes the latest-and-greatest technology to both measure and control light

ADJUSTABLE OPTICS

Mechanical devices positioned in lamps are automatically controlled by a timeclock device to reduce uplight at a pre-defined citywide curfew.

Lighting will transition from aesthetically pleasing and prominent to solely functional, disabling all potential for light above 90 degrees.

FINE-TUNED COLOR SPECTRUM

Biodiversity can inform LED spectrum production. By applying tuned color spectrums based on the visual sensitivity curves of adjacent wildlife, we can craftfully avoid disturbances to the natural habitat.

SKY QUALITY METER -

Integrated into every 4th streetlight, this device monitors night sky brightness by reporting data on local environmental light conditions.

We can use this reporting method to track relative changes as new site and area lighting offenders significantly add to collective light pollution.

SMART CONTROLS

Occupancy and vacancy controls will be integrated into all lights, with slow-dim settings to be set at 10% output during typical night hours and ramp up output only as needed, saving energy and mitigating sky glow.

We can also re-think street illumination for the eventual prevalence of autonomous vehicles by providing light predominantly for pedestrian safety while allowing vehicle sensors to navigate darker environments.



Image Snip from "What is Intelligent Lighting?" by TVILIGHT SMART CITY LIGHTING

NIGHT SKY AS A COMMON POOL RESOURCE

SMITHGROUP

Photo by Tyler Nix via Unsplash, photo by Bernard Hermant via Unsplash, photo by Peter Stumpf via Unsplash



CENTRALIZED REGULATION: AREA COMPARISON

Gather better and more detailed data to inform governmental, institutional, and financial decisions. One of the most challenging aspects of reducing light pollution is quantifying and tracking the night sky resource at a detailed level in order to enact these ideas. "Although night-time light has long been viewed as a proxy for economic activity at coarse resolutions and large units (countries and their sub-regions), the underlying mechanism connecting economic activity and artificial light has not been explored yet at high spatial resolutions and at the building level, because of the limitations of existing night-time sensors."¹⁰ We propose three major avenues:

A - Use detailed satellite imagery to create a competitive B - Employ drones to evaluate and report light pollution C - If all projects complied with the Model Lighting benchmark for different municipalities. Cross-reference at a higher resolution. Satellite imagery is limited in Ordinance Guidelines, would cities still experience GIS (Geographic Information Systems) Modeling data tracking light pollution to individual parcels or areas. light pollution? Leverage Machine Learning to model to analyze how cities and municipalities of similar Partner with organizations such as Google to develop a thousands of theoretical building/facade designs parcel/zoning compositions perform relatively better nighttime version of Google Earth or maps. Hire local to calculate average lumens emitted from site or sky or worse than others. What are these local areas doing people to become dark sky advocates and monitors. differently? What systems or policies are producing true light pollution mitigation?

luminance contribution. Generate data base to understand what a particular project construction type is expected to emit and multiply by parcel area (based on GIS data) to scale upwards and project cites' performance.

Light Pollution from Satellite Imagery



Light Pollution from Satellite Imagery (Zoomed) Radiance info (2020) Coordinates: 47.62075, -122.32420

EXAMPLE OF PROJECTED LIGHT EMISSION BY PARCEL



Parcel Data Base Zone: MIO-240-HR (M) Present Use: Office Lot Area: 15,360 Sq. Ft. Lumens at Property Line: 5,000,000 Avg. Sky Luminance Contrib: 1.07 cd/m² Data above is fictional and for illustrative purposes only.











ttle Department of Construction & Inspections

CENTRALIZED REGULATION: INDIVIDUAL TAX INCENTIVES



Utilize quantifying techniques such as calculation modeling during design and drone-measured environmental impact verification after construction; the government can leverage tax incentives based on this data to kick-start individual and business rebates that encourage public support. At a residential level, develop a culture of reasonable neighbourhood care and monitoring to help establish a darker local sky condition. Home owners could receive similar tax incentives for taking steps to reduce light pollution.

STEP 1 : Compliance Calculations

STEP 2 : Drone Impact Verification **STEP 3 :** Tax Rebates







AGI32 Image by Lighting Analysts

Photo by Goh Rhy Yan on Unsplas

Further Resources

For a deeper dive into the research and development of these topics, please visit the websites listed below. We are grateful for their work and continued research into the exciting topics, however please note that these organizations are not affiliated with nor have they endorsed this proposal.

International Dark-Sky Association - https://www.darksky.org/ Illuminating Engineering Society - https://www.ies.org/ International Association of Lighting Designers - https://www.iald.org/ Light Pollution Map - https://www.lightpollutionmap.info/

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