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**ILLUMINATING THE PATH TO SUSTAINABLE SKIES: A Study
on Light Pollution and Environmental Impacts**
Syamala Kandadai & Dipendu Das

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ILLUMINATING THE PATH TO SUSTAINABLE SKIES: A Study on Light Pollution and Environmental Impacts

Syamala Kandadai & Dipendu Das***

[Abstract: *Light pollution, a pervasive consequence of urbanisation and industrialisation, result in a significant danger to the human health, environment and biodiversity. Excessive or inappropriate use of outdoor artificial lighting, known as light pollution, disturbs natural wildlife behaviours and contributes to rising CO2 levels, disrupts human sleep and obscures the beauty of the night sky with four primary forms: glare, skyglow, clutter and light trespass. This article examines the issues of light pollution and the cross-jurisdictional regulations for dealing with the problem of light pollution. It also provides few possible directions in which solutions may be identified for sustainable environmental protection.*]

I

Light Pollution: A Brief Overview

Light pollution, a pervasive consequence of urbanisation and industrialisation, result in a significant danger to the human health, environment and biodiversity. Excessive or inappropriate use of outdoor artificial lighting, known as light pollution, disturbs natural wildlife behaviours and contributes to rising CO2 levels, disrupts human sleep and obscures the beauty of the night sky with four primary forms: glare, skyglow, clutter and light trespass. The misdirected and excessive artificial lighting pollutes the natural darkness which disrupts natural ecosystems and wildlife, causing behavioural changes in the wildlife. It also has profound implications for astronomical observations and energy consumption. Impact involves the change of sleep patterns, loss of sleep, increase of stress and rapid alteration to circadian rhythms resulting in unnatural hormone production. Excessive artificial lighting is rapidly affecting the symbiosis

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which is essential to plant pollination for germination and further negatively impacting amphibians' reproduction habits and foraging.

According to a published study of Science Magazine from 2023 titled, "Citizen scientists report global rapid reductions in the visibility of stars from 2011 to 2022", written by Christopher C. M. Kyba noted that from 2011 to 2022, there was an annual decrease of 7 to 10% in the number of stars visible in the night sky. This translates to a significant reduction over a decade; for instance, a location witnessing 500 visible stars in 2011 would have experienced a decline to around 200 stars by the end of that period. The International Dark-Sky Association claims that more than four-fifths of the global population resides in areas with light pollution, resulting in the disappearance of the Milky Way from view. In the United States alone, light pollution wastes an estimated \$3 billion annually in energy costs and contributes to the emission of millions of tons of CO₂ into the atmosphere.¹

In January 2019, a study was published in *Urban Climate Journal* which noted the steady rise of increasing brightness in various parts of India from 1993 to 2013 where New Delhi, Telangana, Maharashtra, Karnataka and Uttar Pradesh experienced an increase in 'very high light pollution intensity' during this period.² In cities such as Bangalore, India's bustling corporate hubs, there's been a noticeable surge in nighttime illumination, leading to a concerning issue of light pollution. Data from NASA's Blue Marble Navigator, depicting nighttime light distribution, reveals a consistent escalation in light pollution levels within Bangalore over time. A study conducted in 2021 focusing on light pollution underscores Bangalore's position as the third-most affected city in terms of light pollution coverage nationwide. Additionally, Karnataka, the state in which Bangalore is located, has been flagged for a significant uptick in 'very high light pollution intensity' from 1992 to 2013.³

¹ *Light pollution wastes energy and money and damages the climate*, DARK SKY INTERNATIONAL, available at: <https://darksky.org/resources/what-is-light-pollution/effects/energy-climate>

² *How to dark sky parks tackle the growing problem of light pollution*, DOWNTOEARTH (Jan. 19, 2024) available at: <https://www.downtoearth.org.in/pollution/how-do-dark-sky-parks-tackle-the-growing-problem-of-light-pollution--93999>

³ *Time to turn the lights off*, THE SOFTCOPY (Mar. 7, 2024) available at: <https://thesoftcopy.in/2024/03/07/time-to-turn-the-lights-off/>

II

Laws relating to Light Pollution: Cross-Jurisdictional Study

Several European nations such as Italy, Slovenia, Spain, France and Croatia have enacted laws at both regional and national levels to address the issue of light pollution.⁴ Other States within the European Union have established regions that enjoy protected status due to their pristine dark skies.⁵ In 2002, the Czech Republic made history within the European Union by enacting national legislation aimed at mitigating light pollution. Followed shortly by Slovenia in 2007 with the enactment of *the Slovenian Decree on limiting values of light pollution*. In 2005, the United Kingdom passed *the Clean Neighbourhoods and Environment Act* criminalising light pollution. In Scotland, flight light pollution now falls under the Public Health Act (Scotland Act 2008). In Northern Ireland, it is part of the Clean Neighbourhoods and Environment Act 2011. In 2015, the European Union launched its STARS4ALL project with the aim to inform and aware people about light pollution while also promoting approaches to mitigate the problem. Catalonia introduced a series of measures in the early 2000s targeting the issue of light pollution. Similarly, France took a significant step forward on 1st January, 2021 by enacting highly advanced regulations aimed at preserving the natural darkness of the night sky.

In January 2019, the European Union updated the Green Public Procurement Criteria for Road Lighting and Traffic Signals (GPP) with the aim of decreasing light pollution, cutting down on energy usage and enhancing the long-lasting quality of fixtures. At present the GPP employs on the principle of 'As Low As Reasonably Achievable (ALARA)' which aligns with the *Low Impact Lighting (LIL)* standards of German, Italian and Slovenian member States of the European Environmental Bureau. The appropriate light levels for traffic signals and road lighting are standardised by ALARA.⁶ The GPP provides the *Ratio for Upward Light Output (RULO)*, recommending lighting to be rated with a 0.0% RULO. It also discusses constraints on Correlated Colour Temperature due to concerns about environmental and disturbance effects caused by blue light. It requires light sources to have a CCT of 3000K or lower and restricts the G-index, which

⁴ Anthony Di Domenico, *European Union Adopts New Guidance to Reduce Light Pollution*, ENVIRONMENT PROTECTION (Dec. 6, 2019) available at:

<https://eponline.com/articles/2019/12/06/european-union-adopts-new-guidance-to-reduce-light-pollution.aspx>

⁵ *European Protected Sites*, European Environment Agency, available at:

<https://www.eea.europa.eu/data-and-maps/explore-interactive-maps/european-protected-areas-1>

⁶ A.W.K. Yeung, *The "As Low As Reasonably Achievable" (ALARA) principle: a brief historical overview and a bibliometric analysis of the most cited publications*, RADIOPROTECTION (2019), available at:

<https://www.radioprotection.org/articles/radiopro/pdf/2019/02/radiopro190010.pdf>

is linked to blue light emission, to a maximum of 1.5 in environmentally fragile regions and 2.0 within 100km of an astronomical observatory. Additionally, it mandates that installed luminaires must be marked with RULO, G-Index, CCT, input power, flux codes and dimming control details, following the outlined guidelines.

In United States of America, at least 19 states, have laws or regulations relating to *'dark skies'* in order to reduce light pollution and provide protection from unnatural artificial lighting. In 2021, there was significant legislative activity across 17 states regarding light pollution and preserving dark skies, with 40 bills introduced for consideration. Many municipalities within these states have also integrated light pollution regulations into their zoning ordinances. These regulations predominantly focus on outdoor lighting fixtures on state property or public roads. Typically, these laws require the installation of shielded fixtures that direct light downwards, aiming to reduce light pollution. Transitioning from unshielded to fully shielded fixtures often allow for the use of lower wattage bulbs, leading to energy savings. Furthermore, some regulations may stipulate the use of low-glare or low-wattage lights, impose restrictions on the duration of light usage and incorporate standards from the Illuminating Engineering Society (IES) into state regulations. Arizona State, known as a worldwide hub for astronomy, enacted light pollution law in 1986.⁷ The regulation mandates that all exterior lighting fixtures be either fully or partially shielded, except for emergency, construction and airport navigational lights. Non-compliant fixtures are permitted if they are automatically turned off between midnight and sunrise. In Colorado, new outdoor lighting fixture installation mandates individual accountability for expenses, energy efficiency, reducing glare, limiting light pollution and maintaining the natural night sky.⁸ A "full-cutoff fixture" must be used when output is greater than a certain number of lumens.

Several other states have aimed to promote such regulations at the community level. For instance, New Hampshire has prioritised maintaining dark skies to enhance its rural charm. Consequently, state legislation motivates local governments to implement rules and policies that conserve energy and reduce excessive night lighting.⁹ Coastal states express worry over how beachfront lights affect birds and sea creatures. In Florida, a comprehensive lighting rule serves as a blueprint for local authorities to develop measures protecting nesting sea turtles.¹⁰ Texas is alone in its focus on reducing light pollution around military bases. Back in 2007, the Texas Legislature updated a law about outdoor lighting, allowing counties to regulate outdoor lighting within a five-mile radius of a military base if the military asks for it.¹¹ The rule is relevant solely to nations that have a minimum of five military installations and a population exceeding one

⁷ Ariz. Rev. State. Ann. Section s 49-1101 et seq.

⁸ Colo. Rev. Stat. Sections 24-82-901 et seq.

⁹ N.H. Rev. Stat. Ann Section 9-E:3.

¹⁰ Fla. Stat. Section 161.163; Fla. Admin. Code Sections 62B.55.001 et seq.

¹¹ Tex. Local Government Code Ann. Section 240.032.

million, or to neighbouring counties within a five-mile radius of a base. County rules should aim to prevent disruptions to military training exercises.¹²

In 2012, South Korea passed the Act on the Prevention of Light Pollution from Artificial Lighting, with its most recent update in 2019. This legislation aims to ensure a healthy and enjoyable living environment for everyone by curbing the negative impacts of excessive artificial light on public health and the environment. It promotes the eco-friendly management of artificial lighting to mitigate such effects. The Act defines light pollution due to artificial lighting, as “a condition in which excessive light resulted from inappropriate use of artificial lighting or light leaked to the outside of its illumination field disturbs the healthy and pleasant lives of citizens or causes harm to the environment”.¹³ Article 3 of the Act outlines the obligations of the State which mandates the State create and enforce comprehensive policies to curb light pollution and develop and promote the necessary technologies. Local governments are also required to devise and execute light pollution prevention strategies tailored to the specific characteristics of their regions, including providing information about light pollution to local residents. Additionally, citizens are expected to contribute to light pollution prevention efforts and cooperate with initiatives implemented by the State or local governments.¹⁴ Chapter V of the Act deals with penalty provisions, where in the range of fines imposed for violation of the various provisions of the Act range between 2 million won to 10 million won.¹⁵

In 2016, South Korea established a decree aimed at aiding the execution of the law addressing the prevention of light pollution caused by artificial lighting. This decree outlines specific details and responsibilities outlined in the act. It includes eight sections addressing different topics like clarifying intent, setting boundaries for lighting fixtures, organising the structure and function of the Light Pollution Prevention Committee, detailing steps for creating Light Environment Management Plans, defining exemptions to the approved level of light emission, facilitating proxy-led survey and research initiatives and establishing guidelines for imposing administrative penalties.¹⁶

In 2021, during the National Congress, China’s top legislative body, representative Li Dajin put forward the idea of implementing laws across the nation to address light

¹² States Shut Out Light Pollution, National Conference of State Legislatures (NCSL) USA (Mar. 25, 2022) available at: <https://www.ncsl.org/environment-and-natural-resources/states-shut-out-light-pollution>

¹³ Miao Cao, et al., *Understanding light pollution: Recent advances on its health threats and regulations*, JOURNAL OF ENVIRONMENTAL SCIENCES (May, 2023), <https://doi.org/10.1016/j.jes.2022.06.020>

¹⁴ Act on the Prevention of Light Pollution Due to Artificial Lighting, art. 3.

¹⁵ *Act on the Prevention of Light Pollution Due to Artificial Lighting*, Law Viewer, Elaw, available at: https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=52771&type=part&key=39

¹⁶ *Enforcement Decree of the Act on the Prevention of Light Pollution Due to Artificial Lighting*, Republic of Korea, FOOD AND AGRICULTURE ORGANIZATION, available at: <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC168213/>

pollution. Shanghai took the lead by being the first to enact regulations specifically targeting light pollution. The Shanghai Environment protection regulation enacted in February 2022, aimed to improve light pollution in the city. Ensuring darkness prevails in the night sky is a priority in the regulation update. The city explicitly forbids placing landscape lights that beam directly into residential windows. There's a strong emphasis on controlling reflective surfaces, like glass walls on buildings, with the environmental department assessing their impact on local light conditions. New lighting setups must adhere to brightness standards, ensuring both road safety and peace for nearby residents. For nighttime construction, lights must be shielded to avoid bothering locals. Those flouting the rules face fines ranging from 5,000 to 50,000 yuan if they don't fix or remove offending lights promptly.¹⁷

There is no law in India which directly deals with the light pollution in India. However, the debate and discussion around regulating the light pollution started in India. India is emitting light into its nighttime environment at a rate that exceeds the global average by nearly threefold.¹⁸ On January 11th, 2024, Maharashtra's Pench Tiger Reserve was honoured with the distinguished recognition of being India's first-ever International Dark Sky Park, bestowed upon it by the International Dark-Sky Association. This recognition marks the fifth such park in Asia and underscores its mission to safeguard the nocturnal sky while fostering interest in astronomy.¹⁹ The citizens become aware of the negative effects of light pollution, and incidents of lodging complaints against the institutions and others for having bright lights after 10 PM is increasing.²⁰

Constitution of India through judicial review, incorporated right to clean environment and environmental protection as fundamental right under Article 21. The Preamble of the Indian Constitution states every person's dignity is safeguarded, which may encompass ensuring a respectable quality of life and a clean environment free from pollution. Article 51A(g) of the Indian Constitution provides that, "It shall be duty of every

¹⁷ *Shanghai regulation aimed at improving light pollution comes into force*, Shanghai (Feb. 8, 2022) available at:

<https://www.shanghai.gov.cn/nw48081/20220802/d32c25ab71064438a1f1a9d81cb868f5.html>

¹⁸ Charu Bahri, *Light pollution; India losing its night at over 3 times the world average*, BUSINESS STANDARD (Dec. 3, 2017) available at: https://www.business-standard.com/article/current-affairs/light-pollution-india-losing-its-night-at-over-3-times-world-average-117120300415_1.html

¹⁹ *How to dark sky parks tackle the growing problem of light pollution*, DOWNTOEARTH (Jan. 19, 2024), available at: <https://www.downtoearth.org.in/video/pollution/how-do-dark-sky-parks-tackle-the-growing-problem-of-light-pollution--93999>

²⁰ A complaint was lodged by a resident against a local gym to switch off their lights after 10PM. Badri Chatterjee, *South Mumbai Resident files light pollution complaint against Wilson Gymkhana*, 28th November 2017, Hindustan Times, available at: <https://www.hindustantimes.com/mumbai-news/south-mumbai-resident-files-light-pollution-complaint-against-wilson-gymkhana/story-TfN1Vv26FXtiRSAGH5E2vL.html>

citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.”

A key aspect of a welfare state is ensuring a clean and healthy environment. In Article 47, Part IV of the Directive Principles of State Policy, it emphasizes that the State must prioritize enhancing nutrition levels, raising living standards, and enhancing public health. This commitment extends to safeguarding and enhancing the environment. Article 48 underscores the State’s responsibility to modernize agriculture and animal husbandry practices, including preserving and enhancing animal breeds and prohibiting the slaughter of certain cattle, indicating the State’s duty towards the health of both domestic and wild animals. Article 48A further emphasizes the importance of environmental protection, including safeguarding forests and wildlife.²¹

The efforts of the Hon’ble Supreme Court of India against firecrackers²² and the odd and even number cars permit for regulating the traffic in Delhi can also relate to the light pollution indirectly. In the fire crackers case, the discussion of the court took direction towards light pollution about testing of light emitting firecrackers. In *Re: Ramlila Maidan Incident v. Home Secretary, Union of India*, the Supreme Court ruled that Article 21 of the Indian Constitution encompasses the right to sleep. The apex court concluded that individuals have the entitlement to leisure time, including the right to sleep undisturbed, the right not to be subjected to noise, and the right to maintain silence. Throughout various instances, the Hon’ble Supreme Court of India has consistently penalized those who disrupt the peace of others by using amplifiers or playing drums during religious ceremonies.

III

Precautionary Principle of Environmental Law & Light Pollution: Suitable Solutions

The concept of the “*precautionary principle*” advocates for proactive measures to safeguard against potential risks, even in the absence of conclusive scientific evidence. This principle has been integrated into various global environmental agreements, with some asserting its recognition as a fundamental tenet of international environmental law. Particularly in realms like food safety and the protection of plant and animal health, the necessity of pre-emptive action amid scientific ambiguity has been widely acknowledged for quite some time.

The precautionary principle involves four key elements: acting to prevent potential harm when faced with uncertainty, requiring those advocating for an activity to prove

²¹ India Const. art. 48A.

²² *Arjun Gopal and Ors v. Union of India and Ors.*, 2023 LiveLaw (SC) 816.

its safety, considering a variety of alternative actions that could be less harmful and encouraging greater public involvement in decision-making processes.²³ The UK Dark Skies at Night Partnership, in collaboration with organizations such as the International Dark-Sky Association, the Commission for Dark Skies, the Countryside Charity (CPRE), the Institution of Lighting Professional and the Society of Light and Lighting, has crafted a 'Dark Sky Standard'. This standard is designed to conscientiously apply the precautionary principle in tackling light pollution. This standard, built on four key pillars, emphasises the importance of appropriate lighting: ensuring it's used where needed, in suitable amounts and for the appropriate duration. The term 'right light' encapsulates the concept of providing adequate visibility for humans while also prioritizing environmental and health considerations.²⁴ Additionally, Clanton devised a method for lessening light pollution that centres on (i) utilizing lights only when essential; (ii) employing the least amount of illumination feasible; and (iii) decreasing the amount of light dispersed into the sky.²⁵ The national guidelines on light pollution in Australia propose that the foundation of any lighting plan should be the preservation of natural darkness. They recommend that artificial lighting be incorporated only for explicit purposes, in predetermined areas and for the duration necessary for human activities.²⁶

IV

Conclusion

Light pollution, an outcome commonly associated with the expansion of urban and industrial areas, presents a notable hazard to environmental integrity, human well-being, and biodiversity. Defined as the excessive or improper application of artificial illumination during nocturnal hours, light pollution perturbs wildlife's innate behavioural rhythms, exacerbates atmospheric carbon dioxide levels, interferes

²³ Science for Environment Policy (2017) *The Precautionary Principle decision making under uncertainty*. Future Brief 18, European Commission's DG Environment by the Science Communication Unit, UEW, Bristol, available at:

https://environment.ec.europa.eu/research-and-innovation/science-environment-policy_en

²⁴ *Dark and Quiet Skies for Science and Society II*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (2021) available at: <https://zenodo.org/records/5874725>

²⁵ Clanton, N., *Opinion: Light Pollution: Is it important?*, LIGHTING RESEARCH & TECHNOLOGY (2014) available at: <https://journals.sagepub.com/doi/10.1177/1477153513519378>

²⁶ Commonwealth of Australia, 2023, National Pollution Guidelines for Wildlife Version 2.0 (May): 1-198 available at:

<https://www.dcceew.gov.au/environment/biodiversity/publications/national-light-pollution-guidelines-wildlife>

with human sleep cycles, and obscures celestial observation of stars within the nighttime sky. This highlights the importance of taking proactive steps to address light pollution. Several nations, including France, Croatia, and the European Union, have implemented comprehensive laws to tackle this issue. These regulations focus on controlling outdoor lighting, establishing brightness standards and enforcing penalties for non-compliance. Importantly, the Precautionary Principle guides environmental legislation, emphasizing the need for preventive measures even in uncertain circumstances, shifting the burden of proof onto activities with potential harm. Organizations like the International Dark-Sky Association and initiatives like the Dark Sky Places program demonstrate how raising public awareness can promote environmental responsibility and combat light pollution effectively.