Biannual Open Access Journal
Peer-Reviewed/Refereed International Journal
JOURNAL OF GLOBAL RESOURCES
ISDESR, Jaipur, India

www.isdesr.org

ISSN: 2395-3160 (Print)
ISSN: 2455-2445 (Online)
July 2024, Volume 10 (02)
DOI Prefix: 10.46587/JGR

05

LIGHT POLLUTION IN INDIA: AN EMERGING ENVIRONMENTAL CONCERN

Hasibur Rahaman Molla
Assistant Professor, Department of Geography, Sivanath Sastri College, Kolkata, India
Email: hasiburmollavb@gmail.com

How to cite this paper:
Molla Hasibur Rahaman (2024) Light Pollution in India: An Emerging Environmental Concern, Journal of Global Resources, Vol. 10 (02)

DOI:
10.46587/JGR.2024.v10i02.005

Received: 30 March 2024
Reviewed: 25 April 2024
Final Accepted: 20 June 2024

OPEN ACCESS
Freely available Online
www.isdesr.org

Abstract: *Light pollution, the excessive and misdirected artificial lighting in urban areas, has become a growing environmental concern with far-reaching implications. India, as a rapidly developing country, has witnessed a substantial increase in artificial lighting over the past few decades. The expanding urbanization, commercialization and infrastructure development have led to a significant rise in outdoor lighting, resulting in the encroachment of artificial light into the nighttime environment. This paper explores the sources of light pollution in India, including streetlights, advertising signage, industrial facilities and residential areas. The impacts of light pollution on human health are multifaceted. Disruption of circadian rhythms, sleep disorders and increased risks of chronic diseases are among the significant health consequences associated with excessive artificial lighting. The research also highlights the ecological effects of light pollution on wildlife, such as altered behavior, disrupted migratory patterns and reduced biodiversity. This research paper provides a comprehensive overview of light pollution in India, addressing its causes, impacts and potential mitigation strategies. It emphasizes the urgency of taking collective action to minimize light pollution and protect the natural darkness of the night sky, while also fostering sustainable development and improving the well-being of human populations and ecosystems.*

Key words: Light Pollution, Artificial Lighting, Night Time Environment, Natural Darkness, Ecosystem

Introduction

Light pollution is one of the fastest growing and most pervasive of environmental pollution (Chepesiuk, 2009). It is a rapidly growing global environmental issue with 24 X 7 culture. As urbanization and development continue to accelerate in countries like India, the problem of light pollution is becoming increasingly prevalent and concerning. India, the most populous country in the world, has experienced rapid economic growth and urban expansion in recent decades. This development has led to a surge in the use of artificial lighting, both in urban and rural areas, resulting in a significant increase in light pollution. The country's growing population, coupled with expanding industries, commercial centers and transportation networks has contributed to the widespread illumination of the night sky. The purpose of this research paper is to provide an overview of light pollution in India, examining its causes, effects and potential solutions. The sources of light pollution in India are diverse and widespread. Street lighting, which is necessary for public safety and road visibility, often contributes to the problem when excessive or poorly designed. Advertising signs, industrial facilities, residential areas and outdoor sports facilities also contribute to the artificial glow that blankets the night sky. The high population density in urban areas exacerbates the issue, as there is a greater concentration of artificial lights. The disruption of natural circadian rhythms due to excessive exposure to artificial light at night can lead to sleep disorders, hormonal imbalances and an increased risk of chronic diseases such as obesity, diabetes, and cardiovascular problems. The field of astronomy also suffers from the detrimental effects of light pollution. Urban areas with high light pollution levels make it difficult to observe celestial objects, limiting scientific research and public engagement in astronomy. An obvious effect of light pollution is the limitation in observable astronomical bodies detected by naked eye (Cinzano and Falchi, 2014). Diminished visibility of stars and other celestial phenomena hampers our understanding of the universe and our cultural appreciation of the night sky. Ultimately, this research aims to emphasize the urgent need for collective action to mitigate light pollution in India. Researches on individual-level effects of light pollution were still relatively new, where research on its ecosystem-level and long-term cumulative effects remains unexplored (Lyytimaki, 2015). By raising awareness and fostering collaboration among various stakeholders, artificial lighting in the outdoor areas can coexists harmoniously with the natural environment.

Materials and Methods

Specific tools and techniques have been used during the entire research to assess and quantify the level of light pollution, understand its spatial distribution, evaluate its impacts and develop strategies for mitigation. Light meter (illuminometer or lux meter) and Sky Quality Meters (SQMs) quantify the level of light pollution (Table-2). Light meter is used to measure the intensity of light (lumens per square meter) in the urban centers of Kolkata, Mumbai, Delhi, Bengaluru and Chennai. Quantitative data on the levels of artificial lighting have been collected from 25 different sample locations of each city. Data have also been collected from the same sample locations using SQMs to measure the brightness (mag./arc sec^2) of the night sky. They provide readings of the sky's brightness in magnitudes per square arcsecond. SQMs are used to quantify sky glow and assess the level of light pollution in a particular area. Depending on the type of light pollution, the Illuminating Engineering Society of North America (IESNA) has adopted the concept of environmental zones (Table 01).

VIIRS (Visible Infrared Imaging Radiometer Suite) is a satellite sensor that can detect and quantify nighttime lights emitted from Earth's surface. VIIRS includes the Night Band specifically designed to detect low-light signals at night. This high sensitivity makes it ideal for capturing the extent and intensity of artificial light emissions from human activity across India.

VIIRS data provides readings for various locations across the country (Figure-1). This spatial information helps identify hotspots of light pollution and track changes over time.

Figure 01: Comparison of Light pollution in India between 2013 and 2023 (VIIRS-2013 & 2023)

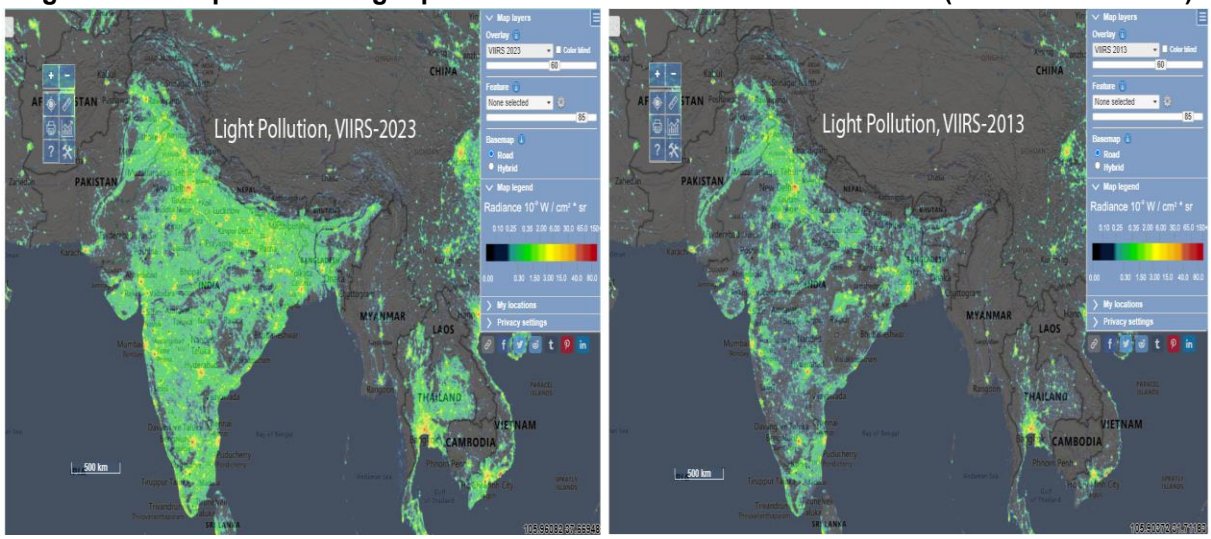

Table 01: Description of the Lighting Environmental Zones, as Adapted by IESNA

Zone rating	Description
E1	Areas with intrinsically dark landscapes. National parks or residential areas with strict limits on light trespass. Roads usually unlit.
E2	Areas of low ambient brightness. Outer urban or rural residential areas.
E3	Areas of medium ambient brightness. Urban residential areas.
E4	Areas of high ambient brightness. Urban areas, residential and commercial with high levels of night time activity.

Source: IESNA 1999

Questionnaire surveys have been conducted to gather subjective data on people's perceptions and experiences of light pollution. Data have been collected across each city covering populations belonging to each zone as per IESNA following systematic sampling method. It provides insights into the social and cultural impacts of light pollution, as well as public awareness and attitudes towards lighting practices.

Table 02: Magnitude of light pollution in Indian Cities - 2022

City	SQM	Brightness	Artificial Brightness	Bortle
Delhi	17.87 mag./arc sec^2	7.68 mcd/m^2	7500 µcd/m^2	class 8-9
Kolkata	18.75 mag./arc sec^2	3.43 mcd/m^2	3260 µcd/m^2	class 7
Mumbai	19.11 mag./arc sec^2	2.45 mcd/m^2	2280 µcd/m^2	class 6
Bengaluru	18.18 mag./arc sec^2	5.75 mcd/m^2	5580 µcd/m^2	class 8-9
Chennai	19.59 mag./arc sec^2	1.57 mcd/m^2	1400 µcd/m^2	class 5

Source: VIIRS-2023

Results and Discussion:

Causes of Light Pollution

Gross Domestic Product (GDP) and population density are explanatory variables of light pollution (Gallaway, Olsen, & Mitchell, 2010). India is experiencing a rapid urbanization vis-à-vis rapid growth of cities which lead to an increase in artificial lighting. As urban areas expand,

the number of streetlights, buildings and outdoor lighting fixtures also increases. It contributes to a higher density of artificial light sources. Light pollution is the effect of inefficient and unnecessary artificial outdoor lighting (Chepesiuk, 2009). Poorly designed lighting systems contribute significantly to light pollution. This includes fixtures that emit excessive light or illuminate areas beyond their intended scope. Improperly shielded or directed lighting fixtures can cause glare, light trespass, and skyglow, further exacerbating light pollution.

In many areas, lighting regulations and enforcement are inadequate or nonexistent. This lack of control allows for the installation of bright and poorly designed lighting fixtures without considering the impact on the environment or neighbouring areas. In the absence of proper guidelines, there is little incentive for individuals or organizations to minimize light pollution. Over-illumination, where an area is illuminated more than required, wastes energy and contributes to light pollution. Unnecessary lighting, such as leaving lights on in unoccupied spaces or illuminating buildings throughout the night also adds to the problem.

Brightly lit billboards, neon signs and other outdoor advertisements are common sources of light pollution. These signs are often designed to be eye-catching and visible from a distance, leading to excessive lighting and contributing to light pollution, especially in urban areas. Cultural and festive celebrations often involve the use of decorative lighting, which may be excessive and poorly controlled. These events can result in temporary spikes in light pollution, especially during festivals that feature elaborate lighting displays or fireworks. Changes in brightness in various part of India were observed due to industrial, economic, infrastructural and agricultural development (Pavan Kumar, Haroon Sajjad, et.al, 2018).Inefficient lighting technologies, such as older generation light bulbs, consume more energy and contribute to light pollution. These inefficient lighting emitted from its source, scatter off atmosphere dust or aerosols particles and reflected back to Earth as skyglow (Longcore and Rich, 2004). Industries, factories, warehouses and commercial establishments often require significant lighting for operational purposes. If not properly designed and regulated, these lighting installations can contribute to light pollution, particularly in industrial zones or areas with a concentration of commercial activities.

Impact of Light Pollution

In the previous couple of years various researches have been conducted to find out the negative impact of light pollution in different parts of the world. A review of empirical studies by Navara and Nelson (2007) on effects of light pollution shows convincing evidence of physiological and medical implications, i.e. immunity system, energy metabolism, and eating behavior.

Ecological Impact

Nocturnal animals rely on natural darkness for their survival and reproduction. Artificial lighting can interfere with their behavior, disrupting foraging, mating and predator avoidance patterns. This can lead to reduced reproductive success and population declines. Light pollution can disrupt the natural balance of ecosystems. For instance, it can affect the interactions between predators and prey, as well as the relationships between plants and their pollinators. Changes in these interactions can have cascading effects on biodiversity and ecosystem functioning.

Many species, such as birds, sea turtles and insects, use natural cues like stars and moonlight for navigation during migration. Light pollution can disorient them, leading to migration errors, collisions with buildings and habitat loss. Light pollution can disrupt the pollination process, as artificial lights attract nocturnal pollinators away from their natural habitats. The investigation shows lights at night can stop the release of the photochrome hormone, resulting in the

extermination of the plants (Raven & Cockell, 2006). This can result in reduced plant reproduction, affecting biodiversity and ecosystem services such as crop pollination. Artificial lighting can disrupt the natural balance between predators and prey. For example, it can make prey more visible and vulnerable to predation or disturb the hunting behaviors of nocturnal predators.

Impact on Human Health

Exposure to artificial light at night can disrupt the circadian rhythm, affecting the quality and quantity of sleep. This disruption can lead to sleep disorders, including insomnia, which can have negative effects on physical and mental health. Artificial light at night can interfere with the production of melatonin, a hormone that regulates sleep-wake cycles. Disruptions in melatonin production have been linked to an increased risk of certain obesity, diabetes, and cardiovascular diseases. Light pollution can contribute to increased stress levels, anxiety and mood disorders. The constant exposure to artificial light can disrupt the natural daily rhythms and affect overall mental well-being.

Impact on Astronomical Observations

Light pollution creates skyglow, a brightening of the night sky that obscures stars, planets and other celestial objects. This reduces visibility for both amateur and professional astronomers, limiting their ability to observe and study the universe. Dark night skies have cultural and educational significance. Light pollution diminishes the cultural value of stargazing and celestial observations and restricts the ability to connect with the wonders of the universe. The presence of light pollution limits the scientific research conducted in fields such as astronomy, astrophysics and cosmology. It hampers the study of distant galaxies dark matter, and other astronomical phenomena, hindering our understanding of the universe.

Conclusion

Light pollution in India is a complex and pressing issue that requires immediate attention. Addressing light pollution requires a multi-faceted approach, combining technological advancements, regulatory reforms, public engagement and collaboration between various stakeholders. The development and enforcement of guidelines for outdoor lighting can help limit the unnecessary and excessive use of artificial lighting. Promoting the use of energy-efficient lighting technologies, such as Light Emitting Diodes (LEDs), can significantly reduce light pollution and energy consumption. LEDs provide better control over light directionality, color temperature and intensity. Educational campaigns, workshops and outreach programs can inform the public about the importance of dark skies, the health effects of excessive artificial lighting and the need for responsible lighting practices. As India continues its journey towards progress, it is essential to ensure that this advancement is not at the expense of the very environment and well-being it seeks to enhance. Encouraging collaboration between government bodies, non-governmental organizations, lighting professionals, astronomers and other stakeholders is vital in addressing light pollution comprehensively. Collaborative efforts can lead to the development of effective strategies, policies and initiatives to mitigate light pollution. Comprehensive research on the ecological, health and societal impacts of light pollution can provide valuable insights for policymakers and guide the development of effective mitigation strategies. Encouraging innovation in lighting design and technology can lead to the development of more sustainable and eco-friendly lighting solutions.

References

1. Chepesiuk, R. (2009) Missing the dark: Health effects of light pollution. *Environmental Health Perspectives, 117*(1), A20-A27.

2. Cinzano, P. & Falchi, F. (2014) Quantifying light pollution J. Quant. Spectrosc. Radiant. Transf. 139 13-20
3. Gallaway, T., Olsen, R. N., & Mitchell, D. M. (2010) The economics of global light pollution. *Ecological Economics, 69*(3), 658-665.
4. IESNA, 1999: Lighting Research Centre. https://www.lrc.rpi.edu/programs/nlpip/lightinganswers/pdf/print/LightPollution.pdf
5. Kumar, P., Sajjad, H., Rehman, S., Tripathy, B. R. (2018) Analyzing trend in artificial light pollution pattern in India using NTL sensor's data. Urban Climate · December 2018. DOI: *10.1016/j.uclim.2018.12.005*
6. Longcore, T. & Rich, C. (2004) Ecological light pollution *Front. Ecol. Environ*. 2(4) 191-8
7. Lyytimaki, J. (2015). Avoiding overly bright future: The system intelligence perspective on the
8. management of light pollution Environ. Dev. 1-11
9. Navara, K. J., & Nelson, R. J. (2007) The dark side of light at night: Physiological, epidemiological, and ecological consequences. *Journal of Pineal Research, 43*(3), 215-224.
10. Raven, J. A., & Cockell, C. S. (2006) Influence on photosynthesis of starlight, moonlight, planet light, and light pollution (reflections on photosynthetically active radiation in the universe). Astrobiology, 6(4), 668-675. Doi: 10.1089/ast.2006.6.668