Impacts of Light Pollution on Ecosystem

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Abstract –. Due to urbanization, amplifying the artificial illumination gets to unwanted & unintended places. Especially the light predisposed towards skyline categorized as light pollution. Light pollution has proved catastrophic for ecosystem. Light pollution obfuscates skydome, leads to a surge in the energy utilization, interferes with astronomical investigation, perturbing ecosystems, and consequently health and well-being of mankind & nature. Light pollution augmenting the levels of carbon emission in the environment. Astronomical investigators have marked negative impacts on the ecosystem, and have proved it in many examinations. Due to an upsurge in the illumination of astral sky, magnifying the problem of viewing stars using unaided eye & immigrant birds that conform to stars could deviate from their migrating path because of the enhanced background light of the sky. Light pollution has proven detrimental to the population of some insects, mammals &reptiles.

Keywords: light pollution / artificial illumination /ecosystem / sky glow /light trespass / Glare / nocturnal / diurnal / sky dome (atmosphere)

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Introduction: Due to reinforced development of the mankind, metropolitans have taken all over the world from cities & towns. Overnight illumination in cities and suburbs, is noticeable. Outdoor lighting at night to safeguard human interests, such as boosting commercial development, safety and security, & also making noticeable landmarks & historical monuments of metropolitans. Light pollution is an intruding result of outdoor lighting amplifying sky glow, glare &light trespass. Light pollution is a by-product overnight illumination, especially utilizing inefficient illuminating facilities, lighting excessively. It is inexplicable invasion of artificial illumination. Both natural and artificial sources lead to Sky glow [1]. The natural elements of sky glow has five origins: sunlight scattered off interplanetary dust (zodiacal light), scattered sunlight off the moon and earth, faint gleam of apical layers of atmosphere (a persistent, dull aurora), starlight spread in the gases enveloping the earth, and skylight from dim, unclear stars and nebulae (diffused mass of cosmic dust and gases apparent as light smudges). Artificial illumination amplifies natural sky glow. Light emitted perpendicularly upwards by luminaries or scatters from the ground is in-turn re-scattered by gas molecules & dust constituting the sky dome, generating an luminaries backdrop [2]. It reduces the ability of viewing stars. Sky glow is altering based on prevalent weather conditions, percentage of dust & gas constituting sky dome, frequency of light inclined skyward, and the point of perception. Inclement weather phenomenon increase the presence of particles in the sky dome, scattering the light inclined upwards, producing noticeable sky glow result of wasted energy & light [3]. Sky glow proves to be biggest deterrent for astronomical research, especially viewing celestial objects. Dark sectors of the sky encounter an upsurge in the brightness, consequently reducing the contrast of celestial objects or stars or viewed against black backdrop of the sky [4]. Astronomical probes require like very dark, dry & clear backdrops for observations. Suburban skies are 5 to 10 times illuminated at the zenith than dark sky (angle that is inclined upward, or 180°, pertaining to the point of perception). Zenith observed 25 or 50 times brighter than the natural sky dome considering city centers [5].

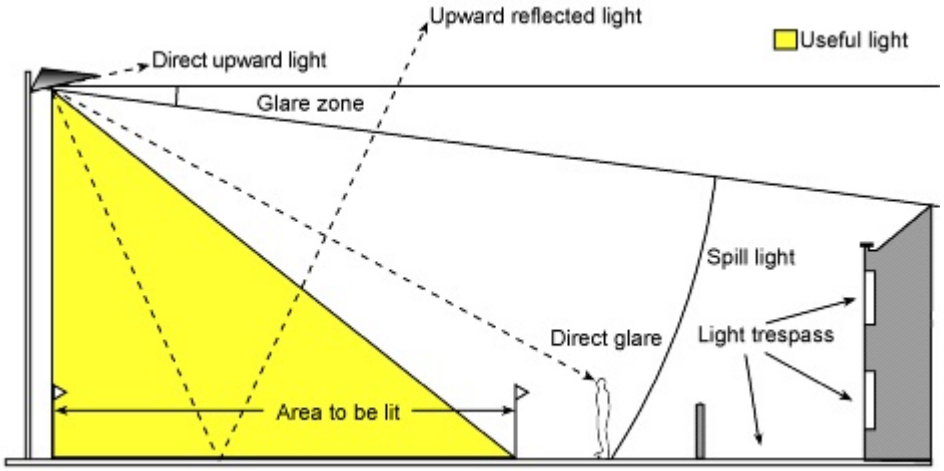

Figure: The logics behing light pollution is attributed to its emission from lighting equipment selecting appropriate equipment and mounting it, makes a significant difference[6].

Perception of Light Pollution: As a result of human activities alteration in the natural overnight illumination is termed as light pollution. Intruding man made illumination is considered as light contaminating. Consequently, for a couple of years, the night sky illumination of the sky has enhanced manifolds. The impacts of light pollution on the aspects such as astronomical, ecological & polarized have been hereby discussed in detail. [7]

Astronomical: Noxious impact of unrestricted lighting causing light pollution drew the attention of the astronomical researchers., Since intensity of perturbing light sources was far more than the natural background lighting, therefore it became impossible to pursue astronomical research [8] Stars observed by the unaided eye has decreased alarmingly. Due to burgeoning of artificial light, Milky Way would disappear in most of Europe by 2025. Researchers investigated a 10 % increase in artificial lighting with respect lighting of backdrop. Cinzano and his colleagues have generated a backdrop-illumination map with one kilometer viewpoint range modulations. Budapest and its surrounding emerged as a red spot where the overnight illumination is nine times more illuminated than natural lighting in bright conditions approximating zenith [9]

Ecological: Light trespass is light spilled to unwanted places. Light trespass is epitomized when streetlight or floodlight spills the gleam intruding a window and illuminating a region indoor. Animal kingdom could be differentiated on the basis of activity during the day and night known as diurnal and nocturnal animals respectively. It suggests that diurnal animals have their metabolic activities up regulated during the day and down regulated during the night, vice versa for nocturnal [10]. Overnight darkness significantly influences paradigm of humans. Light trespass has led to insomnia. Production of melatonin (anti-oxidant hormone), is blocked by overnight illumination consequently results in decreased concentration, insinuates the development of malign tumors proving to be adversary for the body's defense mechanism and metabolism. Women working in night shifts have a increased probability of developing the mammary cancer and intestinal cancer [11]

A visual sensation due to unrestricted or ever increasing brightness is termed as glare. It can be impairing or uncomfortable. Senility augments the problems of glare due to the aging condition of an eye. Reduced visibility due to intense light originations is categorized as disability glare, while annoyance sensation or pain induced by overly bright sources is termed as discomforting

glare [12]

Luminous intensity determines the decisive competency, behavior and the migratory directions of birds for food and breeding. Ornithologist suggests that a few bird species utilize astral conformity as the night progresses. Due to the increased backdrop lighting reduces astral glow, can't be discerned by birds, they drift away from their course of migration. [13] Light trespass insinuates that bird species must choose their nesting places /dwelling habitats way away from bright locales, however there is no alteration in their habitats or dwelling habits. It constricts their dwelling space and also they have to migrate to distant areas for nutrition needs. [14] the biorhythm of certain bird's species has also been affected by artificial illumination. Specific nocturnal habits of bird species are reported as singing throughout the night (e.g.Turdus merula), badly affected by light pollution. They couldn't discern between natural & artificial illumination Due to artificial illumination there is an apparent lengthening of days and shortened nights compelling some species alter their nesting intervals [15]. Birds migrating habits is affected by sustained brightness during the day as well as during the night hinting there is about the scopes of navigation for the nourishment sources. In England (Cygnus columbianus), a unique species of a wintering little swan have a tendency for fat accumulation. It maintains reserves prerequisite for sustained migration habits and hence they fly to Siberia a little earlier then anticipated [16]. Floodlights, dazzling towers perturb birds so much that can be literally blindfold and fly against intensely lit towers. European bat (Rhinolophus hipposideros) species lured by the heaps and heaps of flying insects around street lamps. [17] Certain reduction in the individuals of the European bat population is noticed at some places in Switzerland due to installation of intense-light luminaries Minibats (Pipistrellus pipistrellus) outnumbered European bats from their habitat acknowledging the fact that insects gather around intensely illuminated streetlights, serving as nutrition source. [18] Ornithologist revealed that bats reacted completely opposite for illuminated high towers as compared to low or non-illuminated buildings. Places unexploited with excessive illumination affected the departure of bats 30 minutes, post twilight as compared to intense bright ambience lured bats until reflectors were switched off. [19] The artificial illumination postpones or delays their flight for nutrition leveraging their hunting time period by reducing the interval to catch their prey and lose harbingering hunting time [20].

Artificial high-lights lure nocturnal insect species way away from their original and pristine habitats, serving as prey & hence there population reduced drastically. [21] Light spectrum of the illuminating facility, its installation height, its capacity & intensity to brighten up its surroundings lures many insect species gathering around street lamps serve as easy derivational source of nutrition for frogs and birds. The intensely lit light sources serves as navigation points for insects and is also perturbed by vehicles headlights. [22] They usually get exhausted flying continuously towards the given light source & usually dies under lamp cover. Increased light pollution has also led to the reduction in the population of big fireflies (Lampyris noctiluca). Female species lure male species by fire-flash signaling significant in breeding. The perturbing consequences of ever increasing light pollution have marred their probabilities of reproduction considerably [23].

In Florida, Sea turtles (Chelonoidea) population is badly affected by the ill consequences of light pollution, having the luxury vast hatching regions. Newly hatched sea turtles creep out from the eggs. Night darkness provides them the assisting ambience protecting them from predators, crawling towards sea. They are hinted the direction of the sea by the virtues of astral luminance. The light is reflected from the surface of water, indicates its presence. Apparent lights blindfold the turtles, equivocates them to pursue incorrect course of path, ultimately detrimental to their

population. [24]

Polarized: Researchers examined that not only the intensity of light but also its polarization is a significant aspect for living creatures. Hungarian and American anthropologist have described that linearly polarized light, reflected from various screens or polished surfaces is imperceptible to various animals and humans. The space & time correlation is disturbed as a consequence of ecological light contamination (excessive of anything is polluting). This phenomenon is known as polarized light pollution, an unfamiliar type of damage to environment. Polarized light pollution negatively leverages animal's sensitivity to polarization. It also effects the activity of polar tactic aquatic insects (Nepomorpha) Polarized light which is intense & directed horizontally, reflected from polished surfaces perturbs polar tactic animals [26].Artificial illumination inclined on water bodies reflects much of the light also proved to perturbing for insects. Over 300 insect navigate in water for suitable habitats assisted by the virtues of positive polar taxis [27]. These polar tactic insects can easily be lured and equivocated by any polished surface reflecting strongly. An apparent watery outlook or "pseudo water" appearance deludes aquatic insects soliciting water if the degree of linearly polarized light reflected from such surfaces is more in comparison to water. Horizontally polarizing smooth surfaces act as polarized ecological traps for ovipositors [28]. Consequently lures polar tactic insects deluded by intense reflecting attributes, spawn in vain. Smooth water surface only cause of strong and horizontally reflected polarized light at larger optic angle considering natural optical environment. Installation of several polished surfaces has led to an increase in the polarized light pollution since few decades such as, asphalt roads, plastic sheets & foils, glass window panes, dazzling autographic open oil spot source of intense & horizontally polarized light. The catastrophic effects of polarized light pollution augmented by photo tactic orientation various bird species. Entomologists have reported that dragon-flies are deluded by polarized light polluting sources. These source acts as illusion of watery appearance like a mirage in a desert or on hot sunny day influencing their territorial protection, patrolling flights, water touch, catching prey during flight. [29]

Combating Light Pollution: Several awareness programmes, research, and developmental endeavors addressing light pollution have been carried out. It includes designing illuminating facilities reducing light contamination. Endeavors include awareness and law making through various levels legislature. Directing the inclination of light downwards can decrease light pollution and reducing the upward lighting to a minimal level utilizing shading screens such as glass shades. Plains of the horizon should be unexploited by direct interference of light. [30] Use of white foil instead of black or by painting our cars white in lieu of black reduces polarized light pollution in agriculture reducing the framing of glass panes. Converting glassy and dazzling asphalt roads into rugged roads [31]. In order to reduce light pollution research and developmental endeavors have been carried out to ameliorate technological advancements designing efficient illuminating facility & inclining light to places where necessary. Illuminating Engineering Society of North America (IESNA) has set parameters for developing efficient luminaries. Manufacturers are focused mainly on developing lighting facility with given beam distributions reducing glare and dissipated light. Lamp technology ameliorations led to the production of highly efficient illuminators, reducing light contamination. It saves energy as well. Public awareness for improving quality of overnight outdoor illumination at the regional, local, and state level, the lighting dictums must be revisited. Adoption of legislation by many states regulating overnight outdoor illumination enforcing many other states to pass pending outdoor lighting bills in their legislature [32].

Legislation involves standards setting cut off for luminaries, light level ranges, or wattage restrictions, type of light sources utilized, regulated operating intervals, stalling and the eliminating usage of certain kinds of illuminating facility.[33] (Surveillance for outdoor illumination parameterized by local planning bodies focused on anticipated utilization of area needed for illumination. Preservation of dark skies by legislation is made possible on the basis of minimization of dissipated energy and wasted money hence a reduction in the intruding light in the vicinity of bedroom windows) consequently reduces annoying dazzle, and conserving wild animal breeding time and their respective migrations to a distinct habitat. In India the topic of light pollution still seem unaddressed. [34]

Table: IESNA parameterization of distinguishing various zones on the basis of illumination[35]

Zone ranking	Description of points of distinction
E -I	Native dark appearance of the regions such as national parks & wildlife conservation facilities. Light trespass is minimized in residential sectors with no streetlights
E- II	Suburbs & residential areas faintly illuminated
E-III	Moderate brightness in urban residential sectors
E-IV	Industrial & commercially oriented areas are intensely illuminated.

Summary and Conclusion: The ecosystem is under threat by unfamiliar environmental damage because of the over indulgence of mankind in urbanization, incognizant of consequences. We can discuss the impacts of light pollution in 3 possible ways on the basis of perturbance caused to astronomical investigation, environmental or ecological antithetical or polarized. The overexploitation luminaries perturb astronomical investigation. It is detrimental to the human machinery. Light pollution interferes the orientation & conformity of bird species negatively. It influences the development & migration of bats. Nocturnal insects encounter a serious risk by artificial lighting, since high intensity lights lure them away from habitats natural to them. If the issue of light pollution is not addressed in time may lead to irreparable damage to ecosystem

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