

# A THEORITICAL DESCRIPTION ON UNKNOWN POLLUTION TO THE WORLD::LIGHT POLLUTION

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**Abstract:** Light pollution, also known as photo pollution or luminous pollution, is excessive, misdirected, or obtrusive artificial light. Pollution is the adding-of or added light itself. Light pollution is a topic gaining importance and acceptance in environmental discourse. This concept provides a framework for categorizing the adverse effects of nighttime lighting, which advocacy groups and regulatory efforts are increasingly utilizing. However, the ethical significance of the concept has, thus far, received little critical reflection. In this paper, I analyze the moral implications of framing issues in nighttime lighting via the concept of light pollution. Avoidable light pollution refers to light flow emitted at night by artificial light sources which are inappropriate in intensity, direction and/or spectral range, unnecessary to carry out the function they are intended for, or when artificial lighting is used in particular sites, such as observatories, natural areas or sensitive landscapes.

**Keywords:** Light Pollution, Glare, Trespass, Clutter and Sky Glow.

## 1. Introduction

Light pollution, also known as photo pollution or luminous pollution, is excessive, misdirected, or obtrusive artificial light. Pollution is the adding-of or added light itself, in analogy to added sound, carbon dioxide, etc. Scientific definitions thus include the following, Degradation of photic habitat by artificial light or Alteration of natural light levels in the outdoor environment owing to artificial light sources or Light pollution is the alteration of light levels in the outdoor environment (from those present naturally) due to man-made sources of light or Indoor light pollution is such alteration of light levels in the indoor environment due to sources of light, which compromises human health or Light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment. Light pollution competes with starlight in the night sky for urban residents, interferes with astronomical observatories, and like any other form of pollution, disrupts ecosystems and has adverse health effects. Light pollution can be divided into different types based on Unpleasant light that intrudes on an otherwise natural or low-light setting and Excessive light (generally indoors) that leads to discomfort and adverse health effects. Light pollution is a side effect of industrial civilization. Its sources include building exterior and interior lighting, advertising, commercial properties, offices, factories, streetlights, and illuminated sporting venues.

## 2. Classification of Light Pollution

Light pollution is a broad term that refers to multiple problems, all of which are caused by inefficient, unappealing, or (arguably) unnecessary use of artificial light. Specific categories of light pollution include light trespass, over-illumination, glare, light clutter, and sky glow. A single offending light source often falls into more than one of these categories.

**Light trespass:** Light trespass occurs when unwanted light enters one's property, for instance, by shining over a neighbor's fence. A common light trespass problem occurs when a strong light enters the window of one's home from the outside, causing problems such as sleep deprivation or the blocking of an evening view.

**Over-illumination:** Over-illumination is the excessive use of light. Over-illumination is responsible for approximately two million barrels of oil per day in energy wasted. Over 30% of all primary energy is consumed by commercial, industrial and residential sectors.

**Glare:** Glare can be categorized into different types. Blinding glare describes effects such as that caused by staring into the Sun. It is completely blinding and leaves temporary or permanent vision deficiencies. Disability glare describes effects such as being blinded by oncoming car lights, or light scattering in fog or in the eye, reducing contrast, as well as reflections from print and other dark areas that render them bright, with significant reduction in sight capabilities.

Discomfort glare does not typically cause a dangerous situation in itself, though it is annoying and irritating at best. It can potentially cause fatigue if experienced over extended periods. The blinding effect is caused in large part by reduced contrast due to light scattering in the eye by excessive brightness or to reflection of light from dark areas in the field of vision, with luminance similar to the background luminance. This kind of glare is a particular instance of disability glare, called veiling glare. (This is not the same as loss of accommodation of night vision which is caused by the direct effect of the light itself on the eye.)

**Light clutter:** It refers to excessive groupings of lights. Groupings of lights may generate confusion, distract from obstacles (including those that they may be intended to illuminate), and potentially cause accidents. Clutter is particularly noticeable on roads where the street lights are badly designed, or where brightly lit advertising surrounds the roadways. Depending on the motives of the person or organization that installed the lights, their placement and design can even be intended to distract drivers, and can contribute to accidents. Clutter may also present a hazard in the aviation environment if aviation safety lighting must compete for

pilot attention with non-relevant lighting. For instance, runway lighting may be confused with an array of suburban commercial lighting and aircraft collision avoidance lights may be confused with ground lights.

**Sky glow:** It refers to the glow effect that can be seen over populated areas. It is the combination of all light reflected from what it has illuminated escaping up into the sky and from all of the badly directed light in that area that also escapes into the sky being scattered (redirected) by the atmosphere back toward the ground. This scattering is very strongly related to the wavelength of the light when the air is very clear (with very few aerosols). Rayleigh scattering dominates in such clear air, making the sky appear blue in the daytime. When there is significant aerosol (typical of most modern polluted conditions), the scattered light has less dependence on wavelength, making a whiter daytime sky. Because of this Rayleigh effect, and because of the eye's increased sensitivity to white or blue-rich light sources when adapted to very low light levels, white or blue-rich light contributes significantly more to sky-glow than an equal amount of yellow light. Sky glow is of particular irritation to astronomers, because it reduces contrast in the night sky to the extent where it may even become impossible to see any but the brightest stars.



**Fig.1. Light Trespassing**



**Fig.2. Over Illumination**



Fig.3. Glare



Fig.4. Sky Glow

### 3. Effects and Controlling Methods of Light Pollution

**Increase in atmospheric pollution:** Light pollution destroys nitrate radicals thus preventing the normal night time reduction of atmospheric smog produced by fumes emitted from cars and factories

**Reduction:** Reducing light pollution implies many things, such as reducing sky glow, reducing glare, reducing light trespass, and reducing clutter. The method for best reducing light pollution, therefore, depends on exactly what the problem is in any given instance. Possible solutions include: **I.** Utilizing light sources of minimum intensity necessary to accomplish the light's purpose. **II.** Turning lights off using a timer or occupancy sensor or manually when not needed. **III.** Improving lighting fixtures, so that they direct their light more accurately towards where it is needed, and with fewer side effects. **IV.** Adjusting the type of lights used, so that the light waves emitted are those that are less likely to cause severe light pollution problems. Mercury, metal halide and above all first generation of blue-light LED road luminaires are much more pollutant than sodium lamps: Earth atmosphere scatters and transmits blue light better than yellow or red light. It is a common experience observing "glare" and "fog" around and below LED road luminaires as soon as air humidity increases, while orange sodium lamp luminaires are less prone to show this phenomenon. **V.** Evaluating existing lighting plans, and re-designing some or all of the plans depending on whether existing light is actually needed.

**Improving lighting fixtures:** The use of full cutoff lighting fixtures, as much as possible, is advocated by most campaigners for the reduction of light pollution. It is also commonly recommended that lights be spaced appropriately for maximum efficiency, and that number of luminaires being used as well as the wattage of each luminaire match the needs of the particular application (based on local lighting design standards). A full cutoff fixture, when correctly installed, reduces the chance for light to escape above the plane of the horizontal. Light released above the horizontal may sometimes be lighting an intended target, but often serves no purpose. When it enters into the atmosphere, light contributes to sky glow. Some governments and organizations are now considering, or have already implemented, full cutoff fixtures in street lamps and stadium lighting. The use of full cutoff fixtures help to reduce sky glow by preventing light from escaping above the horizontal. Full cutoff typically reduces the visibility of the

lamp and reflector within a luminaire, so the effects of glare are also reduced. Campaigners also commonly argue that full cutoff fixtures are more efficient than other fixtures, since light that would otherwise have escaped into the atmosphere may instead be directed towards the ground. However, full cutoff fixtures may also trap more light in the fixture than other types of luminaires, corresponding to lower luminaire efficiency, suggesting a re-design of some luminaires may be necessary. The use of full cutoff fixtures can allow for lower wattage lamps to be used in the fixtures, producing the same or sometimes a better effect, due to being more carefully controlled. In every lighting system, some sky glow also results from light reflected from the ground. This reflection can be reduced, however, by being careful to use only the lowest wattage necessary for the lamp, and setting spacing between lights appropriately. Assuring luminaire setback is greater than 90° from highly reflective surfaces also diminishes reflectance. A common criticism of full cutoff lighting fixtures is that they are sometimes not as aesthetically pleasing to look at. This is most likely because historically there has not been a large market specifically for full cutoff fixtures, and because people typically like to see the source of illumination. Due to the specificity with their direction of light, full cutoff fixtures sometimes also require expertise to install for maximum effect. The effectiveness of using full cutoff roadway lights to combat light pollution has also been called into question. According to design investigations, luminaires with full cutoff distributions (as opposed to cutoff or semi cutoff, compared here have to be closer together to meet the same light level, uniformity and glare requirements specified by the IESNA (Illumination Engineering Society of North America). These simulations optimized the height and spacing of the lights while constraining the overall design to meet the IESNA requirements, and then compared total upright and energy consumption of different luminaire designs and powers. Cutoff designs performed better than full cutoff designs, and semi-cutoff performed better than either cutoff or full cutoff. This indicates that, in roadway installations, over-illumination or poor uniformity produced by full cutoff fixtures may be more detrimental than direct upright created by fewer cutoff or semi-cutoff fixtures. Therefore, the overall performance of existing systems could be improved more by reducing the number of luminaires than by switching to full cutoff designs.

**Re-designing lighting plans:** In some cases, evaluation of existing plans has determined that more efficient lighting plans are possible. For instance, light pollution can be reduced by turning off unneeded outdoor lights, and only lighting stadiums when there are people inside. Timers are especially valuable for this purpose. One of the world's first coordinated legislative efforts to reduce the adverse effect of this pollution on the environment began in Flagstaff, Arizona, in the U.S. There, over three decades of ordinance development has taken place, with the full support of the population, often with government support, with community advocates, and with the help of major local observatories, including the United States Naval Observatory Flagstaff Station. Each component helps to educate, protect and enforce the imperatives to intelligently reduce detrimental light pollution.

#### 4. Remedial Methods to Control Light Pollution

**I.** Not using timers, occupancy sensors or other controls to extinguish lighting when not needed. **II.** Improper design, especially of workplace spaces, by specifying higher levels of light than needed for a given task. **III.** Incorrect choice of fixtures or light bulbs, which do not direct light into areas as needed. **IV.** Improper selection of hardware to utilize more energy than needed to accomplish the lighting task. **V.** Incomplete training of building managers and occupants to use lighting systems efficiently. **VI.** Inadequate lighting maintenance resulting in increased stray light and energy costs. **VII.** Daylight lighting demanded by citizens to reduce crime or by shop owners to attract customers. **VIII.** Substitution of old mercury lamps with more efficient sodium or metal halide lamps using the same electrical power and Indirect lighting techniques.

#### 5. Conclusion

Ecological light pollution comprises direct glare, chronically increased illumination and temporary, unexpected fluctuations in lighting. The sources of ecological light pollution are very various and found in nearly every ecosystem in the form of sky glow, illuminated buildings and towers, streetlights, fishing boats, security lights, lights on vehicles, flares on offshore oil platforms, and even lights on undersea research vessels. Among all causes having a negative effect on night sky quality, light pollution shows the highest immediate risks but, at the same time, it can be reduced through viable solutions.

#### References

- [1] Cambridge Handbook of Psychology, Health and Medicine, edited by Andrew Baum, Robert West, John Weinman, Stanton Newman, Chris McManus, Cambridge University Press (1997)
- [2] Lumina Technologies, Santa Rosa, Ca., Survey of 156 California commercial buildings energy use, August, 1996
- [3] Peter Boyce and Boyce R Boyce, Human Factors in Lighting, 2nd ed., Taylor & Francis, London (2003)
- [4] Susan L. Burks, Managing your Migraine, Humana Press, New Jersey (1994)
- [5] L. Pijnenburg, M. Camps and G. Jongmans-Liedekerken, Looking closer at assimilation lighting, Venlo, GGD, Noord-Limburg (1991)
- [6] Igor Knez, Effects of colour of light on nonvisual psychological processes, Journal of Environmental Psychology, Volume 21, Issue 2, June 2001, Pages 201-208
- [7] Narisada Kohei and Duco Schreude, Light Pollution Handbook, Springer, Netherlands (2004)
- [8] Biological Effects of Power Frequency Electric and Magnetic Fields, Office of Technology Assessment, U.S. Congress, University Press of the Pacific (2002)
- [9] R.J. Reiter, Cardiovascular Research; 58:10-19 (2003)
- [10] Schreuder, D. A. (1998). Road Lighting for Safety. London: Thomas Telford Publishing.

- [11] Murray Ian (12 October 2007). "Glare (C7654)". OpticianOnline.net. Reed Business Information Limited.
- [12] CIE 117-1995 Discomfort Glare in Interior Lighting. CIE. 1995
- [13] F.E. Roach & Janet L. Gordon (1973). The Light of the Night Sky. D. Reidel (Dordrecht-Holland/Boston-USA).
- [14] Flanders, Tony (December 5, 2008). "Rate Your Skyglow". Sky & Telescope. Sky Publishing of New Track Media.
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