

# Research Report

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Environment Commission

Measures to combat light pollution



**MUNISH '14**

<b>Forum</b>	Environment Commission
<b>Issue:</b>	Measures to combat light pollution
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## Introduction

Light pollution is defined as the alteration of light levels in the outdoor environment due to man-made sources of light – man-made sources of light being street lighting, car headlights etc. Recent studies on the effects of light pollution on human health have found proof that light pollution is, if not the sole factor, an important factor that contributes greatly to the chance of someone contracting a host of different diseases. Most notable is the link between light pollution and adverse mental health issues such as insomnia, depression, and most other sleep disorders and syndromes.

Other studies looking at the effects of light pollution on ecosystems around the world have found that light pollution heavily disrupts ecosystems, and as such, these studies prove that light pollution has a detrimental effect on the life of both flora and fauna. In fact, light pollution has been proven to be a major factor in the declining population of wildlife around the globe. One of its most serious adverse effects is the way in which light pollution impacts trees. Trees are prevented by artificial light from adjusting to their seasonal norms and thus do not produce the leaves and fruits which form the basis of the food chain. This leads to the populations of many species, which depend on trees for nutrients or shelter, decreasing.

Artificial light also confuses the sense of direction of many animals, leading to fatal collisions with objects they could normally avoid. For example, the U.S. Fish and Wildlife Service estimates that in the whole North American region, around 98 million migratory birds die each year from collisions with heavily illuminated communication towers. This figure reveals how crucial it is to prevent light pollution in the interest of preserving natural wildlife and preventing the extinction of multiple species.



## Definition of Key Terms

### Light pollution

Light pollution is a very broad term that can be loosely defined as every form of artificial light that shines outside the area it is meant to illuminate. Light pollution causes the alteration of natural levels of light in an environment and as a result damages several aspects of said environment.

### Light Nuisance

Light nuisance is a form of light pollution that can also be referred to as 'light trespass' or 'indoor light pollution'. Light nuisance is commonly defined as a glare or shine from exterior lighting e.g. a streetlight that shines into a building through for example a bedroom window. Light nuisance alters the natural level of light indoors and as such, this specific sub category of light pollution is most responsible for the light pollution related health diseases experienced by humans.

### Glow

Glow is another form of light pollution; it is a combination of the residual light produced by light reflecting from illuminated surfaces and by unshielded lighting. This glow affects the sky in a radius of up to 80km around the illuminated area, and is the reason that rural areas without a lot of lighting are also suffering from light pollution.

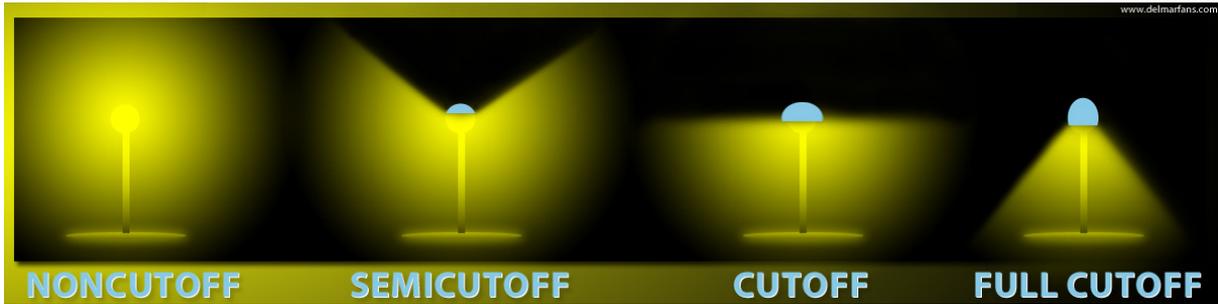
### Circadian Clock

The circadian clock in most organisms allows them to co-ordinate their biological, psychological and behavioral functions with daily and seasonal changes in the day-night cycle. For example, one of the most basic functions of the circadian clock is regulating sleep patterns. If the day-night cycle changes, the clock adapts according to the new cycle. Changes in light levels in an organism's direct environment often lead to complications, as all of the things the clock is responsible for regulating – biochemical processes, psychology and behavior – are affected.

### 'Full Cutoff' lighting

Full cutoff lighting is a way to minimize light being released above the horizontal plane. This means that it is possible to minimize light pollution and light nuisance by using full cutoff lighting designs.





**Comparing full cutoff lighting to other kinds of lighting**

"Why Is Security Lighting Important?" Del Mar Fans & Lighting's Guide to Outdoor Security Lighting. Del Mar Fans, 2014. Web. 27 June 2014. <<http://www.delmarfans.com/educate/outdoor-security-lighting/>>.

## General Overview

### Causes of light pollution

All light that is released into the environment and causes a change in the natural levels of light can be counted as light pollution. Light pollution is most present in densely populated urban areas, however more and more rural areas are also beginning to be affected by light pollution. The glow produced by major cities can be seen up to 80km away, affecting all rural areas within that radius. The main causes of light pollution are: poorly designed streetlights, heavily illuminated buildings and advertisements, and car headlights. It must be noted, however, that out of the three contributors mentioned, street lighting produces by far the most light pollution.

### Effects of light pollution

#### *Effects on flora and fauna*

Light pollution impacts animals in a very severe manner. Changes in light levels causes the circadian clock of several species to be thrown off, resulting in changes in behavior which often lead to a decreased chance of survival. More specifically, light pollution affects the following types of animals in the following ways;

**Mammals:** nocturnal mammals suffer most from the effects of light pollution. Animals such as bats, raccoons and deer are heavily affected by the loss of the dark and this leads to difficulties with finding food, higher exposure to predators and an overall decrease in population.

**Birds:** as stated before, according to the U.S. Fish and Wildlife Service in the whole North American region, around 98 million migratory birds die each year

from collisions with heavily illuminated communication towers. Add to that the fact that artificial light in the night sky inhibits the navigating abilities of these birds, and the losses to the bird population prove to be immense.

**Insects:** Insects are attracted to light. However, it is not natural for them to gather all in one heavily illuminated point – such as under a streetlight – during nighttime. The impromptu gathering of insects in one place during the night makes it easier for predators to catch these insects, resulting in heavily decreased insect populations. This in turn affects all animals that feed on insects, thus damaging the food chain.

**Reptiles:** a famous example of the destructive nature of light pollution in wildlife is little sea turtles that hatch at night on the beach and crawl towards the lightest are in the hopes of finding the sea. In a normal environment that is not polluted by artificial light, the water would be lighter than the shore, as the moon reflects off the water. However, lighting of beachside towns and cities means that most little turtles now crawl further in land where they invariably die.

All in all it is clear that all animals are affected by light pollution and these effects are all negative.

### *Effects on human health*

Exposure to artificial light cause the circadian clock of humans to be disturbed and as such has an effect on all of the processes that the circadian clock controls. The link between light pollution and sleeping disorders is a fairly obvious one, and one that has been proven by research – exposure to light during normal dark hours tempers with the circadian clock, resulting in sleep disorders such as insomnia.

Research has recently revealed that light pollution may be responsible for other more deadly diseases as well. Light pollution may soon be counted as a carcinogen. Melatonin is a hormone produced by the body only at night, and any type of artificial light – even a little bit – can halt melatonin production. Since melatonin controls the production of hormones such as estrogen, a link between melatonin levels and breast cancer has been established. This means that women working irregular night shifts or exposed to light nuisance or light pollution are more likely to get certain types of cancer, for instance breast cancer. This link was first noticed in women working irregular night shifts whom appeared much more likely to get breast cancer. Since then, a research study published in the “December 2005 issue of *Cancer Research*



implicated melatonin deficiency in what the report authors called a rational biologic explanation for the increased breast cancer risk in female night shift workers.” (Chepesiuk, Ron. "Distracted by the Light."). The study proved that melatonin depleted blood allowed tumors to grow much faster, while melatonin rich blood prevented tumor growth. This suggests that changes in melatonin levels (caused by changes in light levels) may be cancer inducing. However, more research needs to be done before a conclusion can be drawn.

Possible links between light pollution and other diseases such as depression and cardiovascular conditions have also been found. These too require further study before any solid conclusions can be drawn.

### *Effects on scientific research – Astronomy*

Light pollution is making it more and more difficult for astronomers to observe the night sky, impeding their process in studying stars, tracking meteorites etc. This hits students of astronomy especially hard. Most universities are, after all, located in urban areas and it is almost impossible to observe the night sky from university campus. Students have to travel up to 80km away from their university (along with very expensive equipment) to study the stars and make progress in this field of science. However, this consequence of light pollution is only minor in the face of the impacts it has on human and animal welfare.

### **Cost of light pollution and its link to other types of pollution**

Light pollution, as well as being harmful to the environment, is also a huge waste of resources. Most lighting is frighteningly inefficient; this is demonstrated by the fact that 60 to 70% of the energy used for lighting could be cut down if lighting with smarter designs was used. Outdoor street lighting produces the most waste, these lights are often unshielded and shielding these lights so that they become full cutoff lighting would decrease light pollution and save energy and money. Full cutoff lighting produces the same amount of illumination as unshielded light, and is a far better option both cost and environment wise.

It is estimated that the US alone wastes about \$2.2 billion on unnecessary and/or inefficient lighting each year. That amounts to 22,000 gigawatts of wasted light, the production of which released 14.7 million tons of carbon waste. Aside from the negative impacts on the environment because of energy production, glare from inefficient and unshielded lighting has also been proven to decrease certain oxidants in the ozone and air, increasing pollution levels.



## Major Parties Involved and Their Views

### International Dark-Sky Association (IDA)

The IDA is the largest organization dedicated to preserving the night sky. The IDA aims to achieve its goal mostly through educating the public about the importance of preserving the dark, and further educating them on how they can contribute to the preservation efforts.

### United States of America (USA)

The US is one of the main contributors to light pollution. Most aerial photos taken at night reveal that the US is one of the most brightly illuminated countries in the world. The US is also a prime example of how much money (\$2.2 billion per year) could be saved if energy efficient full cutoff lighting was used.

### Italy

Italy is significant since it has some of the strictest laws in place regarding light pollution in the world, and other countries could look to these laws when thinking about regulating light pollution in their respective states. In most regions of the country, only full cutoff lights can be newly installed and the yearly brightness degree increase is set at 1%, forcing investors to make older streetlights full cutoff to allow new ones to be built.

### UNESCO

UNESCO signed the starlight declaration in 1992 to protect the night sky and strongly hoped that similar provisions would be made in national legislation to preserve the dark. This declaration has had varying forms of success in different members states: some chose to heed UNESCO's word, while other member states disregarded it completely. However, this does show the position of the UN on the issue of light pollution.

## Timeline of Events

Date	Description of event
1879	Thomas Edison's invention is first used to light a street in New York
1972	The United Nations Conference on the Human Environment (UNCHE) adopted the Stockholm Declaration, which established the link between protecting the environment and human rights.



1992	UNESCO signed the starlight declaration to protect the dark, in hopes that similar provisions would be made in national law to protect the night sky
2007 – Now	Earth hour, an hour in which an area turns off all of its lights for one hour. This initiative originated in Sydney Australia, and has been held every year since 2007. In March 2014, over 7000 cities and towns participated.
2009	UNCHE signed a declaration for the better prevention of environment-related health hazards.
12 <sup>th</sup> November, 2010	The Parliamentary Assembly of the European Union signed Recommendation 1947, which asked for the implementation of laws regarding noise and light pollution.

## UN involvement, Relevant Resolutions, Treaties and Events

UN involvement in the light pollution issue has been very limited to this date. The only relevant UN treaties and resolutions that exist are all general resolutions about protecting the environment as a whole that are signed by the UNCHE. UNESCO has signed one declaration asking for the protection of the night sky, and this is the only specific document in which the UN addresses the issue of light pollution.

- Starlight declaration, 1992, UNESCO.

## Evaluation of Previous Attempts to Resolve the Issue

Although light pollution is not a recent issue, it has only started to garner attention now. Therefore, few solutions have been tested in practice, and there is still a chance that a new solution will be developed in the near future which surpasses the options mentioned in this report.

First of all, there has been little to no UN involvement in this issue thus far. UNESCO has declared the night sky something to be preserved and treasured, but no binding guidelines for reducing pollution have been set for member states. Individual countries, however, have introduced legislations to limit light pollution. Most notably, countries like Italy are reducing light pollution by imposing strict guidelines for all street lighting to minimize glow, light nuisance and light pollution. Most of them achieve this by endorsing full cutoff



lighting and penalizing less efficient lighting - unshielded lighting - heavily. Introducing full cutoff lighting appears to be one of the most feasible solutions. Even though initially the lighting is more expensive, it is also far more efficient and thus requires less energy to run, saving money on the whole.

Other than cutoff lighting, countries have experimented with switch off days and dark reserves. Both of these solutions are mostly to benefit people and do not greatly reduce the amount of light pollution. Switch off days held in large cities such as London, New York and Hong Kong annually are a great way to show the public what the night sky would look like without all the pollution. It serves as a wake up call to teach people about the issue and perhaps help to decrease light pollution.

Dark reserves are a novel idea that allows people suffering from bright lights in the city to escape to a dark location close to home. For example, there is a Dark Sky reserve 70km from Berlin where thousands of people each year take a break from the bright city lights. These parks have the potential of decreasing mental and sleeping disorders in humans that are caused by too much exposure to light during night hours.

## Possible Solutions

One of the most effective solutions, which has been discussed previously, is to switch all outdoor lighting to energy efficient full cutoff lighting. Full cutoff energy efficient lighting has the advantages of protecting the environment, the health of people to a certain degree, and costing less in the long run. The one problem with this solution is that it would be very expensive for countries with existing lighting systems to switch all of their outdoor lighting to full cutoff lighting. However, imposing guidelines for any new lighting, or lighting to be replaced should not be a problem and would already help ease the strain on the night sky. In areas where poorly designed lighting is causing light nuisance and is affecting the lives of people, legislation could be made stricter and all such lights replaced with full cutoff, non-intrusive lighting.

Light pollution is not a very famous form of pollution and relatively few people know and understand what this form of pollution entails and the adverse effects it has on the environment and human health. For this reason, the importance of education in solving this issue cannot be overstated. Very little progress will be made without drawing attention to the issue and educating people about the fact that it is in their best interest to preserve the dark. So things like switch-off days and star gazing trips for children could be of huge assistance.



There are ample charities dealing with the issue of light pollution, so setting up a separate UN committee for this issue would seem a little gratuitous. Most of the finances allocated to dealing with this issue should go through either a reliable charity or the Environmental Commission itself.

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## Appendix or Appendices

- I. <http://assembly.coe.int/Main.asp?link=/Documents/AdoptedText/ta10/ERES1776.htm>
- II. <http://www.darksky.org/about-us>
- III. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2627884/>



