

***“Come over to the Dark  
Side”***

**The Medical Implications of Light Pollution**

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North West Armed Forces Hospitals Programme,  
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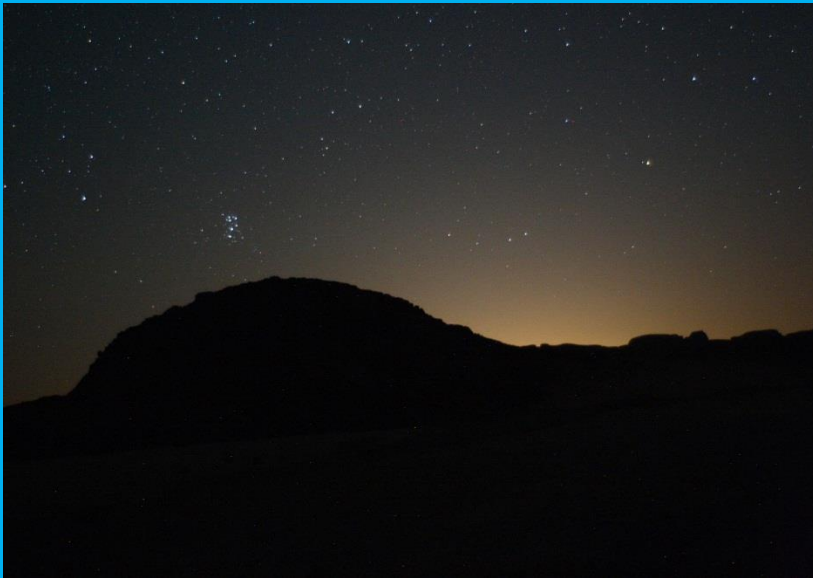
# What is Light Pollution?

## Definition

- *Light pollution is unwanted light that leaks out into the environment at night.*
- It takes three forms:
  - 1) Skyglow.
  - 2) Light trespass.
  - 3) Glare.
- Skyglow is caused by light from cities being reflected off aerosols in the atmosphere.
- Light trespass is the intrusion of light across property lines into bedrooms, gardens and back yards.
- Glare is caused by direct intrusion of light from unshielded light sources.
- The next three images illustrate skyglow, glare and light trespass.

# Skyglow (l) and Glare (r)

Images: C. Henshaw.



# Light Trespass

Image: C. Henshaw.



# Causes

- **Street lighting.**
- **Security lighting (both domestic and commercial).**
- **Commercial lighting (empty offices with their lights left on all night).**
- **Decorative lighting (floodlighting, illuminated regeneration follies, skybeams and lasers).**
- **Sports facilities.**
- **Advertising (billboards and flashing signs).**

# Effects

- Wastes energy.
- Wastes money. The energy consumed has to be paid for.
- Causes global warming and climate change. *Because of this, light pollution is an inconvenient truth.*
- Reduces visibility of stars at night.
- Kills insects. This has effects on higher order consumers.
- Affects plants.
- *Disturbs circadian rhythms in animals and humans.*
- Causes accidents.
- The following slides show Jeddah at night, and the effect of light pollution on the UK and Europe, as seen from orbit.

# Jeddah at night

Image: C. Henshaw.



# LP from Space

These are composite images taken over many nights. They give the impression the light leaks out harmlessly into space. It doesn't. Most of the time it is cloudy, so the energy is absorbed by the environment contributing to global warming. Images: NASA.





**LP from Tabuk, KSA, as seen from Sharma, on the Red Sea coast,  
150kms due West.**

Light travels in straight lines, but the Earth's surface is curved, so lighting from sources below the horizon, (even full cut-off lighting) can still illuminate the cloud ceiling from a great distance.

Image: C. Henshaw.



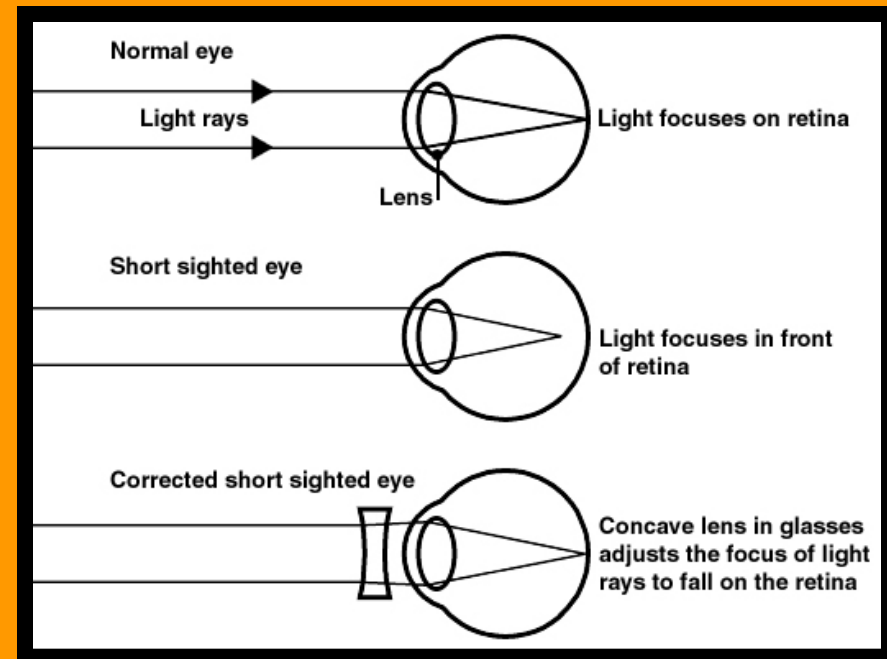
# Effects

- **Street lights contribute to global warming.**
- **This is caused by carbon dioxide emissions derived from the fuel used in keeping them going.**
- **In Europe this amounts to 59,760TWh per annum.**
- **Lighting Industry sources quote night-time lighting accounts for at least 19% of all energy usage and up to 60% of municipal capital expenditure.**
- **In the Italian town of Certaldo, electricity consumption due to street lighting is at least 60%: (Fiaschi, et al, 2012). Other communities are probably similar or worse, especially in developing countries where environmental concerns are of little or no consequence.**

# Effects on Humans

## Short sight

- Children and young people sleeping in bedrooms illuminated by street lights may end up short sighted.
- Children sleeping in bedrooms illuminated by night-lights may likewise be affected.



# Depression (1)

- Exposure to fluorescent lighting, especially in schools and offices can lead to work related stress, high blood pressure and depression.
- Exposure to light at inappropriate times can lead to sleep deprivation, fatigue and impaired thinking. This in turn can lead to accidents.
- The affected patient will not have sufficient REM sleep. During REM sleep the body produces antibodies and *melatonin*.

# Depression (2)

- **The body works on a natural twenty-four hour cycle dependant on the rising and setting of the Sun.**
- **Nocturnal shift work can disrupt these natural rhythms and have adverse affects on the body.**
- **Similar manifestations are seen in people living in high northerly latitudes when the sun hardly sets during the summer and barely rises in the winter. This can affect the suicide rate.**

# Premature Babies

- **Premature babies are babies born before the full term of 39 weeks has elapsed.**
- **They are effectively foetuses that have been born early.**
- **Light pollution may damage their biological clocks.**
- **Consequently the régime under which they are kept has to match the inside of the womb as closely as possible.**
- **They are still developing, so they are kept in a régime of darkness and light to facilitate normal circadian rhythms.**
- **This would not happen if they are illuminated 24 hours per day.**

# Flashing lights

- **These have been known to precipitate epileptic fits in some people with photosensitive epilepsy.**
- **Frequencies of between 5 and 30 Hz have been known to induce seizures.**
- **If flashing signs are deemed necessary then the frequency needs adjusting to avoid triggering photosensitive epilepsy.**
- **There is a risk of flashing signs inducing epileptic fits in drivers.**
- **If a flashing advertising sign induces a fit in a driver, then the effects could be fatal.**
- **Defective fluorescent tubes are known to flicker, and these can have the same effect.**

# Circadian Rhythms

- **Circadian rhythms are twenty-four hour cycles of physiological behaviour in living organisms, ranging from bacteria to plants and humans.**
- **They control daily rhythms of sleep, hormone production, and essential aspects of cell physiology.**
- **As a result of genetic sequencing it is now known the 15% of the genome is regulated by the body clock.**
- **The function of every organ in the body is rhythmic (Loudon, A., 2008, Manchester).**
- **It has been said that a cycle of very bright days and *very dark nights* is the perfect regulator for the human circadian system, *but patterns of light and dark in today's modern world are often inconsistent with this cycle.***



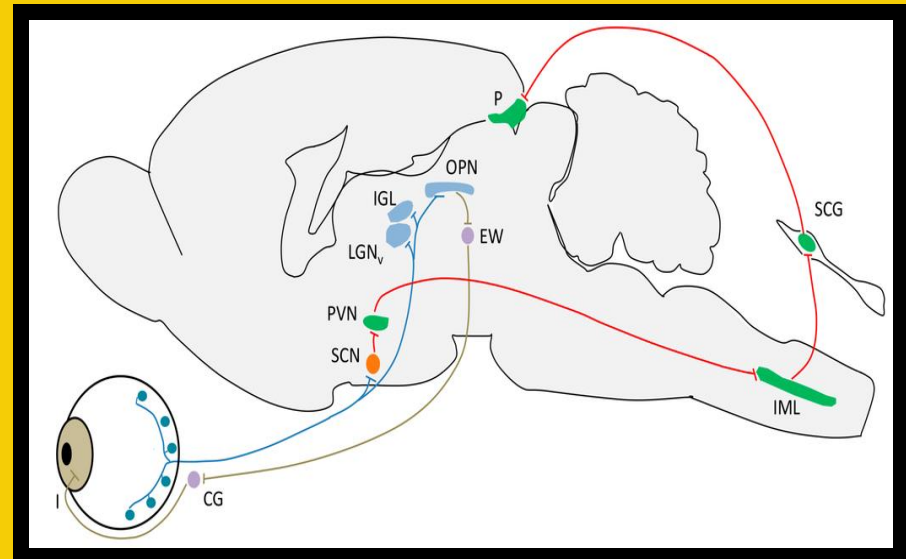
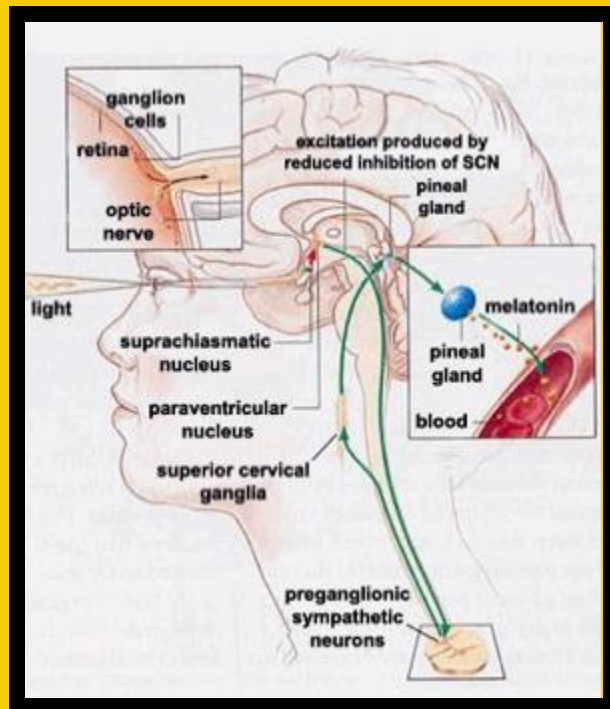
# Circadian Rhythms (cont'd)

- In mammals circadian rhythms are maintained by the Hypothalamic Suprachiasmatic Nucleus, or Circadian Pacemaker.
- Intrinsically photoreceptive retinal ganglion cells or ipRGCs, containing a pigment called *Melanopsin*, are connected to Hypothalamic Suprachiasmatic Nucleus via the optic nerve via the retinohypothalamic tract.
- This is connected to the Pineal Gland (a structure about the size of a pea in humans, located inside the brain) via the Paraventricular Nucleus.
- The pineal gland secretes a hormone called *melatonin*.
- More melatonin is secreted at night.
- Exposure to light at night (especially blue wavelengths) suppresses melatonin production.

# Hypothalamic Suprachiasmatic Nucleus

left credit: Giuliano, V.

right credit: Bonmati-Carrion, M. A. et al



# Melatonin

- **Melatonin serves to reduce cholesterol levels.**
- **It reduces blood pressure.**
- **It is a known antioxidant that helps to maintain the body's immune system by stimulating T-cell production.**
- **It protects nuclear and mitochondrial DNA.**
- **It has been used in the treatment of Seasonal Affective Disorder, and ADHD – Attention Deficit Hyperactivity Disorder, to offset the effects of other drugs used to treat it that can cause insomnia.**

# Cancer

- Melatonin is also important as a cancer suppressor.
- It is said to be *oncostatic*.
- It has been found that the incidence of breast cancer in women, and prostate cancer in men is greater in urban areas that are lit up all night.
- This connection was first identified by Richard Stevens (US Department of Energy's Pacific Northwest National Laboratory) and backed up by later research by Schernhammer and Schulmeister (2003) and Kloog, Haim and Portnov (2005), and Reiter et al (2006).
- It is substantially reduced in rural areas where it is dark.
- It comes as no surprise then, that the incidence of breast cancer is lower in blind people.

# Causes accidents

- Excessively bright or badly aimed lighting causes *glare*.
- At night the eye adapts to the darkness.
- Bright lights destroy the visual purple (*rhodopsin*) in the retina, again if it has a significant blue component.
- The person has been dazzled, and is worse for those with any kind of visual impairment.
- Anyone approaching a bright light source is visually impaired to the point that his/her eyes may not re-adjust for some time.
- If driving a vehicle, or simply walking towards a bright light source, the risk of an accident can substantially increase.

# Obesity

- **The seasonal lengthening of the night in late summer and autumn is masked by artificial lighting. Extended exposure to lighting mimics long summer nights that is now known to cause cravings for carbohydrates.**
- **This behaviour is normal in that it encourages a build-up of body fat in readiness for winter.**
- **However, if present all year long this is no longer advantageous as the winter never comes; [Wiley and Formby (2000)].**
- **This results in excess body mass and obesity in susceptible individuals, leading to depression, Type II diabetes and heart disease.**

# **Aberant behaviour in children**

- **Clark (2003) reports aberrant behaviour in Australian juveniles lying prone in the grass, staring close range at floodlighting installed to floodlight trees in a park outside Melbourne.**
- **This craze would be akin to glue-sniffing behaviour seen elsewhere. It was reported on several occasions, and may well occur elsewhere but has not been observed.**
- **Such lighting contains levels of short wavelength light that is highly damaging to the eye at high intensities.**
- **This lead to the recommendation that the lighting be removed immediately, and sets a precedent for the use of such lighting elsewhere. Since this lighting is decorative it serves no useful purpose and has the added drawback that it is harmful to wildlife that may reside in the trees, and also to the trees themselves.**

# Wasteful, decorative lighting: floodlit trees – hazardous to children





# Excessive Lighting

- The excessive use lighting has not been shown to have any beneficial effects
- More and more scientists and health-care professionals are becoming aware of the dangerous effects of light pollution.
- Though it has been regarded by some as a problem for over forty years, it is only recently that it has been recognised as such by the medical profession.
- Its long term effects are unknown.
- Unfortunately society has been tricked into dependency on lighting by a devious lighting industry intent on maximising profits.
- This will take many years to overcome.

# Recommendations

- Of course some lighting at night is needed as people need to work and move around at night.
- *However, lighting should only be installed sparingly, where needed, when needed, in the correct amounts, using appropriate smart lighting technology specifically designed for the purpose.*
- Most conventional lighting systems do not satisfy these requirements.
- A considerable amount of lighting can be eliminated without any serious effect.

# Recommendations (cont'd)

- **Switch off lights when they are not needed.**
- **Prevent over-lighting.**
- **Subject exterior lighting to planning control.**
- **Encourage industry, commerce, local government and domestic consumers to use efficient lighting and minimise energy wastage.**
- **Make light pollution a statutory nuisance.**

# Street Lighting (1)

- To reduce sky glow and light trespass, street lighting should be 45 degree full cut-off, or better.
- In these the luminaire is shielded by a flat glass shroud, oriented parallel to the ground and not tilted.
- Such lighting does not allow light to leak out above the horizontal, so should not penetrate bedrooms located above the light.
- All-night lighting should only be permitted in city centres and major thoroughfares in suburban areas, where people are constantly active.

# Street Lighting (2)

- **Minor roads in suburban and residential areas should operate on an 11 p.m. till dawn curfew to give the environment time to recover. In addition new LED lighting can be motion operated so they only switch on when needed.**
- **However, the downside of LED lighting is its blue component is hazardous and needs to be filtered out.**
- **In winter, schools and businesses can adopt a winter timetable starting work in daylight and finishing later. This obviates the need for people to get up in the dark and as a consequence, early morning lighting. It will also lead to a reduction in accidents.**
- **Local government is under no responsibility to illuminate streets for people who chose to be out after that time. The onus is on them to provide their own lighting. They should use a torch.**
- **Lighting is not an option in rural areas so as to maintain the distinction between town and country.**

**Left: Rampant Cobra.** Image: Graham Cliff.

**Right: Full Cut-off.**



# Security Lighting

- This should be motion operated so it only comes on when needed. At all other times it remains switched off.
- It should be aimed downwards to avoid light trespass.
- They should be hooded. Naked lights should not be used.
- In this way the light only shines on the target area, and if correctly installed, does not cross property lines.
- There is no point in lighting up an area all night if no-one is there to see what is going on. It only makes the criminal's job easier.

# Security Lighting. Left; Bad: Right; Better.





# The Lighting Industry (1)

- The lighting we use is provided by the lighting industry and municipal lighting departments.
- Unfortunately the lighting industry is out of control and needs to be regulated.
- It promotes the view “Light is good, darkness is bad.”
- That’s why we have a problem with light pollution.
- It promulgates urban myths that more and brighter lighting = greater security and less crime.
- It is an established fact that criminality drops to almost to zero during power failures and by up to 50% in those areas where street lighting is switched off at midnight.
- It perpetuates these myths in order to maximise profits, and to keep themselves and street lighting engineers in jobs.

# The Lighting Industry (2)

- Most crime occurs in daylight.
- Therefore criminals need light.
- Increasing lighting encourages people to behave at night more as they would during the day.
- Therefore more lighting = more crime. High crime areas are always intensively lit.
- *The problem with the lighting industry and municipal lighting departments is that they don't want to understand the issue because their profits and salaries depend on them not understanding it. So our health is suffering as a result.*
- They don't care about the damage they cause as they have their own ill-conceived agenda, and they don't have to live with the problem.
- They need to be regulated by a body made up of people without any vested interests in the industry.

# The Lighting Industry (3)

- People are demanding more light.
- The environment is demanding less.
- Darkness at night is normal and essential for the well-being of humans, animals and plants.
- Therefore society should learn to adapt and accept darkness as part of the natural order of things.

# Conclusions (1)

- **Light-pollution is a serious environmental problem that has medical implications.**
- **It disturbs circadian rhythms.**
- **It has been linked to short sightedness in children.**
- **Children (and adults) need to sleep in dark bedrooms where street lighting is not allowed to penetrate.**
- **It has been linked to breast cancer in women and prostate cancer in men.**
- **It can cause depression.**
- **It disturbs sleep, causing fatigue and impaired thinking, leading to accidents**
- **It can be remedied by introducing more modern full methods of smart street lighting.**

# Conclusions (2)

- **Curfews can be imposed on street lighting in residential and suburban areas to maintain the balance between day and night.**
- **LED street lighting can also be introduced in these areas as it can be motion operated, so as to switch on only when needed. However it is imperative to filter out the damaging blue component.**
- ***New legislation can be introduced to reduce light trespass by controlling the type of exterior lighting that can be used at night. This should include the compulsory use of motion operated security lighting.***
- **Restrictions on the wattage and luminance of exterior lights and height restrictions on street lights to minimise light nuisance.**
- ***All exterior lighting must be shaded and aimed downwards to prevent light trespass.***

# Conclusions (3)

- The banning of unnecessary lighting that serves no useful purpose, such as illuminated advertising in residential and rural areas, decorative lighting, skybeams, lasers and floodlit buildings.
- *Switching off lighting in buildings that are not going to be functional at night.*
- Controls on obtrusive lighting may be unpopular at first, *but the essence of good governance is to know what the people want, and to know what the people need, and to have the wisdom to understand the difference.*
- In addition to improving our health we will be helping the environment by preventing energy wastage, saving money, and reducing the carbon dioxide emissions responsible for climate change and global warming.

# Epilogue

- You may not agree with the evidence presented here, but at least I hope I have made you think.
- Please take some time to consider the issues I have raised.

• **Thank you.**

- [www.lightpollution.org.uk](http://www.lightpollution.org.uk)