

# Environmental Aspects of Urban Lighting

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**Abstract:** This paper focuses on the causes of urban light pollution, regulations and practices for urban light pollution prevention and control, with special attention to the impacts of light pollution on ecosystems and human health, as well as lighting standards and regulations in different countries and regions. The paper argues that rational urban design and scientific management techniques are the key to combating light pollution, while the preservation of historical features and the mood of ancient cities is also an important aspect of public interest.

**Keywords:** Urban light pollution, Light environment quality, Urban design, Urban management.

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## 1. General

Light is an important environmental factor that plays a role far beyond illumination. As a source of energy, it affects all life on Earth. High-quality artificial lighting in public spaces is one of the necessary functions of a sustainable city. It is not just about providing sufficient light intensity, reduced energy consumption and low environmental impact. Addressing this challenge is not only a technical issue, but also requires consideration of subjective approaches such as psychological, sociological and aesthetic functions.

While humans benefit primarily from light, the presence of artificial night-light in urban environments affects ecosystems, animals and vegetation. Light emission is rarely neutral and may have serious ecological and evolutionary consequences for many organisms and may reshape entire ecosystems. Light reflected from illuminated surfaces can also cause skylight and alter natural conditions. Some insects or birds are attracted to artificial light. Their behavioural patterns, migration routes and breeding schedules will be affected.

Urban lighting influences the emotions of the observer. These emotions are related to the cultural context, such as surprise, inspiration, disagreeable surprise, contempt and disappointment.

Widely discussed are the negative effects on human health of the introduction of artificial night-time lighting. Evidence suggests that these effects may be due to the suppression of melatonin by exposure to artificial light at night.

## 2. Light Pollution

Light pollution is also known as light interference. Generally speaking, the phenomenon of excessive or inappropriate light radiation generated by modern society on the adverse effects of human life and production environment is collectively referred to as "light pollution". In China's promulgation of the industry standard "City Night Lighting Design Code" in the definition of "light pollution" is the interference with light or excessive light radiation (including visible, ultraviolet and infrared radiation) on people, the ecological environment and astronomical observation caused by the negative impact of the general term.

Light pollution is a global problem. This became apparent when the World Atlas of Night Sky Brightness, a computer-generated map based on thousands of satellite photos, was published in 2016. The atlas, which can be viewed online,

shows how and where our planet is illuminated at night. Large areas of North America, Europe, the Middle East and Asia are glowing, while only the most remote parts of the planet (Siberia, the Sahara and the Amazon) are completely dark. Some of the most light-polluted countries in the world are Singapore, Qatar and Kuwait.

There are three types of light pollution: glare, clutter and light trespass. glare is excessive brightness that causes visual discomfort (e.g., while driving). Clutter is the combination of bright, chaotic and excessive light sources (e.g. Times Square, New York). Light trespass is the extension of light into an unwanted or unneeded area (e.g., a streetlight illuminating a nearby bedroom window). Most outdoor lighting is poorly placed and sends wasted power into the sky.

Sky glow is the brightening of the night sky, mainly in urban areas, as a result of electric lights from cars, street lamps, offices, factories, outdoor advertisements and buildings that turn night into day for people who work and play long hours after sunset. The phenomenon is caused by scattered (both visible and non-visible) light from gas molecules and aerosols in the atmosphere, reflected in the direction of astronomical observations. It consists of two independent components: natural sky glow and artificial sky glow (artificial daytime). Liu Ming et al. established a distribution model of urban night sky brightness, discussed the distribution law of urban night sky brightness, and preliminarily explored the influencing factors, monitoring methods and evaluation procedures of urban night sky brightness. From the perspective of environmental psychology, BP neural network was applied for the first time to study the prediction of urban night sky brightness.

More than 80% of the world's population, and 99% of Americans and Europeans, live under sky glow. This sounds beautiful, but sky glow caused by human activity is one of the most prevalent forms of light pollution.

Urban light pollution is also manifested in light misdirection, light misdirection in the light colour misdirection performance more, the survey found that especially the installation of lighting facilities on the overpass misdirection of the colour of the driver has a clear misleading effect, especially in the queue through the red light, due to the invisibility of intersection signals, it is very easy to come from the vehicle above the signal colour interference, the phenomenon of early start more often. Visual shielding shows up more in some mid-range and high-end hotels, and the floodlight sweeping through the windows does reduce the

visibility of the city's nightscape. Light-colour imbalance is shown less frequently and sometimes exists as a special artistic effect.

### 3. Hazards of Light Pollution

Artificial light can wreak havoc on the natural body rhythms of humans and animals. Light at night interrupts sleep, confuses circadian rhythms - the internal 24-hour clock that guides circadian activity - and affects physiological processes in virtually all living organisms. One of these processes is the production of melatonin, which is released in the dark and suppressed in the presence of light. Increased light at night reduces melatonin production, which leads to sleep deprivation, fatigue, headaches, stress, anxiety and other health problems. Recent studies have also shown a link between reduced melatonin levels and cancer.

Medical experts believe that light pollution is strongly associated with increased rates of breast cancer, depression and other human diseases. Inappropriate artificial lighting at night disrupts the body's hormone levels, which affects human health, which is why the incidence of breast cancer is five times higher in industrialised societies than in developing countries. If you are in a light situation for a long time. Hormone production rhythms can be disrupted, causing chronic fatigue, depression, loss of fertility and even cancer. This is also the reason why women who work shifts at night, such as nurses and textile workers, have a higher risk of breast cancer than the general population.

In fact, new scientific findings on the health effects of artificial light have convinced the American Medical Association (AMA) to support efforts to control light pollution and conduct research on the potential risks of nighttime exposure. Blue light, in particular, has been shown to reduce melatonin levels in humans. Blue light is found in mobile phones and other computer devices, as well as in light-emitting diodes (LEDs), a type of bulb that has become popular for home and industrial and urban lighting because of its low cost and energy efficiency.

Bavaria, Germany, through a survey of 200 citizens, of which one-third of the people complained of night sleep by outdoor lights, especially bright neon interference, two-fifths of the people reflect the inability to sleep, and feel dizzy, blurred vision, ringing in the ears, coughing, and even cause asthma.

It was astronomical observers who first introduced the concept of light pollution. Since astronomical observations are mostly carried out at night, the requirement for sky brightness is very high. When the sky is 10 times brighter than the natural sky, the beautiful night sky loses a large number of stars in people's view. More serious to astronomical work is the devaluation of astronomical telescopes. For example, the value of a large telescope with a four-metre aperture worth \$500 million has become equal to that of a small telescope with a one-metre aperture worth \$20 million against the background of the original sky brightness. At present, the brightness of the night sky in many big cities is far more than 10 times the brightness of the natural sky. In order to avoid the pollution of the night sky by lighting and a thousand disturbances, has made the whole country and even the world's astronomical observation work has paid a huge price. Most of the observatories built in the early days were located close to the city centre in order to facilitate work and life. Later, with the development of outdoor lighting at night, the rapid increase in the brightness of the night sky around the

observatory. This made it impossible for many observatories to carry out normal astronomical observations and forced them to move to remote areas.

The Tokyo Observatory in Japan has been relocated four times due to the impact of unreasonable night lighting in the city. Modern astronomy developed in Europe and the United States can not escape the hazards of light pollution. California and Arizona in the United States, Toronto and Ontario in Canada, many observatories have been relocated several times, with huge losses. Finally, they had to build astronomical observatories in foreign countries far away from their own countries, such as the British Observatory to Australia's New South Wales to look for observation points. French astronomers to the United States of America, Hawaii, Mona Kea to build an observatory, as well as Western Europe, Spain and Portugal and other four countries to the far away from the miles of South America, Chile's Lassa to establish an astronomical observatory, the reason is that these newly relocated to the address of the night sky protection is better, basically not subject to light pollution.

In the architectural decorative modelling lighting, to coronation rainbow lighting and floodlighting produced the most serious light pollution.

Neon lighting is most widely used in commercial buildings. In some commercial buildings facing the street, in order to attract people's attention, a large number of colourful neon lights are used on their facades for night lighting. The strong colour contrast forms colour pollution. It causes a certain amount of interference to the sight lines of passing pedestrians and drivers. Therefore, the use of neon lighting should be appropriately restricted according to the specific environment for commercial buildings facing the street and close to residential areas.

Floodlighting produces light pollution in the main reasons are: floodlight installation lamp position and projection direction is unreasonable, resulting in a part of the light shot into the air or directly to the surrounding buildings, resulting in a large number of overflow light or interference with the light, resulting in glare glare, clutter clutter and light invasion of light trespass. if the glass curtain wall, especially for the hidden frame of the glass curtain wall building also use If the glass curtain wall, especially for hidden frame glass curtain wall building also use floodlighting, due to the glass is a translucent material, the light shot to the glass curtain wall directly into the room, it will produce serious light interference on the indoor environment.

### 4. Lighting Quality in Urban Environments

Outdoor lighting is an extremely broad topic. Illumination is a measurable entity in terms of technology-oriented energy efficiency. However, sustainable management also includes the human dimension. It is not possible to talk about absolutely measurable lighting efficiency here - the environment is perceived differently by different people and depends on the spatial context (urban and architectural). The results of the Laze study show that users are dissatisfied with street lighting, even though all light measurements are above the CIE standard. These results suggest that street lighting needs to be improved to meet public expectations.

Night lighting is not the brighter the better, the size of the brightness to meet people's activities to reflect the viewing distance between the feeling of light and energy saving

optimisation. Therefore, a good city night view is to express the relationship between the light and dark objects of artistic cooperation. Brightness according to the partition has to go to the view and the concept of the microscopic twofold significance. For buildings. Zoning that is, the four sides of the building have light and dark, to ensure that the building's distinctive volume. Outline is not covered by the lighting; for the region, zoning is a comprehensive consideration of regional functions, aesthetic characteristics of the brightness of the overall arrangement, the zoning of light and dark, clear and distinct. Lighting zoning also contains the meaning of green lighting design. Different lighting divisions, according to a reasonable distribution, so that the lighting and energy saving, environmental protection, functionality, object form an optimal match.

Illumination classification is to determine the night landscape highlights in each illumination sub-district, and the average illumination level table to differentiate the brightness of each highlight, so that the expression of the object of the primary and secondary, the focus is clear. Highlights and the main points of the landscape is inseparable from the main points of the landscape is the main points of the main points of the landscape is an important basis for the level of illumination. Similarly, this concept of highlights, can be used in the city in the macro and micro architecture. In the city outline of the night landscape treatment, lighting organisation should effectively match the overall musical outline of the city, highlighting the "accent" part, weakening the "bass" part, in order to reflect the beautiful city skyline, in the architectural monolithic night landscape treatment, the top and the bottom of the building is the main points of the landscape, this is the need for lighting This is the lighting needs to focus on the expression of the place.

Illuminated areas are an important part of the city and other urban areas. Lynch defends the idea that the basic structure of the city should be revisited as an important tradition; that building lines and street corridors must be preserved; and that planning directions and ideas must be developed or continued. Only in this way is the long-term development of the city possible. Especially since the concept of the urban landscape is not only a material reality, but also a mental structure generated by subjective perception. We experience the urban structure as part of the visual environment. Urban lighting can influence the visual quality of the environment, enabling us to better recognise structural relationships and influencing the mental image of urban space, which further strengthens the identity of the city. According to Huber, high-quality illuminated surfaces are more attractive and therefore used more frequently. Optimising lighting in the direction of improving quality is already needed to reduce costs.

The earliest urban lighting can be traced back to 17th century France, where people illuminated streets and cities to ensure the safety of night-time activities, so the initial urban lighting began with functional lighting. With the development of the city, when people meet the low-level functional lighting needs, they begin to pursue a higher level of urban aesthetics. City lighting from being used to active design, performance of the city's night image. On the basis of meeting the needs of residents' night activities, lighting design uses the form, colour and brightness of light to design the urban space, thus bringing psychological and emotional changes to people.

Debreczeni suggests the following factors of lighting quality: brightness, uniformity of illumination, glare, colour of light, direction of light and constancy of illumination.

Pellegrino is also looking for solutions in the direction of technological and aesthetic improvements.

Lighting is not always suitable for all users. The environment will give us more information than we can take in. We only select information that is important and useful to us at a given time, and only that which we can process. Both low light and excess light can affect the quality and quantity of this information. This inconsistency can lead to discomfort, inappropriate behaviours or incorrect responses in certain situations. The consequences are manifested in the deterioration of the quality of the living space and in behavioural changes, i.e. the shortening of sleep patterns from nine to seven hours per night.

An urban place is a socio-physical structure consisting of buildings, streets, spaces, different land uses and user communities [7]. If these places are unattractive to users, or if they do not feel safe there, this may be due to the fact that the places are poorly organised and basically do not offer enough interesting possibilities. One possible reason could be poor outdoor lighting, especially if this occurs during certain time intervals. The presence or absence of night light as a quality of the physical environment has the greatest impact on large green spaces such as parks and all other paved areas such as public squares or streets. This situation can lead to conflicts between different user groups and will undoubtedly lead to a reduction in the number of visitors to these areas.

In urban environments, it is not only linear structures such as streets that are illuminated. There are other public spaces, such as public squares and parks, which are gathering points for people who move around on open surfaces. The most common activities there are walking, running, standing, sitting, socialising, playing, in-line skating, rollerblading and sightseeing. While many of these activities take place primarily during the day, they may extend into the evening. Such architecturally and advertently illuminated places are often unevenly lit. The absence or reduction of nighttime lighting does not necessarily mean that the environment is of poor quality; in fact, it may be desirable where there is a view of the night sky.

Artificial lighting is the specific design of a space, where it is important which spatial components should be seen and emphasised, what the lighting effect should look like, what kind of light should be used, where the lighting elements can be placed and, last but not least, who is the user of the place.

In today's cities, numerous different lighting arrangements are intertwined. Successful are those arrangements that provide the best conditions for all user groups in a given situation. Unsuccessful are those that do not fulfil the needs of at least one user group. In general, too much light or the wrong direction of light is a drawback in terms of space utilisation, power consumption and ecological acceptance. Artificial night lighting strategies for cities must be addressed first globally at the city level and then locally at specific sites.

Urban lighting is a general term for both urban functional lighting and urban landscape lighting, which are both independent and interrelated in terms of function, layout and construction. Functional lighting at night can enhance the utilisation rate of the city, reduce the fear of residents and lower the crime rate. Urban landscape lighting to meet the aesthetic needs of people and the enhancement of the city's night image. City night image can express the city culture and regional characteristics, so that people perceive the city image. Urban landscape lighting should be considered from the overall atmosphere of the environment, residents' feelings,

cultural background and other aspects to meet the spiritual and cultural needs of residents.

In September 2016, the United States of America, New York, lower Manhattan held in commemoration of the 15th anniversary of the "9-11" terrorist attacks, "Light of Remembrance" activities, two blue pillars of light from the World Trade Center site near the night sky into Manhattan, a symbol of the "9-11" incident disappeared in the New York World Trade Center Twins will always stand in people's hearts. "The twin stars of the World Trade Centre in New York, which disappeared during the September 11 attacks, will always remain in people's hearts. The quiet surroundings and the infinite extension of the blue column of light into the sky give people a strong sense of nostalgia for the deceased and hope for rebirth. Urban lighting focuses on the harmony between the environment and people, who are the protagonists of the environment, so that residents can feel the communication between light and people to create a city night scene.

Urban lighting design can be divided into basic lighting design and landscape lighting design. Basic lighting is generally street lamps on both sides of the road symmetrically distributed, staggered distribution or unilateral distribution, there is an induced arrangement. Basic lighting design must first meet the safety needs of pedestrians and vehicles travelling, in addition to the need for a certain level of illumination, but also consider the illumination of the vertical surface space, brightness, in order to meet the safety needs, to avoid the effect of the outline of moving objects, can not see the details. CIE, IES standards on urban road classification and corresponding lighting requirements should be strictly followed. In this case, consider the integration of the form of lamps and lanterns with the surrounding environment, and appropriately select the modelling of lamps and lanterns to make them harmonious and unified. Landscape lighting design, on the other hand, needs to be in accordance with the actual configuration, selective lighting, light settings should reflect the characteristics of the building or structure. Commonly used in the building itself or neighbouring buildings on the set of lighting equipment, or will be a combination of two kinds of lights, can also be placed on the ground in the green belt.

## 5. Treatment of Urban Light Pollution

Unified management of lighting can effectively reduce light pollution. Its main method is to reasonably reduce the amount of light used by flexibly deploying urban lighting time. The overall concept is the basis of the aesthetic beauty of urban night landscape, while unified management and unified planning are the necessary means to ensure the overall beauty. Through advanced control and supervision technology, (such as based on GSM, GPRS wireless platform remote control, central management mode) will be a region, and even the whole city's night lighting management unity, on the one hand, can ensure that the urban night landscape effect of the overall play, reasonable deployment of power resources, more importantly, can also be at any time according to the degree of light pollution (such as the sky background luminance), the flexibility of scheduling of the district Nightscape equipment on or off.

From the perspective of preventing and controlling light pollution and saving energy, there are two main management modes, namely, time-segment control and intelligent control, for urban nightscape lighting. The unified management of urban night lighting is to prepare scientific urban lighting

planning and design, to carry out high-tech urban lighting construction, and to prevent light pollution brought about by unreasonable night lighting.

The first step is to establish a scientific approach to urban lighting planning and design. At the right time, the right amount of light to the right place, is the scientific urban lighting planning to achieve the goal. For urban planning and management, can control the lighting facilities are mainly public transport, urban green space, important buildings and advertising signs lighting, should introduce a set of lighting standards to regulate, to prevent light pollution in the lighting.

In the practice of light pollution control, most countries have carried out special legislation based on environmental elements, and established a more complete legal system for light pollution prevention and control on the basis of special laws to provide the necessary prerequisites and rule of law safeguards for pollution control. The Czech Republic's Act on the Protection of the Dark Environment is of pioneering significance, and is the first law in the world to be formulated at the national level for the prevention and control of light pollution. The Act clearly defines light pollution, i.e., all kinds of human-induced irradiation scattered outside the designated area, especially high above the ground level, are regarded as light pollution, and makes it an obligation of citizens and organisations to take appropriate measures to prevent light pollution, which greatly enhances the enthusiasm of citizens to participate in the prevention and control of light pollution, a precedent that has been widely acclaimed in the international community. France is an international famous fashion place, into the 20th century Paris began to suffer from light pollution, the world's first case of light pollution on the citizens of the infringement of the case took place in Paris. 1980s, light pollution has become a common problem of the French major cities, in this context, France formulated the "Light Pollution Prevention and Control Act" in 1981, and in 1984 formulated the "night luminous advertisement law", which effectively protects the light environment. which effectively protects the light environment. Japan's modernisation has also caused damage to the natural landscape and ecological environment, especially the use of various types of light to the Japanese night scene has caused a great impact. 1989, the Japanese government formulated the "Protection of the beautiful starry night sky Meisei Town Light Pollution Prevention Ordinance", as can be seen from the name of the light pollution hazards at that time is not in-depth, incomplete understanding of the night sky visibility is still more focused on the starry sky. It was not until 2005 that this ordinance was renamed the "Mihoshi-cho Light Pollution Prevention Ordinance of Ihara City", which more accurately defines light pollution, defining light pollution (light pollution) as "scattered light from artificial illumination reflecting through dust or certain obstacles, etc., that makes the night sky brighter than it is naturally, and which interferes with the state of observing the stars". . The ordinance also stipulates that the prevention and control of light pollution is the responsibility and duty of communities, enterprises and residents, and specifies the incentives and penalties for the prevention and control of light pollution, giving incentives to those who comply with the provisions of the ordinance and cooperate with its promotion, and imposing penalties for violating the ordinance by causing light pollution, and making the names and behaviour public.

Light pollution control also requires the clarification of environmental standards. Environmental standards are very

rich in content, including quality standards, technical standards, control standards, testing standards and other specific indicators. Environmental standards have normative, guiding and incentivising and other important features, is the basic premise and the main basis for pollution control work and pollution infringement damage compensation. Developed countries' light environment standards are not consistent, the specific indicators set and the value of each indicator will be different, but the same is that they will be in a certain field or a specific indicator on the provision of a clear standard value, for the protection of the light environment and prevention of light pollution to provide scientific and technological support.

Japan's "Mihoshi-cho, Ihara City Light Pollution Prevention Ordinance" sets specifications and standards for lighting fixtures, and in principle, based on the actual need for lighting in different areas, requires that the light from outdoor lighting not escape, and that the light from decorative laser lamps, etc., not continue to illuminate a certain area.

France's luminous night advertising law on the luminous advertising area, brightness, installation and other aspects of the standard provisions, greatly enhancing the reality of operability, so as to achieve the purpose of reducing light pollution at night.

Italy's light pollution control programme is more detailed and specific, stressing that different buildings in the city should adopt different standards for light use, especially for the use of classical building lights to develop standards and norms, and its 1985 enactment of the Law on Lighting in Public Places at Night, which sets up standards for urban lighting in terms of luminance, height, volume, etc., and based on this, it also develops different light use standards according to different ages and colours of different buildings. On the basis of this, different light standards have been formulated according to the age and colour of different buildings, so as to maximize the use of urban lighting to highlight the age and artistic sense of classical buildings. In addition, all kinds of decorative lighting of buildings are also stipulated in detail, including the choice of light colour, the determination of installation position, the change of holiday lighting and a large number of other details, these specific environmental standards not only make light pollution effectively prevented and controlled, but also further enhance the quality of the light environment, so that Italy's classical architecture has become a world-famous landscape.

## 6. Conclusion

The main reason for urban light pollution is the lack of scientific and reasonable urban design, and the failure of the planning and management departments to coordinate the needs of different interests, which leads to a disconnect between urban design and urban construction. Therefore, "rational urban design and scientific management technology" is the fundamental strategy to combat light pollution. At present, Paris, France, has established a night lighting master plan aimed at preserving the night mood of the city with historical style. Venice, Italy, also in order to protect the ancient city style, and the development of light construction planning, so that the whole city to maintain low illumination. The "protection of historical style, mood", "preservation of the ancient cityscape" is the public interest of these two cities. The formation of light pollution is not only a simple technical problem, it is also related to the comprehensive impact of social, economic, cultural and ideological factors.

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