

THE IMPACT AND RISK OF LIGHT POLLUTION VERSUS THE NEED OF SKY CONSERVATION

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ABSTRACT: *The natural night sky has always been a part of our heritage, a wonderful gift of humans, a true portal for understanding the entire Universe that hovers not only over the past, but also over the present and future of all humanity. However, a phenomenon with complex connotations represented by light pollution, was able to separate humanity from all the benefits of the starry sky and thus close the window to the Universe.*

Light pollution has become over time a very real and emerging environmental problem very closely related to the intensification of industrialization and urbanization, demographic growth as well as technological development.

The consequences of light pollution are not wide-ranging but can also generate serious risks for many aspects of life on Earth, harming biodiversity and wildlife, harming human health as well as global energy efficiency, contributing thus to the phenomenon of climate change. There are reasons why this alarming phenomenon is situated at the top of some of the most pressing global issues. The consequences generated by light pollution on the environment are an area of great concern of the science of global change, although light pollution does not equal other global change phenomena of great concern and interest.

The problem that arises frequently is that of recognizing the human right to a starry sky. The right to preserve the sky is a modern theory, which has become a constant concern in recent decades, as a result of installation and perception of an unusual form of pollution, namely light pollution, a pollution capable of exerting a major anthropogenic pressure on the environment on a global scale (Challéat, 2021) (Sánchez de Miguel, 2022).

KEYWORDS: *light pollution, natural darkness, human health, harmful effects, environment protection.*

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1. HOW LIGHT POLLUTION BECAME A RELEVANT STRESSOR AS POLLUANT

Many of us have probably wondered what inspired or motivated Vincent van Gogh to paint the famous „The Starry Night” with those amazing and vibrant bright spots in the

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swirling sky. Perhaps for him, that fantastic starry night was a mirror, a place full of emotion, where desire and hope could be projected. Surely, it was not just a blue and starry sky, but also a cosmic wonder, a real and not imaginary wonder. Looking at this masterpiece, we feel the universe moving, inviting us on an emotional journey by offering a visual symphony that captures us completely. Where is the starry sky that inspired the famous painter? If he were to paint now, would he use his own imagination or reality?

Now, the brightness of external, artificial light, which has become increasingly uncontrolled, obscures our stars, affects our visual emotion, and changes our perception of the starry night, of the nocturnal environment as a vital natural resource. The starry night sky was humanity's inalienable heritage before electric lighting which increasingly this right more and more seriously by restricting access to the dark and starry sky (Feathers, 2022).

Unfortunately, satellite images show that planet Earth is like a glowing globe. It is a reality of this era of constant night lighting that has led to this phenomenon of light pollution becoming a worrying problem. By lengthening the day in this way, the rhythms necessary to sustain all living things, including humans, are disrupted (Eklöf, 2023).

The concept of light pollution, which initially emerged as a widely accepted term for the negative or adverse effects of artificial night-time lighting (Hölker, 2010) (Cao, 2023) although has received relatively little attention compared to other environmental issues, has over time become important, widely accepted and frequently used in environmental discourse. This concept with scientific, technical and normative significance, but with an ethical significance that receives few critical reflections, points to important and emerging issues affecting the biosphere.

In addressing the issue of light pollution we aim to show the origins and understandings of this phenomenon, but also the moral and political importance of framing environmental problems due to artificial lighting. Moreover, the concept of light pollution provides the necessary framework to classify the adverse effects that the increased presence of artificial light has on biological processes, ecosystems and biodiversity. We will also try to address the regulatory limitations related to this topic but also the regional and national policies and strategies related to this issue.

Light pollution is perceived as the form of pollution caused by excessive artificial lighting at night, consisting of the alteration of the amount of existing daylight, which, of course, is absolutely vital for the proper functioning of natural ecosystems. A form of pollution that has come to be recognised as a major threat to global biodiversity because it alters the quantity, quality and connectivity of habitats and affects the entire ecological network.

Constantly, light pollution is perceived by environmental specialists as an atypical type of pollution, as artificial lighting on the one hand addresses needs and problems related to comfort, needs and security, and on the other hand contributes to the destruction of ecosystems based on night-day sequences and generates health problems in the population. So, artificial lighting, necessary and much desired for centuries, which has brought with it many advances and possibilities and embodied a range of values, has come to represent, through its adverse effects, a pollutant of the night sky, ecosystems and our health. It has become abundantly clear that the impact of artificial lighting is causing repercussions which, although unintended, are worrying and negative, as it damages ecosystems and adversely affects human health, either causing or exacerbating human health problems.

There are sound considerations involving the issue of protecting the dark and starry skies (Stone, 2017).

Not only researchers but also a number of bodies and authorities have addressed the issue of light pollution, starting from its definition and specificities. For example, the International Dark Sky Association, a leading authority on light pollution, defines light pollution as "any adverse effect of artificial light". It should be noted here that many authors, in their contemporary definition and use of this term, do not condemn artificial lighting as a whole, a process which they perceive to be closely linked to modern societies, but rather, condemn its specific uses and outcomes as negative or undesirable ecological, cultural and human health aspects. According to statistical assessments, threats to human health due to light pollution have increased worrying in the last decades, so about 83% of the world's population is affected by the prevalence of light pollution in various ways (Xu, 2023) (Davies, 2018). According to recent research the global light pollution has increased by 50% over 25 years to 2020, and the real figure could be much higher, unfortunately.

As far as we are concerned, we will not attempt in this paper to condemn or, on the contrary, to approve from an ethical perspective, the use of artificial lighting whose contribution is significant to the increase in light pollution through its negative effects, or to offer definitive answers to the ambiguities that this concept inherently raises.

We show that the implications of light pollution, which are increasingly reflected in environmental problems, have led to various approaches, initially aimed at the adoption of night lighting strategies to reduce the amount of lighting, and subsequently, the implementation of more efficient lighting technologies capable of reducing both energy consumption and minimising other undesirable consequences (Stone, 2017).

Clearly, for a good understanding of light pollution, studies exploring the origins and emergence of the concept, understanding the development of night lighting and the role of technological innovations, as well as studies on the social implications of artificial lighting and the social, economic and legal aspects of the artificial lighting process must be corroborated. This is the only way to reach a contemporary understanding of the causes and negative effects of artificial night lighting.

As we pointed out at the very beginning of the study, compared to other forms of pollution faced by mankind, which have serious and often irreversible consequences, light pollution, although it can generate undesirable consequences (such as the disruption and destruction of delicate ecosystems and the compromise of biodiversity, the emergence of health and safety problems for humans and other forms of life, the aesthetic deterioration of the natural environment, and a number of negative influences on astronomical observations), has unfortunately received less attention, which is why there are many unknowns.

In addition, some studies show that the impact and intensity of light pollution, of artificial light in the night environment, are similar to those produced by atmospheric pollutants on human physiology (Pantel, 2019) and ecosystems. Many reports from astronomy specialists show that light pollution has a detrimental effect and makes it impossible to observe the sky properly. However, most studies show that the danger lies in the fact that light pollution is increasing dramatically, and so are its harmful consequences (Falchi, 2003) (Cao, 2023) (Candolin, 2025).

In recent centuries increasingly advanced technology has allowed man to push the frontier of darkness, apparently to satisfy his needs, but unfortunately without taking into account the preservation of the quality of the environment in all its facets, and without much interest in preserving its diverse cultural integrity. Perhaps it is precisely because, in relation to climate change, acid rain, the destruction of natural habitats and other obvious burdens on the environment as a whole, the need for natural darkness and the impact of artificial light have often been neglected at the expense of the need to protect biodiversity, the natural world and the cultural heritage of mankind (Bennie, 2015). However, artificial light, which is clearly extremely necessary and important, has over time become a complex issue that has led to the initiation and development of worldwide movements to raise awareness of the consequences of artificial light and to take action to mitigate its harmful effects on biodiversity, human life and living things. Much information from astronomical experts indicates that due to light pollution, artificial glow in the night sky, the sky can no longer be properly observed, galaxies and even stars are hidden and a fundamental human experience is degraded.

Light pollution remains an extremely complex real phenomenon, with diverse and combined sources and causes, which have increased alarmingly in recent times and which have negative consequences or polluting effects on nature and human life alike, a reason which calls for responsibility not only in tackling it but also in finding solutions to combat it. Of course, knowledge of the multiple causes of light pollution is important as it enables prompt and effective action to be taken to combat this phenomenon, which has grown in scale and intensity.

More and more specialists are converging on the idea that artificial lighting at night contributes to a rapid increase in light pollution (Kyba, 2018). Thousands of observations made by scientists around the world over the last decade have shown that the faintest stars in the night sky are obscured by artificial brightness that causes the sky to dim. Based on recent estimates by scientists, light pollution has become a silent public enemy, with an alarming increase of almost 10% per year over the last decade, mainly due to the large number of satellites and luminous debris. All this is accompanied by important arguments about the consequences and significant impact that light pollution can have on the functionality and resilience of the ecosystem and its fundamental life-supporting ecosystem services (Summers, 2012).

Specialists' concerns about light pollution, a phenomenon that has not been taken into account for a long time, probably because it is not as dangerous as other sources of pollution, initially led to the production of light pollution maps to identify the impact and consequences of artificial lighting at global level. Thus, expert studies carried out in 2016 claim that light pollution has skyrocketed and become one of the most widespread forms of environmental damage, although its extent is less known on a global scale (Cabrera-Cruz, 2018). Also, the study's data show that about 99% of people in developed countries live their lives under skies contaminated by artificial light, that about 80% of Europe's population cannot see the Milky Way, and that more than a third of the Earth's population can no longer see the galaxy. Economically developed areas, mainly in North America, Asia and parts of Europe, are indicated as severely polluted by artificial light, while areas belonging to the African continent appear to have a lower incidence of this polluting phenomenon, even though it is established. Processes such as excessive urbanisation, accompanied by the enlightenment of cities, industrialisation and the development of

technology, which are a cumulative benefit to human life in general, a necessary and inevitable process for the evolution of society, have over time generated negative effects on the environment, human health and the ecology of wild species (Criado, 2022) (Dogaru, 2022). Some recent research on the impact of night-time lighting also highlights the great paradox that people are generally struck only by the beauty of urban lighting, without perceiving it as an image of pollution (Falchi F. o., 2016).

2. INTERNATIONAL VIEW ON THE PROTECTION OF SKY QUALITY. STRATEGIES AND POLICIES TO REDUCE LIGHT POLLUTION AND PROTECT AND VALORISE DARK NIGHT SKIES

Statistical data show that many statements about human rights have come from the UN. The United Nations Educational, Scientific and Cultural Organisation (UNESCO), for example, organised a conference on light pollution and its impact on the environment and human and non-human health. This was the International Conference in Defence of the Quality of the Night Sky and the Right to Observe the Stars, held in spring 2007 in the Canary Islands, Spain, as part of which adopted the Palma Declaration, entitled Declaration in Defence of the Night Sky and the Right of the Stars to Light.

This international document, based on the principle of the integral protection of nature proclaimed in the 1992 Rio de Janeiro Declaration on the Environment (Dogaru, Environmental Law, 2-nd edition, 2020) (Dogaru, The globality of climate change-between ecological thinking, policies and strategies, 2021) recognises the process of deterioration of the clarity of night space and the serious risk of widespread loss of a cultural, scientific and natural resource with unpredictable consequences. The Universal Declaration of Human Rights is also invoked, a document which states that future generations have the right to an uncontaminated and undamaged Earth, including the clear sky, and that they have the right to enjoy it as the foundation of human history and social culture (Article 1 of the 1994 La Laguna Declaration states that "people of future generations have the right to an uncontaminated and undamaged Earth, including pure skies". This context affirms the scientific, cultural, educational, environmental, safety and energy benefits of preserving the night sky, which require not only attention but also decisions capable of influencing the reversal of the degradation process affecting the quality of this environment.

Taking all this into account, a set of relevant principles and objectives have been proposed. Thus, the La Palma Declaration considers that the right to an unpolluted night sky must be recognised as an inalienable human right equivalent to other environmental, social and cultural rights, due to its impact on the development of peoples and on the conservation of biodiversity. Similarly, the progressive degradation of this environment must be considered an imminent risk that needs to be addressed in the same way as the main problems concerning resources and the environment (Teitelbaum, 2019) (Dogaru L. D., 2022) (Najmaldin Ezaldin, 2024). The facts demonstrate that, the conservation, protection and reassessment of the natural and cultural heritage associated with nightscapes and skywatching must be seen as a prime opportunity and obligation to cooperate in order to protect the quality of life. Access to knowledge, education, policies for the conservation of nature and biological diversity and for guaranteeing the common

right of mankind to the night sky must be a priority, together with the promotion of intelligent, responsible and sustainable use of artificial light in order to minimise any negative consequences for this natural heritage.

Optimal astronomical observation areas are also mentioned, which must be preserved precisely for the benefits of the know-how and scientific and technological development that astronomy offers. In the complex task of protecting nature, reserves and protected areas, as well as world heritage sites combining exceptional landscapes and natural values based on the quality of their night sky, must include the protection of the night environment.

Another international environmental organism, the International Union for Conservation of Nature (IUCN) (Dogaru L. , Environmental Law, 2-nd edition, 2020), recognises the importance of natural darkness for nature conservation, for the ecological integrity of protected areas and for the sustainability of life healthy urban environment. Within IUCN's World Commission on Protected Areas, the Dark Skies Advisory Group has been established to help promote this recognition, providing a useful and comprehensive website to encourage protected areas and human communities to understand the concept and values of dark skies and the impacts of light pollution on people and nature.

The night sky is attributed by UNESCO as a natural and cultural heritage, a heritage that transcends national borders, an area that must remain intangible. The increasing use of outer space is beginning to have a significant impact on the quality of the night sky, with the planned launch of hundreds of thousands of new satellites, which will become veritable megaconstellations in the 2020s. And the main international treaty signed in 1967 governing the use of outer space makes no mention of this subject, as such concerns were not on the radar of the signatory states.

Threats to human health from pollution of environmental factors, including outer space, of the dark of night as a key to human and non-human well-being and health, must dictate strong and effective measures to reduce pollution.

Recognition by the nations of the world of the rights of nature is an extremely important step in restoring the damage of any kind caused to the environment and in establishing principles and legal means for the preservation of the night sky as the common natural and cultural heritage of mankind.

It is to be appreciated that, following the approaches, studies and warning signals concerning the consequences of light pollution, most countries have adopted legislation on the dark sky, with the aim of promoting energy conservation, public safety, aesthetic interests and astronomical research capabilities. We show in this context that in 2021, a number of 17 states have taken into account in their national legislation the factors that determine light pollution or dark skies and the huge costs of artificial lighting.

Another aspect we would like to point out is that a number of reports made in recent years by specialised institutions focus on some types of lighting considered sustainable, such as LED lighting, showing that it considerably reduces energy and fossil fuel consumption, minimises glare and harmful effects on humans and the environment, but unfortunately generates a blue light outdoors that is not dark-friendly. There are also sets of studies and reports related to the impact of outdoor and roadway lighting that seek to prioritize the adoption of policies that do not cause negative impacts on human safety while minimizing any other impacts that such lighting may cause (Arroyo, 2024).

In order to balance light and dark for people, ecosystems and nature, a challenge is also in the field of lighting design and ecology to find the right balance between functionality, aesthetics and environment, to think holistically about light. Experts agree that it is important to control light through intelligent control systems, to lower lighting levels during the progressive night-time hours and to design lighting with biodiversity in mind. Low-energy, low-impact, customised lighting strategies need to be developed to keep conservation areas of World Heritage value and dark skies undisturbed, while ensuring adequate comfort for users.

Recent satellite images of Europe at night show a continent 85% covered by artificial light, which means an alarming loss of natural darkness with all the negative consequences for biodiversity and ecosystems, the quality of nature and the environment. Such alarm signals related to this process induced by artificial pollution, motivate the need for intensified regional and national policy efforts to reduce light pollution and for sustainable economic development linked to dark sky protection.

There are European countries that have developed policies for light pollution prevention, dark sky conservation and sustainable exploitation of sites, thus creating natural areas where dark skies have protected status and positioning this for the development of new eco-tourism facilities and services to such areas with dark sky reserve status. Dark Sky Reserves have been designated by the International Dark Sky Association (IDA), a recognised authority on light pollution established in 2015, as the world's leading light pollution organisation promoting responsible artificial lighting. These reserves are defined as those specially protected areas where artificial light pollution is restricted and astronomy is promoted, areas considered true sanctuaries of the night sky.

In Europe, at the end of 2020, the International Dark Sky Reserve will be set up with a scientific, educational, heritage and cultural role. The criteria for Dark Sky Reserve status have been set by the IDA, and include among others: a high percentage of night sky-friendly artificial lighting sources; high-performance systems for monitoring the impact of artificial light; financial support from states to the public; and dedicated education and public awareness programmes highlighting the value of natural darkness.

3. CONCLUSION

Light pollution has come to seriously harm natural levels of darkness and profoundly change the conditions of the nocturnal environment, with obvious impacts and effects on the quality of life. The trends of this phenomenon of temporal and spectral change are closely dependent on advanced light production technologies and its increasingly intense social uses. The reality is that if we look up from the city any night the chances of being able to count the visible stars are minimal, reduced. Urban lighting has managed to disconnect people from the urban environment from the night sky.

This paper shows that light pollution is a global problem, affecting most of the world, with the planet shrouded in a haze of light that prevents a large part of the Earth's population from observing the galaxy. And this has a potential impact not only on culture, but causes global environmental consequences, public health problems and wasted energy and money.

Addressing the phenomenon of artificial lighting at all levels is necessary because, while it can be mitigated temporarily and instantaneously, its consequences of loss of biodiversity and culture will not be mitigated but rather the opposite. A growing body of scientific sources shows that the overall effects of light pollution, whose magnitude, extent and distribution have become alarming, are generating many and varied global disturbances to the nighttime environment.

A number of techniques are known to substantially reduce light pollution, some of which have already been implemented on a fairly large scale. The main prescriptions for reducing light pollution are: complete shielding of lights, use of minimum light, switching off or substantially lowering light levels in unused areas, lowering the total installed flux, strongly limiting blue light, etc. It is clearly technology that can help reduce the impact of light pollution by implementing adaptive lighting (e.g. traffic and weather sensor-based street lighting).

There are many experts who are optimistic in believing that advanced technology as well as informing and educating the population about this type of pollution will result in only the current generation having to experience such a light polluted world because this type of pollution can be controlled. Such as, if the night sky is something that the current generation is losing, it is vital that it is preserved for future generations.

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