

National Light-Pollution Mitigation and Dark-Sky Preservation Action Plan

1. STRATEGIC COMMITMENTS

1. Publish the PA/ERA guidelines on light pollution
2. Establish officially designated Dark Sky Heritage Areas in Malta (like there are in Gozo and Comino), each protected by proper, legally- defined buffer zones and enforcement.
3. Deploy full-cutoff, warm (i.e. not blue-rich), properly shielded, non-excessive lighting across all government-owned infrastructure, including streets, schools, public buildings, and large facilities: E.g. Ta' Qali National Stadium could serve as a showcase for proper installation.
4. Eventually replace all lighting in state-owned sports complexes, industrial zones, and public car parks with dark-sky-friendly luminaires.
5. Implement proper lighting management plans for major light-emitting sites such as Malta International Airport, Malta Freeport, Gozo Channel terminals, and Transport Malta-managed car parks.

2. PUBLIC EDUCATION & OUTREACH

2.1 National Awareness Campaign

- Launch a coordinated campaign on TV, radio, and social-media channels explaining the harm caused by light pollution and the benefits of dark-sky protection.

2.2 School-Based Educational Programme

- Introduce curriculum-aligned teaching modules on astronomy, ecology, and responsible lighting.
- Use dark-sky locations such as (eventually) Fort Bingemma for field demonstrations and night-sky education.

3. INCENTIVE-BASED TRANSITION PROGRAMMES

3.1 Commercial Sector

- Offer financial incentives for businesses to replace non-compliant lighting—especially in car parks, industrial yards, and “security lighting” installations—with certified dark-sky-friendly alternatives, employing the use of motion-activated lights where appropriate.

3.2 Residential Sector

- Introduce phased incentives supporting homeowners in replacing external lighting with low-impact, fully shielded fixtures.

All incentives should be accompanied by proper certification and not just a money handout.

4. LEGISLATIVE FRAMEWORK

Introduce a modernised lighting law that defines, regulates, and enforces proper lighting standards.

4.1 Key Legal Provisions

- Ban excessive façade lighting and improperly shielded “security lights.”
- Require exterior lighting to be full-cutoff, warm (with a G-index >2 or S-P ratio < 1), not directly visible from public streets, and motion-sensor-controlled where feasible.
- Mandate that digital signage and billboards be dimmable, with required dimming after twilight and further reduction after 23:00.
- Establish meaningful fines for:
 - excessively bright or non-compliant billboards
 - upward-directed floodlights
 - facilities leaving high-intensity lighting on throughout the night
 - any lighting with visible LED sources outside the property boundary

5. ENFORCEMENT & REPORTING MECHANISM

Create an independent national authority dedicated to light-pollution oversight, separate from the police. This body shall:

- receive and process citizen reports of improper lighting
- conduct inspections
- issue formal compliance notices and fines
- maintain a public registry of resolved and active cases

6. IMPLEMENTATION ROADMAP (5-YEAR PLAN)

PHASE 1 — FOUNDATION (YEAR 1)

- Publish the PA/ERA light pollution guidelines.
- Launch the national awareness campaign.
- Begin educational outreach in schools.
- Start upgrading lighting in all state-owned facilities.

Phase 2 — Incentivised Transition (Years 2–3)

- Roll out commercial-sector incentives for replacing non-compliant lighting.
- Begin residential-sector incentive programme.
- Complete upgrades of government buildings, schools, sports facilities, and public car parks.

Phase 3 — Regulation & Compliance (Years 4–5)

- Enact the national lighting legislation.
- Activate the enforcement body.
- Introduce grace periods for private entities to achieve compliance.
- Commence focused regulation of major light-emitting sites such as airports, ports, and major car parks.
- Eventually outlaw the sale of inappropriate unshielded lighting – as was done in case of filament lamps.

7. EXPECTED OUTCOMES

- Protect Malta's night sky as an environmental and cultural heritage asset.
- Significant reduction in night sky brightness.
- Significantly reduce energy waste and carbon emissions.
- Improve nighttime driving safety by reduction of glare from exposed light sources, and enhanced pedestrian safety.
- Improve nocturnal wildlife habitats.
- Enable citizens to once again enjoy the night sky from the Maltese islands.
- Enhance astronomical research and tourism potential.
- Establish Malta as a regional model for responsible outdoor lighting

Defining Light Pollution

Components of light pollution include:

1. **Glare:** Excessive brightness which causes visual discomfort. This can be particularly problematic for drivers at night as it reduces contrast and depth perception.
2. **Sky glow:** Skyglow is the brightening of the night sky over populated areas due to scattered artificial light from sources like streetlights, buildings, and illuminated signs. This form of light pollution creates a persistent haze that makes it difficult to observe the night sky.
3. **Light trespass:** occurs when unwanted artificial light spills over from one property to another, often entering homes through apertures. This can disturb sleep and reduce privacy for residents. Streetlights and security lights are common sources of light trespass, which can be mitigated with better shielding and directional lighting
4. **Light clutter:** refers to the excessive grouping of bright lights in a specific area, such as in densely lit urban spaces or along roadsides. Clutter increases the risk of glare and can distract drivers, leading to unsafe conditions. Additionally, it contributes to skyglow and disrupts natural habitats for nocturnal wildlife
5. **Over-illumination:** The presence of lighting in an area in excess of what is necessary. Minimum illuminance required for safe working conditions in a given area are provided by European guidelines. The minimum illuminance required depends on the main use of the area and should be seen as a target and adjusted according to intended use, but not exceeded.

Adapted from DarkSky International (<https://darksky.org/resources/what-is-light-pollution/>)

What is light pollution?

Light pollution is the human-made alteration of outdoor light levels from those occurring naturally. When we over-light, fail to use timers and sensors, or use the wrong color of light, we negatively affect many parts of our world.



Learn more about light pollution ↗

Light pollution...

Destroys critical wildlife habitat



Plants and animals depend on Earth's daily light and dark cycle to govern life-sustaining behaviors. Research shows that artificial light at night has adverse and even deadly effects on many species.

Decreases safety and security



There is no clear scientific evidence that increased outdoor lighting deters crime. In fact, glare from unshielded streetlights can decrease personal safety, contributing to both crime and accidents.

Wastes energy and money



Most outdoor lighting is wasted. This energy waste increases greenhouse gas emissions contributing to climate change and wastes billions of dollars each year.

Robs us of our night sky heritage



Our ancestors experienced a night sky that inspired science, religion, philosophy, art, and literature. Now, millions of children across the globe will never know the wonder of seeing the Milky Way.

Harms human health



Studies indicate that artificial light at night negatively affects human health by increasing our risks for obesity, sleep disorders, depression, diabetes, breast cancer, and more.

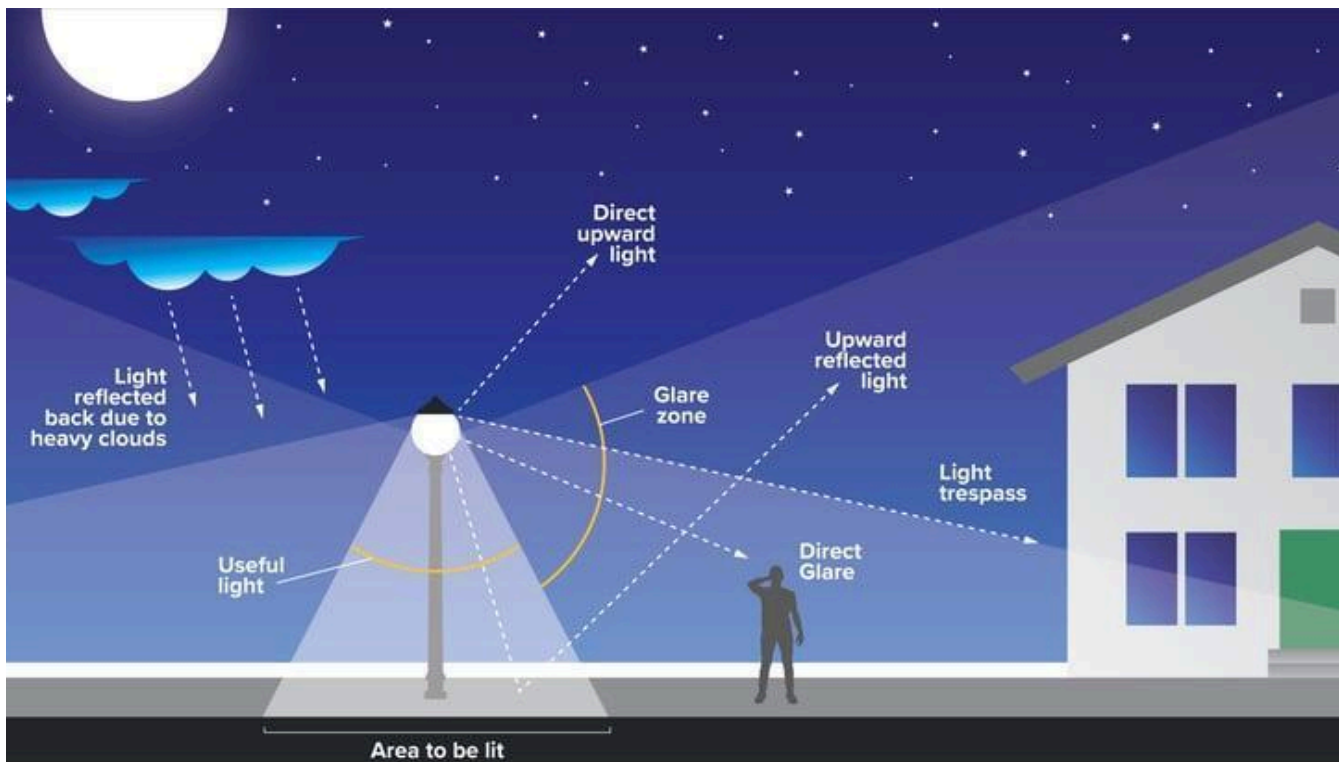
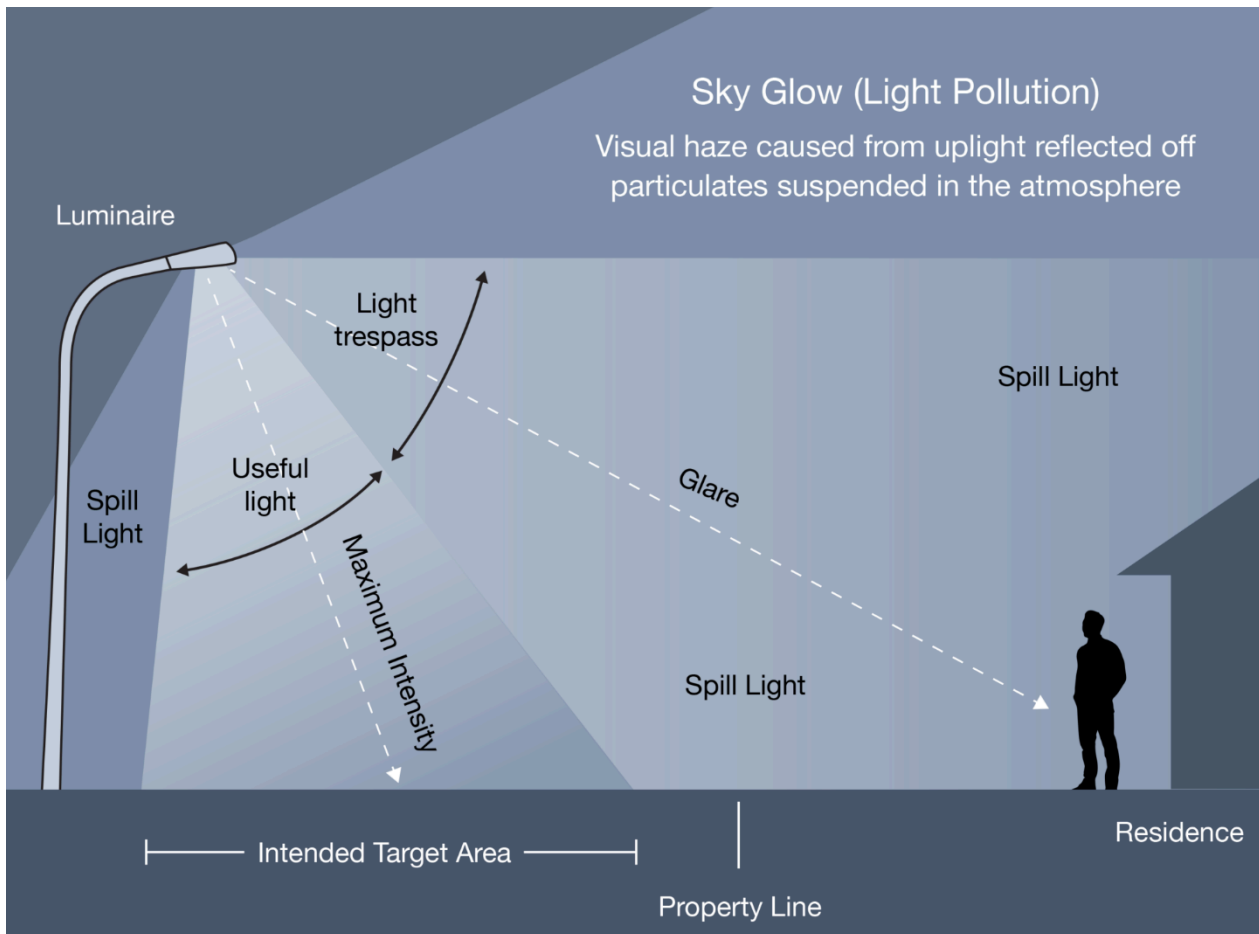
Inhibits scientific research



Satellites in low Earth orbit create visible trails in the night sky, inhibiting astronomical research and jeopardizing NASA's early warning system for asteroid collisions.

Figure 1: Overview of the several adverse effects of light pollution

Source: [DarkSky International](https://www.darksky.org/)



Figures 2 and 3 illustrate the different elements of light pollution, caused by poorly designed lighting systems.

Consequences of Outdoor Light Pollution and Artificial Light at Night on Human Health

The proliferation of artificial light at night (ALAN) from urban development has significantly disrupted natural light cycles, contributing to broader public health and ecological impacts and highlighting the need to rethink urban lighting design with a focus on health, sustainability, and environmental protection.

In the Maltese Islands, this is reflected in widespread skyglow and elevated night sky brightness, with 87% of the Islands experiencing heavy light pollution (Bortle Class 5 or worse), 37.3% in very bright conditions (Class 6 or worse), and only 12.8% retaining skies dark enough for the Milky Way to be visible. The shift from High Pressure Sodium lamps to LEDs since around 2014 has further increased night sky brightness, with growing encroachment on Dark Sky Heritage Areas, including those in Gozo designated under a 2006 Malta Environment and Planning Authority plan. Despite these protections, ongoing development continues to threaten these areas, highlighting the need for stronger conservation and monitoring. Light pollution contributes to glare, reducing visibility, contrast, and road safety. Light pollution also has significant health impacts, disrupting melatonin and circadian rhythms, and has been linked to increased risks of breast and prostate cancers. In addition,, reinforcing the need for effective mitigation (Caruana et al., 2020)

Please refer to **Figures 4 and 5**

Night Sky Brightness Map of the Maltese Islands

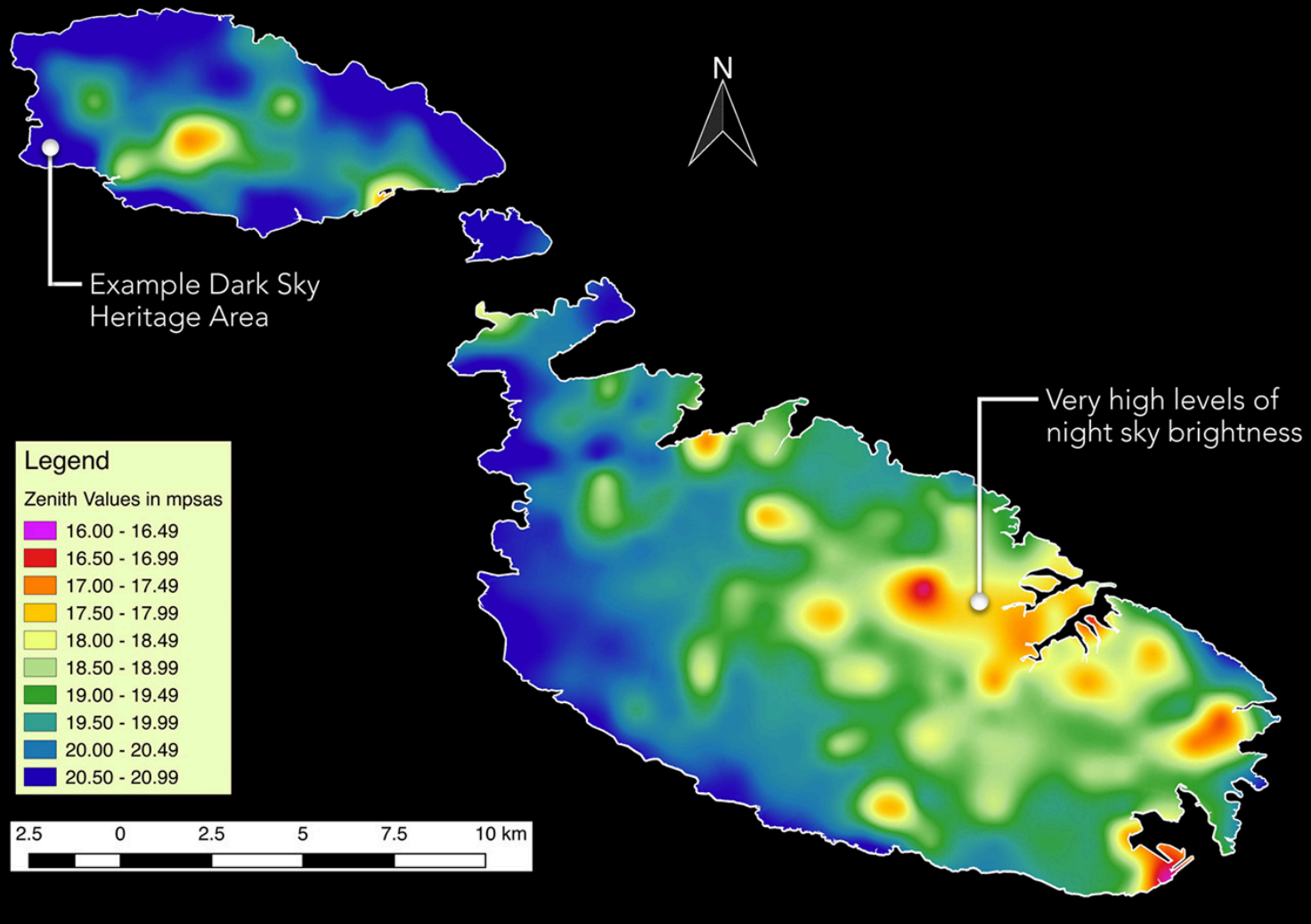


Figure 4: Night Sky Brightness Map of the Maltese Islands (Source: Caruana et al., 2020)



Figure 5: Visual representation of the Bortle scale (Source: <https://www.eso.org/public/images/dark-skies/>)

A) Sleep Disorders

Exposure to artificial light during nighttime disrupts the human circadian rhythm, which is crucial for regulating sleep–wake patterns. ALAN exposure yields physiological responses that impair melatonin production, essential for sleep onset (Capezuti et al., 2018; Posadzki et al., 2018). The suppression of melatonin can lead to increased insomnia and sleep disturbances, exacerbating sleep-related issues already prevalent in urban populations (Dautovich et al., 2019). Sleep duration and quality are also impaired (Osibona et al., 2021; Rojas-Rueda et al., 2021), with evidence showing that shorter wavelength light intensifies these effects, as 460 nm light causes twice the melatonin suppression and circadian phase delay compared to 555 nm, while 5600 K lighting produces greater suppression than 2700 K, and 3000 K versus 6200 K comparisons show higher effects, particularly in children and adolescents (Caruana et al., 2020). In children, evening exposure to high-intensity artificial light has been linked to increased risks of sleep disorders and can negatively affect developmental outcomes (Ho et al., 2019).

B) Mental Health Consequences

Outdoor light pollution (OLP) is linked to an increase in mood disorders (Eigenschenk et al., 2019). The suppression of melatonin and its impact on serotonin levels are thought to play a role in mood dysregulation, potentially increasing depression rates (Posadzki et al., 2018). The relationship between light exposure and mood disorders is particularly significant in the context of Seasonal Affective Disorder, a condition in which individuals are especially sensitive to changes in light exposure, with artificial light failing to induce the same therapeutic effects as natural light (Agustini et al., 2019).

In addition, OLP can influence patterns of social interaction, whereby increased levels of light in urban environments may deter nighttime social activities, exacerbating isolation and depression (Eigenschenk et al., 2019).

C) Cardiovascular Risks

Emerging research points to a significant association between ALAN exposure and cardiovascular risk factors. It has been shown that individuals exposed to higher levels of nighttime light exhibit a higher incidence of hypertension and other metabolic disorders (Lai et al., 2020). The mechanisms by which ALAN influences cardiovascular health are thought to relate to disrupted sleep, increased stress response and inflammation, and metabolic dysregulation (Batacan et al., 2015).

Sleep disorders induced by nighttime light exposure are themselves strong predictors of cardiovascular events, and in fact, a clear correlation has been established between poor sleep quality and increased prevalence of cardiovascular diseases, including heart disease and stroke (Murri et al., 2020).

The multifaceted effects of ALAN suggest that improving nighttime lighting conditions could have beneficial effects on population-wide cardiovascular health. Interventions to mitigate exposure to artificial light during nighttime are therefore critical. Behavioural changes, like increased awareness and education about the impact of light exposure, alongside light pollution mitigation strategies, can therefore contribute to reduced cardiovascular disease risk (Schmitt et al., 2011).

D) Metabolic Syndrome and Obesity

Metabolic syndrome is increasingly being linked to disrupted circadian rhythms caused by ALAN. Evidence shows that individuals exposed to artificial light at night are more likely to experience obesity and metabolic dysregulation, with significant associations between ALAN and weight gain being established (Lai et al., 2020).

In addition, there is research which shows how chronic exposure to ALAN may lead to insulin resistance and glucose intolerance, which are hallmark characteristics of metabolic syndrome (Wongtrakul et al., 2021).

E) Association with Cancer

Research consistently shows that individuals living in brightly lit urban environments face a significantly higher risk of cancer than those in darker, rural settings (Turner et al., 2020; Vardoulakis et al., 2018). A clear link has been demonstrated between exposure to light at night and the increased incidence of breast cancer (Lai et al., 2021). In fact, satellite data analysis has shown a positive association between cumulative light pollution and breast cancer incidence (Lamphar et al., 2021). The pathways leading to this heightened risk include alterations in hormonal function, specifically oestrogen and melatonin, both of which are crucial to regulating cell growth. A broader review encompassing multiple types of cancers has indicated that light pollution contributes to elevated risks not just limited to breast cancer but across various malignancies, including colorectal and prostate cancer (Wong et al., 2020).

The epidemiological data therefore point to significant implications for public health policies aimed at reducing artificial light exposure. Enhanced regulation of outdoor lighting, particularly in residential zones, holds promise in reducing the cancer burden linked to environmental factors (Lai et al., 2021).

Impact on Bees and Pollinators

Artificial light has been shown to disrupt the natural behaviors of bees and other pollinators, interfering with essential activities such as foraging, navigation, and reproduction. Studies indicate that exposure to outdoor light pollution (OLP) can disorient bees and alter their foraging patterns by disrupting their ability to use natural navigational cues, ultimately reducing their pollination efficiency and causing serious consequences for both wild ecosystems and agricultural production (Mallinger et al., 2017; Shackelford et al., 2013).

Increased exposure to artificial light negatively affects wild bee populations. Although managed honeybee colonies benefit from controlled conditions, their presence can heighten competition with native species. Artificial lighting may attract honeybees to illuminated flowers more frequently, skewing pollination dynamics in their favour and disrupting community balance (Mallinger et al., 2017). This added pressure can reduce the reproductive success of wild bees, contributing to declines in species diversity and overall abundance (Nicholson & Egan, 2019).

Moreover, many pollinator species depend on natural light cycles to regulate their reproductive behavior. Disruptions caused by artificial lighting can lead to mismatches in reproductive timing, weakening population stability. Artificial light may also induce premature blooming in plants, creating a temporal mismatch between flower availability and pollinator activity (Mallinger et al., 2017).

Impact on Bats

Outdoor light pollution (OLP) affects not only insects but also mammals such as bats. Although artificial lighting attracts insects and draws bats toward urban areas, it disrupts their natural foraging behavior and increases mortality risks, particularly from vehicle collisions as they venture into urban areas (Shackelford et al., 2013).

Changes in light levels can also disrupt bats' circadian rhythms, affecting feeding behaviour, reproduction, and overall activity. Artificial illumination near roosting sites may alter roost selection or lead to abandonment, reducing reproductive success and threatening population viability (Nicholson & Egan, 2019).

Impact on Birds

Artificial light at night significantly impacts birds, particularly migratory species that depend on celestial cues for navigation. Bright city lights can disorient them, leading to fatal collisions with buildings and communication towers, a phenomenon known as 'fatal light attraction', which can divert birds from their migratory paths and hinder their ability to reach breeding grounds. (Costas-Ferreira & Faro, 2021; Tashakkor et al., 2011).

Light pollution also disrupts birds' biological rhythms by altering sleep patterns and delaying migratory readiness. Exposure to artificial light can interfere with melatonin production, a hormone essential for regulating sleep and seasonal behaviour, further complicating migration timing (Costas-Ferreira & Faro, 2021) and adding to the challenges already faced by bird populations in urban environments.

In Malta, in addition to impacts on migratory birds, light pollution represents a serious and growing threat to breeding seabirds. Artificial illumination of nesting cliff faces, has been shown to disrupt colony attendance patterns and decrease Yelkouan shearwater attendance in presence of light sources (Austad et al., 2023). In cases where illumination is permanent, it has been shown to lead to nest and colony abandonment locally (Borg et al., 2008). In fact, elsewhere in the Mediterranean, it has been demonstrated that Yelkouan shearwaters and European Storm-petrels select dark nests that are sheltered from mainland light pollution (Bourgeois et al., 2008; Oro et al., 2005). The same effect has been demonstrated at Rdum tal-Madonna (Haber et al., 2009), Malta's largest Yelkouan shearwater colony, which has since been impacted further by light pollution. Brincat & Pace (2018), highlight several sources of light pollution that affect seabird colonies that can be mitigated.

Light pollution not only affects colony attendance by adult seabirds, but has been shown to disorientate young shearwaters on their first flight resulting in collision and grounding at

illuminated areas. Studies by Crymble et al. (2020) and Laguna et al. (2014) identify light pollution as a key driver of seabird groundings across the Maltese Islands, with four major coastal hotspots, these being Xlendi, St Paul's Bay to Qawra, Marsaxlokk Freeport, and Hal Far, accounting for nearly half of all recorded cases. Grounding events predominantly affect fledglings of all three breeding seabirds, namely the Yelkouan Shearwater, Scopoli's Shearwater, and European Storm-petrel, which are especially vulnerable to disorientation from artificial lighting.

The scale of the problem has intensified markedly, with groundings increasing by up to 20–40 times over the past four decades (Crymble et al., 2020). This trend highlights a clear relationship between light intensity, urban development, and proximity to breeding colonies (Laguna et al., 2014). The continued rise in incidents, including record numbers in recent years, indicates that current mitigation efforts remain insufficient, reinforcing the need for urgent action through both the reduction of existing light pollution and more careful planning in sensitive coastal zones.

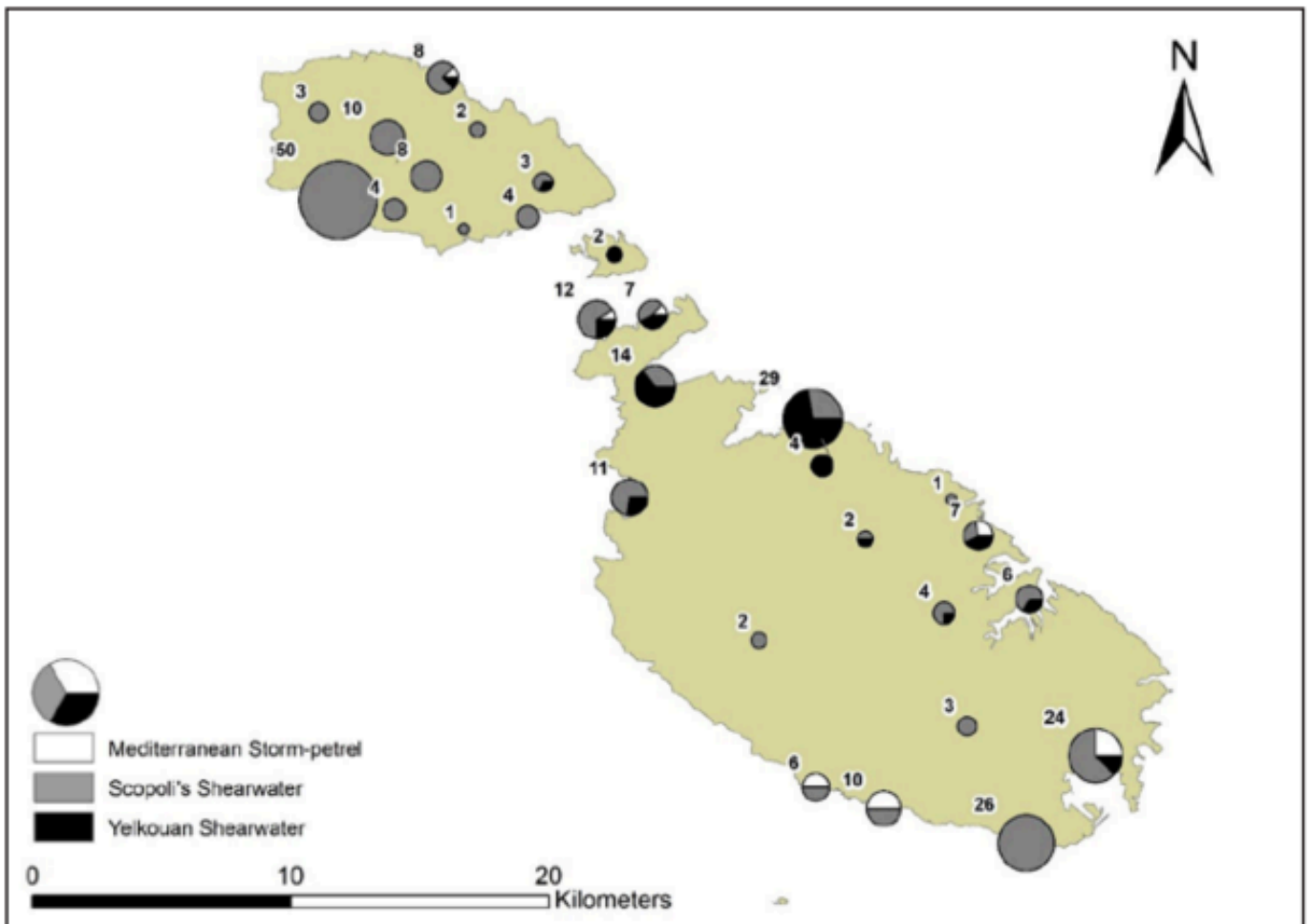


Figure 6: Image obtained from Crymble et al. (2020), showing a graphic representation of the recorded light-induced grounding cases per species. The size of the pie chart is relative to the total number of grounded birds found at each location

Impacts on Vegetation and Ecological Relationships

Artificial light at night (ALAN) disrupts plants' natural photosynthetic rhythms, reducing efficiency and interfering with normal growth cycles. By altering established day–night patterns, plants divert energy into unnecessary nighttime processes, potentially impairing functions such as nutrient absorption and overall development (Sanders et al., 2020).

Disruption of the natural light-dark cycle also interferes with chlorophyll production, which is central to efficient light energy capture. Prolonged exposure to artificial light has been shown to inhibit chlorophyll synthesis in some species, leading to diminished photosynthetic performance during the day and decreased leaf quality (Buti et al., 2019; Poorter et al., 2019).

In terms of morphological effects, ALAN can trigger shade-avoidance responses, whereby plants elongate stems and reduce lateral growth to seek light. These adaptations weaken structural stability, reduce resilience, and make plants more vulnerable to environmental stress, ultimately impairing their ability to compete within natural ecosystems (Sellaro et al., 2017).

Artificial light at night (ALAN) disrupts plant reproduction by altering flowering times, reducing seed viability, and desynchronising plants from their pollinators (Sanders et al., 2020; Xie et al., 2014). Many plants depend on nocturnal pollinators whose behaviour is guided by natural light cues. Artificial lighting can reduce pollinator visitation, further lowering reproductive success and affecting overall plant health and ecosystem functioning (Sanders et al., 2020).

Artificial light adds to abiotic stress by altering how plants use water. Extended exposure to light can increase transpiration, resulting in greater water loss and lower drought tolerance. As a result, plants become more vulnerable to water shortage stress, a concern that is increasingly relevant under climate change (Anderegg et al., 2016; Jo et al., 2019).

Furthermore, ALAN can also alter soil microbial dynamics by influencing plant root exudation patterns. Changes in root secretions affect microbial communities that support nutrient uptake, potentially reducing beneficial symbioses and impairing nutrient acquisition efficiency (Araus et al., 2020; Sanders et al., 2020).

Forests are particularly sensitive to the cascading effects of ALAN. Altered light regimes can compromise the adaptability of tree species to environmental pressures and invasions. Changes in canopy structure due to artificial light also influence light distribution and microclimates within the forest, potentially leading to shifts in species dominance and long-term forest composition (Battle et al., 2020; Decunta et al., 2021).

In conclusion, light pollution significantly impacts plant physiology and ecology, affecting everything from photosynthesis and morphology to reproduction and ecosystem interactions. The widespread implications for biodiversity and ecosystem resilience underscore the need for urgent and effective measures to mitigate artificial lighting in natural environments.

Broad Ecological Impacts and Declining Biodiversity

The widespread disruption of natural light cycles by artificial lighting carries significant ecological consequences that extend across entire ecosystems rather than affecting individual species in isolation. The decline of key pollinators, including bees, bats, and migratory birds, threatens essential ecosystem services such as pollination and the regulation of insect populations. Because these organisms are closely interconnected within ecological networks, their decline can initiate cascading effects, ultimately weakening ecosystem stability and reducing overall resilience. (Mallinger et al., 2017; Nicholson & Egan, 2019).

Declines in pollinator populations lead to reduced plant diversity, as fewer species receive effective pollination, which in turn impacts the wildlife that rely on these plants for food and habitat (Mallinger et al., 2017; Shackelford et al., 2013). For bats and birds, changes in insect abundance and distribution alter prey availability, disrupting predator–prey relationships and ultimately affecting the structure and functioning of entire ecosystems (Nicholson & Egan, 2019).

In conclusion, the harmful impacts of outdoor light pollution (OLP) and artificial light at night (ALAN) on pollinators and nocturnal wildlife, such as bats and migratory birds, represent a growing environmental concern. Their essential roles in maintaining ecological balance underscore the need for urgent action to reduce light pollution. As urban development continues, both research and policy must prioritise protecting biodiversity from the widespread effects of artificial lighting.

Impacts on Astronomy and Scientific Research

The growing prevalence of ALAN presents significant challenges for astronomical research and celestial observation. The interaction between artificial lighting and night sky visibility hampers both scientific discovery and public appreciation of natural nocturnal environments, impacting astronomers and wider communities alike.

Currently, close to 20% of the Earth's land area is affected by light pollution, which poses significant challenges for researchers who depend on naturally dark skies for their work (Frensch-Constant et al., 2016).

Light pollution disrupts natural nocturnal light conditions and limits the visibility of the night sky (Levin et al., 2020). Increasing urban brightness obscures celestial bodies, restricting both public stargazing and scientific observation. Sky glow, which refers to the brightening of the night sky from artificial sources, has long concerned astronomers, as elevated ambient light reduces contrast and makes faint astronomical features more difficult to detect and analyse (Davies et al., 2013).

The issue has intensified to the point where even historically dark-sky observatories are experiencing interference, prompting calls for protective zoning laws and urban planning measures to preserve night sky visibility (Gaston et al., 2021; Hänel et al., 2018).

The spectral composition of artificial lighting further compounds the problem. Blue-rich LED light, in particular, is especially disruptive, affecting nocturnal wildlife while also impairing astronomical observations. These shorter wavelengths alter animal behaviour and physiology and contribute to spectral interference, reducing the clarity of sky observations (Aubé et al., 2013; Dimovski et al., 2023).

Understanding and managing the spectral distribution of light sources is therefore essential for both ecological protection and the preservation of access to dark skies (Davies et al., 2013).

Impacts on the Cultural and Recreational Value of the Night Sky

The cultural and recreational importance of dark, unobstructed night skies is considerable, yet increasing urban lighting is limiting opportunities for stargazing (Jechow, 2024). This contributes to a growing disconnect from nature and reduces public engagement with astronomy, potentially weakening support for efforts to fund and protect dark-sky environments (Bennie et al., 2014).

While artificial lighting in cities is designed to improve safety and visibility, it can lead to visual disruption when poorly implemented. Modern LED lighting often creates stark contrasts that diminish the aesthetic and functional quality of urban environments, particularly in historic areas. Inadequate lighting can also produce uninviting spaces that discourage outdoor activity, whereas well-planned lighting can enhance urban character, encourage social interaction, and improve quality of life. These points highlight the need for careful lighting design in urban planning (Kyba et al., 2018; Rodriguez et al., 2010).

Mitigation Strategies, Policy Action, and Public Awareness

Light pollution is a growing environmental concern, with strong evidence linking it to negative impacts on biodiversity and human health. Research shows that artificial lighting disrupts natural ecosystems while also contributing to a range of public health issues.

As urban development accelerates and artificial lighting becomes more widespread, coordinated action is increasingly necessary. Addressing this issue requires a combination of policy reform, well-designed lighting in line with DarkSky International standards, and public education to encourage more responsible lighting practices. Urban planners, policymakers, and communities must work together to integrate light pollution mitigation into sustainability efforts, ensuring future development protects ecosystems, preserves dark skies, and supports public health.

Addressing the impacts of light pollution on astronomy and ecosystems requires stronger lighting regulations, with a focus on ecological effects, alongside increased awareness among planners, policymakers, and the public (Gaston et al., 2012; Elgert et al., 2021; Aubé et al., 2020). Technological solutions such as motion-activated lighting and LEDs with reduced blue light can help lower environmental impacts (Tähkämö et al., 2018), while community-led initiatives can support wildlife conservation (D'Antoni et al., 2017).

Effective mitigation also depends on improved lighting design, including fully shielded fixtures and controlled light intensity and wavelength to reduce spill, glare, and ecological disturbance. Examples from Italy and Chile demonstrate that such measures can significantly reduce sky brightness (Falchi et al., 2016; Ditmer et al., 2021). Additional strategies, such as lighting curfews in sensitive areas and on-demand lighting systems, can further limit disruption to nocturnal wildlife (Hölker et al., 2023; Rodríguez et al., 2017; Medubi et al., 2022; Syposz et al., 2021). Urban planning initiatives, including the creation of National Dark Sky Parks, can also help preserve natural nightscapes while supporting conservation and education (Papalambrou & Doulos, 2019).

Adopting alternative lighting spectra, such as red or amber hues, along with smart lighting systems that adjust to real-time conditions, can help reduce ecological impacts while maintaining safety and visibility (Durmus et al., 2024; Gan et al., 2023). Public education and engagement are also essential, as informed communities are more likely to support and adopt sustainable lighting practices (Evans, 2023).

Beyond environmental concerns, light pollution contributes to energy waste, higher public costs, and increased carbon emissions, underscoring the need for immediate government action through awareness campaigns, updated legislation, and improved lighting infrastructure. Coordinated

initiatives, such as the EU LIFE Yelkouan Shearwater Project (2006–2010), demonstrate how targeted efforts can reduce light pollution, protect wildlife habitats, and lower environmental impacts, as seen in Malta (Borg et al., 2008).

Effective mitigation also depends on strong government policies. Countries such as South Korea and several European nations have implemented national regulations to address light pollution, highlighting the importance of collaboration between policymakers, scientists, conservationists, and lighting experts to develop guidelines that balance environmental protection with public needs (Lim et al., 2018; Rodrigo-Comino et al., 2021; Barber & Cole, 2020).

Several countries have already implemented effective policies to combat light pollution, demonstrating that tangible results are achievable:

France: In 2019, France enacted comprehensive regulations, restricting outdoor lighting during night hours, mandating fully shielded fixtures, and limiting blue light emissions (<https://darksky.org/news/france-light-pollution-law-2018/>; <https://www.legifrance.gouv.fr/loda/id/JORFTEXT000037864346/>)

Slovenia: Slovenia's legislation mandates energy-efficient lighting, bans upward light emissions, and regulates lighting in protected areas, resulting in significant reductions in light pollution (<https://programme2014-20.interreg-central.eu/Content.Node/Dynamic-Light/15.01.18.Slovenia---Country-Report-Final.pdf>)

South Korea: The country's "Act on the Prevention of Light Pollution by Artificial Lighting" regulates lighting in both urban and rural areas, significantly reducing its impact on human health and ecosystems (<https://english.seoul.go.kr/redesigning-nights-seoul/>)

These examples underscore the effectiveness of binding legislation in reducing light pollution while promoting sustainable development

In conclusion, mitigating light pollution requires a holistic and adaptive approach. Through policy reform, technological advancements, public education, and thoughtful urban planning, it is possible to reduce the harmful effects of light pollution, protect ecosystems, improve public health, and preserve the natural night sky for future generations.

Measures for the reduction of light pollution

The following is adapted primarily from the [International Dark-Sky Association Board Policy on the Application of the Lighting Principles](#), with additional reference to [Guidelines for Ecologically Responsible Lighting](#), by BirdlifeMalta, and [ERA Guidelines for the Reduction of Light Pollution in the Maltese Islands](#)

1. Responsible outdoor lighting must consider all five principles in its design and installation, and only through attention to all five principles will light pollution be minimised to its practical extent (**refer to figures 7 and 8**).
2. Where existing fixtures are replaced, the project should demonstrate how they will reduce light pollution.
3. Where new installation or lighting retrofit projects are proposed, they should be guided by an assessment process to determine whether such lighting is necessary and responsible.
4. To reduce sky glow, glare, spill light, and over-lighting, indoor and outdoor lighting should contain and minimise the emission of light so that it does not extend beyond the intended target. Light emitted toward or above the horizon can have extraordinarily high environmental impacts (**refer to figures 9 and 10**).
5. To prevent overlighting, actual illumination levels should be as close as reasonably practical to the minimum values recommended by accredited professional bodies such as the [Illuminating Engineering Society \(IES\)](#) and the [International Commission on Illumination \(CIE\)](#), and appropriate for the task and environmental setting.
6. New installations should have active controls to reduce illumination levels or extinguish lighting completely based on time of day or occupancy. Such controls are currently underutilised in outdoor lighting and can substantially reduce light pollution and save energy.
7. The spectral content, or colour, of light should be limited to only what is necessary for the task. Because of the disproportionate impact on the nighttime environment, particular attention should be paid to reducing the total emissions of short-wavelength or “blue” light (defined for the purposes of this resolution between the wavelengths of 380 nm and 520 nm) through light source spectrum management (**refer to figure 11**).
 - A. To minimise negative environmental impacts, DarkSky recommends using a CCT of 2200 K, phosphor-converted amber LED, or some filtered LEDs whenever possible.
 - B. When a CCT higher than 2200 K is necessary to meet lighting objectives, keep the total emission of blue light into the environment as low as reasonably possible

through low intensities (the selected source must not emit more than 8% blue light), careful targeting, and reduced operating times.

- C. Near sensitive sites, such as conservation areas, sensitive wildlife habitats, ecological reserves, parks, astronomical observatories, or stargazing sites, DarkSky recommends that lighting installations use 0% blue light and a narrower spectrum of emission.
 - D. Critically sensitive environments such as Dark Sky Heritage Areas must be kept naturally dark, with artificial lighting strictly prohibited to protect their ecological, cultural, and astronomical value.
8. Solutions that result in no net increase in light pollution should be considered a minimum requirement, whereas best management practices would result in the maximum practical restoration of intrinsic darkness.
 9. In order to implement the *'Five Principles for Responsible Outdoor Lighting'* and recommendations provided by DarkSky International, whilst complying with all relevant regulatory frameworks, including guidelines, procedures, standards, codes, and laws, decisions should be informed by a suitable environmental impact assessment, and backed by regular monitoring of light levels in the surrounding environment.
 10. Launch Urgent Public Awareness Campaigns: Public outreach initiatives must be amplified, educating citizens, local governments, and businesses on the health and environmental risks of light pollution. These campaigns should emphasise the benefits of turning off non-essential lights, advocating for "lights-out" events and campaigns, and encouraging sustainable lighting practices at the household and commercial levels. To enhance public engagement, collaborative efforts with schools, NGOs, and environmental organisations should be bolstered.
 11. Urgently Enforce Night-Sky-Friendly Lighting Policies: Immediate publication and enforcement of the [ERA Guidelines for the Reduction of Light Pollution in the Maltese Islands](#) is imperative. This must include reducing excessive lighting, enforcing strict curfews for non-essential illumination, and mandating the use of warm-coloured LEDs with a colour temperature of less than 2300K to minimise blue light emissions. In line with DarkSky International's recommendations, luminaires must be equipped with full cut-off shielding to direct light solely downward, thereby preventing upward light spill and reducing sky glow. Furthermore, timers or motion sensors should be implemented to ensure lights are only operational when needed, thereby minimising both light pollution and energy wastage.

Five Lighting Principles for Responsible Outdoor Lighting



Responsible outdoor lighting is

1 Useful

Use light only if it is needed

All light should have a clear purpose. Consider how the use of light will impact the area, including wildlife and their habitats.



2 Targeted

Direct light so it falls only where it is needed

Use shielding and careful aiming to target the direction of the light beam so that it points downward and does not spill beyond where it is needed.



3 Low Level

Light should be no brighter than necessary

Use the lowest light level required. Be mindful of surface conditions, as some surfaces may reflect more light into the night sky than intended.



4 Controlled

Use light only when it is needed

Use controls such as timers or motion detectors to ensure that light is available when it is needed, dimmed when possible, and turned off when not needed.



5 Warm-colored

Use warmer color lights where possible

Limit the amount of shorter wavelength (blue-violet) light to the least amount needed.



Rev. 06-2023

Figure 7: The Five Principles for Responsible Outdoor Lighting

Published jointly by *DarkSky International* and the *Illuminating Engineering Society*

Source: <https://darksky.org/resources/guides-and-how-tos/lighting-principles/>

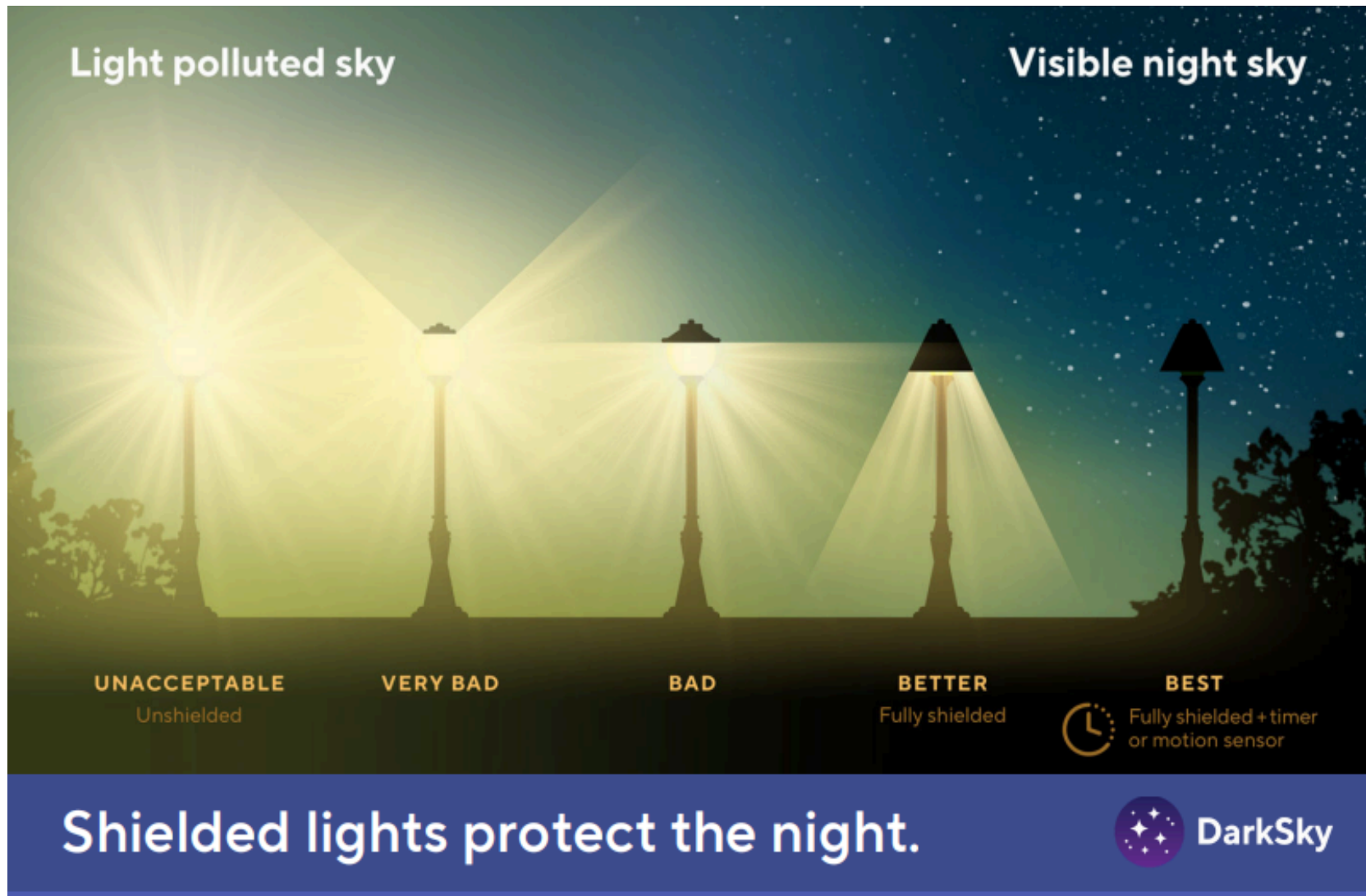


Figure 8: The use of shielded lights, especially when combined with a motion or time sensor, can significantly reduce light pollution

Source: [DarkSky International](https://www.darksky.org/)

Unacceptable Fixtures

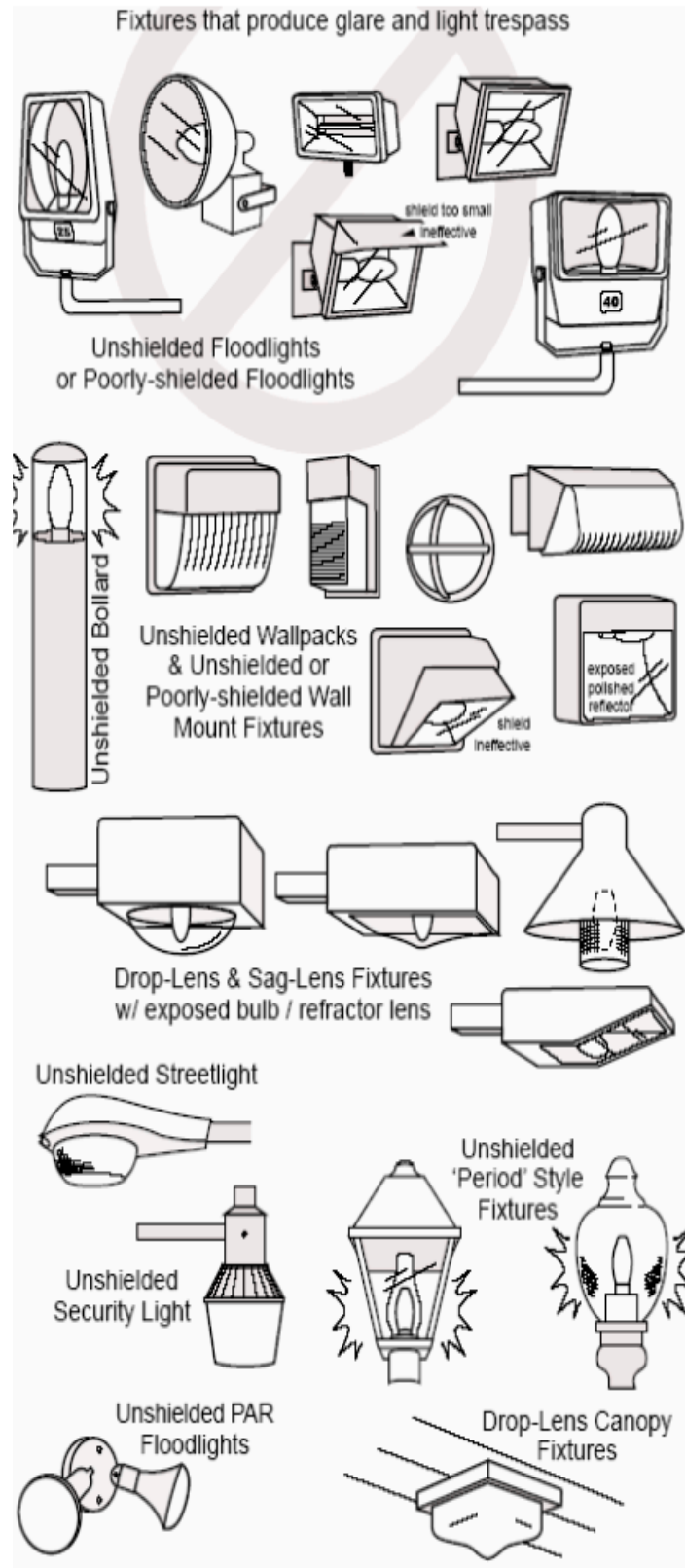


Figure 9: Examples of unacceptable light fixtures, the use of which should be heavily discouraged

Acceptable Fixtures

Fixtures that shield the light source to minimize glare and light trespass and to facilitate better vision at night

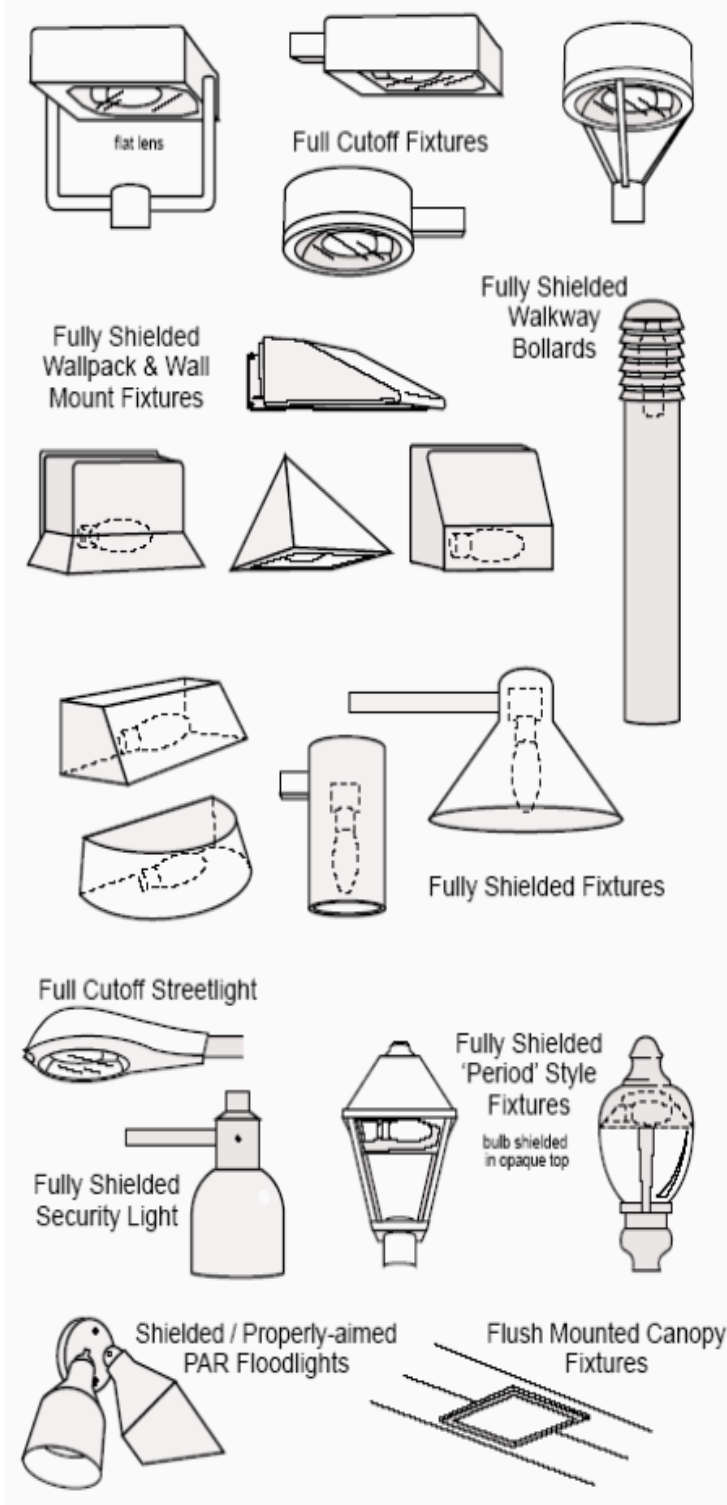


Figure 10: Examples of acceptable light fixtures, in which the light source is shielded to minimise glare and light trespass and facilitate better vision at night



Figure 11: Correlated colour temperature (CCT)

A measure (in kelvins, K) of the warmth or coolness of the appearance of a light source.

Warm-coloured lights having a CCT <2300K should be used.

The ‘Spectral Power Distribution’ (SPD) of a warm CCT light source tends to show less light in the blue spectrum. As shorter blue wavelengths are more easily scattered, blue light contributes to glare, skyglow and can be challenging for older drivers. In addition, it negatively affects the health and welfare of humans, flora, and fauna.

A Critical Call to Action

While the efforts of the *Environment and Resources Authority* (ERA) to develop guidelines for reducing light pollution are welcome, guidelines alone are insufficient to address the scale and urgency of the issue. Continued delays in implementation allow harmful light pollution to persist, negatively affecting ecosystems and wildlife, posing risks to human health, and diminishing the natural beauty of the night sky, an important part of both environmental and cultural heritage.

To ensure meaningful progress, these guidelines must be strengthened into robust, enforceable legislation that guarantees consistent application and accountability across all sectors. It is therefore essential that ERA prioritises the development of binding policies with clear authority. We call on ERA to expedite the implementation of light pollution reduction measures, transition from guidelines to enforceable legislation, and establish clear, measurable, and enforceable standards within the policy framework.



**Light Pollution
Awareness Group**

**The Astronomical Society
of Malta**



**The Astronomical
Society of Malta**



**Foundation
for the Conservation
of the Maltese Honey Bee**



**BEE
SAVERS
MALTA**





Din l-Art Helwa
NATIONAL TRUST OF MALTA



**Wirt
Għawdex**





**MOVIMENT
GRAFFITTI**



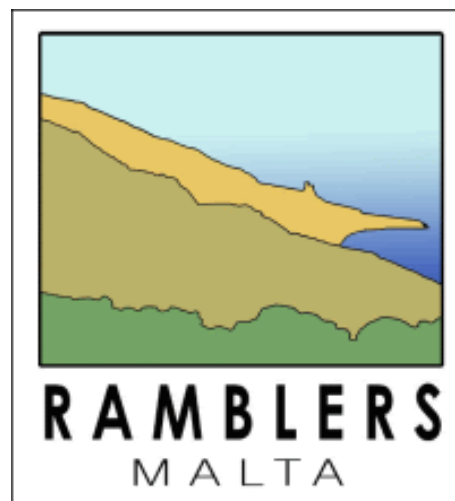
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Foundation



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malta**



FLIMKIEN GHAL AMBJENT AHJAR



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[DarkSky International](#)

[ERA Guidelines for the Reduction of Light Pollution in the Maltese Islands](#)

France National Light Pollution Policy:

<https://darksky.org/news/france-light-pollution-law-2018/>

<https://www.legifrance.gouv.fr/loda/id/JORFTEXT000037864346/>

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[Illuminating Engineering Society \(IES\)](#)

[International Commission on Illumination \(CIE\)](#)

[International Dark-Sky Association Board Policy on the Application of the Lighting Principles](#)

Slovenia light pollution legislation:

<https://programme2014-20.interreg-central.eu/Content.Node/Dynamic-Light/15.01.18.Slovenia---Country-Report-Final.pdf>

South Korea's 'Act on the Prevention of Light Pollution by Artificial Lighting'

<https://english.seoul.go.kr/redesigning-nights-seoul/>