

Can we turn off the



Hannah Dalgleish reports from a workshop that discussed the widespread effects of light pollution – and how to bring back dark skies.

Over millennia, Nature has evolved according to the cycles of day and night; living things are regulated by an internal biological clock – the circadian rhythm. But since the invention of electric light in the 1800s, humans have been interfering with the dark. Today, light pollution triggers problems for plants, insects, animals and humans. There is a critical need for light pollution policies that incorporate health, the protection of ecosystems, and the preservation of cultural heritage.

Light pollution was an important topic at NAM2021 this year. Discussions began with a series of talks at the “Light pollution is bad for all” session given by Sophie Spencer, Bob Fosbury and Bob Mizon. The speakers continued the conversation at an online workshop led by the RAS, University of Bath, and CPRE (formerly Campaign to Protect Rural England) Avon and Bristol on Tuesday 27 July. A series of short introductory talks reviewed different aspects of light pollution, laying down the foundation for the audience to discuss solutions in breakout rooms.

The harm caused by light pollution

The consequences of artificial light at night (ALAN) have been exacerbated in the last decade by rapid uptake of light-emitting diodes (LEDs). LEDs – which use up to 80% less energy than incandescent bulbs – are appealing as an energy-efficient alternative and apparently environmentally friendly solution. But their benefits are overshadowed by physiological, ecological and socioeconomic aspects (Hölker 2010a).

Bob Fosbury (astronomer emeritus, ESO) explained that high-intensity, blue-rich and poorly directed LEDs have colour temperatures above 2700K and strong emission at blue wavelengths, what Fosbury calls the “danger zone”. The blue light emitted by LEDs is much brighter than what we receive from the natural light of a sunset. It scatters high into the atmosphere, causing five times more skyglow than incandescent lamps and contributing to glare and light intrusion.

The interactions between blue light and living things are complex and there is much we do not understand. In humans, the presence of blue light suppresses the production of melatonin, which is needed for the onset of sleep and to facilitate the body’s repair mechanisms. Research has already found a wide array of effects on human physiology when exposed to blue light outside

daytime hours, including the disruption of sleep cycles, metabolism, reproduction, blood pressure, emotional balance, the immune system and cell renewal processes (Zielińska-Dabkowska 2018).

Doctoral researcher and astrophotographer **Maria Leite** (University of Westminster) talked about imbalances brought on by anthropogenic light sources. ALAN affects the circadian rhythms of vertebrates and invertebrates (Gaston *et al.* 2017) and nocturnal species are particularly affected – around 30% of vertebrates and more than 60% of invertebrates are nocturnal (Hölker *et al.* 2010b). Artificial night lighting distracts nocturnal and diurnal insects and drives their decline (Owens *et al.* 2020); threatens pollination networks and impacts plant reproduction (Knop *et al.* 2017); alters the behaviours of bats (Stone *et al.* 2015) and disorients dung beetles (Foster *et al.* 2021); interferes with the biological rhythms of birds (Dominoni 2015); and affects navigation, reproduction, predator-prey interactions and communication of marine species (Davies *et al.* 2014).

Turning off the lights would bring not only physiological and ecological benefits, but socioeconomic advantages too. A dark, starry nightscape creates “greater life satisfaction, happiness, and other emotional or psychological states associated with subjective well-being” (Dill 2021). Our view of the heavens is also deeply ingrained in our heritage; it embodies aesthetic, cultural, historical, inspirational, recreational, scientific and spiritual values (Gallaway 2010). In darkness, the act of observing stars, planets, meteors, comets and even other galaxies transcends borders and time. The study of celestial objects is both ancient and universal; astronomy has cross-cultural appeal and has been a globally inclusive scientific endeavour for centuries (Dalgleish 2021). It is also important to note that light pollution is not only ground-based: mega-constellations contribute to artificial night sky brightness and threaten the loss of our cultural heritage from above (Venkatesan *et al.* 2020, Kocifaj *et al.* 2021a).

How dark is the UK?

The CPRE, the countryside charity, conducts a nationwide Star Count each year, where citizens count the number of stars they can see in the constellation Orion in February. **Sophie Spencer** (director of CPRE Avon and Bristol) talked about the 2021 event, which gathered data from almost

lights?



8000 participants. The results show that 51% of people live in areas of severe light pollution (where 10 or fewer stars are visible), compared to 5% who observed 30 or more stars, an indication of truly dark skies. Unusually, these figures are an improvement on previous years. This may have been a result of pandemic restrictions, with businesses and sporting facilities using less night-time lighting. Reductions in air pollution could be another factor (e.g. Kocifaj & Barentine 2021b).

CPRE has also been involved with other major light pollution mapping projects. The latest survey looked at data taken by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (NPP) weather satellite, which was captured at 1:30 a.m. each night in September 2015. The findings show that only 22% of England is free of light pollution (57% of Wales and 77% of Scotland), with significant contributions from motorways, seaports, airports, business districts and football stadiums (figure 2).

Looking at England's pristine night skies, 47% are in areas without national protection, while 53% lie in National Parks and Areas of Outstanding Natural Beauty (AONBs). **Judith Chubb-Whittle** (landscape planning officer, Mendip Hills AONB) discussed the potential of reducing light pollution across AONBs, stressing that the "environment exists not only between 9–5, but lives 24/7". For every future development project, the Mendip Hills AONB asks for an assessment of night-time impacts and ensures fittings comply with the Institution of Lighting Professionals (ILP).

Dan Oakley (South Downs dark sky officer) emphasized the importance of engaging with local communities, from residents to parishes to astronomy societies. Dark skies should not only be preserved, but can also be used to improve education on light pollution and astronomy, and to show the public the value of our dark skies through direct experience. Many of our present generation have lived never having gazed upon a star-filled sky, which "helps explain the striking ambivalence toward the loss of the night" (Galloway 2010). In 2008, the *New York Times* wrote: "Light is so pervasive that during a blackout in Los Angeles, some residents became alarmed at a liquid-like substance that had taken over the sky. It was the Milky Way." It is so important to value and encourage night-time visits to our dark sky sites (see

e.g. darkskydiscovery.org.uk), an activity that also brings significant benefits for rural tourism (Dalgleish 2020).

Some of the most well-known dark sky oases in the UK overlap with the International Dark Sky Places (ISDP) programme, run by the International Dark-Sky Association (IDA) since 2001. There are currently 17 across the UK and Ireland (see figure 3). Dark Sky Communities refer to towns or cities that preserve the night sky via quality outdoor lighting ordinance, dark sky education and citizen support. Dark Sky Parks and Reserves are lands that possess both an exceptional quality of starry nights and a nocturnal environment that is protected for its scientific, natural, educational, cultural heritage and/or public enjoyment. One of the key differences between a Park and a Reserve is that the latter requires a minimum land area of 700km².

Saving the night

So what, then, are the solutions to ALAN? These can be summarized under three key strategies: standards and lighting regulations; greater public awareness via education and science communication from researchers and practitioners; more transdisciplinary research, especially on the socioeconomic impacts of light pollution as well as the benefits of darker skies.

In the workshop, **Bob Mizon** (UK coordinator of the BAA Commission for Dark Skies) reviewed lighting legislation (or rather, lack of it) in the UK and noted that lights are manufactured to no standards and are often falsely advertised as being "dark-sky friendly". The UK lags far behind nations such as France, Liechtenstein, South Korea and Mexico, which have laws that control the emission of light in outdoor spaces. Dunedin, New Zealand, shown in figure 1 with sodium lighting, embarked on a city-wide LED-replacement project. French law in particular features a curfew on outdoor lighting, encourages the use of smart technology such as motion sensors, limits upward light and glare, sets thresholds on the use of LEDs above 2400, 2700 or 3000K (location-dependent) and restricts the lumen levels of installations. It also prohibits light trespass, the use of sky beams, and night lighting over bodies of water. The legislation could go further, but it is a very good start.

Progress in the UK is frustratingly slow, despite the launch of the All-Party Parliamentary Group for Dark Skies

1 *Light pollution from the sodium lights of Dunedin City, New Zealand, in an image taken before a six-year LED replacement project.* (Brad Phipps)

2 (inset) *The British Isles on the night of 27 March 2012, created using VIIRS day-night band (0.5–0.9 μm) and MODIS Blue Marble data. Similar data from 2015 can be explored in an interactive map at nightblight.cpre.org.uk/maps.* (NASA Earth Observatory, Suomi NPP)

– co-chaired by Lord Rees of Ludlow and Andrew Griffith MP – which produced “Ten Dark Sky Policies for the Government” (appgdarks skies.co.uk/policy-plan) last year. The proposed policies build on the National Planning Policy Framework and Environmental Protection Act 1990, and advocate for the creation of a new cross-departmental minister for dark skies. Many in the workshop also referred to the International Astronomical Union’s “Report and Recommendations on Dark and Quiet Skies for Science and Society” as an invaluable resource (iau.org/news/announcements/detail/ann21002).

Introducing stricter regulations on ALAN would also be an easy way to help reach climate targets. Local councils spent an estimated £613 million on street lighting in 2014–15, accounting for 15–30% of a council’s total carbon emissions. Turning the lights off where and when they are not needed is a relatively easy way to save costs and meet climate-change targets, but so far councils are not doing so. In Mizon’s words: “We don’t need guidelines – we need regulations.”

Communication, communication, communication

By putting pressure on government and local organizations to act, and incorporating light pollution topics into the relevant curricula, we can stop the night from disappearing (Pothukuchi 2021). **Charles Draper** (chairman of Bath and Surrounds Starlit Skies Alliance and the Herschel Society) talked about the importance of bringing together different stakeholders to share and receive knowledge, from local councillors to the police, teachers and universities. Developers and planners need to be involved too, which can be achieved through providing a Technical Advice Note – such as the one developed by the South Downs National Park Authority – to help ensure that managing darkness becomes an integral part of future conservation planning. Participants also suggested writing to MPs or relevant chief scientific advisers as a means to build momentum. Other possible avenues include the Parliamentary Office of Science and Technology (POST), which encourages communication between research and policy by inviting researchers to contribute to POSTnotes and through fellowships.

Moreover, clear communication is needed to overcome misinformed ideas about ALAN. One of the main arguments against reducing night-time lighting is that the illumination helps to prevent crime or increases safety on the roads – but these claims have been shown not to stand up to close scrutiny. Studies on light pollution in the UK and Switzerland show no correlation between no or lower illumination and crime rates (Steinbach *et al.* 2015, Schuler *et al.* 2015). Both works similarly found no relationship between the number of traffic collisions and darkness. In fact, one of the participants in the workshop, Paul Marchant, talked about his research which illustrates an increase in road accidents with street lighting in the city of Birmingham (Marchant *et al.* 2019). In all, healthy lighting design is an important ethical issue

International Dark Sky Places (UK and Ireland)

IDSP name	location	category
Coll	Scotland	Dark Sky Community
Moffat	Scotland	Dark Sky Community
Bodmin Moor	England	Dark Sky Park
Galloway Forest Park	England	Dark Sky Park
Northumberland National Park and Kielder Water & Forest Park	England	Dark Sky Park
Mayo Dark Sky Park	Ireland	Dark Sky Park
OM Dark Sky Park and Observatory	N. Ireland	Dark Sky Park
Tomintoul and Glenlivet	Scotland	Dark Sky Park
Elan Valley	Wales	Dark Sky Park
Cranborne Chase	England	Dark Sky Reserve
Exmoor National Park	England	Dark Sky Reserve
Moore’s Reserve	England	Dark Sky Reserve
North York Moors National Park	England	Dark Sky Reserve
Yorkshire Dales National Park	England	Dark Sky Reserve
Kerry	Ireland	Dark Sky Reserve
Brecon Beacons National Park	Wales	Dark Sky Reserve
Snowdonia National Park	Wales	Dark Sky Reserve

3 Places in the UK and Ireland with accredited status from the International Dark-Sky Organisation (darksky.org).

that the general public deserves to know about, and when they do, there are many routes for citizen action (Zielińska-Dabkowska *et al.* 2020).

In order to precipitate culture change, we need to better understand the complex sociologies surrounding the topic of light pollution. One is the issue of vanity lighting. Colin Henshaw and Keith Venables, participants in the workshop, noted their disappointment in the use of crude illumination on caravans, public buildings or art festivals, among others. Henshaw asked for “a universal culture change in public attitudes to outdoor lighting”. At the same time, we need to appreciate and explore the cultural significance of the dark – especially its associations with fear (Edensor 2013, Bjelajac *et al.* 2021).

The desire to establish networks and transdisciplinary work related to light pollution is not new. Challéat *et al.* (2021) call for novel socioecological approaches via a dark ecological network, and the need to intersect these approaches with our understanding of knowledge production as well as biodiversity and conservation planning. Others advocate for the creation of an interdisciplinary field of “Night Studies”, bringing together biological, chemical, physical and social themes (Kyba *et al.* 2020). Finally, Pérez Vega *et al.* (2021) propose a research framework for a transdisciplinary urban lighting network.

Ultimately, with transdisciplinary research and diverse stakeholder engagement we can cut across boundaries between the scientific disciplines, policy and practice, and restore the night. ●

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