Bright sparks

Light pollution specialists **Professors Franz Hölker, Thomas Posch** and **Abraham Haim** explain why an interdisciplinary approach holds the key to understanding the broader impacts of artificial lighting



Could you begin by describing the main objectives of the Loss of the Night Network (LoNNe) project?

LoNNe aims to improve knowledge of the multiple effects of increasing artificial illumination. Innovations in technology and policy are urgently required to address the impact of artificial lighting on the natural environment, biodiversity, ecosystems, human health and society, and to identify potential corrective measures. Existing research associated with the impact of artificial lighting on the environment and human wellbeing is fragmented. The current potential of networking to enhance mobility between different actors from science, healthcare, public authorities and industry is limited. LoNNe aims to coordinate cooperation between these players in order to crossfertilise skills. The project will be open to any field of research, with the goal of identifying innovative technologies and creating guidelines that are ecologically, socially, and economically sustainable.

Could you summarise the impact of artificial lighting on the natural environment, biodiversity, ecosystems, human health and society? Why does this issue need to be addressed?

Humans often illuminate their environment uncritically, with no regard for the manifold impacts of artificial light, but light regulates the circadian rhythm of most organisms. Due to the increasing use of artificial light, the distinction between day and night has become blurred, disturbing the synchronisation between organisms and their environment.





There is clear evidence that artificial light can alter physiology, including hormonal balance, as well as behaviour, orientation, organism fitness, food web interactions, and biotope connectivity and may have serious psychophysiological and even medical consequences for humans, along with ecological and evolutionary implications for animals, plants and even entire ecosystems.

Can you explain why the current potential for networking to enhance mobility between different actors from science, healthcare, public authorities and industry is limited?

Light is a very complex phenomenon, more complex than it is generally assumed. Public authorities consider economical rather than ecological aspects and often rely on the advice of energy suppliers when it comes to designing their street illumination, which does not always lead to good results. Research efforts on the physiological, human health, ecological, and socioeconomic significance of the loss of the night, as well as monitoring light at night have been started worldwide. However, these studies lack an interdisciplinary approach. Almost all existing research programmes are limited to separate fields of science or to regional and national projects. Thus, there is an urgent need for networking and capacity-building activities that address how illumination can be improved both technically and institutionally with a commensurate reduction in adverse effects.

How does LoNNe aim to promote cooperation of these players and maximise the impact of their mixed

skillset to realise the aims of the project and create standards?

LoNNe will provide the coordination necessary to set up an interdisciplinary and supraregional network of research groups associated with the impacts of artificial light. The main means to form a critical mass of expertise encapsulating a wide range of competences in biological, social, and technological disciplines are an enhanced collaboration of researchers involved in the quantification and modelling of artificial light, the identification of state-of-the-art R&D facilities and expertise for research exchange within the COST network, the collaboration and cooperation for joint publications, and assembling existing data concerning artificial light and light pollution.

Technological innovations should not only target economical optimisation, but also consider human health, ecological and socioeconomic aspects. What are the main challenges associated with this? How does LoNNe propose to overcome these challenges?

There are a number of new challenges associated with artificial light. These challenges include: quantification of the state-of-the-art of artificial light in Europe; the definition of thresholds at which artificial light becomes light pollution; the quantification of the relationship between artificial light and light pollution; the organisation of data concerning the impact of artificial light; creating standard procedures to help decision makers quantifying the consequences of light pollution; and interaction with stakeholders on the research results to increase public awareness of the impacts of artificial light when it becomes light pollution.

Are there any events or workshops on the horizon relevant to LoNNe that you would like to highlight?

At the beginning of September, Croatia hosted a scientific training school on light pollution measurement techniques. On 28-30 October 2013, the first transdisciplinary conference on Artificial Light at Night (ALAN) will be held. The conference programme will consist of 12 plenary talks, contributed talks in parallel sessions, and a poster session (organised by Verlust der Nacht and the International Dark Sky Association). In addition, there will be a combined LoNNe/ ALAN stakeholder workshop in the afternoon on 30 October.

Leading lights

The effects of artificial light on biodiversity, physiology and society are yet to be fully understood. The current state of the art of research in this field is characterised by fragmented, singular studies. Addressing this shortfall in knowledge, **LoNNe** is an endeavour to ensure that policy makers and the public are better informed

LIGHT IS ONE of the most fundamental yet understudied phenomena that influences human wellbeing. As with many other natural resources, the advancement of science and technology has provided an alternative to relying on the supply of light by the natural world – we have learned to produce our own light and now do so on an enormous scale. This is of great benefit to humankind as a species because – unlike many animals – our eyes are quite poorly developed for dark conditions.

However, in evolutionary terms, light and dark periods are very important to the internal circadian clockwork of animals - ourselves included: "Diffuse scattered lights of big cities exceed the brightness of the full moon. Hence, biological processes which were once synchronised with the lunar phases may run into problems," explains Dr Thomas Posch, a senior scientist at the Department of Astrophysics of the University of Vienna. Beyond regulating schedules for nocturnal and diurnal animals, light patterns can govern growth, health, behaviour and physiology in many species. "The day-night rhythm in humans and animals is threatened by artificial light at night, leading to sleep disturbances, adverse effects on the endocrine system and on our immune system," continues Vice-Chair of the Action Professor Abraham Haim, from the University of Haifa. By disrupting a system as old as the planet itself, we may be wreaking untold havoc on city dwelling fauna.

A NEW NETWORK

Global recognition of this problem is now growing and many groups are dedicated to examining light pollution with urgency. At present however, existing research associated with the impact of artificial lighting on our environment and lives is fragmented, and generally of highest quality at a regional or national level. Moreover, understanding of the adverse effects of light pollution is vague, based mostly on anecdotal observations and case studies, with no biological definition. In order to achieve holistic understanding of the issues at hand requires mobilisation of an effective international research community.

To address this fragmentation, the European COST Office is supporting the Loss of the Night Network (LoNNe) Action – a network open to any group planning on influencing the development of modern illumination technology, or the policies that govern our use of such technology. It is hoped that, through the new network, researchers and policy makers in diverse fields will be able to share their relevant experience, and move towards development of innovative policy measures and sustainable technological innovations to improve our use of light.

FUTURE CONCERNS

Against a context of energy conservation, the EC has issued the European Ecodesign Directive, which calls for the establishment of a framework to phase out the use of energy-intensive lighting products by 2015. This represents an interesting period for artificial lighting in Europe. High-pressure mercury lamps - which are currently the main source of outdoor lighting in Europe (more than ~20 million light spots at present) are due to be replaced as a result of this. It seems likely that LED lighting will be introduced in the wake of mercury lamps but the broader societal and ecological impacts of their wide-scale introduction across major cities has yet to be fully examined. Several characteristics of LEDs differ substantially from the conventional light sources; these include easily programmable light intensity, spectrum, and light angular distribution. These features all have consequences for light pollution but their effects on health and the environment remain understudied.

While a drop in the cost of lighting services is expected, higher energy consumption may result due to rebound effects along with a wider loss of natural nightscapes. Studies to date demonstrate that in the UK luminous efficiency has doubled in the last 50 years – but expenditure has guadrupled in the same time. LoNNE hopes to

INTELLIGENCE

LONNE LOSS OF THE NIGHT NETWORK

OBJECTIVES

To improve knowledge of the multiple effects of increasing artificial illumination worldwide. Innovations in technology and policy are urgently required to address the impact of artificial lighting on the natural environment, biodiversity, ecosystems, human health and society, and to identify potential corrective measures.

PARTNERS

Participating countries:

Austria, Croatia, Finland, France, Germany, Greece, Ireland, Israel, Italy, Malta, The Netherlands, Romania, Slovakia, Slovenia, Spain, UK

FUNDING

COST is an intergovernmental framework for European Cooperation in Science and Technology, allowing the coordination of nationally-funded research on a European level.

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ABRAHAM HAIM has been a full professor at the University of Haifa, Departments of Biology and Evolutionary & Environmental Biology since 1996. He is also Chair of the Department of Natural Resources & Environmental Management. He recently published a book on light pollution breast and prostate cancers.

THOMAS POSCH is senior scientist at the Department of Astrophysics of the University of Vienna. His research fields include infrared astronomy, interstellar matter and the brightness of the night sky. The ecological impact of poorly designed artificial light is the main topic of the book *Das Ende der Nacht*, of which he is co-Editor (2nd edition 2013).



use this opportunity to bring together researchers from many fields to provide ecologically, socially, and economically sustainable solutions – but time is limited.

AMBITIOUS PLANS

In order to effectively and sustainably answer current and future questions on light pollution, LoNNe will achieve a number of tangible goals that have previously proven difficult for European researchers to fulfil due to the lack of appropriate network. For the first time, research groups will come together to define and quantify the state of the art of European artificial lighting and the threshold at which artificial light becomes light pollution; they will undertake the organisation of data concerning artificial lighting's impacts, create standard procedures to help policy makers quantify the consequences of light pollution, and, most importantly, they will interact with the public to raise awareness of the issues surrounding artificial lighting and light pollution.

In terms of technological advance, LoNNe hopes that, through its work filling in the gaps in present research, the scientific community may be able to advance sustainable technological innovations governing the quality and quantity of artificial lighting in production: new lenses, reflectors and shades, movement sensors and intelligent lighting control systems could have a huge impact on future lighting developments.

THE FIRST OF ITS KIND

After only half a year, LoNNe comprises a wide variety of members performing their own studies into artificial light. Already 16 countries are involved, with projects as diverse as illuminating areas of pristine woodland to map the effects of light, and developing a smartphone app to observe the brightness of the night sky. The more numerous and diverse the projects under the LoNNe umbrella grow, the more effective the collaboration becomes; it's the first network of its type, and the benefit to researchers in the field is therefore unprecedented.

Several of the Action's objectives have already been addressed. The main achievement is bringing interested people from different countries together. It was possible to create a unique platform and appropriate sub-networks for enhanced collaboration of researchers, COST Action Chair Dr Franz Hölker, from the Leibniz Institute of Freshwater Ecology and Inland Fisheries in Berlin, explains: "We are looking forward to the planned workshops for training students and the initiation of common transdisciplinary projects. We believe that, in combination with media coverage, the new Artificial Light at Night (ALAN) conference series will have a strong impact in increasing public awareness of the impacts of light pollution," to which he adds, "We were able to start with the assessment and organisation of data concerning the impact of artificial light".

DISSEMINATION EFFORTS

The communication of the research results is an important aspect of LoNNe. The Network sees its responsibility not only in disseminating the results



within the scientific community but in making them available to a broader audience as well. The Action offers researchers assistance in raising public awareness of the consequences of light pollution. LoNNe contributors are also working hard to bridge the gap between the sometimes separated research fields on artificial light and light pollution, and between science, industry and policy – especially as research results apply to reducing health disparities and environmental disruptions. Since several stakeholders and endusers have significant interest in exploiting the results of this COST Action, LoNNe will produce a wide spectrum of publications for customers, scientists and the general public. This includes joint publications of brochures, guidelines, reports and standard operating procedures, publication of proceedings of open meetings and press releases.

In addition, the researchers organise summer schools and training seminars, open lectures for the interested public, organisation of sessions at international conferences, a comprehensive publication on artificial light and light pollution, and other information media such as press releases, interviews with radio and TV stations, and cooperation with documentary makers. Indeed, the Network's approach to outreach are laudably up-to-date: the German 'Verlust der Nacht' collaboration has developed an app for citizen scientists called 'Loss of the Night'. It uses visual observations of stars to characterise sky brightness and is available to Android users free at: https://play.google.com/store/apps/ details?id=com.cosalux.welovestars. Clearly, the researchers have already shown aptitude for pushing boundaries in the field. If they continue at the current rate of progress, policy makers and the public alike will soon have a clearer view on effects of artificial lighting.