

Symposium on promotion and protection of the night sky

*Artificial light at night, environmental impacts
and sustainable tourism*

SEPTEMBER 13 -14, 2018

CAPRAIA ISLAND - ITALY

SYMPOSIUM ON PROMOTION AND PROTECTION OF THE NIGHT SKY

*Artificial light at night, environmental impacts
and sustainable tourism*

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BOOK OF ABSTRACTS

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Antonio Raschi - *Director of the Institute of Biometeorology*

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APPLIED NIGHTTIME PROTECTION A VERY PRACTICAL REPORT

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ABSTRACT

The UNESCO Biosphere Rhön was awarded IDA Dark Sky Reserve in 2014. This presentation describes the process up to the recognition in large steps. In particular, the importance and the possibilities of public relations work and ways of communication with political decision-makers as well as with various groups of society are presented. In addition, the field of activity of the daily work as a star park coordinator will be explained.

The presentation will be rounded off with best practice examples from the fields of lighting conversion, achievements in terms of astrotourism and the presentation of the network of star guides and the approved program. In addition, obstacles in communication or with legal defaults are also to be "lit up".

DARK SKY PLACES OF THE WORLD

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ABSTRACT

From 1993 to March 2018, 149 dark sky parks and communities in 23 countries have been recognized by various organisations, notably the International Dark Sky Association (IDA), the Royal Astronomical Society of Canada (RASC) and the Starlight Initiative.

Because light pollution impacts species and their interactions, many natural area organizations implement lighting systems friendly to night sky viewing and night ecology. Parks Canada and the RASC developed guidelines for outdoor lighting in parks, now recommended by IDA. These guidelines apply in the 27 Canadian dark sky preserves. The Natural Sounds and Night Skies Division of the US National Park Service has guided 22 of its sites to be among USA's 65 dark sky places, mostly recognized by the IDA. The Starlight Initiative certifies 16 Starlight Reserves mostly in Spain. Several other places are certified by sub-national levels of government or by astronomy research groups. As well as parks and communities, the IDA certifies "Developments of Distinction" and, likewise, the Starlight Initiative "Starlight Tourism Destinations."

Because these programmes use many different naming systems, the IUCN Dark Skies Advisory Group developed a 6 class system, some with sub-classes, to enable world-wide comparisons.

- 1, Dark Sky Astronomy Site, 14 places around the world.
- 2, Dark Sky Park, 86 places.
- 3, Dark Sky Heritage Site, 3 places.
- 4, Dark Sky Outreach Site 9 places.
- 5, Dark Sky Reserve, 13 places.
- 6, Dark Sky Community, 24 places.

Several challenges remain.

- 1) Light pollution reduction is often overshadowed by other threats to nature, such as climate change.
- 2) Much work remains to be done to reduce light pollution in urban areas, where protected areas can play a role through outreach, visitor engagement and demonstrating best practices.
- 3) There still needs to be recognition that protected areas, by default, should be dark sky places.

KEYWORDS:

protected areas, nature conservation, parks, communities, best practices, outreach

EFFORTS TO ESTABLISH DARK SKY PLACES BASED ON SYSTEMATIC MEASUREMENTS OF THE NIGHT SKY BRIGHTNESS IN UPPER AUSTRIA

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ABSTRACT

We present the results of 23 SQM stations, installed in Upper Austria as part of a light monitoring network. By taking measurements every minute, about 12 million data points on the night sky brightness have been collected per year in order to gain an overview of the night sky quality in different parts of the country. The analysis focusses on the years 2015-2017, not only on clear nights, but also on cloudy to overcast sky conditions. Circalunar periodicity, weather dependence and seasonal variations are obvious but depend on the amounts and kinds of light sources in the respective surroundings. We show a strong circalunar periodicity of the night sky brightness in small towns and villages with amplitudes of up to 5 magnitudes. On the other hand, we demonstrate that the examined city skies brighten by up to 3 magnitudes under cloudy conditions. We show histograms and plots which emphasise the divergent levels of light pollution in big cities, suburban and rural areas. Measurements

in rural areas of Upper Austria show night sky brightness values down to 21.8 mag/arcsec² and should allow the establishment of official Dark Sky Places according to the International Dark Sky Association.

The aim is to preserve and protect such locations through responsible lighting policies and public education. Together with the provincial government of Upper Austria, we hope to create two Dark Sky Places in the county: possibly a "Dark Sky Reserve" in the Nationalpark Kalkalpen region with an area of up to 1000 km² and/or a smaller "Dark Sky Park", e.g. in the region "Freiwald" in the northeast of Upper Austria.

We are currently trying to perform a multiple factor analysis to examine more carefully how dark skies as measured within our network, meteorological conditions, local infrastructure, presence of already established observatories and nature protected areas can be best 'combined' in the choice of suitable dark sky places.

KEYWORDS:

night sky brightness, monitoring, measurements, sky quality, dark sky reserve

BUIOMETRIA PARTECIPATIVA

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ABSTRACT

The presentation will provide an overview of ten years of the BuioMetria Partecipativa project. This was started in Italy as a “bottom-up” initiative in 2008 with the idea of combining three components: outreach on the issue of light pollution, collection of night sky brightness data via sky quality meters with a citizen science approach, and promotion of rural areas, combining the dark sky resource with other assets.

A peculiarity of the project is that this was not originated by an institution related to astronomy, a research organisation, or a promotion agency, but by local communities where experts in environmental monitoring were collaborating with citizens. This perspective led the project team to “learn by doing” many issues, and to conduct an extensive exercise of interacting with many different categories of stakeholders related to artificial light at night. In relation to extremely limited resources, the project has obtained a significant level of engagement at the national level, and has established interesting collaborations internationally.

Another peculiarity of the project is that its base is in the Farma Valley, in Southern Tuscany, a rural part of Italy with very good night sky quality: on one side this aspect represents an asset, on the other side, the setting poses significant organisational challenges. The talk will explore the story of the project from different angles, and hint to connections to other similar initiatives.

KEYWORDS:

citizen science, rural areas, buiometria

THE DARK SIDE OF A PARK

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ABSTRACT

The Protected Area of Migliarino San Rossore Massaciuccoli is located along the northwest coast of Tuscany, the internal area includes 24 km of coast and 12,000 ha of forests, wetlands, beaches, dunes and extensive agricultural fields. The 11,000 ha and 10 km of coast of buffer zones includes the more human modified land (agriculture, villages and transport infrastructure). Around this P.A. live around 400,000 inhabitants in a densely urban context.

The issue of light pollution is of strategic importance for the role that this P.A. plays in bird migration and for the importance that the day-night alternation has in the biological cycles of plants and like natural cue for animal. Our planning instrument keep in mind this issue, indeed prescribes the most restrictive rules among the Light Pollution Guidelines of the Tuscany Region. In addition, e.g. Assessments (sensu Habitats Directive) of Project of artificial light system in forest for military purposes have been rejected and Environmental Impact Assessments for works at the boundary of the SAC Selva Pisana had, among the prescriptions, pre and post operam monitoring of light pollution within the nearby SAC.

In our experience it is very difficult for the judicial authorities to pursue environmental crimes related to light pollution as opposed to other such as noise pollution or non-legal behaviour that are more easily measured by environmental agency, with an identifiable source and therefore demonstrable during the judicial trial.

Our idea for the future is to maintain high standards in planning and regulatory instruments and, at the same time, start a project that leads to an environmental certification that takes into account, and

therefore gives a value understood, appreciated and perceived by stakeholders, that take into account a integration measure of the absence of nightlight (like IDA in U.S.), noise pollution and the presence of high values of landscape and biodiversity.

KEYWORDS:

protected areas, light pollution, nature conservation, planning, environmental certification.

THE SKY OF MONTSEC. HOW A DARK SKY IS IMPACTING IN THE ECONOMY OF A RURAL AREA.

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ABSTRACT

Montsec is a calcareous mountain range more than 40 kilometres long in the regions of Catalunya and Aragon in the north-east of the Iberian Peninsula. The Catalanian part includes around 20 municipalities in the counties of Pallars Jussà and La Noguera.

This area showed excellent parameters to develop activities around astronomy and dark skies. For this reason the Government of Catalonia promoted the creation and development of Parc Astronòmic Montsec as a tool to help in the economic development of the region. This development gives the chance to stop the loss of population and the creation and upgrading of new touristic facilities related to dark skies and astronomical activities.

In 2013 more than 1700 km² were declared as Starlight Touristic Destination and part of this area became Starlight Reserve thanks to its wonderful parameters of the night sky and the actions taken in the area to preserve it.

Since 2012 the first's analyses of the economic and social impact have been done in the area. For example the results shown by the evaluation process for the development of the 'Pla de Desenvolupament Sostenible del Turisme Montsec 2020' [SomMontsec 2012] as strategic plan for tourism in the area. In 2014 a new study was done studying the visitors of Parc Astronòmic Montsec and how they participate in the local economy and in

alternative activities in Montsec area. This 2014 study has been updated with 2017 visitors and economy data available.

These studies give us important results in the improvement of Montsec area. For example the number of accommodation facilities has been doubled in the last decade, the stop of the loss of population in the area or the estimation of close to 2.0MEuros of economic activity generated in the area by the visitors of Parc Astronòmic Montsec.

KEYWORDS:

light pollution, economy, astrotourism.

THE LIGHT POLLUTION AT ASIAGO OBSERVATORY

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ABSTRACT

The night sky brightness at Asiago Observatory is affected by light pollution from the local villages and from more distant contributions coming from the cities and villages down on the Padana Valley. We are monitoring the evolution of these components using satellite and local measurements.

We recently started an investigation on the effects of aerosols using combined measurements and a simple model of light pollution propagation.

KEYWORDS:

light pollution, atmospheric aerosol

FOR THE DARKNESS SEEKERS IN CENTRAL SEOUL: THE MOONLIGHT TOUR AT CHANGDEOKGUNG PALACE

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ABSTRACT

While light pollution means those in towns and cities have restricted views of the night sky, there is a tour programme that has uniquely attracted the darkness seekers even in Central Seoul. The established Moonlight Tour at Changdeokgung Palace has offered an opportunity to experience darkness along with palatial beauty at night since 2010. Changdeokgung, built in 1412 and occupies a 110 acres site, has been the only Joseon dynasty period (1392-1910) palace designated as part of UNESCO World Cultural Heritage since 1997. The guided walking tour takes approximately two hours passing through several historical buildings and a secret garden with a large beautiful pond where visitors also experience Korean traditional music and art performance with a tea and snacks.

The main theme of the tour is darkness. Most accent lightings are carefully mounted and positioned to express the significance of their beautiful details of materials and marks of their history. A limited numbers of custom-made full cutoff lamps are only used to cover pathways in the Palace. The whole lighting installations are controlled with the use of a smart lighting control system. Therefore, night-time illumination of the Palace is only applied when the tour takes place as well as different light levels being set upon a seasonal change to create an ambience. As a result, visitors mainly need to rely on the moonlight and appreciate the beauty of the dark sky due to the absence of skyglow.

The tour programme shows how lighting design has been in place to protect night sky while highlighting and preserving architectural quality of the historical site. Measuring photometric variables at several locations of the Palace and linking them with sustainable palace lighting for night sky is being undertaken.

KEYWORDS:

moonlight tour, changdeokgung, lighting design, UNESCO
cultural heritage, tourism, palace

PROBLEMATIC RESEARCH IN LIGHTING AND PUBLIC SAFETY: UNCOVERING MAJOR ERRORS

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ABSTRACT

Exterior lighting can help people to see at night, and so avoid problems such as trip hazards. However, additionally lighting is also installed or increased because of the belief that it has major benefits in increasing public safety, by reducing crime and road traffic collisions. Indeed, there is a body of research that claims to show such public safety benefits. The paper (Marchant 2017) gives some reasons why errors can and do occur.

In this presentation, several papers and reports will be examined to lay bare their specific grave errors, which nullify the claimed findings of large public safety benefits attributed to lighting. Rather than increasing lighting, it would therefore seem that the large sums of money involved in lighting projects might be better spent to achieve desired socially beneficial aims.

The issue of faulty lighting research is just one aspect of wider concerns around research integrity. The Research Integrity Inquiry of the UK Parliament's House of Commons Science and Technology Committee is one manifestation of such concerns.

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including, <http://data.parliament.uk/writtenevidence/committee-evidence.svc/evidencedocument/science-and-technology-committee/research-integrity/written/77124.html>

KEYWORDS:

exterior lighting, security, public safety, crime, road traffic accidents, research integrity, statistical mistakes.

THE CONTRIBUTIONS OF SUSTIANABLE CITIES TO ENVIRONMENTAL PROTECTION AND CLEAR NIGHT SKY

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ABSTRACT

Urban settlements are becoming main habitats for human beings year by year in the 21st century. According to the UN figures, 66 % of the world population will be living in urban areas by 2050. A rapid increase in the number of both urban settlements and urban populations attracts the attention of scientists, researchers, policy makers, governors, and international organizations. In New York, the High-level Plenary Meeting of the General Assembly of the UN in 2015, all member states agreed on 17 sustainable development goals by 2030. One of those goals is Goal 11: Sustainable Cities and Communities (SDG 11) which addresses the risks and expectation for better and liveable life standards in urban areas.

The SDG 11 also considers the environmental impacts of urban settlements. In this respect, policies and strategies with a view to building sustainable cities and communities will make remarkable contributions to the environmental protection and creating clear night sky. In terms of close interaction between the SDG 11 and SDG 7: Clean and Affordable Energy, reduction of energy consumption in cities and creating energy efficient policies are other significant aspects showing the potential support of sustainable cities for environmental protection.

Thus, in this paper, the policies and implementing strategies of the SDG 11 will be elaborated toward achieving the clear night sky. In addition to the links of SDG 11 to other sustainable development goals, the relationship to the SDG

7 will especially be analyzed with respect to environmental protection by reducing energy consumption in cities.

KEYWORDS:

sustainable development, sustainable cities,
environmental protection, energy efficiency, clear night sky

ENVIRONMENTAL IMPACTS OF ARTIFICIAL LIGHT AT NIGHT ON FRESHWATER SYSTEMS

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ABSTRACT

Artificial light at night (ALAN) is increasingly recognized as a major component of global environmental change. Because half of the human population lives within 3 km of a surface freshwater body a substantial fraction of freshwater ecosystems is increasingly exposed to light pollution worldwide, i.e. freshwater ecosystems may be particularly susceptible to changing light regimes at night. Experiments on the effects of ALAN in freshwater systems have demonstrated both physiological and behavioural responses of individual species, and community effects. For example, impacts of ALAN on the biomass and composition of primary producers in benthic communities have been found. Also microbial community composition is altered under the influence of ALAN. Zooplankton exhibit changes in their diel vertical migration pattern in response to ALAN at the low light levels produced by skyglow. Drift patterns of aquatic macroinvertebrates are likewise modified by ALAN. In addition, several studies have demonstrated ALAN-induced effects in fish. Through its effects on the behaviour and physiology of organisms, ALAN is a potentially important driver of ecosystem dynamics and may lead to general changes of food web interactions and ecosystem functions. Recent findings on light pollution include the disruption of critical ecosystem functions such as carbon mineralization by microorganisms and organism flux (e.g. insects) across ecosystem boundaries.

This talk will describe the extent to which artificial light at night has or could have an effect on species, communities and ecosystems. In addition, promising lighting concepts, strategies and measures to reduce environmental concerns are presented.

KEYWORDS:

light pollution, sky brightness, aquatic system, dose-response, light spectrum, night-time

REDUCING THE EFFECT OF DUAL ECOLOGICAL TRAPS ON NIGHT-SWARMING MAYFLIES AT LAMP-LIT BRIDGES

Symposium on Promotion and Protection of the Night Sky

D. Száz, Á. Egri, G. Kriska,

G. Horváth

ABSTRACT

The traffic lights of bridges by lamps at night can elicit positive phototaxis for several insect species that start to swarm around the light sources. Additionally, the asphalt road running on the bridge can reflect strongly and horizontally polarized light that induces positive polarotaxis in aquatic insects. Thus, a dual ecological trap forms in which the conventional ecological light pollution (elicited by the intensity of lamplight) and the polarized light pollution (elicited by the horizontal polarization of asphalt-reflected light) are simultaneously involved with synergistic effects.

We have studied this phenomenon in field experiments on the example of *Ephoron virgo* mayfly species which is protected in Hungary with a conservation value of about 33 Euros per specimen. These mayflies have become victims of the mentioned dual ecological trap. They detect the horizontally polarized light reflected from the water surface that leads the females to the proper places for oviposition. During their compensatory flight, the high-intensity traffic lights elicit phototaxis and attract them towards the lamps. The swarming around the lamps is so intense that after a while they fall onto the asphalt road due to exhaustion. The horizontally polarizing asphalt surface of the bridge mimicking water may also deceive and attract mayflies. Either way, they lay their eggs which perish because of dehydration. During one night, at a single bridge, the population loss can be several millions of mayflies and egg clutches.

This problematic issue cannot be solved easily, since the bridge-lights cannot be switched off due to safety regulations. We worked out a method for the conservation of these mayflies exploiting their positive phototaxis. With downstream-facing light-emitting

diode beacon lights above two tributaries of the river Danube, we managed to guide egg-laying female mayflies to the river surface and prevent them from perishing outside the river near urban lights. By means of measuring the mayfly outflow from the river as functions of time and the on/off state of the beacons, we showed that the number of mayflies exiting the river's area was practically zero while our beacons were operating. Tributaries could be the sources of mayfly recolonization in the case of water quality degradation of large rivers. The protection of mayfly populations in small rivers and safeguarding their aggregation and oviposition sites are therefore important.

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THE ALAN PHENOMENON IN THE BROADER FRAME OF URBAN EVOLUTIONARY ECOLOGY

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ABSTRACT

Artificial light at night (ALAN) is a threat to ecosystem, which due to urbanization it is increasing globally. This review is part of a wider project proposal of evolutionary ecology in urban and peri-urban populations of the Italian fauna. Here we provide an overview of the effects of light pollution on a plethora of organisms, as well as of ecosystem functions. Cloud cover can increase the area where light irradiance arrives, potentially affecting peri-urban habitats like wetlands. Polluted aerosols and the different thermal regimes of cities can increase the phenomenon of cloud cover, directly amplifying ALAN.

Light alters both physiology functions like metabolism, circadian rhythms and behaviours like activity and interactions. This alteration in a wetland area can potentially affect the entire ecology of zooplankton, aquatic insects, urodeles, and anurans. Another common effect of ALAN is the attraction of nocturnal insects, especially moths. They can provide a window to small-scale evolutionary and trophic alteration studies, because they affect the diet of their predators and the delicate equilibrium of the ecosystem. Lastly, an augmented presence of light can alter the effects of communication signals, or create new ones. Visual communication mediated by colours, shapes, and signals is very common between animals, especially for courtship. Light can dimmer the contrast between the environment and an organism, blinding the communication, but can also exacerbate a shape or a reflectance colour in camouflaged animals.

All of these phenomena participate with many others in the differentiation of the urban environment, and they are all necessary to enlighten how the evolution acts in their ecology.

KEYWORDS:

ALAN, urban ecology, evolution, natural selection, adaptation, environment.

MONITORING LIGHT POLLUTION AND ITS EFFECTS IN THE URBAN ENVIRONMENT

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ABSTRACT

The aim of this work is to present the activities for studying light pollution in Tuscany and its effect on plant phenology in the urban environment.

This experience started in 2014 when IBIMET was part of the COST Action Loss of the Night Network, aimed to share knowledge of the stakeholders involved in the study of light pollution, its impacts on the environment, best practices for illumination and promotion of dark sky night for its social and economic value. IBIMET

Monitoring activity started in 2015 with the setup of a network of fixed sky quality meter devices for measuring light pollution in cities and uncontaminated natural sites in Tuscany. Actually three sensors are active, two in cities (Firenze and Livorno) and one in the Island of Montecristo that is one of the less polluted areas in Italy. One of the effects of lighting the urban night was observed in *Platanus x acerifolia* trees in Florence. Therefore the relationship between outdoor public lighting and leaf senescence of young and adult individuals of this species was investigated in autumn and winter season from 2015 to 2018. Leaf senescence resulted delayed in trees that were more exposed to lighting and this effect was enhanced for young trees and under warmer winter conditions.

Meanwhile, IBIMET together with University of Pisa and Attivarti.org was involved and organized several public events to promote and raise awareness of citizen about the topic in the form of measurement campaign, seminars and night guided tours for measuring sky darkness and appreciating the beauty of the natural sky.

KEYWORDS:

artificial light, autumn phenology, *platanus x acerifolia*, urban environment, citizen science.

MEASUREMENTS OF NIGHT SKY BRIGHTNESS IN VENETO REGION: SQM NETWORK IMPLEMENTATIONS AND RESULTS

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ABSTRACT

We present the implementation of a monitoring network for artificial light at night (ALAN), based on Sky Quality Meter devices (SQM) in nine locations of the Veneto region. The system is coordinated by the regional Environment Protection Agency (ARPA-Veneto) and the Department of Physics and Astronomy of the University of Padua in collaboration with the local dark-sky association, Venetostellato.

A new Web portal containing zenithal night sky brightness data has been implemented to collect data from SQM station of the regional territory starting from 2011.

Measurements are recorded in an ARPAV centralized Oracle database and made available for users through a Drupal 6 portal named SQMWEB, from which they can be read, elaborated and downloaded.

The web portal includes some pages with different functionality: from simple reading of nightly data from a single location and calculation of the lunar phase, sky conditions (cloud coverage), mean and slope of brightness curve, to pages where statistics can be calculated for a given location

(histograms of brightness, hourglass diagrams, density plots etc.). Download is also enabled after filtering for time period, lunar phase or sky conditions.

We present also the results of some elaborations from dataset, like statistic for a set of stations, histograms, annual and cumulative plots, nocturnal evolution of the night sky brightness, and also long term trends for some monitoring stations.

KEYWORDS:

SQM network, nocturnal brightness, statistic results.

TRACKING ECOLOGICAL LIGHT POLLUTION WITH DIGITAL CAMERAS – ALL TERRAIN, ALL WEATHER, ALL DIRECTIONS

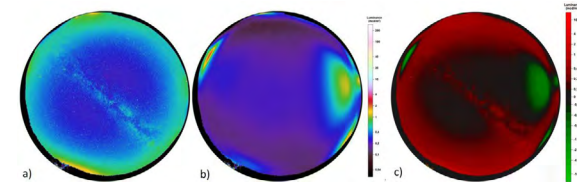
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ABSTRACT



Measuring the night sky brightness [1] is important to evaluate the impact of light pollution on the environment. One easy-to-use and quick measurement method that provides high spatial and reasonable spectral information is to use digital cameras with fisheye lenses [1-4].

This method is well established to study astronomical light pollution under clear sky conditions [1]. However, it allows the study of the change of light conditions due to different weather phenomena like the impact of clouds [2,3] or snow, that have not received much attention so far. Furthermore, it is applicable for field work of e.g. biologists. Here, recent results from different locations will be presented and some new approaches for ecological light pollution will be discussed. Measurements were taken for example on a floating research platform (LakeLab) observing darkening due to clouds, from moving boats [3] to measure light pollution offshore and in remote arctic regions during polar night. Differential photometry [4] allows to subtract images and evaluate different lighting or environmental conditions. Figure 1 shows luminance maps for Lake Stechlin, Germany for a) clear sky b) overcast sky and c) subtracted luminance.

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KEYWORDS:

ecological light pollution, photometry, night sky brightness.

ARTIFICIAL LIGHT POLLUTION MONITORING WITH THE PRISMA ALL-SKY CAMERA NETWORK

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ABSTRACT

The PRISMA (Prima Rete Italiana per la Sorveglianza sistematica di Meteore e Atmosfera) project primary goals are detection of bright meteors and recovery of meteorites. The all-sky cameras of the network perform sky monitoring during night time taking a picture every 10 minutes. This allows to measure the sky luminosity also correlated to artificial light pollution. We present the measurement methods we implemented together with some examples.

KEYWORDS:

light pollution, sky luminosity, all-sky camera, sky monitoring, meteors

LAN³: A MULTISPECTRAL AND MULTIDIRECTIONAL INTRUSIVE LIGHT SENSOR FOR HEALTH AND ENVIRONMENTAL STUDIES

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ABSTRACT

We report the design and first implementation of the LANcube (LAN3), a new device intended to sample the multispectral and multidirectional properties of the direct artificial light at night into the urban or natural environment (indoor or outdoor). We expect that it will become a powerful tool to foster new research in both fields. LAN3 is a cube having on each of its face four sensors of various spectral response in the visible range (red, green, blue and clear). Each band has been calibrated in a way to deliver the integrated fluxes. Thanks to its multispectral capabilities, the sensor can provide an estimate of the correlated color temperature (CCT). The minimum light level detected is of the order of 0.01 lux. LAN3 is based on arduino open source hardware so that it can be replicated by anybody. In its basic version, it comprise a real time clock, a remote RF control, a micro-SD card to store the data and a web server to download the data. LAN3 can be operated in automatic sampling mode or in manual sampling mode.

Future development should include the real-time calculation of the melatonin suppression index, the star light index and the induced photosynthesis index. The addition of temperature, humidity and pressure sensors along with a GPS module and a 3D accelerometer is planned in a mid term.

KEYWORDS:

intrusive light, light at night, multispectral sensing, melatonin suppression

MEASURING LIGHT POLLUTION FROM DRONES OR AIRBALLOONS. THE MINLU PROJECT

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ABSTRACT

Upward light emission from surface light sources can be detected by satellite images, but they are not always calibrated. Furthermore, the obtainable horizontal spatial resolution only recently went below 1km. Data can be obtained by aerial observations, they provide mainly measurements at the zenith of the sources and poor information on the light spectrum, while the knowledge of light emitted in any direction and at any wavelength is also very important. Drones and air balloons can allow to overcome those limits.

Italian Veneto Region in its law asks for a control activity of upward light emission, it is mainly carried out by ground-based surveys and notices from private associations of amateur astronomer and private citizens. Ground based surveys are particularly effort expensive and cannot reach wide spatial extent, furthermore it is of interest to measure the situation of the upward emission and to identify important light sources emitting towards the sky.

MINLU is an autonomous imaging system commanded by a central data management unit connected to the imaging subsystem, which includes three cameras and a spectrometer; telemetry is

also present. All the system is lightweight enough to be carried by drones and air balloons at relatively low altitudes.

Two cameras allow the measurement of the luminous intensity of polluting sources and their spectral power density with a wavelength resolution of about 2 nm, which allows to identify the different lamp technology used in street lighting. The third camera has an RGB colour sensor with the purpose of documentation. The instruments consider rays away from the nadir direction up to more than 40° and cover a surface 360m x 240m with a spatial resolution about tenths of meter.

The use of tethered balloons allows to measure the time evolution of the emissions over many hours during night.

KEYWORDS:

light pollution, artificial lighting, urban analysis, remote sensing, photometry, spectral analysis.

2018 WINTER OLYMPICS GANGNEUNG HOCKEY CENTER: MEDIA-FAÇADE & LANDSCAPE LIGHTING

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This hockey center was designed as a shape of an ice hockey puck, stylized in a modern version to embody the Korean traditional octagon. Six key strategies were used to create beautiful nightscape lighting.

1. The transparent media glass was designed to function as a media façade on the entrance curtain wall, and the image of the Olympic flag was expressed on the façade through lighting at night without damaging the landscape in the daytime.
2. The roof with line LEDs was illuminated to aim at the walls, washing them with light to emphasize the octagon roof surface.
3. White point LEDs on the exterior walls were installed to realize the image of big snowflakes. The arrangement of the lighting fixtures was determined through density analysis considering the exterior finish area and visitor movements to provide rhythmic dimming.
4. The RGB color expression of the roof lighting were coordinated for harmony with the nearby stadiums within the

Olympic Park.

5. Flood lighting on the edge of the building emphasized the octagonal form, a Korean traditional image, through level differences between brightness and darkness.

6. Adjacent auxiliary stadiums were harmoniously designed to balance color temperature and luminance level balances similar to those of the main arena.

The initial concept design of the lighting was conducted by Kang Woon Kim. Later, the landscape lighting design were renewed by Kwang Hoon kim and Nuriplan colleagues by the competition. The center has become a nighttime tourist attraction as well as regional landmark with media facade and image of big snowflakes. The hockey center took a total of 1.8 million Euros in landscape lighting.

KEYWORDS:

Gangneung Hockey Center, 2018 Winter Olympics, landscape lighting, media-façade, night sightseeing

VALORISATION AND FRUITION OF HISTORICAL AND ARTISTIC HERITAGE FOR THE NIGHT SKY PROTECTION AND PROMOTION

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ABSTRACT

The interaction between the activities of astronomical observation and dissemination and the historical and artistic heritage of the Salento area, linked to the plurality of its fruitive modalities, represented the basis of the initiative to involve a large audience by the amateur astronomers association CRA located in Lecce. In particular the ten-year experience at the Torre Lapillo and Torre Chianca coastal towers (16th century, in the Marine Protected area at Porto Cesareo LE) in collaboration with a pool of associations, aims to be a possible reference in similar projects.

The enhancement of a unique fresco dating back to the fourteenth century, situated in a crypt in the municipality territory of Copertino LE (twin country with Cupertino, California, for fifty years), depicting the Knight Sourè and his lady's images embraced tenderly under the starry sky, has been used as an icon for the night sky protection and promotion, thanks to appropriate "messages" through social networks.

KEYWORDS:

historical artistic heritage, Salento, coastal towers, Knight Sourè

THE IMPACTS OF LIGHT POLLUTION IN MARINE ECOSYSTEMS

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ABSTRACT

Coastlines are illuminated with Artificial Light At Night (ALAN) from piers, promenades, ports harbours, and dockyards. Artificial sky glow created by lighting from coastal settlements can now be detected above 22% of the world's coasts nightly, and will dramatically increase as coastal human populations more than double by year 2060. During this presentation, I will discuss the nature, extent and ecological implications of marine light pollution, providing a synopsis of research advances over the last five years. Recently documented ecological impacts include those on the timing of reproductive events, daily migrations of organisms, recruitment, the composition of ecological communities, and predator-prey interactions.

KEYWORDS:

ecological light pollution, marine ecosystems, reproduction, recruitment, migrations, community composition, predator prey interactions.

INCORPORATING LIGHT POLLUTION INTO CUMULATIVE EFFECTS ASSESSMENT IN COASTAL AREAS OF THE ITALIAN ADRIATIC SEA

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ABSTRACT

Artificial light at night (ALAN) from coastal urban areas represents a direct threat to marine organisms as it can affect their natural behaviour, migration and reproduction, and it may interfere with community interactions such as competition or predation. Despite increasing research activities on assessing ecological consequences of ALAN, the overall effects of this threat on marine ecosystems remain largely unknown. Besides, ALAN can interact with other human stressors contributing to multiple impacts on marine ecosystems. In order to adequately assess the cumulative effects of human stressors to marine biota, it is therefore essential to integrate ALAN into decision support systems including impact assessment models. An advanced model for coastal light pollution assessment, based on expert elicitation and on a spatially detailed artificial night sky brightness dataset, is presented and tested for coastal areas of the Italian Adriatic Sea. Effects on marine organisms (e.g. turtles) are mapped and discussed for their ecological relevance, importance within multiple environmental impacts, as well as for their significance for coastal management and planning.

KEYWORDS:

light pollution, coastal ecosystems, cumulative impacts, modelling, Adriatic sea

ARTIFICIAL LIGHT AT NIGHT AND MARINE FOOD WEBS: AN INTERTIDAL CASE STUDY

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ABSTRACT

Artificial light at night (ALAN) is a globally widespread phenomenon. Despite increasing evidence of its pervasive effects on patterns of species distribution and abundance, the potential of this emerging threat to alter ecological processes in marine ecosystems is still far from being elucidated.

Coastal ALAN can disrupt natural light/dark cycles for marine organisms and those living higher on the shore are more likely to be impacted by the presence of direct sources of night light. Here, we present a manipulative field experiment aimed at testing potential effects of ALAN on a rocky intertidal system constituted of epilithic bacteria and gastropod grazers feeding on them (littorinids). We hypothesised that artificial nighttime light might influence the system either through direct effects on the physiology of both bacteria and littorinids, or through indirect effects on bacteria mediated by changes in the trophic pressure of herbivores. In each of two sites, chosen randomly among four naturally dark sites at night, we artificially lit the rocky shore by means of LED lamps to mimic coastal nighttime lights

due to land-based developments (e.g. cities and harbors).

The other two sites were left dark at night and served as controls. At each site, 10x10cm plots were either left untouched or treated to exclude gastropod grazers. Results showed direct and interactive effects of ALAN and herbivores on bacterial assemblages, including a generalized, unexpected facilitation due to the presence grazers. In particular, ALAN could increase diversity of cyanobacteria only in presence of herbivores, while it canceled out the positive effect of grazers on diversity of heterotrophic bacteria. More generally, our results suggest that ALAN might alter ecological processes on rocky shores, through complex effects on organisms playing key roles in numerous ecosystem functions, including primary production and degradation of organic matter.

KEYWORDS:

artificial light at night, food webs, cyanobacteria, heterotrophic bacteria, gastropods

EFFECT OF NIGHT LIGHTING ON CIRCADIAN GENE RHYTHMS IN THE SEAGRASS POSIDONIA OCEANICA

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ABSTRACT

Daily control of plant growth and development is coordinated by the circadian clock, a tightly interconnected series of molecular and metabolic fluctuations that impose a 24-h periodicity to several biological processes. This time-keeping biological device is essential for plant fitness, by gating developmental and physiological adaptations to variable environmental conditions after a predicting fashion. Although, once established, the circadian clock periodicity is resilient to environmental cues, its early entrainment requires the light and temperature variations associated with the day/night cycle.

In this perspective, continuous perturbation of night darkness might alter circadian rhythms and thereby affect plants' responses to the environment. This is likely to occur in areas exposed to extensive nocturnal lighting such as coastal anthropized areas. In the present study, we evaluated whether differences in circadian

regulatory networks in the seagrass *Posidonia oceanica* display differential patterns when plants are spontaneously grown in areas characterized by different degrees of lighting during the night. We therefore focused on genes homologous to the ones characterized in land angiosperms, including those coding for core-oscillator (clock genes) and their targets that control photosynthesis and developmental transitions (output genes).

Several of tested genes displayed circadian regulation. Moreover, our preliminary data indicate that, while clock genes are not significantly altered, the expression pattern of photosynthetic genes significantly differs in plants grown in coastal sites characterized by elevated illumination. Analyses to assess the impact of such alteration on photosynthetic performance are currently ongoing.

KEYWORDS:

circadian clock, night illumination, gene expression, *Posidonia oceanica*, photosynthesis

WINKELMOOSALM – THE FIRST INTERNATIONAL DARK SKY PARK IN THE ALPS

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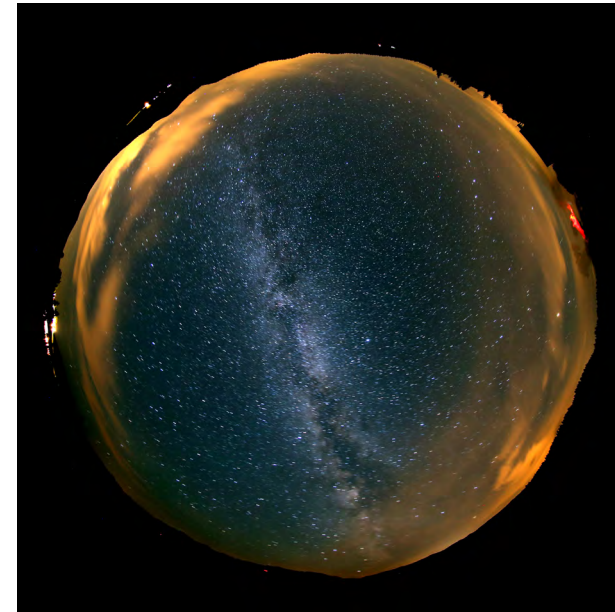
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ABSTRACT

Winklmoosalm is a famous mountain plateau in Germany bordering Austria and used for traditional transhumance and as a touristic destination for skiing in winter and hiking in summer. This place belongs to the municipality of Reit im Winkl, but lies isolated at an altitude of 1100 m. Due to the exceptionally dark sky, one of the authors (M.P.) offered successfully since some years star tours at the Alm. For two years the sky brightness was monitored and indicates exceptionally values down to darker than 21.8 mag/arc-sec². To protect this darkness the application for the designation as International Dark Sky Park from the International Dark Sky Association (IDA) was decided and officially supported by the town of Reit im Winkl.

A lighting inventory of the 35 houses on the Alm, of which two are larger hotels, showed, that most of the 240 lighting installations were not conform to the guidelines of the IDA. According to these, luminaires with lamps over 500 lumens must be fully cut-off and all lamps must have low content of blue light, corresponding to a correlated colour temperature of 3000 Kelvin or less. In summer 2017 M.P. brought 92% of the lighting installations with inexpensive and simple methods and with the help of some of neighbours on the Alm into compliance with the IDA guidelines, that finally in May 2018 the Winklmoosalm was designated as IDA International Dark Sky Park.



Allsky image of the nocturnal sky at Winklmoosalm (photo: A. H.)

KEYWORDS:

dark sky parks, International Dark Sky Association (IDA), sky brightness, full cut-off luminaires, correlated colour temperature.

OBSERVING ATMOSPHERIC CONDITION OF NIGHT SKY BRIGHTNESS FOR LIGHT CURVE PROFILE IN SELECTED AREA OF SHAH ALAM, MALAYSIA

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ABSTRACT

Night sky refers to the sky at night that can be seen by using human naked eyes. The celestial body, such as moon, stars and planets could be viewed clearly in the night sky. However, the night sky nowadays is not darker anymore due to the surrounding light source, meteorological and atmospheric conditions.

The invention of artificial light has caused a light pollution that made the night sky brighter than before. The atmospheric conditions is refers to the state of the atmosphere in terms of clouds, wind, temperature and precipitation, which these conditions strongly affect the brightness of the night sky. This research was done in order to observe whether the atmospheric conditions affect the conditions of night sky brightness around the Shah Alam area and to plot the light curve of the night sky brightness over a period of time and produce a light curve profile of the atmospheric conditions of the night sky brightness. It is also done in order to compare the area that has a brighter, night sky in the area have darker night sky around Shah Alam and the light curve for a period of days. It is found that the brightness of the night sky in Shah Alam at certain area is high since, most of

the magnitude reading is from 9 mag arcsec⁻² to 10 mag arcsec⁻² because of the presence of artificial light such as street lights, buildings, city and residential area that dominated the Shah Alam area which cause the light pollution. It is also because of the cloud and the precipitation at the night sky that cause the light to scatter, thus will increase the brightness of the night sky in the area. From the results, Shah Alam is considered as the light polluted area.

KEYWORDS:

atmospheric condition, sky brightness, light curve, magnitude, night sky

DETERMINING NIGHT SKY QUALITY IN DARK SKY PARKS

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ABSTRACT

Modern digital cameras make it possible to provide an objective qualification of international darksky places. Measuring the nighttime sky luminance or radiance distribution is possible with these devices. However, precise measurements can only be obtained if the whole system is calibrated thoroughly.

We present the sequence of calibration like spectral and vignetting corrections of the cameras and lenses.

We also present an open source GNU-octave compatible software, DiCaLum, which can be used to process raw camera images.

ROCK AND ROLL INDUCED SKYGLOW: A CASE STUDY DURING LOLLAPALOOZA BERLIN 2016

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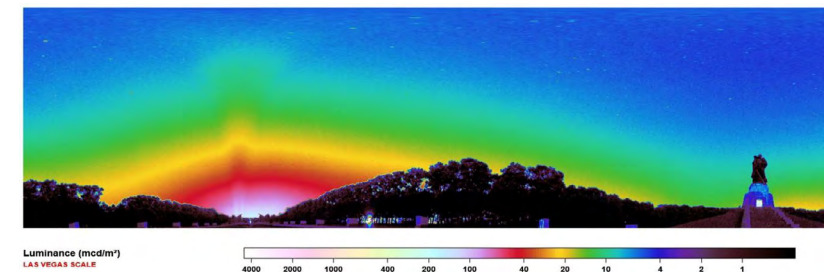
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ABSTRACT

Outdoor music festivals have become very popular in recent years and represent a growing market for tourism. Although some festivals claim to be eco-friendly and sustainable, research on the environmental consequences and the sustainability of festivals is difficult and sparse [1]. In particular, the influence of such events on ecological light pollution and on skyglow has not been investigated yet. Here, the impact of a major rock festival, Lollapalooza Berlin (140,000 visitors) held in Treptower Park in Summer 2016 (140,000 visitors), on the urban night sky brightness was investigated. The festival organizers provided access to the facilities during construction and allowed to install a photometer (sky quality meter, SQM) directly on site (FOH "front of house" tower). Furthermore, photometry with DSLR cameras [2,3] was used from a nearby observation spot inside of the park (Fig. 1). Data was taken during the festival and for representative weather conditions in summer 2016. Measurement results and further research ideas will be discussed.

Figure 1 Sky luminance map obtained on 09.09.2016, 23:37 local time within Treptower Park, Berlin, during light check one night before the Lollapalooza festival.



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KEYWORDS:

ecological light pollution, urban skyglow, recreational pollution, photometry, night sky brightness

A SPECTROSCOPIC ANALYSIS OF THE LIGHT POLLUTION AT ASIAGO OBSERVATORY

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ABSTRACT

We present the spectra evolution of the sky at Asiago Astronomical Observatory from an unprecedented archive collected in the last half century. They will be compared with typical city lamp spectra. The artificial light pollution spectral evolution during the night is also investigated and its impact on astronomical observations is briefly discussed.

KEYWORDS:

light pollution, site testing, night sky spectra, aurora lines, sodium lines

NOTES

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ABSTRACT

We report the first light of Sky Quality Meter (SQM-LE) in Universiti Teknologi MARA (UiTM) Shah Alam, Malaysia as a fixed station to monitor urban night sky brightness. UiTM is situated in the city centre of Shah Alam. Shah Alam as a state capital of Selangor was the first planned city in Malaysia after the Independence in 1957. Therefore, it has urban cityscape with administrative buildings, commercial centres, industrial areas and residential areas (occupied most of the city). Less than ten (10) years ago, Shah Alam City Council has decided to switch sodium/florescent lighting to LED. The invention of artificial light has increased the numbers of surrounding lights around us. This man-made light is now everywhere especially in cities, either on the street, buildings, house and vehicles. The SQM-LE is put together with other equipment such as All-Sky Camera and Sky Scanner as a part of integrated photometric system of a rooftop of Cempaka 4, UiTM Shah Alam (3.066888; 101.502633). As preliminary result, it showed that minimum magnitude is around 15 mpsas and it has a sudden increase of light around 2AM and later decreased around 4AM. We will monitor the trend and try to find out what is the reason behind by cross checking it with All-Sky Camera. To date, this station is already included in Globe at Night Network. We hope that this monitoring will be able to contribute to humankind.

KEYWORDS:

Sky Quality Meter (SQM), urban, light pollution, Universiti Teknologi MARA Shah Alam, Night Sky Brightness (NSB)

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