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Session 21.5 – Light at Night and Protected Areas

Zhao Yongheng

National Astronomical Observatories
B313, 20A Datun Road, Chaoyang District, Beijing, China, 100012
email: yzhao@bao.ac.cn

1. The Ecological Implications of Light at Night (LAN)

(C. Henshaw, Health Studies and Training Centre, North West Armed Forces Prince Salman Hospital, Tabuk, SAUDI ARABIA)

Light at night (LAN) is now an established environmental problem, not only for astronomers but for the population at large. It has serious ecological effects that are wide ranging, and its environmental effects may be more serious than ever imagined. The ecological and environmental consequences are examined and emphasis is stressed on resolving the problem before it is too late.

Summary:

It has been demonstrated here that lighting has serious environmental implications, and is a contributor to climate change. One of the easiest ways to mitigate climate change is to eliminate unnecessary lighting.

It is a green issue, so environmental organisations in addition to astronomers need to campaign against it. Though light pollution cannot be eliminated entirely, technology is now available that can mitigate its worst effects (Fig. 1).

Public outreach campaigns by environmentalists need to be pro-active in creating awareness of the problem amongst the general public, the lighting industry, commerce, industry, municipalities, sporting and artistic communities and any other parties that may be tempted to abuse light.

Otherwise they will be considered as campaigns by a minor interest groups and may be construed as being a tyranny by a minority.

2. Ecological Impact of LAN: San Pedro Riparian National Conservation Area

(E.R. Craine, B.L. Craine, Western Research Company, Tucson, Arizona, UNITED STATES, STEM Laboratory, Inc., Tucson, Arizona, UNITED STATES)

The San Pedro River in Southeastern Arizona is home to nearly 45% of the 900 total species of birds in the United States; millions of songbirds migrate though this unique flyway every year. As the last undammed river in the Southwest, it has been called one of the "last great places" in the US. Human activity has had striking and highly visible impacts on the San Pedro River. As a result, and to help preserve and conserve the area, much of the region has been designated the San Pedro Riparian National Conservation Area (SPRNCA). Attention has been directed to impacts of population, water depletion, and border fence barriers on the riparian environment. To date, there has been little recognition that light at night (LAN), evolving with the increased local population, could have moderating influences on the area. STEM Laboratory has pioneered techniques of coordinated airborne and ground based measurements of light at night, and

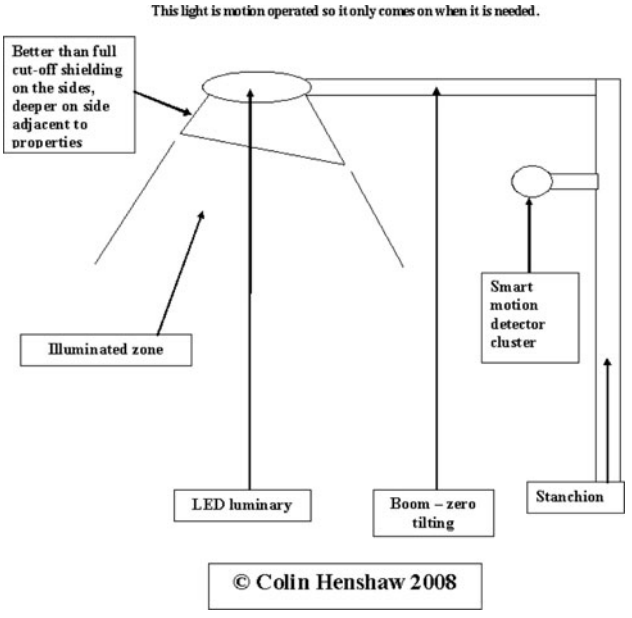

Figure 1. Anti-light pollution street light suitable for residential areas.

has undertaken a program of characterizing LAN in this region. We conducted the first aerial baseline surveys of sky brightness in 2012. Geographic Information Systems (GIS) shapefiles allow comparison and correlation of various biological databases with the LAN data. The goal is to better understand how increased dissemination of night time lighting impacts the distributions, behaviour, and life cycles of biota on this ecosystem. We discuss the baseline measurements, current data collection programs, and some of the implications for specific biological systems.

Summary:

LAN plays important, but largely unexplored, roles in wildlife ecology.

Such interactions can be extremely complex and may require years to characterize.

Comprehensive LAN databases are critical to the conduct of LAN/wildlife behavior research studies.

To understand impacts in specific regions, temporal monitoring is essential (Fig. 2).

3. Stars For Citizens With Urban Star Parks and Lighting Specialists

(Valentin Grigore, The Romanian Society for Meteors and Astronomy, Targoviste, Dambovita, ROMANIA)

General context

One hundred years ago, almost nobody imagine a life without stars every night even in the urban areas. Now, to see a starry sky is a special event for urban citizens.

It is possible to see the stars even inside cities? Yes, but for that we need star parks and lighting specialists as partners.

Educational aspect

The citizens must be able to identify the planets, constellations and other celestial objects in their urban residence. This is part of a basic education. The number of the

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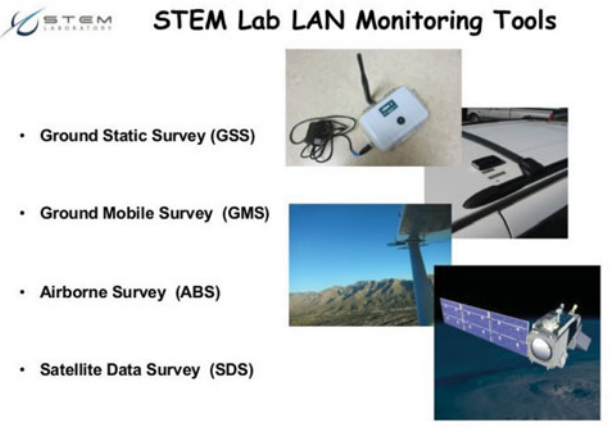

Figure 2. LAN monitoring tools.

Figure 3. Activities for urban community.

people living in the urban area who never see the main constellations or important stars increase every year. We must do something for our urban community (Fig. 3).

What is an urban star park?

An urban public park where we can see the main constellations can be considered an urban star park. There can be organized a lot of activities as practical lessons of astronomy, star parties, etc.

Classification of the urban star parks

A proposal for classification of the urban star parks taking in consideration the quality of the sky and the number of the city inhabitants,Two categories:

· city star parks for cities with $<$ 100.000 inhabitants

· metropolis star parks for cities with $>$ 100.000 inhabitants

Five levels of quality:

1* level = can see stars of at least 1 magnitude with the naked eyes

2* level = at least 2 mag

3* level = at least 3 mag

4* level= at least 4 mag

5* level = at least 5 mag

The urban star urban park structure and lighting system

A possible structure of a urban star park and sky-friend lighting including non-electric illumination are descripted.

The International Commission on Illumination

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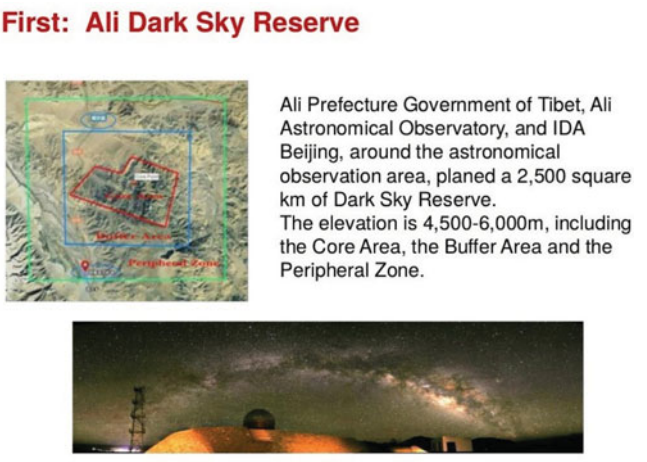

Figure 4. A Dark Sky Reserve around Ali astronomical observatory.

A description of this structure which has as members national commissions from all over the world.

Dark-sky activists - lighting specialists

National Commissions on Illumination organize courses of lighting specialist. Dark-sky activists can become lighting specialists. The author shows his experience in this aspect as a recent lighting specialist and his cooperation with the Romanian National Commission on Illumination working for a law of illumination in Romania and to implement the sky protection elements into the lighting specialist accreditation.

4. The New Progress of the Starry Sky Project of China

(Xiaohua Wang, Starry Sky Project of China, International Dark Sky Association Beijing Chapter, Beijing, CHINA)

Since the 28th General Assembly of IAU, the Starry Sky Project of China (SSPC) team made new progress:

1. Enhanced the function of the SSPC team. Established the contact with IAU C50, IUCN Dark Skies Advisory Group, AWB and IDA,and undertakes the work of the IDA Beijing Chapter. Got supports from China's National Astronomical Observatories, Beijing Planetarium, and Shanghai Science and Technology Museum. Signed cooperation agreements with Lighting Research Center, English Education Group and law Firm; formed the team force.

2. Put forward a proposal to national top institution The SSPC submitted the first proposal about dark sky protection to the Chinese People's Political Consultative Conference.

3. Introduced the Criteria and Guideline of dark sky protection The SSPC team translated 8 documents of IDA, and provided a reference basis for Chinese dark sky protection.

4. Actively establish dark sky places Plan a Dark Sky Reserve around Ali astronomical observatory (5,100m elevation) in Tibet (Fig. 4). China's Xinhua News Agency released the news. Combining with Hangcuo Lake, a National Natural Reserve and Scenic in Tibet, to plan and establish the Dark Sky Park. Cooperated with Shandong Longgang Tourism Group to construct the Dream Sky Theme Park in the suburbs of Jinan city.

In the IYL 2015, the SSPC is getting further development: First, make dark sky protection enter National Ecological Strategy of "Beautiful China". We call on: "Beautiful

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China" needs "Beautiful Night Sky"; China should care the shared starry sky, and left this resource and heritage for children. Second, hold "Cosmic Light" exhibition in Shanghai Science and Technology Museum on August.Third, continue to establish Dark Sky Reserve, Park and Theme Park. We want to make these places become the bases of dark sky protection, astronomical education and ecological tourism, and develop into new cultural industry. Fourth, actively join international cooperation.

Now, "Blue Sky, White Cloud and Starry Sky" have become the common pursuit of Chinese society. In order to obtain this goal, the SSPC team would like to pay more efforts.

5. Measuring light pollution in Beijing and effects on Xinglong Station of National Astronomical Observatory

(Ligen LU, B. ZHANG, S. ZENG, Department of Astronomy, Beijing Normal University, Beijing, CHINA; M. AI, Liaoning Province Institute of Metrology, Shenyang, CHINA; J. LIU, National Institute of Metrology, Beijing, CHINA)

A light pollution survey in Beijing has been carried on to assess the quality of the night sky. To measure the absolute luminance of night sky directly, a portable night-sky luminance meter was developed specially for this survey. With a 2-degree field of view, the meter is sensitive only to a narrow cone of the sky and capable of detecting the minimum luminance of $10^{-6} cd/m^2$ (equivalent to 27.4 mag/arcsec2). The night-sky brightness was measured at seven sites, of which six are almost in line but with different distances from the city center. The Xinglong Station of National Astronomical Observatory was included to study the impacts of city lightings on an astronomical observatory. The survey shows that night skies at later time (from 0:00 to 3:00) keep mostly unchanged and are evidently darker than earlier time (e.g. the night-sky at 23:00 is about 40% brighter than midnight), which can be attributed to substantial artificial lightings for human activities being turned off after midnight. Moreover, zenith luminance of the night sky decreases with increasing distance from the city center. Compared with the night-sky luminance (21.50 mag/arcsec2) at Lingshan observation site which is closer to the city center, the night-sky brightness at Xinglong Station is a litter brighter (21.37 mag/arcsec2). This indicates that night sky at Xinglong Station has been brightened by outdoor lighting of the county town of Xinglong. The survey shows that either the luminance of zenith dark sky or the average luminance of skies at 45 degree altitude in all directions could be considered as a reasonable indicator of light pollution.

Summary:

A portable night-sky luminance meter (Fig. 5)

· Independent of the telescope.

· With narrow field of view (2 degrees) and high sensitivity ($10^{-5} cd/m^2$).

Measuring night-sky brightness in Beijing

· Seven observation sites with different distances from the city center, including Xinglong Station, a major optical site for astronomical observations in China.

· Potential risks to night sky.

6. Light pollution modelling the UK Highways Agency new environmental policy, inc. astronomical impact of blue- rich LED luminaires

(Christopher Baddiley, BAA Campaign for Dark skies, Nr. Malvern, UNITED KINGDOM)

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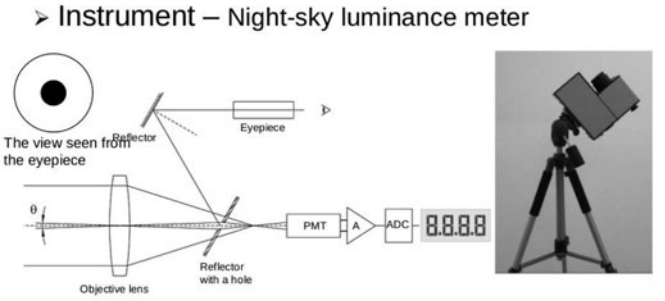

Table 1 Specifications of the Night Sky Luminance Meter.

Objective aperture	50 mm	Focal length	70 mm
Field of view	2 degrees	Sensitivity resolution	10^{-5} cd/m^2
Measurement range	0 ~ 19.99 cd/m^2	Measurement error	± 4.6% (± 0.05 mag/arcsec^2)

Figure 5. A portable night-sky luminance meter.

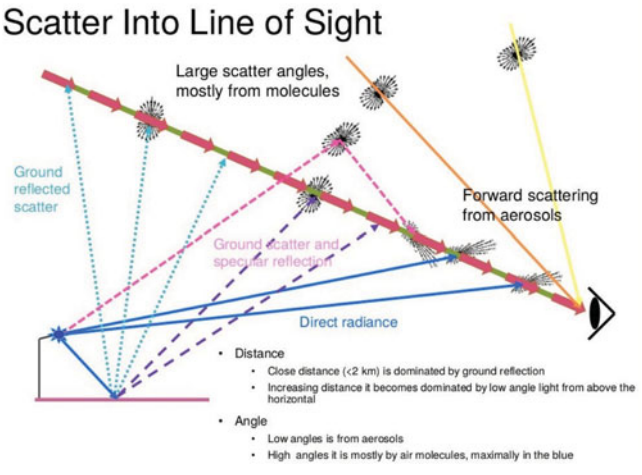

Figure 6. Light pollution model.

The Highways Agency are replacing their policy of full cut off class G6 road lighting specification on motorways (originally based on the author's work), and are adopting a categorised environmental impact based point system that can accommodate technical advances, such as LED lighting. The Skyglow component of this will be based on the modelling of skyglow versus cut-off angle, developed for determining the relative light pollution environmental impact of different streetlight designs, by the author (Fig. 6). Further modelling has been done concerning the effect of LED lighting, which potentially, has highly directional properties. But increasingly used blue rich colour temperatures may increase skyglow by 5 fold, compared to traditional lighting. This is due to enhanced reflection of vegetation and greatly increased atmospheric molecular Rayleigh scattering; a potential astronomical environmental disaster.

Prior to this, the author carried out a dark sky survey of the Malvern Hills area of outstanding natural beauty (AONB), relating it to the same light pollution model. The results confirm the general predictions of the model and also clearly illustrate the relative significance of different designs of light sources at different distances, to the dark sky environment.

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The paper also briefly describes the results from the same model adapted to study the night-time environmental impact of a proposed very large sea based wind farm project in the English Channel, as a part of the planning process.

Summary:

The individual red tilted a aviation and navigation warning lights 15 km from landfall will be visible from the coast on the horizon at night. The brightness will be brighter than a bright Star, but dimmer than Jupiter.

The angular distribution is quite different from that caused by normal road lighting in a landscape environment. The reflectivity off the sea is also very low angle.

The skyglow from the navigation lights is limited to near the horizon, and on a clear night will be still less than those from that from external lighting in France.

This is due to their directionality, and being deep red, where scattering is low.

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