

COMMISSION C.B7

PROTECTION OF EXISTING AND POTENTIAL OBSERVATORY SITES

PRESIDENT
VICE-PRESIDENT
PAST PRESIDENT/ADVISOR
ORGANIZING COMMITTEE

Constance E. Walker
James D. Lowenthal
Richard Green
Constance Walker, James Lowenthal,
David Galadi-Enriquez, Harvey S. Liszt,
Diane Turnshek

INTER-DIVISION B-C COMMISSION-C.B7 WORKING GROUPS

Int-Div. B-C/Commission C.B7 WG Site Protection

Int-Div. B-C/Commission C.B7 WG Technical

**Int-Div. B-C/Commission C.B7 WG Achieving Sustainable Development
within a Quality Lighting Framework
(Joint with Commission C1)**

TRIENNIAL REPORT 2018-2021

1. Summary

The term began with the very successful two-day, off-campus focus meeting held during the 2018 IAU GA that brought together members of the Commission Internationale de L'Eclairage (CIE) and IAU Commission C.B7 to discuss next steps. The fruition of that was their involvement in the Dark and Quiet Skies for Science and Society working groups which did extensive research in establishing recommendations for optical observatories, radio observatories, dark skies oases, bio-environments and the impact of satellite constellations. This was a meeting requested by the UN. (As an outcome, a Memorandum of Understanding between CIE and IAU is presently being composed.) The final reports included attendees' feedback from the workshop and has been published as a full workshop report (<https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>) and a Conference Report Paper (<https://www.iau.org/static/publications/uncopuos-stsc-crp-8jan2021.pdf>) to be presented at the United Nations Office of Outer Space Affairs (UN-OOSA) Committee on the Peaceful Uses of Outer Space (COPUOS) Science and Technology Sub-committee in April 2021. This was preceded by the SATCON1 workshop. The B7 President was co-chair for both workshops, and many B7 members including the vice-president, organizing committee and members of the Executive Committee Working Group on Dark and Quiet Sky Protection were also engaged in the workshop Science Organizing Committees and working groups (WG), which were also responsible for the research before each workshop. Strategically as well, B7 members involved in these workshops have had meetings on satellite constellations with EAS, RAS, CIE, SpaceX and COSPAR, as well as organized special sessions every year on light pollution and satellite constellations with the America Astronomical Society.

The progress on stopping encroachment of artificial sky glow and radio-frequency interference on major astronomical research facilities has been on an individual member

level, as with Richard Green (U.Arizona), John Barentine (IDA) and Connie Walker (NOIRLab), winning the battle for the Outdoor Lighting Code and the Sign Code in the Tucson, Arizona, USA area. Zouhair Benkhaldoun, David Galadí-Enriquez, Martin Aubé, Josefina F. Ling, Ramotholo Sefako, Diane Turnshek and Harvey Liszt, have also contributed on local and national efforts, as is described later in this report.

We have also made world-encompassing educational/outreach events for the public through the IAU100 Dark Skies for All Global Project in 2019. Many of our B7 members have led local, national and international events and programs, like Globe at Night, the successful, longest-running citizen science campaign measuring light pollution worldwide. C.B7 Working group chairs and members contributed to IAUS367 with a 2-hour event dedicated to light pollution issues, highlighting the efforts of our commission. This, as well as two art-focused events, IAU's First e-Light Pollution Exhibition and a worldwide children's art campaign themed "Together Under One Sky", will be discussed later in this report.

2. Site Protection Working Group

2.1. *Highlights of the Working Group's effort in the past three years*

During the past triennium, the main task of the Working Group on Site Protection was to serve as the vehicle for Commission C.B7 and the Executive Committee Working Group for Dark and Quiet Sky Protection to support the IAU commitment to the Dark and Quiet Skies Workshop. That workshop was co-sponsored by the IAU, the Instituto de Astrofísica de Canarias (IAC), and the United Nations Office of Outer Space Affairs (UN-OOSA). The purpose was to develop a set of policy recommendations for consideration and approval by the UN Committee on the Peaceful Uses of Outer Space (COPUOS), first through its Scientific and Technical Committee, then by the full UN General Assembly. The opportunity was originated by former IAU General Secretary, Piero Benvenuti, in collaboration with Simonetta Di Pippo, Director of UNOOSA.

The Workshop Scientific Organizing Committee (SOC) was chaired by the Commission President / EC WG Chair, Constance Walker, with support from Simonetta Di Pippo. The original intention was to hold the workshop in person in Santa Cruz de La Palma, Spain, in early October, 2020, but because of travel and other restrictions from COVID-19, the conference was held virtually, with some 900 global registrants. A follow-up workshop is now being planned for October, 2021 in the same venue.

The outcome of the process was a technical document, Dark and Quiet Skies for Science and Society (<https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>), and a 'Conference Room Paper' (<https://www.iau.org/static/publications/uncopuos-stsc-crp-8jan2021.pdf>), the summarized recommendations formatted for consideration by UN COPUOS.

The process was managed by the SOC that coordinated the efforts of five Working Groups: Dark Sky Oases, Bio-Environment, Optical Astronomy, Satellite Constellations, and Radio Astronomy. The Working Groups met several times over the course of the spring and summer of 2020 in order to prepare draft reports for presentation and discussion at the Workshop in October. The input from the workshop participants was then taken into account in producing the versions of the technical document and conference room paper referenced above.

2.2. Commission and other IAU participation

The Working Group recommendations and documents represent a hard-won consensus, because membership included participants from lighting engineering and lighting manufacturing associations, as well as satellite constellation operators. Commission C.B7 members played very active roles in the research and development of the reports. (IAU officers and members of other commissions are listed in parentheses.)

SOC: Constance Walker (Chair), John Barentine, Zouhair Benkhaldoun, (Piero Benvenuti), Richard Green, (John Hearnshaw), Harvey Liszt, James Lowenthal, Casiana Muñoz Tuñón, (José Miguel Rodríguez Espinosa), Antonia M. Varela Perez.

Dark Sky Oases: (John Hearnshaw (Co-Chair)), Antonia M. Varela Perez (Co-Chair), John Barentine, Zouhair Benkhaldoun, Casiana Muñoz Tuñón, (José Miguel Rodríguez Espinosa), Constance Walker.

Optical Astronomy: Richard Green (Co-Chair), Casiana Muñoz Tuñón (Co-Chair), John Barentine, Zouhair Benkhaldoun, (Chris Benn), (John Hearnshaw), (Sergio Ortolani), (José Miguel Rodríguez Espinosa), Antonia M. Varela Perez, Constance Walker.

Bio-Environment: James Lowenthal (Co-Chair).

Satellite Constellations: (Lori Allen), (Michele Bannister), (Martin Barstow), (Cess Bassa), (Piero Benvenuti), (Roger Davies), (Daniel Devost), David Galadí-Enríquez, Richard Green, Olivier Hainaut, Harvey Liszt, James Lowenthal, (Sara Lucatello), (Robert Massey), (Jonathan McDowell), Angel Otarola, Meredith Rawls, (Rob Seaman), (Patrick Seitzer), (Rachel Street), Jeremy Tregloan-Reed, (Tony Tyson), (Eduardo Unda-Sanzana), Richard Wainscoat, Constance Walker, (Olga Zamora).

Radio Astronomy: Harvey Liszt (Chair), (Michael Lindqvist), (Masatoshi Ohishi), (Adrian Tiplady), (Tasso Tzioumis), (Bevin Ashley Zauderer).

2.3. Conclusion and future plans for the Working Group

Commission C.B7 and Workshop SOC members have been active along with the Presidents of IAU National Committees in engaging national COPUOS delegates to familiarize them with the contents of the Conference Room Paper and to encourage their endorsement. The late April, 2021, meeting of the COPUOS Scientific and Technical Committee will be the first to be held in virtual format, so the IAU presentation of the Dark and Quiet Sky protection recommendations is particularly challenging. The prospect of UN endorsement makes the substantial effort well worthwhile.

Richard F. Green
Chair of the Working Group
Saeko S. Hayashi
Co-Chair of the Working Group

3. Technical Working Group

3.1. Highlights of the Working Group's effort (2018-2019)

a. Major Objectives:

- i.. Provide technical specifications at engineering levels for standards for outdoor lighting that promote dark sky protection.

- ii. Inform the broader professional astronomy community about the technical issues of radio-frequency interference and mitigation efforts.
- iii. Provide data and access to modeling that maps artificial sky glow by region and over time and that could provide the basis for assessing impact of new installations.
- iv. Provide measurements and other data on the impact of enhanced airborne dust from mining, construction and other activities in proximity to major observatories, to provide the basis for voluntary and regulatory controls.

b. Aspects of Implementation:

- i. Close interaction with the Commission Internationale de L'Eclairage (CIE see, especially CIE divs. 4 and 5) and the Illumination Engineering Society of North America IESNA to set illumination standards that protect astronomical observations.
- ii. Encouragement of industry efforts to produce high-efficiency, narrow-band and low blue-green emitting LEDs.
- iii. Close interaction with IDA, on such issues as certified, quality lighting listed in directories such as the IDA's Fixture Seal of Approval program.
- iv. Establishing and reinforcing links with other scientific communities also affected by light pollution, especially from the fields of Biology and Human Health.

c. Progress on Objectives and Implementations:

Individuals within the Division B Commission C.B7 Technical Working Group have made progress on many of the group's objectives, even if the progress was not coordinated through the group's framework. The stated Major Objectives and Aspects of Implementation have provided a guide for the following work (and correlate with the item designations above):

a i.) In 2019, the Revision of the European Union Green Public Procurement Criteria for Road Lighting and Traffic Signalas was issued. David Galadí-Enríquez contributed and proposed a specific procedure to evaluate the amount of blue light emitted per lumen by road lighting, in the form of the spectral G index, included in the final EU green paper.

a ii.) In October 2019, Ramotholo Sefako presented at the New Zealand Starlight Conference: "Sutherland Central Astronomy Advantage Area (SCAAA) Protection Regulations: Preserving Dark Skies at SAAO".

David Galadí-Enriquez, Martin Aubé and Josefina F. Ling belong to the red española de estudios sobre la contaminación lumínica (REECL, Spanish network of studies on light pollution), which consists of thirteen groups doing research on light pollution in Spain. They develop research projects, scientific meetings and conferences for sharing results, outreach work and citizen science, and media relationships. <https://guaix.fis.ucm.es/reec/>.

Diane Turnshek ran a one-day conference (Dark Skies, CMU, June 1, 2019), which included a medical professional and all the varied aspects of light pollution mitigation.

a iii.) David Galadí-Enríquez took part in the Light Pollution Theory Modelling and Measurements (LPTMM) meeting 2019 in Hungary, presenting the light pollution map of Andalusia (Spain). He is an active member of the CB7 commission working group on the impact of mega-constellations of artificial satellites on ground-based observatories. He coordinates a specific working group on the impact of artificial satellites that has been setup in the Spanish Astronomical Society (SEA). His public outreach article was recently featured the aerospace magazine "Room."

Diane Turnshek is mapping the night skies of Pittsburgh, PA with drones and low-flying aircraft in advance of the city's move to LEDs. She is measuring skyglow over the

city with TESS-W photometers, SQM-Ls and the DarkSkyMeter app. Her astronomy students contribute to Globe at Night. The illuminance at ground level under a variety of current streetlights is being measured with a Sekonic C-7000 SpectroMaster Color Meter. This data will help city officials decide on the new LED streetlight revamp scheduled for 2021.

a iv.) Ramotholo Sefako helped set regulations protecting SAAO observing facilities in Sutherland against threats to astronomy research at the observatory, called “Regulations on Astronomy Protection Regarding certain activities within the Sutherland Central Astronomy Advantage Area” and “Declaration to Prohibit certain Mining Activities within the Sutherland Central Astronomy Advantage Area” in terms of the Astronomy Geographic Advantage Act, 2007 (Act Number 21 of 2007). These regulations delineate the acceptable levels of dust from mining.

b i.) Elizabeth Alvarez del Castillo has offered her background knowledge of past CIE or IESNA efforts to help the Technical Working Group move forward.

b ii.) David Galadí-Enríquez has continued his efforts to promote the adoption of a specific photometric parameter to evaluate the amount of blue light per lumen in the form of the G index.

Diane Turnshek has met with David Mitchell of Lumican Lighting and is testing his LEDs (2700K, 2500K, 2200K) and those of three other manufacturers in public streetlights, prior to a decision being made by the City of Pittsburgh for their new 40K LED streetlights.

b iii.) David Galadí-Enríquez was awarded the 2019 IDA Hoag-Robinson Award for being a pioneer in outdoor lighting reform and for outstanding work educating governmental organizations, businesses and the public about the merits of outdoor lighting control ordinances.

b iv.) David Galadí-Enríquez has been working through the Spanish Network of Studies about Light Pollution, REECL (Red Española de Estudios sobre Contaminación Lumínica).

Diane Turnshek founded local IDA groups in Pittsburgh and PA to find and bring together members of the medical field, professional and amateur astronomers, lighting professionals, health and safety workers, and naturalists.

Highlights of the Working Group’s efforts for 2020 may be provided in the Annual Report for this WG.

Diane Turnshek
Chair of the Working Group

4. Achieving Sustainable Development within a Quality Lighting Framework Working Group

4.1. Goal of the Working Group

The goal of the working group focuses on education, since bringing awareness to future citizens will help reorient them towards sustainable development, while empowering the world’s 60 million teachers to become key agents of change, and ultimately reach local – global authorities to affect change.

4.2. *Highlights of the Working Group's effort in the past three years*

There were three main events on which the Working Group focused, one per year during the triennium. The Working Group worked closely with the IAU Office for Astronomy Outreach (OAO) in all its activities, which also included working on the IAU100 Dark Skies for All initiative and Globe at Night international citizen science campaigns on light pollution (www.globeatnight.org). The three main activities are described below.

a. **IAU's First e-Light Pollution Exhibition and Talk:** *Aug, XXX IAU General Assembly (2018)*, <https://www.iau.org/public/oao/e-lp/>

The Inter-Division B-C Commission C.B7 Protection of Existing and Potential Observatory Sites, The Commission C.C1- Education and Development of the Astronomy, and The Office for Astronomy Outreach (OAO) organised the first e-light pollution exhibition, with 100 photos of observatories around the world, to show how light pollution affects everyone, as well as its impact on astronomical observations. The event was introduced by presentations by the co-chairs as a satellite event during the XXX IAU General Assembly 2018, at the Museum of Natural History in Vienna. The presentations focused on the effects of light pollution and solutions to control it.

b. **A world-wide children's art campaign with the central theme:** *"Together under one sky!" Science and Art Raise Awareness about the Light Pollution Problem (2019)*, <https://sites.google.com/site/ppetogetherunderonesky/>

The Children's Art Gallery of Greece (CAGG) in association with the Inter-Division B-C Commission C.B7 Protection of Existing and Potential Observatory Sites, The Commission C. Working Group C1- Education and Development of the Astronomy, and The Office for Astronomy Outreach (OAO), under the auspice of Division C, organized an international art competition, inspired by the 100th anniversary of the IAU, with the main purpose to sensitise the young generation on the importance of the night sky (nightscape), as the common view that connects us across the world, creating understanding and friendship, vanishing the political borders and the cultural differences. With more than 400 entries mainly from Greece, 70 artworks were selected carefully with art and science criteria.

c. **A workshop dedicated to light pollution issues:** *in the "Education and Heritage in the era of Big Data in Astronomy", IAU Symposium No. 367 (2020) under the title: "Turn on the Night!"*. <https://www.youtube.com/watch?v=vevSIjcF-og>

The "Turn on the Night" associated event at the IAU Symposium No. 367 (2020) on "Education and Heritage in the era of Big Data in Astronomy" had presentations on the latest dark skies protection issues considered by the IAU's Dark and Quiet Skies working groups. Presentations were also made on dark skies education programs and cultural/scientific heritage.

4.3. *Conclusion and future plans for the Working Group*

We intend to establish a strong professional network of pre- and in-service teachers, education policy-makers, and authors of educational materials with the goal of integrating the concept of quality lighting and light pollution into the national educational environmental curriculum in the context of the UN protocol on sustainability under resolution 42/187 and the IAU Resolution 2009B5 Right to Starlight.

Margarita Metaxa
Constance Walker
Co-Chairs of the Working Group

5. Conclusion and future plans for C.B7

The future holds much work in prioritizing and implementing recommendations from the Dark and Quiet Skies workshop. The Dark and Quiet Skies (D&QS) SOC (as well as that of SATCON1) is considering the best means of continuing this effort. One recommendation is to initiate a center to include the work of stakeholders worldwide. One goal is to get UN approval of some version of the D&QS recommendations which may take the course of the coming triennium.

The challenge of changing the mindset of people worldwide in favor of responsible, quality lighting (especially with LED lighting) requires more work on the part of all our working groups, as does the protection of observatory sites and the areas around them. Another goal would be to encourage and enable one or more regional lighting plans to protect observatories and/or critical habitat areas, which could provide exemplars for actual reduction in artificial light at night on a decade timescale.

An additional goal would be to activate real information exchange by serving as a catalyst for organizing groups worldwide to engage with local communities for sustainability. Commission C.B7 is fortunate to have the members who can bring us successfully down these paths.