Too Bright to Observe? Measuring and Combating Light Pollution to Preserve Dark Skies

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NARIT

HKU Light Pollution Photography Competitoin 2014, First runner up “Hong Kong under the Castle Peak” (Credit: Leung Hoi Kit)

Outline

- What is light pollution?
- Adverse effects of light pollution
  - Light pollution and LED
- Ways to reduce light pollution
- A cultural, behavioural and regulation campaign

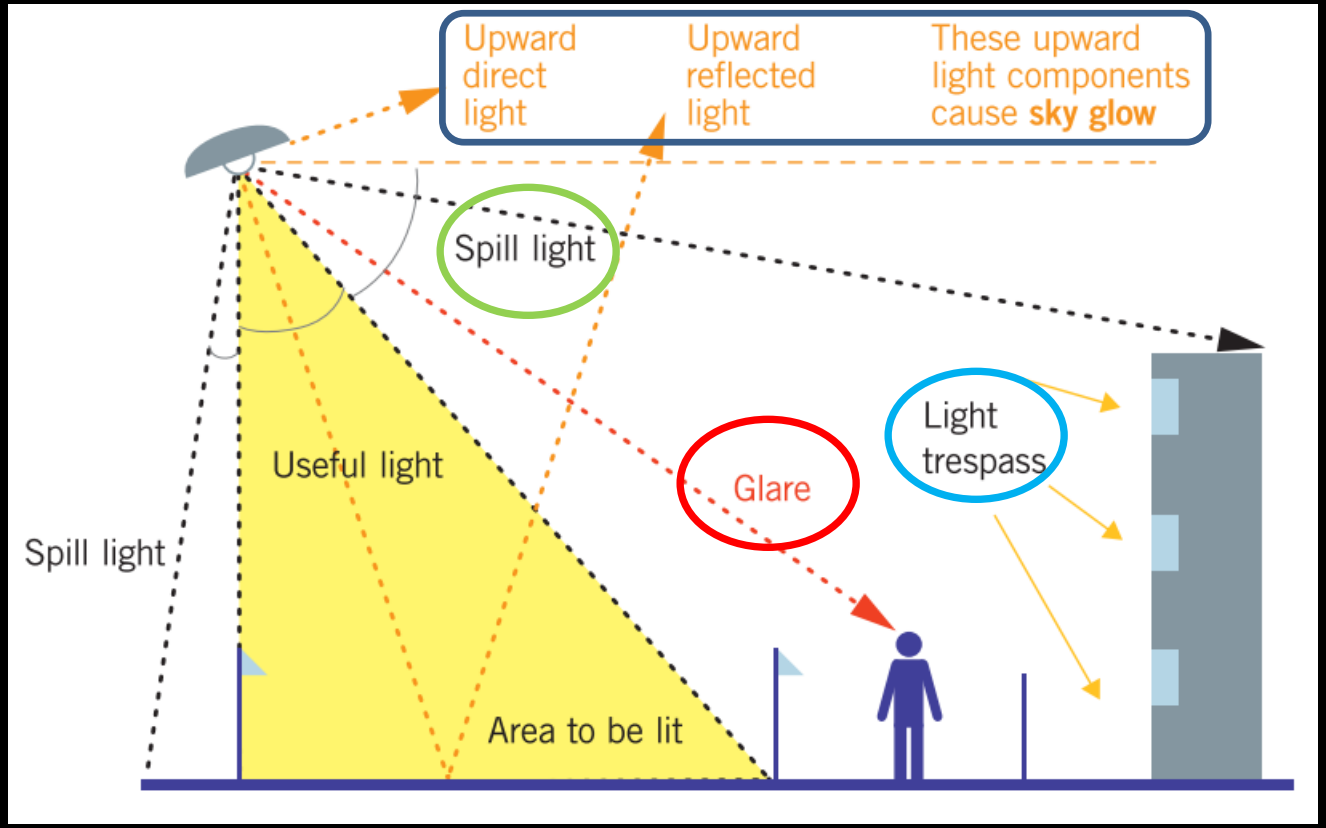
What is light pollution?

"Light Pollution" is inappropriate use of artificial lighting without consideration of its environment, leading to environmental degradation.

Light pollution is excessive light shining unnecessarily to unintended places.

More importantly, light pollution is a problem that can easily fixed without much extra cost.

Sources of light pollution



Credit: Document for Engaging Stakeholders and the Public (Task Force on External Lighting, Environment Bureau)

Light Trespass

Light trespass is the light entering people's home through windows.

Credit: Yu-Chen Chao, Feng Chia University

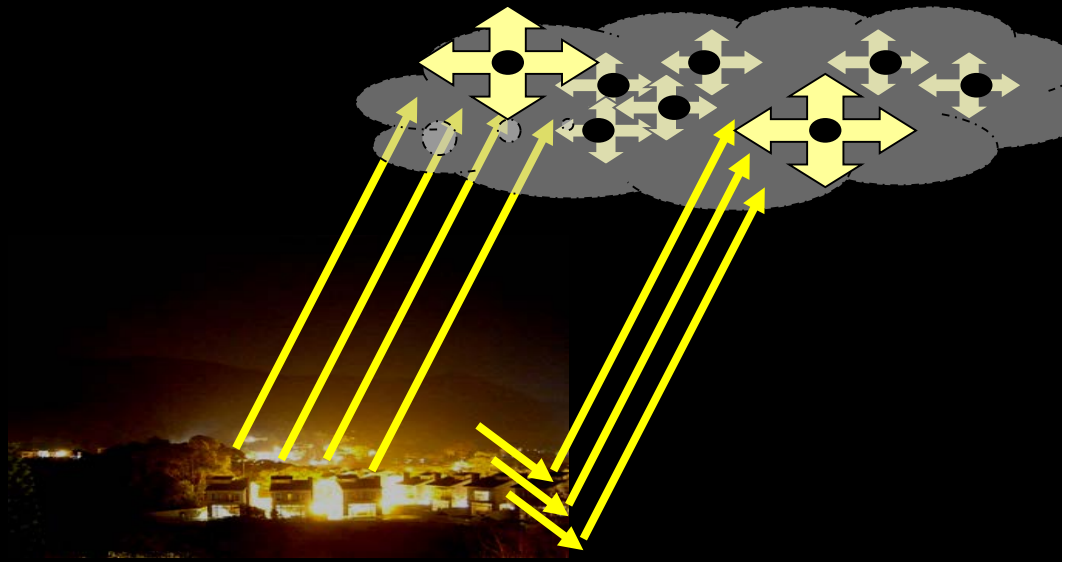
Glare

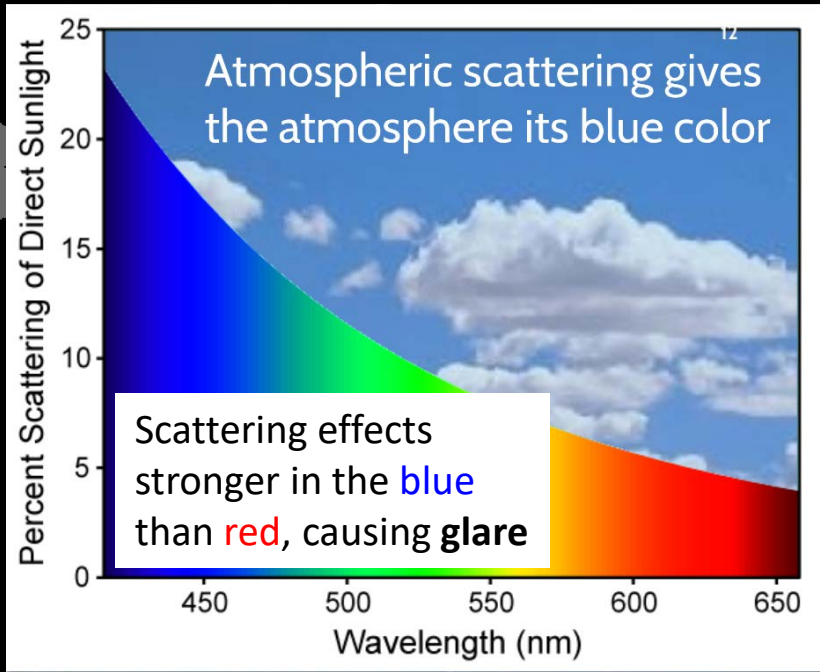
Glare is caused by the direct glimpse of bright light causing annoyance, distraction or discomfort.

Credit: Yu-Chen Chao, Feng Chia University

Skyglow

- Light either emitted directly upwards to the sky or reflected upwards (by the ground or by artificial sources) can be scattered by aerosol (cloud, fog), or pollutants like suspended particulates in the atmosphere.

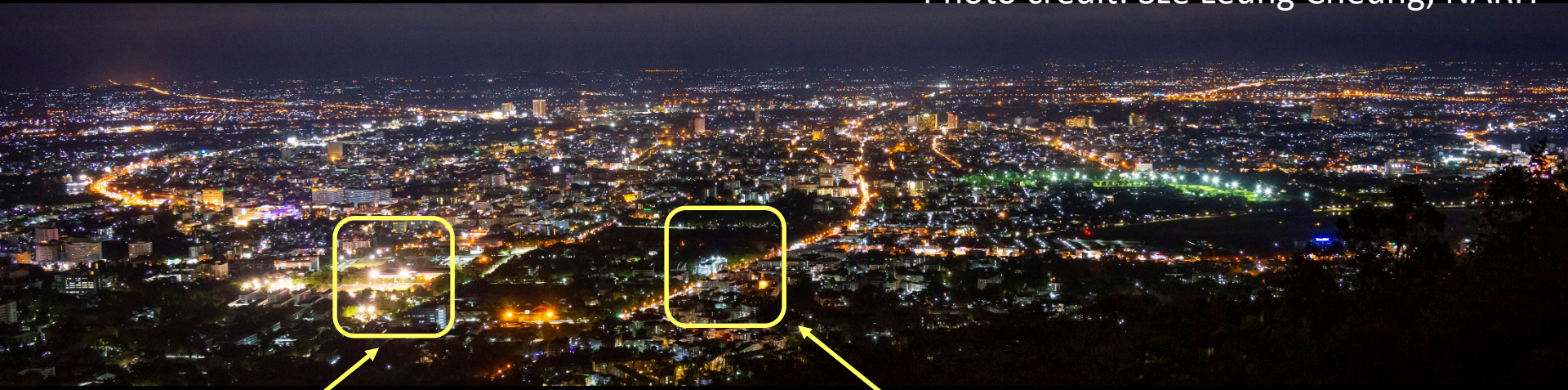




Chiang Mai

(Photographed from the outlook up the hill from Wat Sri So da on June 19, 2019; 8:15pm)

Photo credit: Sze Leung Cheung, NARIT

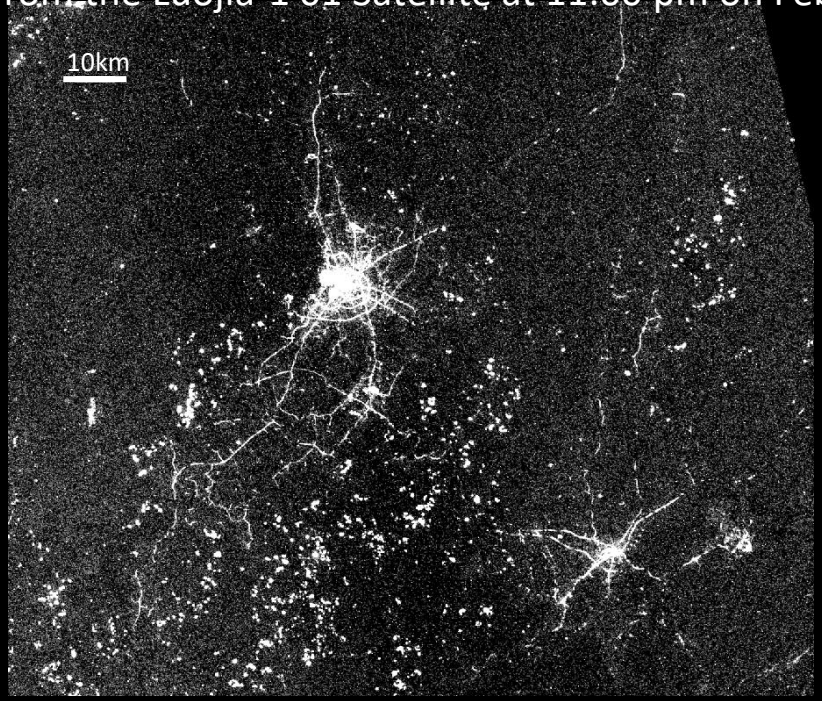


Chiang Mai University football stadium
(light turned off at 10am ?)

Chiang Mai University parking lot

Chiang Mai

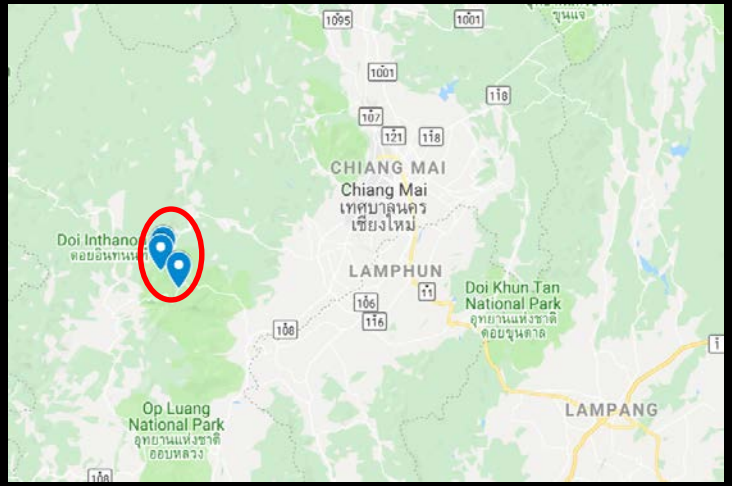
(Photographed from the Luojia-1 01 Satellite at 11:00 pm on February 17, 2019)



http://59.175.109.173:8888/app/single1.html?id=11817

Chiang Mai

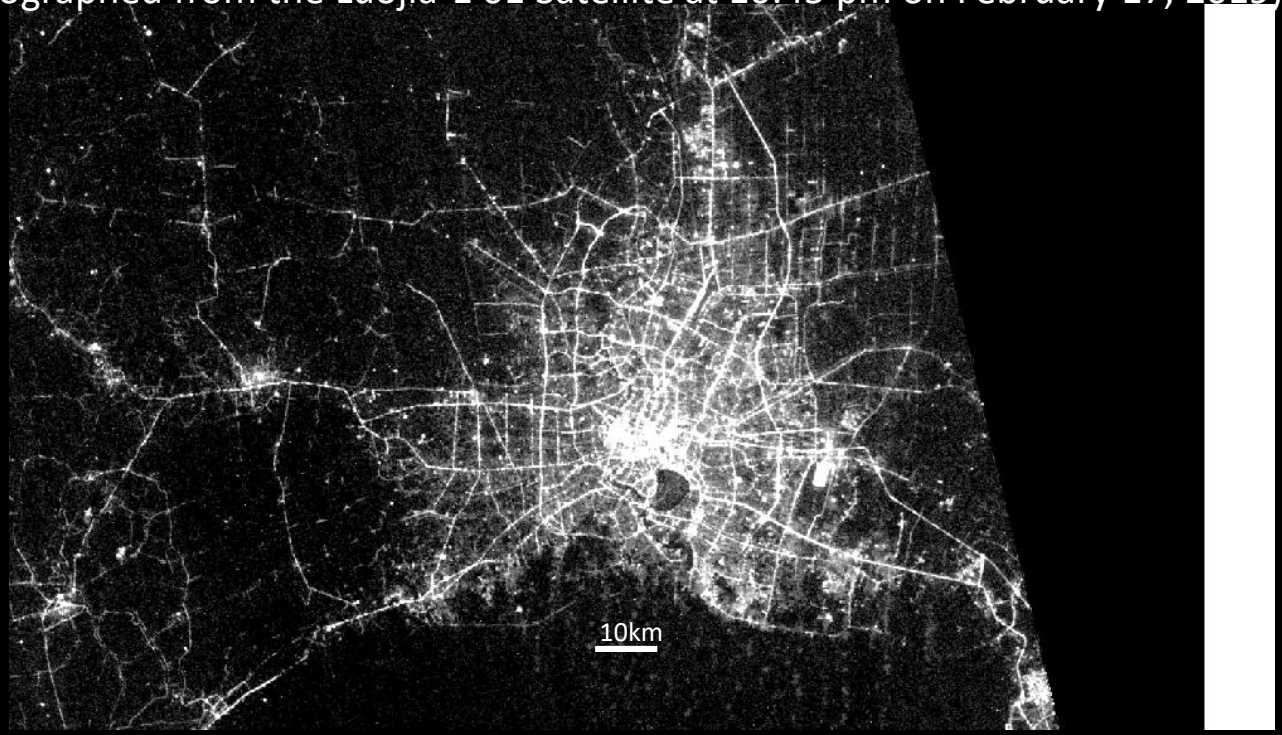
(Photographed from the Luojia-1 01 Satellite at 11:00 pm on February 17, 2019)



Top: Near Earth Observatory (NEO)
Middle: Thai National Observatory (TNO)
Lower: Information Service and Training Center (ISTC)

Bangkok

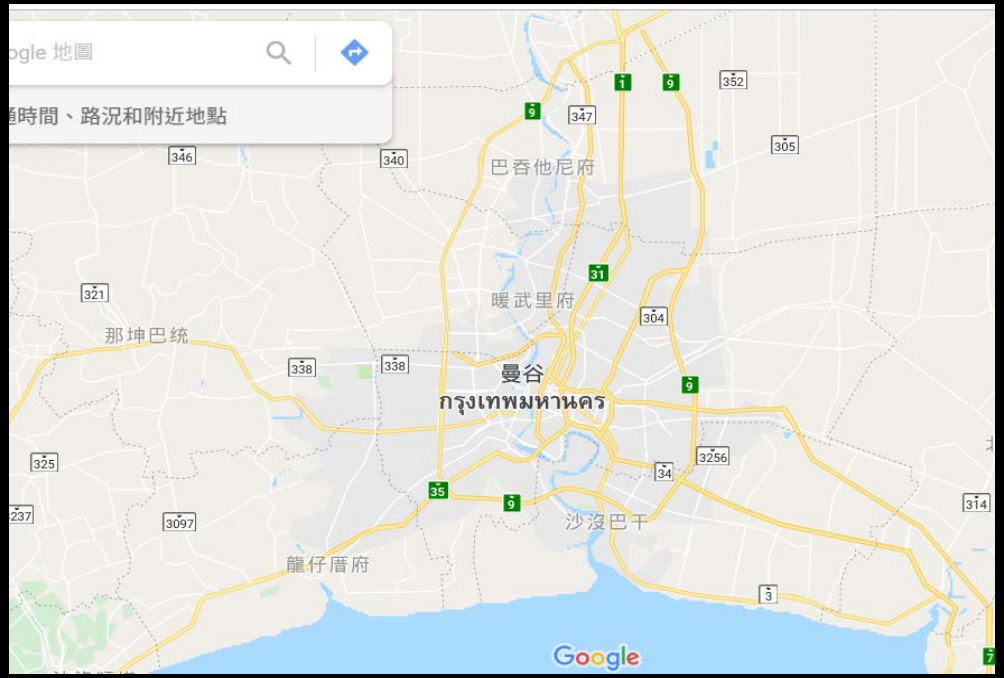
(Photographed from the Luojia-1 01 Satellite at 10:45 pm on February 17, 2019)



http://59.175.109.173:8888/app/single1.html?id=11803

Bangkok

(Photographed from the Luojia-1 01 Satellite at 10:45 pm on February 17, 2019)



Pearl River Delta (Hong Kong, Macau and Guangzhou), 2018.02.28, 4:35 am local time

Light pollution is a global issue

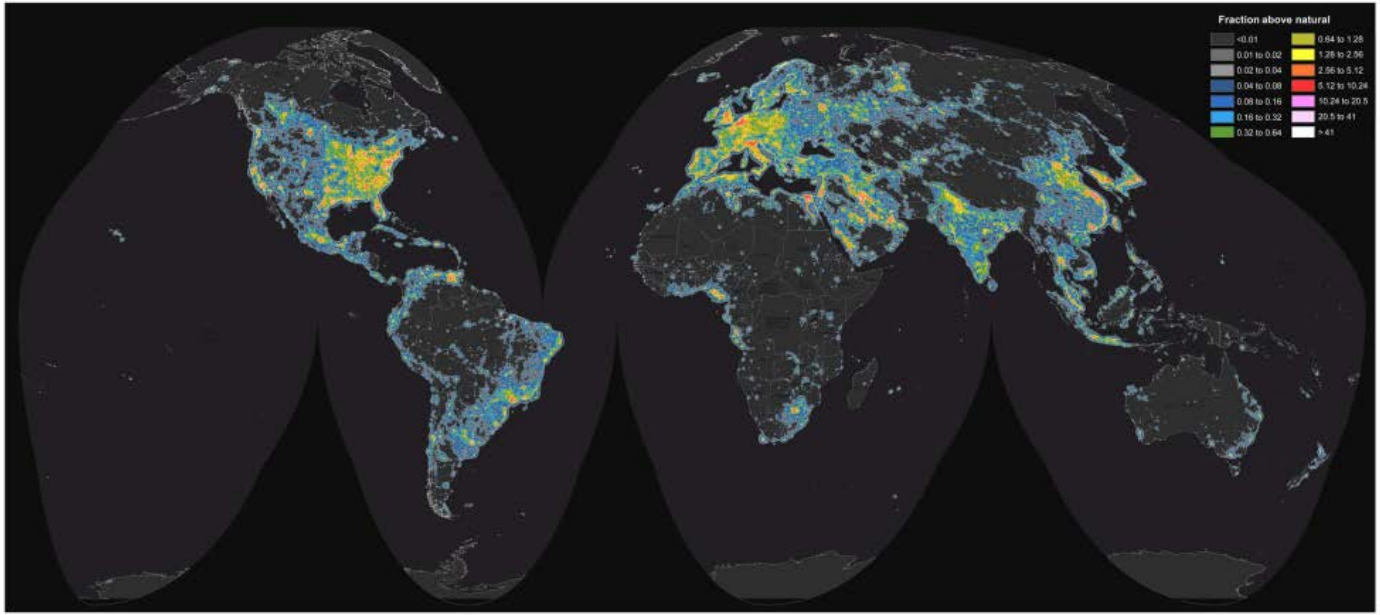


Fig. 2. World map of artificial sky brightness. The map shows, in twofold increasing steps, the artificial sky brightness as a ratio to the natural sky brightness (assumed to be 174 μcd/m^2). Table 1 indicates the meaning of each color level.

Over 80% of the world, and >99% of U.S. and European populations, live under light-polluted skies

Ref: F Falchi, et.al. (2016), The new world atlas of artificial night sky brightness, *Science Advances*, 2, e1600377

Adverse effects of light pollution

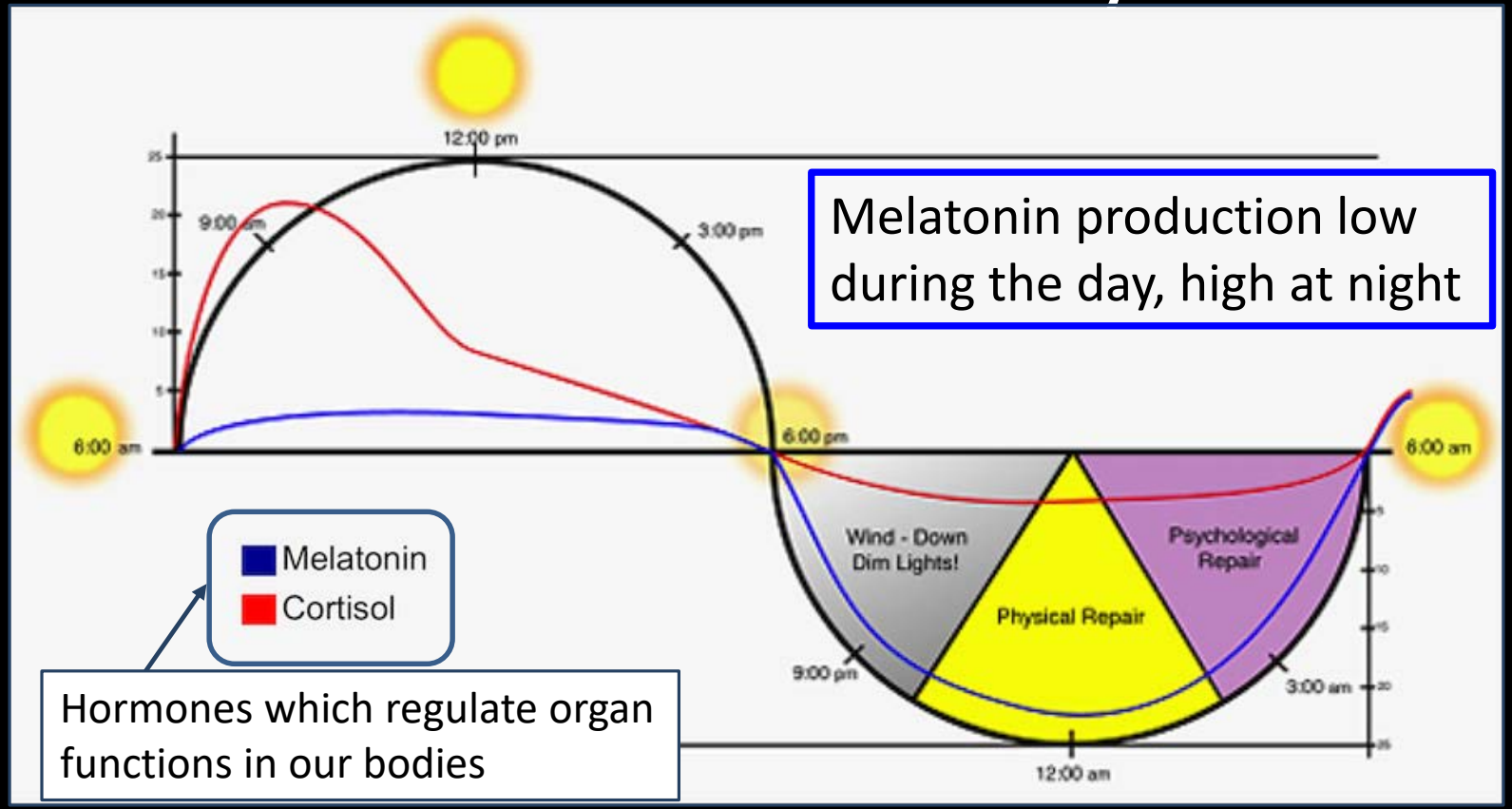
- Health:
- Environmental:
- Energy:
- Astronomical:




Adverse impact of light pollution: Health

- In the 2009 annual meeting of the American Medical Association (AMA), the entire 540 House of Delegates of the AMA voted unanimously in favor of the Resolution 516.
- **Support efforts to control light pollution**

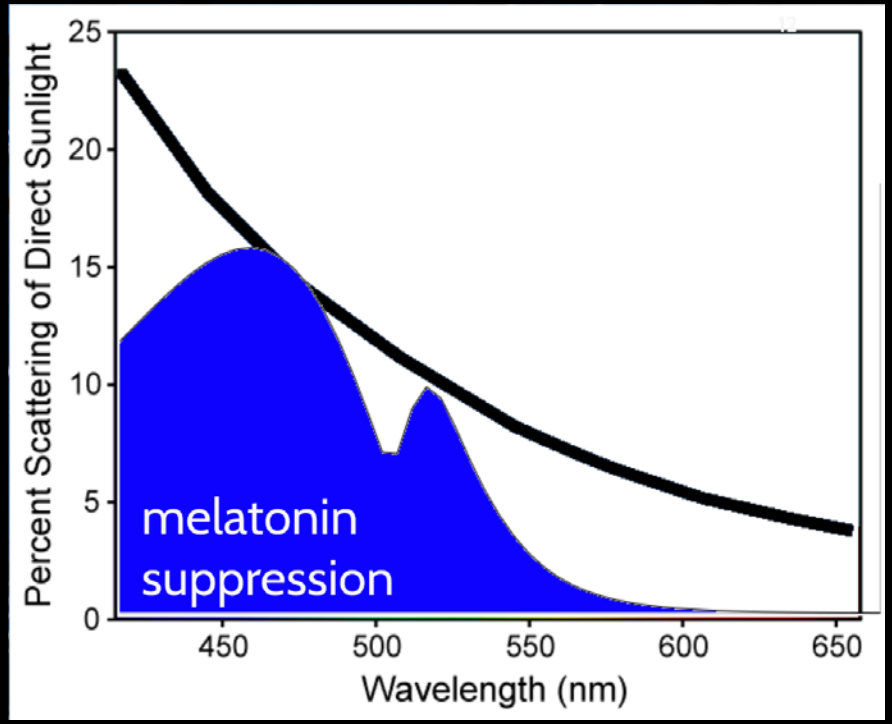
Human's Circadian Rhythm



Source: http://peterbristotte.weebly.com/blog/circadian-rhytm-the-hero-and-the-villain

Melatonin

- **Melatonin production interfered by exposure to light at night**
- **Blue** light more efficient in suppressing production (Melatonin Suppression Action Spectrum)



Adverse impact of light pollution: environmental

- Disrupt natural day-night cycle of **plants**
- Change habits (reproduction and migration) of **nocturnal species**
- **Reducing total biomass and population size**, changing relative composition of populations → **reduce biodiversity**

Adverse impact of light pollution: energy

- Over 30% of outdoor lighting points to the sky in the US
- US$ 1.5 billion of electricity and 6 million tons of coal wasted
- Generation of these wasted electricity involves burning of fossil fuel, generating green house gas, **further damaging the environment.**

Adverse impact of light pollution: astronomy


Before
Credit: Jeff Dai (TWAN)
Kaihua County, China
© Jeff Dai


After
Credit: Jeff Dai (TWAN)
Kaihua County, China
© Jeff Dai

Light pollution reduces contrast in the night sky

- Reduce the number of stars visible
- Reduce accuracy of astronomical measurements
- **Reduce interest of the night sky**

Light pollution reduces contrast in the night sky

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- **Reduce interest of the night sky**

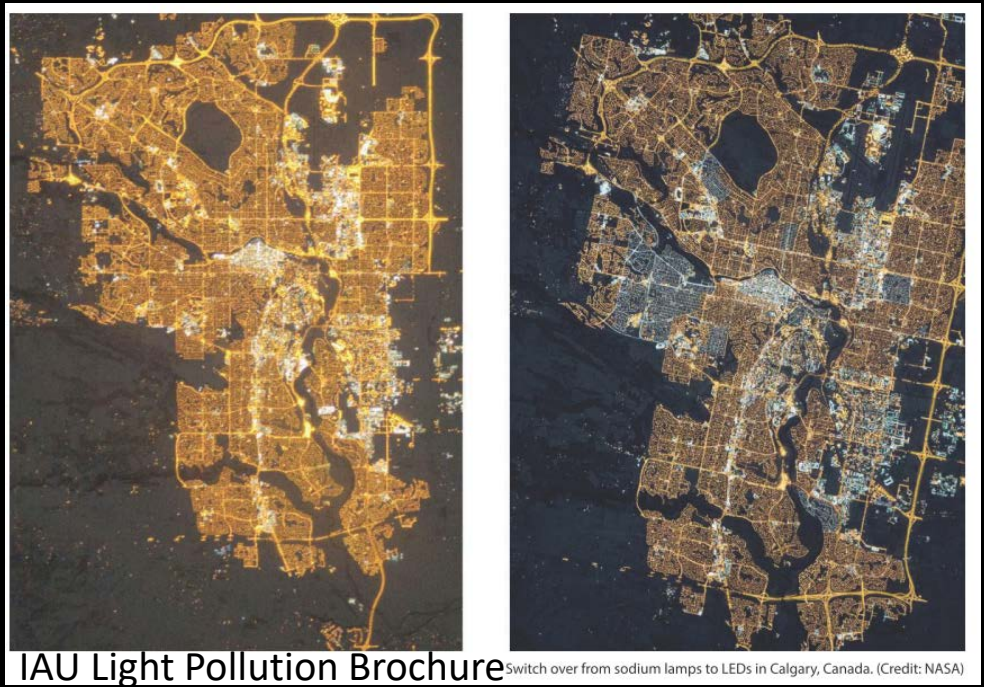
Adverse effects of light pollution

- Health: light trespass/nuisance affects sleep, mental health
- Environmental: nocturnal species, unbalance ecological systems
- Energy: light not targeted for your eyes → wasted energy
- Astronomical: skyglow from urban lighting
- Others: pedestrians, traffic, safety, agriculture, …




Light Pollution and LED

- A large-scale conversion of lighting to LED is taking place around the world



IAU Light Pollution Brochure Switch over from sodium lamps to LEDs in Calgary, Canada. (Credit: NASA)

Switch over from sodium lamps (2010, left) to LEDs in (2015, right) in Calgary, Canada. (Credit: NASA)

https://www.iau.org/public/images/detail/light-pollution-brochure/

Light Pollution and LED

- LED widely used in large scale outdoor lighting
- LED more energy efficient than traditional lighting
- Negative impacts：
  - **Rebound effect**: deployment of more and brighter lighting
  - **Scattering effect**: spectra of LED has larger fraction of high frequency (blue) light

Rebound Effect: from 2012 to 2016

- Area being lit by artificial lighting increases by 2.2% annually
- Total brightness increases by 1.8% annually

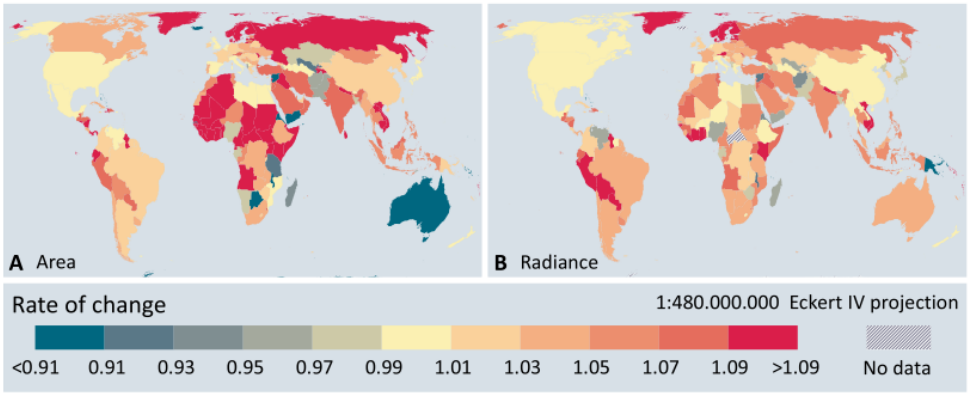


Fig. 1. Geographic patterns in changes in artificial lighting. Changes are shown as an annual rate for both lit area (**A**) and radiance of stably lit areas (**B**). Annual rates are calculated based on changes over the four year period, that is, $\sqrt[4]{A_{2016}/A_{2012}}$, where A_{2016} is the lit area observed in 2016. See fig. S28 for total radiance change instead of stable light radiance change.

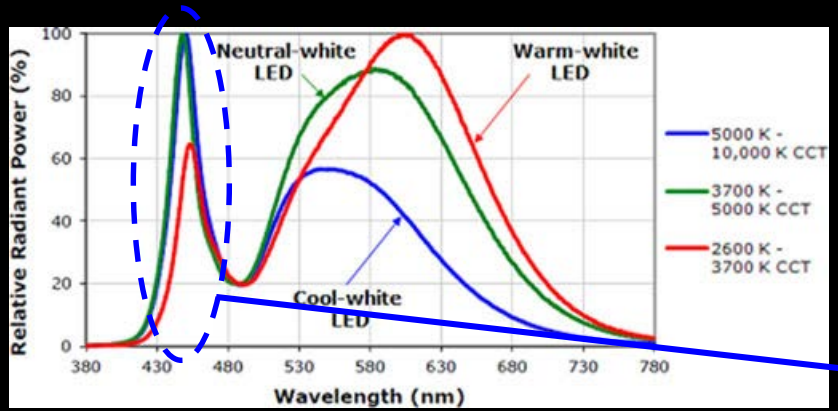
Ref: CCM Kyba, et.al. (2017), Artificially lit surface of Earth at night increasing in radiance and extent, *Science Advances*, 3, e1701528

Scattering Effect: LED color temperature

- Why the blue color of LED is a problem?

➢ Blue light is more easily scattered, spreading impact of light pollution wider

➢ Blue light affects our body clock more by suppressing Melatonin



Ref: Albert T. L. Lee, et. Al. (2016) , Precise Dimming and Color Control of LED Systems Based on Color Mixing, *IEEE Transactions on Power Electronics*, 31

Common LEDs have spectra with strong **blue** components.

Dark Sky friendly lighting:

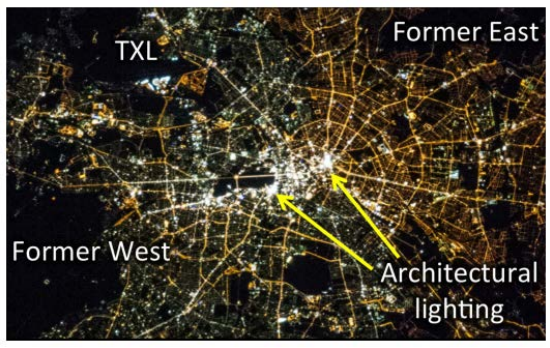
Phosphor-Converted (PC) Amber LED is less blue than white-light LED (4000K)

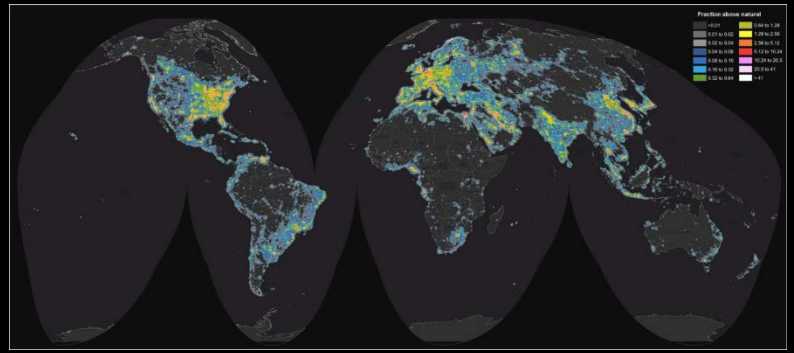
What can we do?

To measure the extent of light pollution over large area

1. Measuring Light Up (↑ or ↓↑)

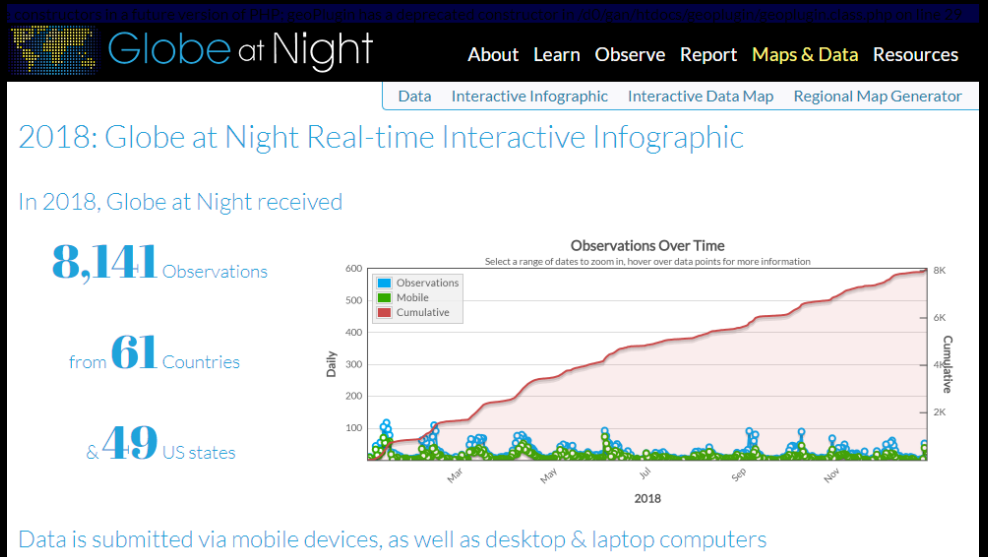
- **Remote sensing** (DMSP-OLS, VIIRS-DNB, ISS, EROS-B, Luojia-1, Jilin 1)
  - Upward light emitted directly from the light sources and light reflected off the Earth's surface.
  - Challenging calibration issues but can be overcome
  - Large spatial coverage (city → regional → global)
  - Low temporal sampling (one overpass per day, e.g., VIIRS: 01:30)





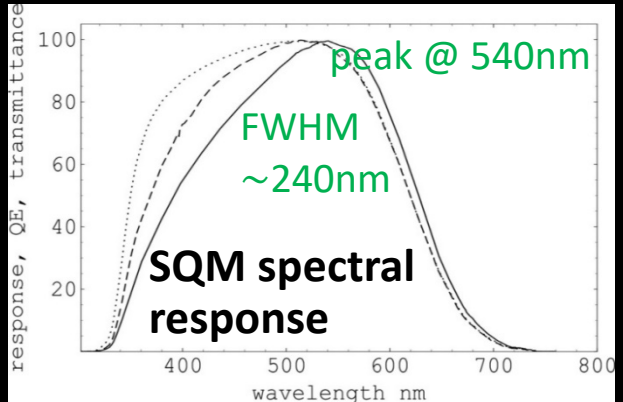
2. Measuring skyglow ↑↓

- **Limiting magnitude** (e.g. *Globe at Night*, since 2006)
  - **Citizen science project** to report conditions of the night sky
  - Large geographical (115 countries) & time coverages with low cost
  - Uncertain quality of data received

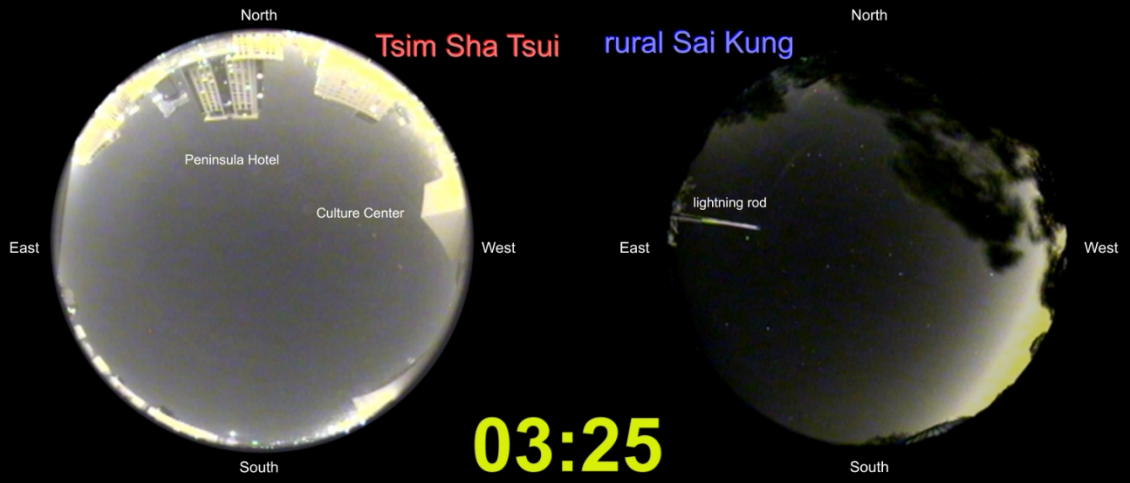


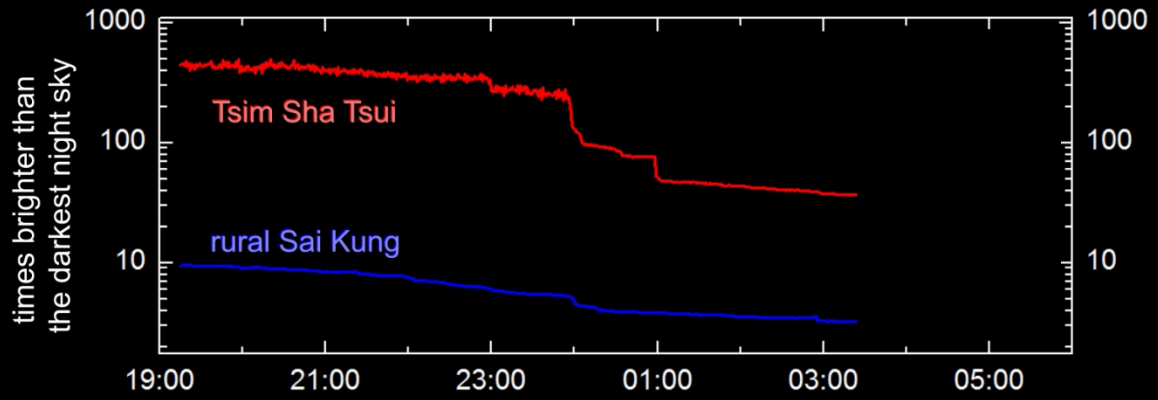
2. Measuring skyglow ↑↓

- **Measuring Night Sky Brightness (NSB)**
  - Dedicated measuring devices: e.g., *Telescope Encoder and Sky Sensor (**TESS-W**)*, and *Sky Quality Meter (**SQM**)*
  - Can get accurate readings AND good time coverage
  - Reasonable cost (USD 300) and accurate ($\pm$ 0.1 mag arcsec^{-2})
  - **Time coverage provides a direct linkage with light usage pattern**



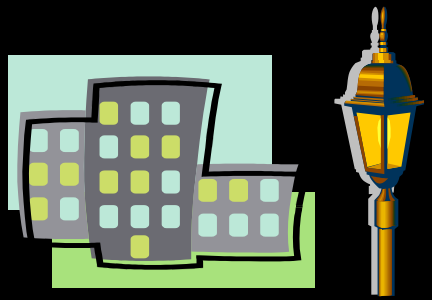
Variations of night sky brightness during 16-17 January 2013





https://www.youtube.com/watch?v=mc7ipCExGsc

Measuring light pollution



Light meter

- Measure direct impact due to light pollution on your vision
- Unit：**Lux** (measure illuminance)
  - Bigger numbers means brighter
- Demo： http://goo.gl/LtRF84

Sky Quality Meter

- Measure indirect impact due to light pollution on the night sky
- Unit: **magnitude per square arcsec** (Night Sky Brightness, **NSB**)
  - Bigger numbers means dimmer
- Demo：http://goo.gl/LtRF84

The Globe at Night - Sky Brightness Monitoring Network (GaN-MN)

- One of the major Cosmic Light program during **IYL 2015**
- One of the **IAU100** Dark Sky for All program
- Co-organizers:
  - Office of Astronomy Outreach, International Astronomy Union (IAU)
  - National Astronomical Observatory of Japan
  - The University of Hong Kong
  - The Globe at Night project

The Globe at Night - Sky Brightness Monitoring Network (GaN-MN)

- **Standardized** method to measure zenith night sky brightness (both for astronomical and non-astronomical sites to get **full impact of light pollution**)
- Highlight **environmental impacts** of abusive artificial lighting for the general public and **policy makers (full sharing of data)**
- Sustain light pollution **public education** and promote **public engagement (full collaboration between partners)**

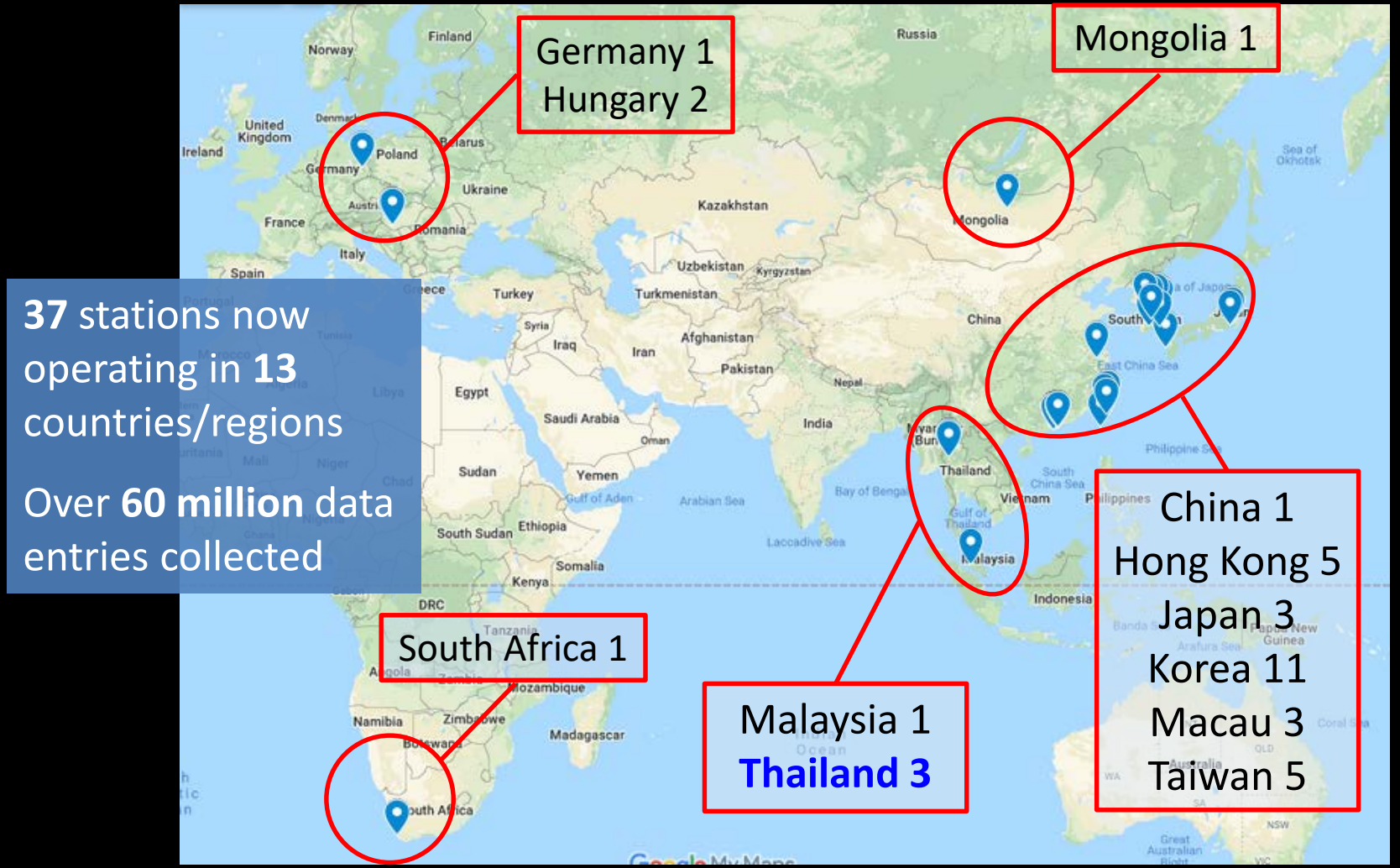
OFFICE FOR ASTRONOMY OUTREACH IAU

国立天文台 NAOJ National Astronomical Observatory of Japan

SAPIENTIA·ET·VIRTUS

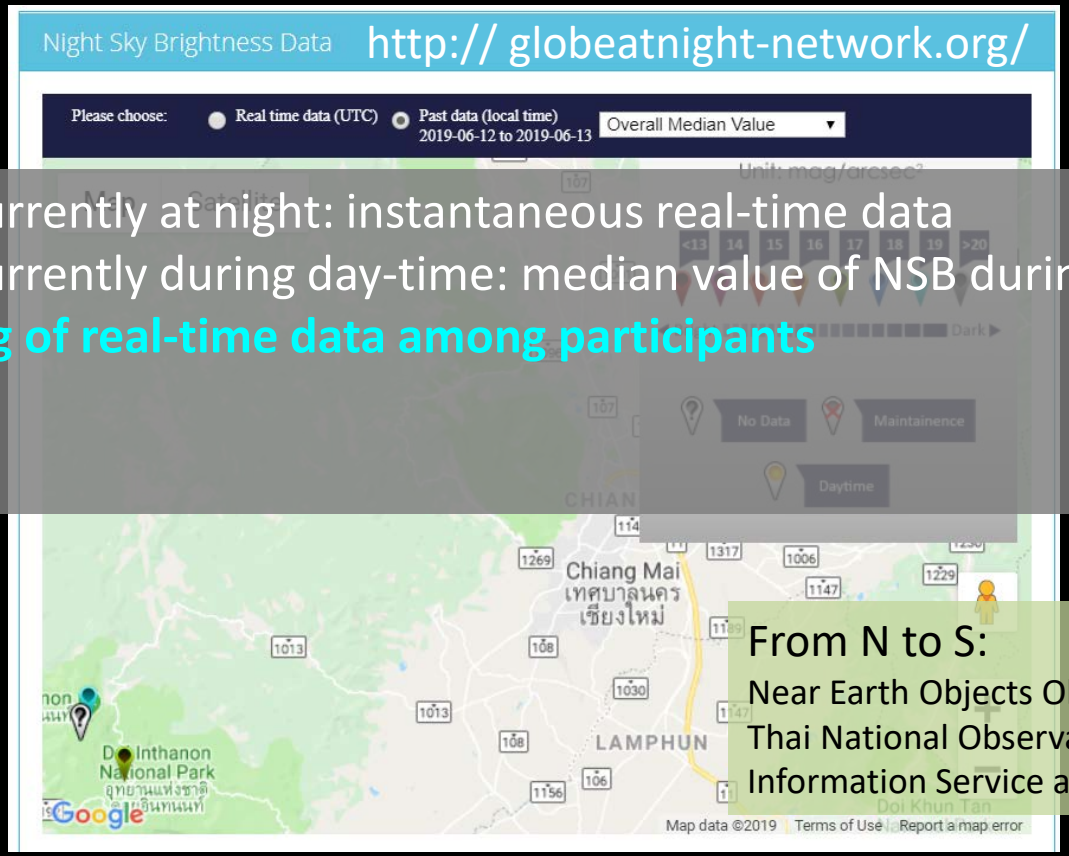
GLOBE AT NIGHT

IAU 100 YEARS: UNDER ONE SKY


Germany 1
Hungary 2
Mongolia 1
China 1
Hong Kong 5
Japan 3
Korea 11
Macau 3
Taiwan 5
Malaysia 1
Thailand 3
South Africa 1
37 stations now operating in 13 countries/regions
Over 60 million data entries collected

Data sharing:

1. Live NSB reporting (embedded in Google map)



- Location currently at night: instantaneous real-time data
- Location currently during day-time: median value of NSB during previous night
- **Full sharing of real-time data among participants**

From N to S:

Near Earth Objects Observatory (**NEO**)

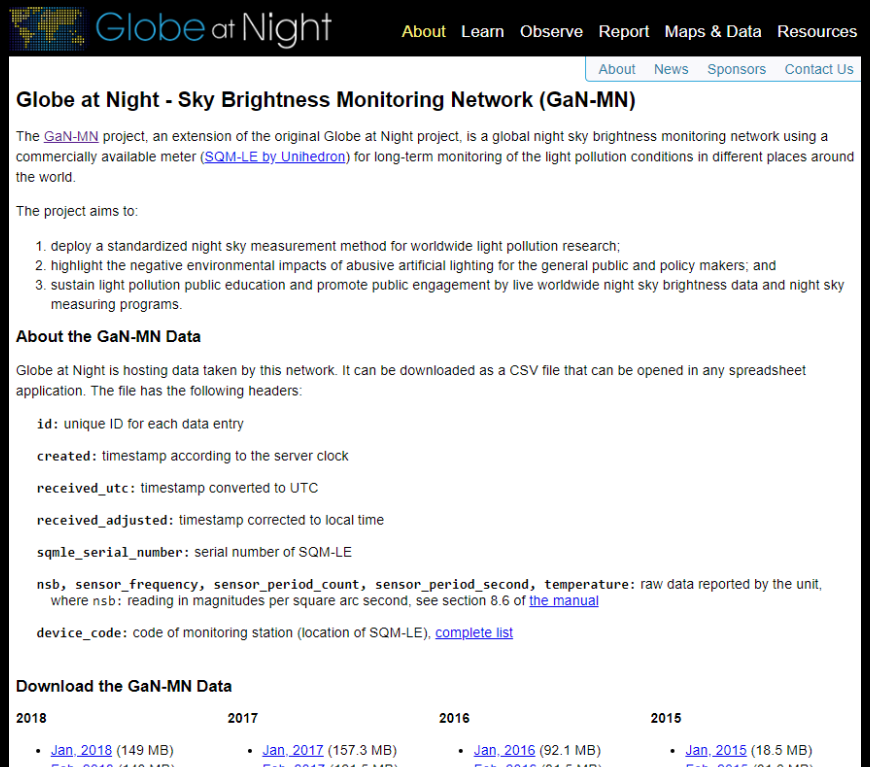
Thai National Observatory (**TNO**)

Information Service and Training Center (**ISTC**)

Data sharing:

2. Archival database (accessed through *Globe at Night* page)

https://www.globeatnight.org/gan-mn.php



Globe at Night

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Globe at Night - Sky Brightness Monitoring Network (GaN-MN)

The GaN-MN project, an extension of the original Globe at Night project, is a global night sky brightness monitoring network using a commercially available meter (SQM-LE by Unihedron) for long-term monitoring of the light pollution conditions in different places around the world.

The project aims to:

1. deploy a standardized night sky measurement method for worldwide light pollution research;
2. highlight the negative environmental impacts of abusive artificial lighting for the general public and policy makers; and
3. sustain light pollution public education and promote public engagement by live worldwide night sky brightness data and night sky measuring programs.

About the GaN-MN Data

Globe at Night is hosting data taken by this network. It can be downloaded as a CSV file that can be opened in any spreadsheet application. The file has the following headers:

id: unique ID for each data entry

created: timestamp according to the server clock

received_utc: timestamp converted to UTC

received_adjusted: timestamp corrected to local time

sqmle_serial_number: serial number of SQM-LE

nsb, sensor_frequency, sensor_period_count, sensor_period_second, temperature: raw data reported by the unit, where nsb: reading in magnitudes per square arc second, see section 8.6 of the manual

device_code: code of monitoring station (location of SQM-LE), complete list

Download the GaN-MN Data

2018

- Jan, 2018 (149 MB)

2017

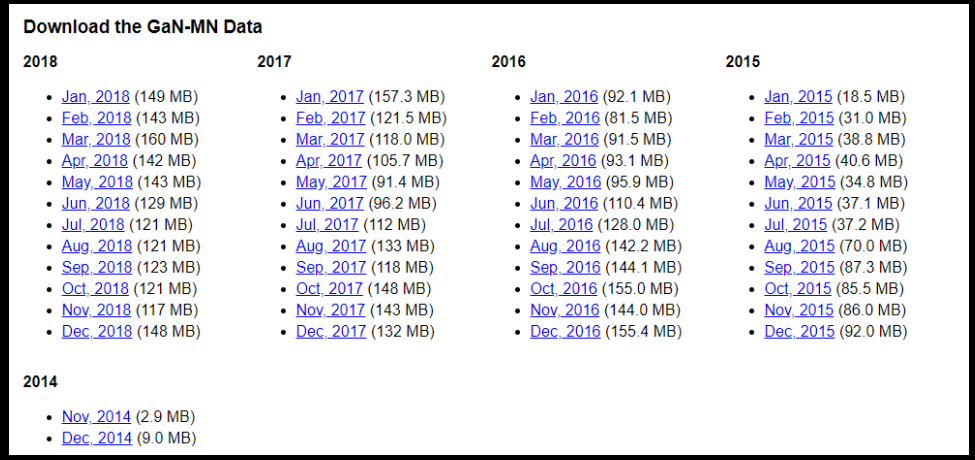
- Jan, 2017 (157.3 MB)

2016

- Jan, 2016 (92.1 MB)

2015

- Jan, 2015 (18.5 MB)



Download the GaN-MN Data

2018

- Jan, 2018 (149 MB)
- Feb, 2018 (143 MB)
- Mar, 2018 (160 MB)
- Apr, 2018 (142 MB)
- May, 2018 (143 MB)
- Jun, 2018 (129 MB)
- Jul, 2018 (121 MB)
- Aug, 2018 (121 MB)
- Sep, 2018 (123 MB)
- Oct, 2018 (121 MB)
- Nov, 2018 (117 MB)
- Dec, 2018 (148 MB)

2017

- Jan, 2017 (157.3 MB)
- Feb, 2017 (121.5 MB)
- Mar, 2017 (118.0 MB)
- Apr, 2017 (105.7 MB)
- May, 2017 (91.4 MB)
- Jun, 2017 (96.2 MB)
- Jul, 2017 (112 MB)
- Aug, 2017 (133 MB)
- Sep, 2017 (118 MB)
- Oct, 2017 (148 MB)
- Nov, 2017 (143 MB)
- Dec, 2017 (132 MB)

2016

- Jan, 2016 (92.1 MB)
- Feb, 2016 (81.5 MB)
- Mar, 2016 (91.5 MB)
- Apr, 2016 (93.1 MB)
- May, 2016 (95.9 MB)
- Jun, 2016 (110.4 MB)
- Jul, 2016 (128.0 MB)
- Aug, 2016 (142.2 MB)
- Sep, 2016 (144.1 MB)
- Oct, 2016 (155.0 MB)
- Nov, 2016 (144.0 MB)
- Dec, 2016 (155.4 MB)

2015

- Jan, 2015 (18.5 MB)
- Feb, 2015 (31.0 MB)
- Mar, 2015 (38.8 MB)
- Apr, 2015 (40.6 MB)
- May, 2015 (34.8 MB)
- Jun, 2015 (37.1 MB)
- Jul, 2015 (37.2 MB)
- Aug, 2015 (70.0 MB)
- Sep, 2015 (87.3 MB)
- Oct, 2015 (85.5 MB)
- Nov, 2015 (86.0 MB)
- Dec, 2015 (92.0 MB)

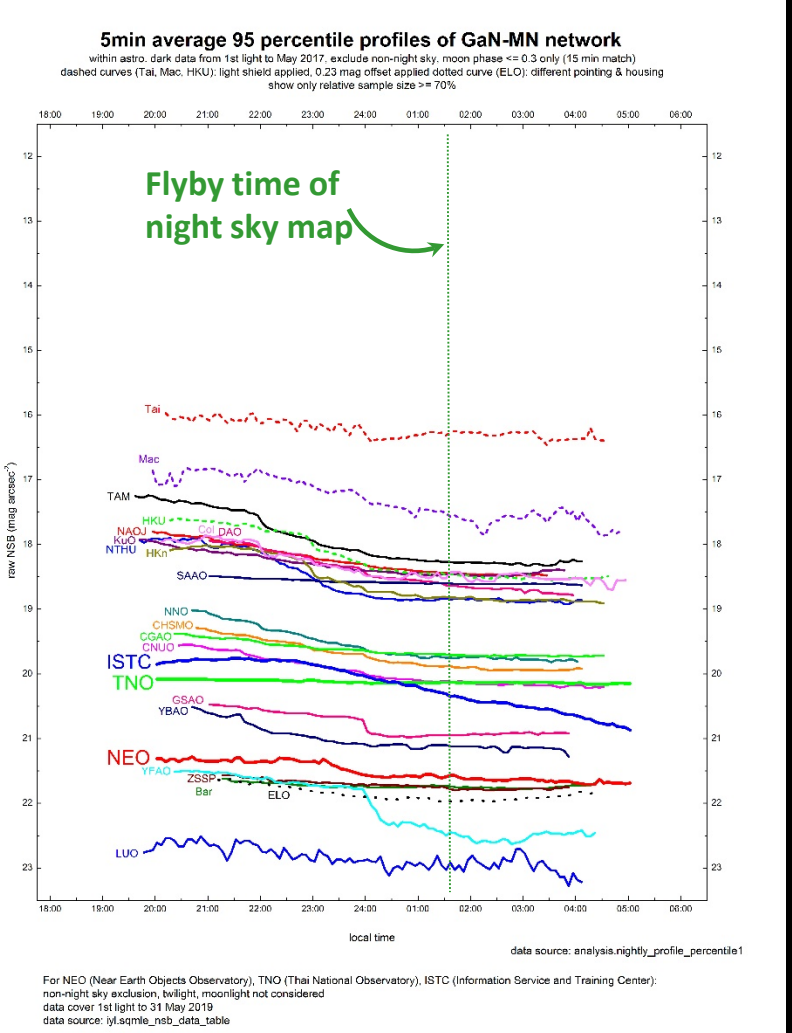
2014

- Nov, 2014 (2.9 MB)
- Dec, 2014 (9.0 MB)

- New archival data uploaded once per month
- **Welcome to download to conduct analyses!**
- Limited data quality check. Contact us for details

Average nightly variation of NSB for each station

- Huge range of NSB among stations
- Different latitudes of stations lead to different sampling time (astro dark durations)
- **Each curve is unique: Depicts the outdoor lighting usage at that particular location**



For NEO (Near Earth Objects Observatory), TNO (Thai National Observatory), ISTC (Information Service and Training Center):
non-night sky exclusion, twilight, moonlight not considered
data cover 1st light to 31 May 2019
data source: iyl.sqmle_nsb_data_table

What can we do?

Optimizing the way we use lighting

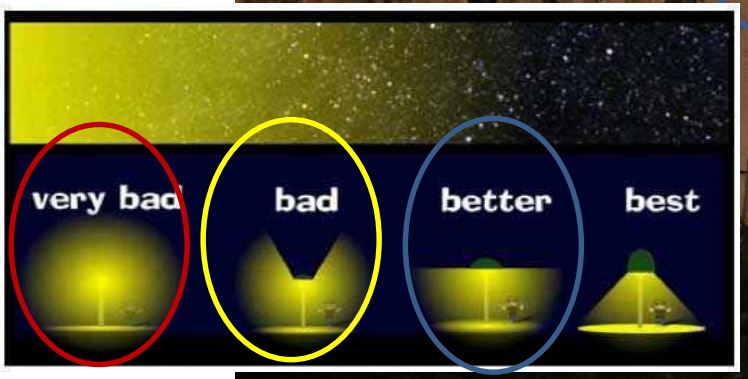
Ways to reduce light pollution

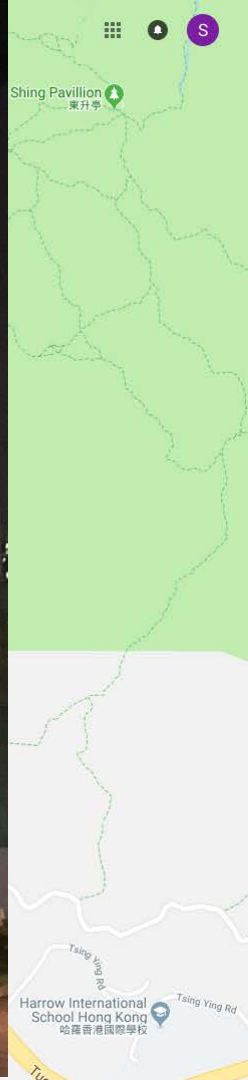
- Modify existing lighting (**shielding**, bulb, angle, etc)
- Reduce abuse of outdoor lighting (time of use, light intensity, location, flashing pattern)
- Design lightings to become more dark-sky friendly (e.g., PC Amber LED)

full cut-off lamp

name
full cut-off lamp

description
photographed on 30/5/2018

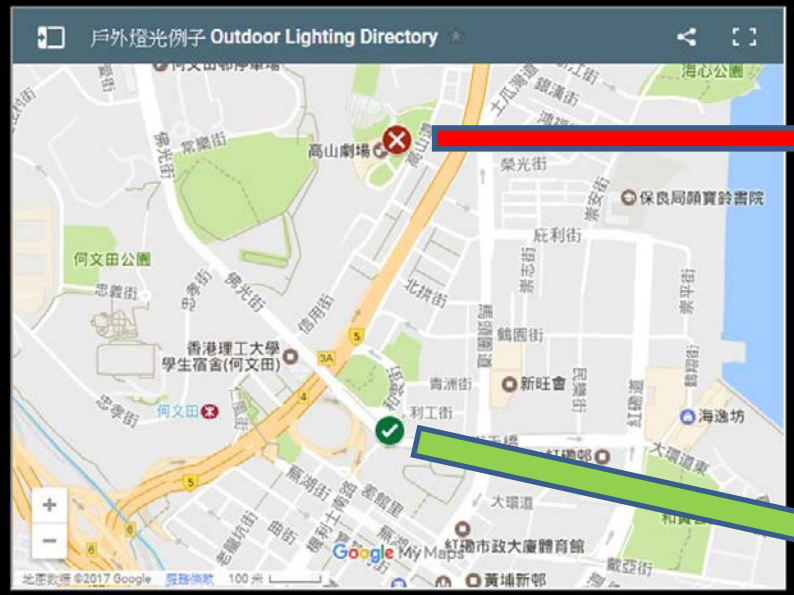


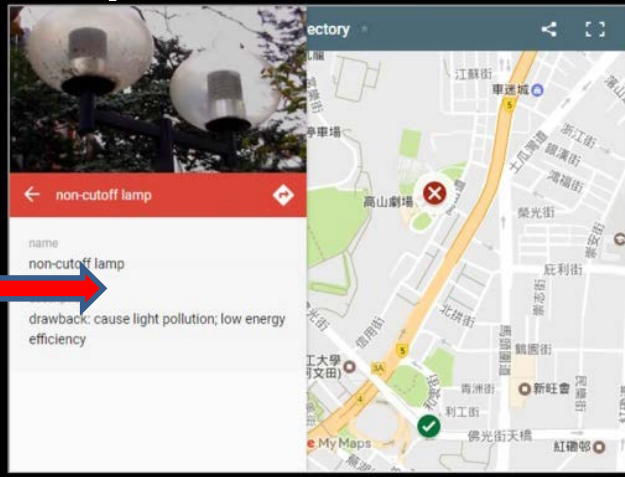


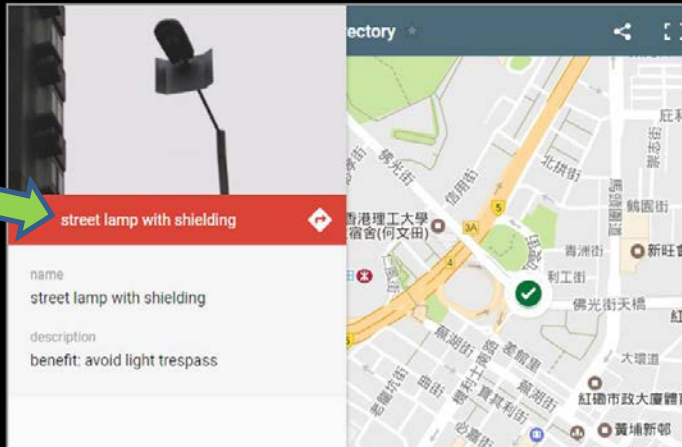
Examples of dark-sky friendly lighting

Credit: Yu-Chen Chao, Feng Chia University

Outdoor Lighting Directory

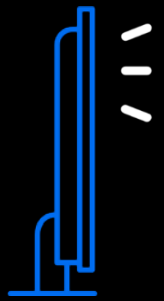






http://nightsky.physics.hku.hk/STEM/lightdir/

Reporting outdoor lighting which reduces or causes light pollution

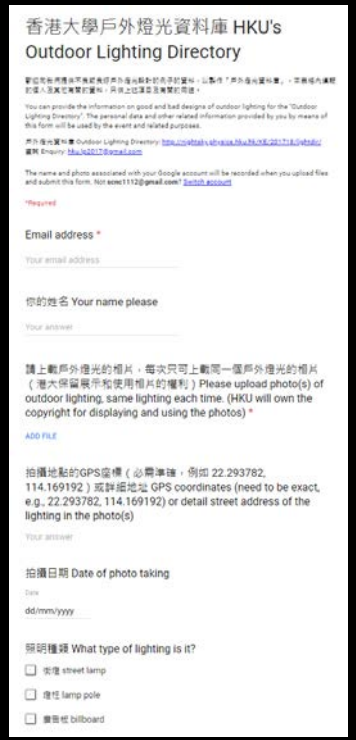


1.
Identify lighting which reduces or causes light pollution

2.
Take a photograph

3.
Record position / time/ lighting-type

4. Submit through the Outdoor Lighting Directory


香港大學戶外燈光資料庫 HKU's Outdoor Lighting Directory

You can provide the information on good and bad designs of outdoor lighting for the "Outdoor Lighting Directory". The personal data and other related information provided by you by means of this form will be used by the event and related purposes.

The name and photo associated with your Google account will be recorded when you upload files and submit this form. Not scnc1112@gmail.com? Switch account

*Required

Email address *

Your email address

你的姓名 Your name please

Your answer

請上載戶外燈光的相片，每次只可上載同一個戶外燈光的相片（港大保留展示和使用相片的權利）Please upload photo(s) of outdoor lighting, same lighting each time. (HKU will own the copyright for displaying and using the photos) *

ADD FILE

拍攝地點的GPS座標（必需準確，例如 22.293782, 114.169192）或詳細地址 GPS coordinates (need to be exact, e.g., 22.293782, 114.169192) or detail street address of the lighting in the photo(s)

Your answer

拍攝日期 Date of photo taking

Date

dd/mm/yyyy

照明種類 What type of lighting is it?

- 街燈 street lamp
- 燈柱 lamp pole
- 廣告板 billboard

https://goo.gl/MNMSo7

What can we do?

A cultural, behavioural and regulation campaign against light pollution

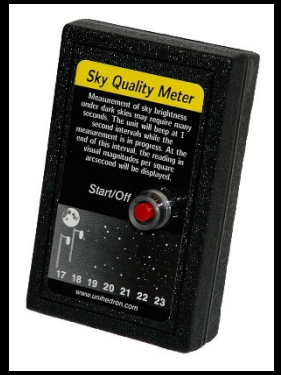
Communicating with the public on light pollution

A big challenge in a city deeply proud of her identity as the ***bright*** **"Pearl of the Orient"**

Communicating light pollution: citizen science

- Distributed portable SQM to participants (high school students, amateur astronomy groups, camp-site managers, …)
- Report NSB readings through a web interface
- Over 2000 measurements from 199 locations with 171 participants

Student Briefing

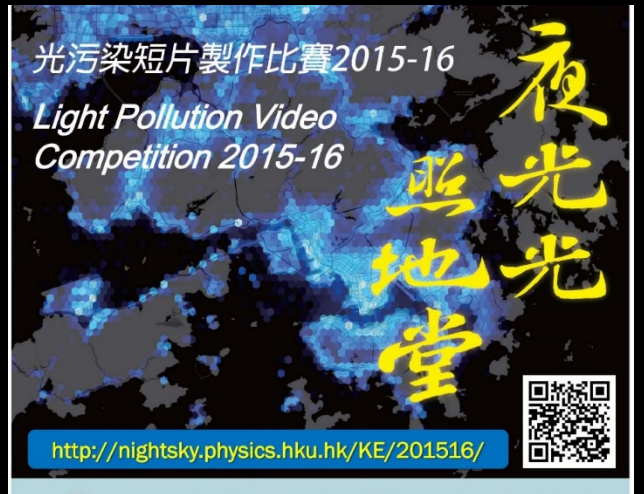


Communicating light pollution: school workshops

- Organized **workshops for secondary schools**
- Rundown of the workshop:
  - Lecture;
  - Measurement workshop;
  - Portable-dome observation
  - Exhibition
  - Student research
- Invited students to study surrounding lighting in the community and conduct SQM measurement

Communicating light pollution: school competitions (research, photograph, video)

- Allow secondary school students to participate in light pollution research
- Allow students to use innovative means to spread the message of light pollution reduction and dark sky preservation
- Students advocate for light pollution reduction in their own communities



HKU Light Pollution Photograph Competition 2014, Champion “Light Polluting home” (Credit: Kwok Man Tai)

https://bit.ly/2XPI3qz

Light Pollution Video competition champion "*To Cast a Bright Light*" (Credit: Leung Yu Hang Crystal)

光污染 LIGHT POLLUTION 研究及短片製作比賽 Research and Video Competition 2015-16

Winning works of the student competitions were presented at a special public exhibition at the Hong Kong Space Museum

Communicating light pollution:
school activities (teacher workshops, field trips)

Star · Night · Hike light pollution field trip

1. Light Pollution public lecture
2. Briefing of the competition
3. Experience effect of light pollution first-hand
   - Started in City Center
   - A short hike through Country Park to see fireflies
   - Ended at Astronomy Park for stargazing

Communicating light pollution: school competitions (STEM)

- **STEM: S** (Science) **T** (Technology) **E** (Engineering) **M** (Mathematics)
- Dark-sky-friendly Light Fixture STEM Competition
- Expanding our presence and reach by co-organizing with lighting engineers at Department of Electrical Engineering

Communicating light pollution: school competitions (STEM)

- Allow secondary school students to use STEM knowledge to come up with innovative designs of lighting which can reduce light pollution
- Public exhibition of the winning entries to spread the Impact
- Student enjoyed the experience introducing their own work to the public

Communicating light pollution:
Integrating into school curriculum

主活素質 59

3. 夜間燈光煙霧？

香港素有「東方之珠」的美譽，鬧市的建築物佈滿招牌燈光，而維多利亞港更以璀璨夜景聞名，吸引大量市民和遊客觀賞。不過，過度使用燈光造成嚴重的光污染，對市民的生活、工作和健康都有着不良的影響，近年引起社會的關注。

3.1 香港的光污染

環保署每年平均接獲約 200 宗戶外燈光污染投訴，主要涉及店鋪招牌和廣告招牌。鬧市有大量燈光招牌及向天空照射的射燈，晚間燈光的亮度比國際組織提出的標準高出幾十倍。

燈光招牌

光污染：又稱為光害，是過度使用人為室外照明而對自然環境和生態造成的損害。有關問題主要包括光滋擾和能源浪費兩方面。

香港鬧市常見的戶外燈光

旺角 西洋菜南街

銅鑼灣 怡和街與記利佐治街交界

射燈 街燈 燈光招牌 戶外電視牆

香港夜空光度分佈圖

Hong Kong Night Sky Brightness Monitoring Network

20:30-23:00

資料解讀

標籤代表「香港夜空光度監測網絡（NSN）」的 18 個監測站位置，標籤顏色代表監測站以夜空光度測量錄得的夜空光度數值。數字愈大（紅、紫、橙），夜空愈光亮；數字愈小（藍、灰、黑），夜空愈黑暗。夜空被照亮，可見星星的數目因夜空的對比下降而減少。

（資料來源：香港大學物理系 · http://nightsky.physics.hku.hk/index.php ·）

Liberal Studies textbook,
Lower Secondary 1-3

Educational Television, EDB 教育局教育電視

About ETV | Categories | Awards Winning Resources | Catalogues | Seminars / Workshops

ETV, EDB > Subject > General Studies for Primary Schools / Science Education

晚上的太陽(光污染) (中文字幕可供選擇)

Author：ETV, EDB

Create Date： 12/09/2016

HKU team interviewed and featured in an official Education Television segment on light pollution

2013年1月16日至17日期間的夜空光度變化

尖沙咀 西貢郊區

00:37

08:45 / 15:04

75,863 views

Chapters 6

1. 何謂光污染 (02:40)
2. 實地觀測鬧市光污染的情況 (03:29)
3. 強光對人類的生理影響 (01:41)
4. 城市光污染對觀星人士造成的影響 (02:37)
5. 光污染對自然生態的影響 (01:50)
6. 反思光污染問題 (02:05)

About the Resource | Transcript | Download | References

本節目透過實地觀測，以及訪問專家學者、環保人士和觀星愛好者，探

75863 views

Communicating light pollution:
science roadshow: HK SciFest (annual)

Communicating light pollution:

I Love the Night Sky • Stargazing is Fun

Communicating light pollution:
science roadshow: Earth Hour

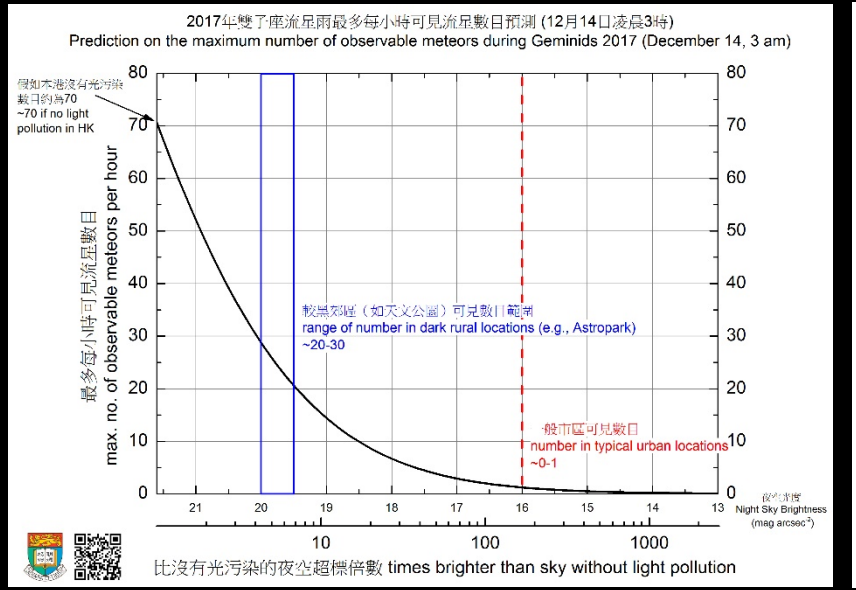
- **Earth Hour** is an annual global environmental activity (organized by World Wide Fund for nature, WWF)
- Lights of buildings turn off for one hour as a symbol of commitment to the planet
- Turning off of light in landmark buildings across the globe provide a spectacular backdrop to explain impacts of light pollution

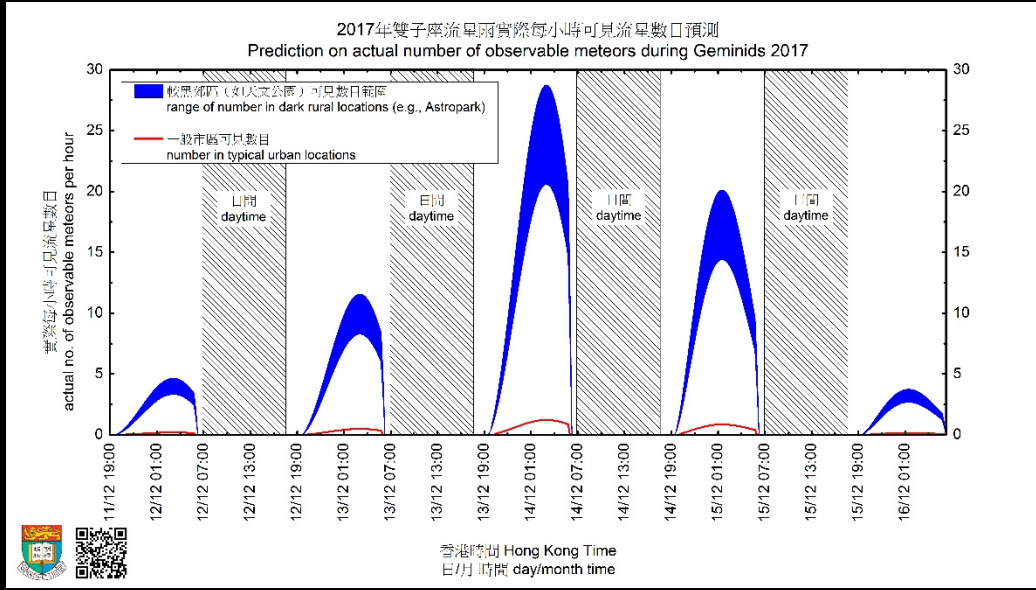
Communicating light pollution: science roadshow: Earth Hour

- Organized a Science Roadshow at the Hong Kong Harbor front during **Earth Hour**
- Allow participants to experience the dark sky when many city lights are out
- Contents of the Roadshow:
  1. Real-time nights sky measurements;
  2. Demonstrations;
  3. Video presentations (https://youtu.be/mc7ipCExGsc);
  4. Panel exhibitions

Communicating light pollution:

Be a responsible stargazer • Enjoy the meteor shower

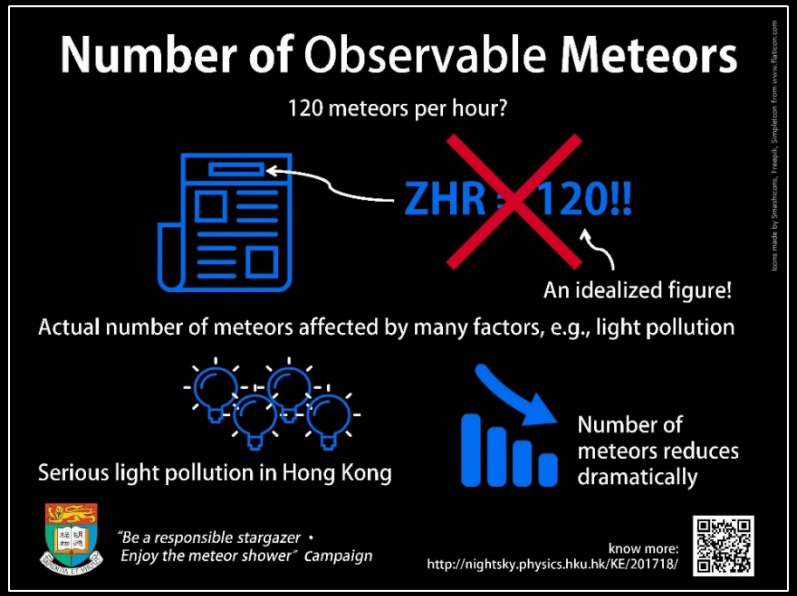


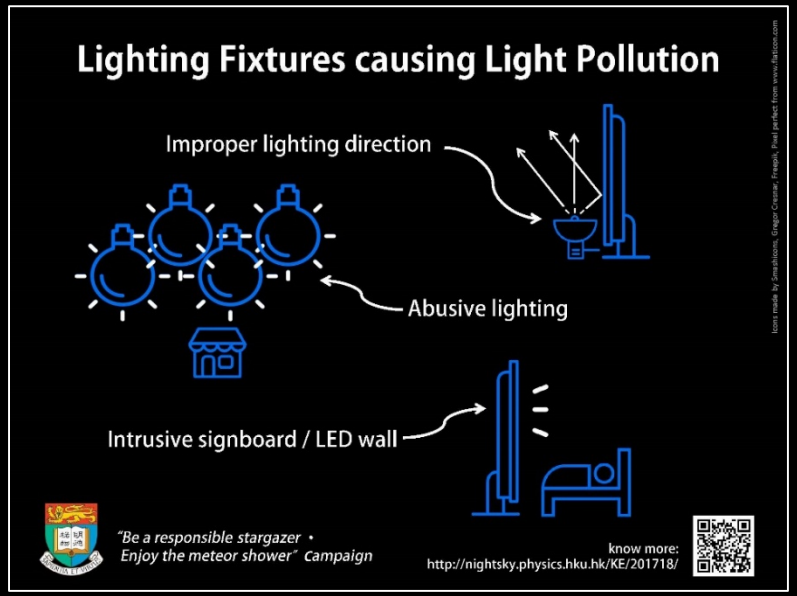


- Meteor shower is an astronomical event that attracts public attention
- Use research data from light pollution study to calculate predicted number of observable meteors

Communicating light pollution:

Be a responsible stargazer • Enjoy the meteor shower





- Infographics to explain science of meteor showers
- **Explain how number of meteors observable is related to light pollution, thus promoting light pollution reduction**

Communicating light pollution:
Engaging the stakeholders

Hong Kong College of Paediatricians
香港兒科醫學院

THE HONG KONG INSTITUTE OF SURVEYORS
香港測量師學會

Almost 20 talks delivered at professional societies to introduce light pollution, its impacts and discuss possible solutions that benefit both parties

HKGBC
香港綠色建築議會
Hong Kong Green Building Council

INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS
IALD

CIE
香港照明學會
CIE (Hong Kong) Limited

Communicating light pollution:
Engaging with the public media

- Light pollution was a new issue when we started in 2003
- 185 newspaper/webpage reports, 40 TV/radio appearances including CNN, Wall Street Journal, Financial Times, CCTV, …
- Usually sympathetic of our concerns and are willing to listen
- Fast-thinking and efficient in learning new ideas and concepts

May 2005
TVB Sunday Report
(星期日檔案)

November 2015
German-French ARTE Channel
"Loss of the Night"

Regulation campaign against light pollution

Charter on External Lighting (Jan 2016)

Government invites outdoor lighting owners to **voluntarily** turn off decorating, promotional and advertising light that affects the environment at pre-set time

Platinum：11pm to 7am
Gold　　：12am to 7am

Signatories
(up to May 2018)：
4,230 (Platinum)
1,058 (Gold)

Policy Address 2018

281. The Government has tasked the **Working Group on External Lighting** to review the effectiveness of the Charter on External Lighting and to **study how to further regulate external lighting**.

Hope for more good news to come in the future

Jun 21, 2009 Before “Dim-it”

Credit: Sedonia Shu, Eimund Loo

Jun 21, 2009 After “Dim-it”

Credit: Sedonia Shu, Eimund Loo

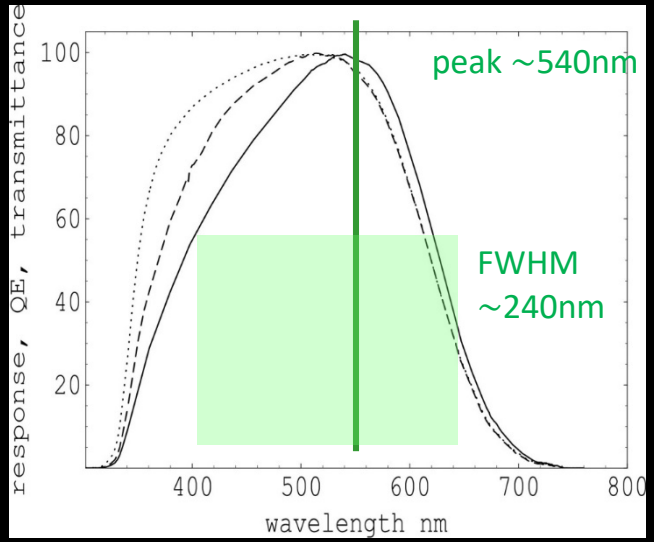

It is never too late to fight against light pollution!
Thank you
Dr Jason Pun (jcspun@hku.hk)

Back up

Sky Quality Meter – Lens Ethernet (SQM-LE)

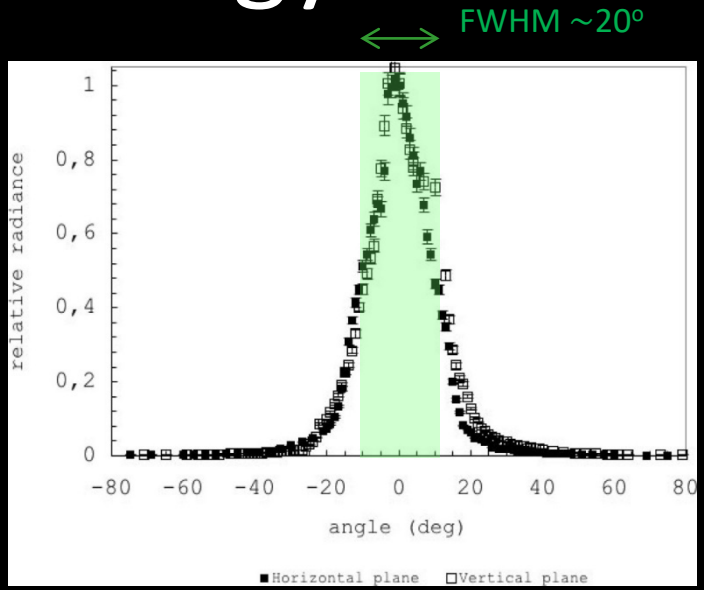
- Manufacturer: Unihedron (Canada)
- Light sensor: TAOS TSL237 High-Sensitivity Light-to-Frequency Converter
- Near-IR blocking filter: Hoya CM-500
- Size 3.6 x 2.6 x 1.1 in.
- Operates from 5-6V DC adapter
- Night sky brightness given in unit mag arcsec^{-2}
- Accuracy of $\pm$0.1 mag arcsec^{-2}
  (Calibrated by the manufacturer before shipment)
- Reasonable price (US$350)

Methodology



Spectral response function of SQM-LE (solid), quantum efficiency (dashed), and filter transmittance (dotted)

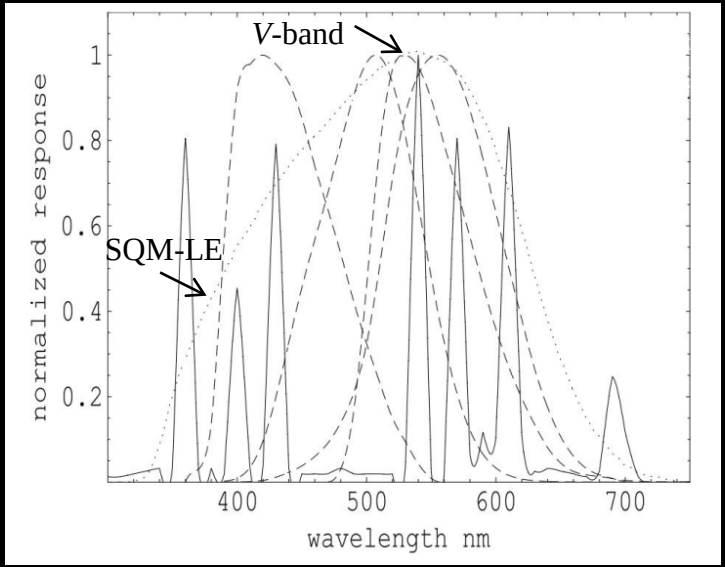
(Cinzano 2005)



Angular response function of SQM-LE

(Cinzano 2007)

Measuring NSB by SQM-LE



Comparison of **SQM-LE normalized spectral response** (dotted curve) with the spectral curves of Johnson B-band, scotopic, **Johnson V-band**, and photopic (dashed curves from left to right) and the emission spectrum of a mercury vapor lamp (solid curve) (Cinzano 2005)

- Compare photometric Johnson V-band vs SQM-LE response:
  - FWHM:
    - SQM-LE: 240 nm
    - V-band: 84 nm (Bessell 2005)
  - Peak:
    - SQM-LE: 540 nm
    - V-band: 545 nm (Bessell 2005)
- The offsets between V-band and SQM-band:
  - Depends on sky spectrum and cloud condition
  - 0 - 0.25 mag arcsec^{-2} (Cinzano 2005)
  - Up to 0.6 mag arcsec $^{-2}$ when cloudy (Puschnig et. al. 2014

GaN-MN Night Sky Brightness (NSB) database: data flow