Light Pollution
A Shared Challenge

Scientific Analysis Tools

UICN 2021
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What is DarkSkyLab?

**Location**
Toulouse, France

**Founded**
in 2014

**Goal**
Deliver expertise as well as services in the field of light pollution and its impacts on ecosystems

**Members**
- Sébastien Vauclair
- Philippe Deverchère
- Michel Bonavitacola
- Gonzague Bosch
Agenda

• What is light pollution?
• Metrology
• Modeling
Casper
(Wyoming, USA)
55,000 inhabitants

August 20, 2017

42.853467 N
106.13447 E

15 km east of Casper. Photo towards west in direction of Casper
Mount Wilson
(California, USA)

25 km north-east
of Los Angeles
downtown
Mount Wilson
(California, USA)

Los Angeles at night in 1908
Mount Wilson
(California, USA)

Los Angeles at night in 1958
Mount Wilson
(California, USA)

Los Angeles at night
in 2008
Western Europe

Evolution of anthropogenic light emission between 1992 and 2010

Between 2012 and 2016, an average growth of 2.2% per year was observed worldwide\(^1\) (6% per year between 1990 and 2000 in Europe)

\(^1\) Artificially lit surface of Earth at night increasing in radiance and extent, *Science Advances*, 2017

The Milky Way is hidden from more than a third of humanity (60% of Europeans and 80% of North Americans)
Asia
1992 - 2010
Agenda

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Metrology
Measuring Light Pollution with Ninox

• Continuous and fully automated recording of sky brightness over long periods of time (months or years)
• Wi-Fi access point and Web interface to control the device and access data on site
• Statistical processing of the measures to fully characterize a location

Measure of sky background brightness (luminance) in mag/arcsec$^2$
Ninox single night recording

Complex profile with multiple events

Moon Set
Sun at -12°

Beginning of the night, activity near the Ninox system

Moon is declining and sky quality improves gradually

Streetlights in the village are turned on at 5:00am local time

Other villages/towns around also turn public lighting off and sky quality improves

Lights in the house are turned off

Streetlights in the village are powered off at 11:00pm local time

Milky Way gets out of the field at zenith and the Moon goes below the horizon (acceleration of sky darkening)

Sky is briefly getting clear and we are back to the NSB level of the beginning of the night

Clouds are coming

Moon Phase: 46%
Natural Light Sources

Ninox measures in Atacama, Chile

Milky Way (Sagittarius)  Milky Way (Puppis)  Zodiacal light  Clouds

Airglow  Aerosol  Humidity
Density Diagrams

51 nights between the 1st of May and 26 of July 2018 with the Mon set

Before extinction

After extinction
**NSB Dispersion Ratio (NDR), an absolute night sky brightness indicator**

NDR = \( \frac{\text{MAD}_{\text{bright}}}{\text{MAD}_{\text{dark}}} \)

*(Median Absolute Deviation)*
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Modeling Light Pollution Simulation with Otus

Production of light pollution prediction maps from various data sources

- Population data
- Geolocated light sources
- NOAA VIIRS-DNB satellite radiance data
- Orthophotography high resolution radiance data (plane or satellite)
Simulation of a dark corridor rehabilitation

Extinction of a specific zone
Simulation of a dark corridor rehabilitation

Example of the rehabilitation of a North / South corridor
Temporal Evolution Indicator
Different Scales for Different Needs
Public Light Source Set Analysis
Ortho-Photography analysis

La Réunion Island
Sport fields and
private lightning
analysis
High résolution satellite imaging (Jilin – CG Sat)
Light source visibility by a ground based observer

Including masking from building and trees
Based on Jilin image and light source extraction

Sarah Potin
Public Lighting Extinction
Public lighting extinction is becoming a more commonly adopted practice.

Example of the *Parc Naturel Régional du Quercy* over 2014 to 2020.
Public lighting Extinction Analysis

- Radiance / population comparison
- Automatic extinction detection
Public Lighting Extinction Analysis

Light pollution maps:
• Night heart
• Night ends
Cloud Coverage Influence

Towards a light pollution national indicator (11/2021 ONB)
Conclusion and Perspectives

What we have:

- Quite good knowledge of light pollution measurement (thanks to a high number of measures under many different meteorological conditions and to statistical analysis);
- Good ability to model light pollution at any time of the night (taking into account public lighting extinctions) and during cloudy nights.

What we need:

- Better understanding of light pollution impacts on biodiversity;
- Better access to outdoor lighting databases;
- Better spatial imaging of the Earth at night (calibration, sensitivity, resolution).