Light pollution hurts the environment: how do scientists quantify its harm?

Ela Gulsen

In the last century, the use of artificial light at night (ALAN) has exploded, growing at a rate faster than world population growth,[1] and its effects can (quite literally) be seen across the globe. For all except those who live in the most rural areas, dark skies have been lost. According to a 2016 study, "99% of the U.S. and European populations live under light-polluted skies," and 80% of Americans can no longer see the Milky Way.[2] But light pollution's harm isn't just aesthetic.

The detrimental effects of ALAN on human health, and especially on human sleep cycles, have long been documented. Perhaps lesser known, though, are its devastating effects on the environment. Many animal species rely on light to navigate. Artificial light confuses them, leading to disruption and harm. Baby sea turtles, for example, are drawn away from the ocean and towards artificial light, mistaking it for the glittering of the moon onto water. Birds' migration patterns are disrupted by artificial light; worse, collisions with reflective buildings kill millions of birds per year. Nocturnal animals, which rely on the dark to navigate and hunt, must face lighting that can be as bright as daytime.[3] Yet how do scientists assess the impact of light pollution?

---

[1] Barentine, "Methods for Assessment and Monitoring of Light Pollution around Ecologically Sensitive Sites". pg.1
[2] Falchi et. al, "The new world atlas of artificial night sky brightness." Pg. 1
[3] IDA: Light Pollution Effects on Wildlife and Ecosystems, 2016

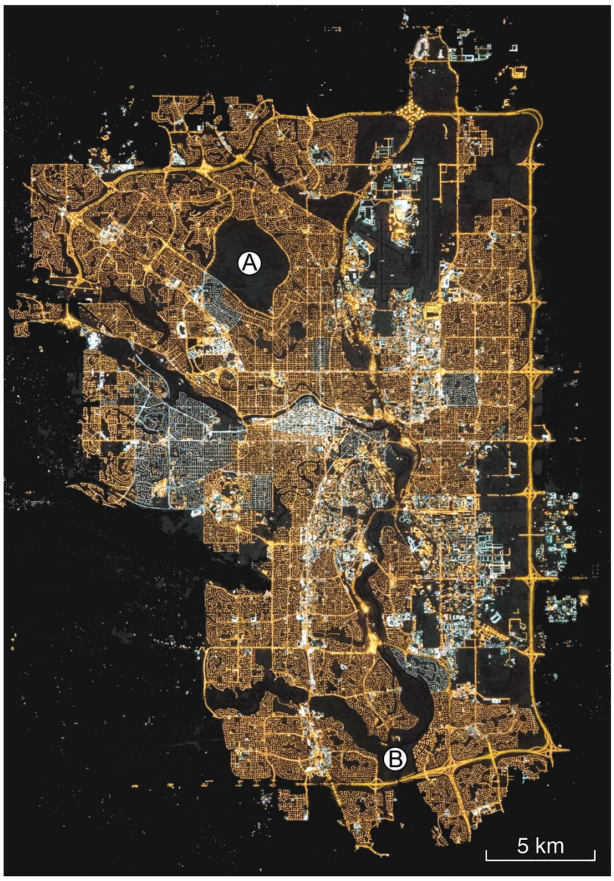
As it turns out, it's more complicated than one might initially think. John C. Barnetine, PhD, member of the IDA and the governance committee of the University of Utah Consortium for Dark Sky Studies, explains the long history of the technological innovations in artificial light measurement, in his 2019 article, *Methods for Assessment and Monitoring of Light Pollution around Ecologically Sensitive Sites*.

Astronomers have been trying to quantify the brightness of the night sky since the early 20th century. But it wasn't until humanity began to take to the cosmos in the 1960s that a groundbreaking opportunity presented itself: the invention of satellites. Originally a product of the U.S. Defense Meteorological Satellite Program (DMSP) but currently spearheaded by NASA, specially equipped satellites orbiting Earth are able to detect artificial light escaping from Earth's atmosphere. These measurements are crucial for astronomers in order to detect skyglow - the hazy illumination of the night sky over light-polluted areas, often seen in cities.[4] Researchers using data provided by DMSP satellites noted that it was now possible "for the first time… to observe brightness variations within urban centers" which were previously impossible to detect.[5]

Surprisingly, images taken by consumer-grade cameras can also be a crucial source of information for scientists. Photos taken by astronauts aboard the International Space Station (ISS) can provide insight into light pollution seen from space, and provide incredible detail. On Earth, promising new developments in drone technology have

[4] "Methods for Assessment and Monitoring of Light Pollution around Ecologically Sensitive Sites". pg.3
[5] Elvidge et. al, "Radiance Calibration of DMSP-OLS Low-Light Imaging Data of Human Settlements" pg. 87

made taking photographs of areas from above easier and more accessible than ever, allowing insight into problematic lighting areas.[6]



A photo taken aboard the ISS, provided by NASA, of the city of Calgary, Canada.

Yet perhaps nothing has been more influential to the world of light pollution research than the invention of the Sky Quality Meter (SQM) in the early 2000s: an affordable, user-friendly, portable device that allows *anyone* to measure light pollution from the ground. Users simply hold the device over their head, and the SQM does all the work for them, outputting a numerical reading that represents the darkness of the sky. By

[6] pgs. 5,8

measuring multiple locations over a large area, scientists can then construct a map of light pollution and determine where light pollution is strongest. Although SQM measurements can sometimes be imprecise, scientists use SQMs to measure the same areas often in order to see changes in light pollution over time.[7]

Dr. Barentine writes that “while the use of ALAN clearly conveys certain social and economic benefits to humans, it is associated with a number of negative environmental externalities.”[8] Artificial light can’t be avoided entirely. But we must learn to peacefully coexist with it, for the sake of both the environment and our own health. Identifying the sources of harmful artificial light and their impact is the first step to minimize its harm.

References

[7] “Methods for Assessment and Monitoring of Light Pollution around Ecologically Sensitive Sites”. pg.6
[8] pg.2

Barentine, J.C. 2019. Methods for Assessment and Monitoring of Light Pollution around Ecologically Sensitive Sites. Journal of Imaging. 5(5):54.

Barnard A. 2009 Sept 9. The 9/11 Tribute Lights Are Endangering 160,000 Birds a Year. New York Times. Sect A:22.

Elvidge C.D., Baugh K.E., Dietz J.B., Bland T., Sutton P.C., Kroehl H.W. Radiance Calibration of DMSP-OLS Low-Light Imaging Data of Human Settlements. Remote Sens. Environ. 1999, 68, 77–88.

Falchi F, Cinzano P, Duriscoe D, Kyba, C, Elvidge C, Baugh, K, Portnov, B, Rybnikova N, Furgoni R. 2016. The new world atlas of artificial night sky brightness. Science Advances. 2.

Light Pollution Effects on Wildlife and Ecosystems. 2016. International Dark Sky Association; [accessed July 5, 2020]. https://www.darksky.org/light-pollution/wildlife