

**Editorial**

# Light Pollution: A Silent but Solvable Threat to Earth's Ecological Balance

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In recent years, the scientific community has increasingly turned its attention to the pervasive yet often overlooked impact of artificial nighttime lighting on ecosystems. While much of global focus remains on pressing issues such as climate change, habitat loss, and traditional pollutants, this subtle yet powerful phenomenon—light pollution—is steadily altering the natural balance of our environment.

A recent study published in *Nature Climate Change* has, for the first time, demonstrated how artificial light at night can disrupt carbon balance on a continental scale. The analysis combined eddy-covariance measurements from 86 sites in North America and Europe, covering 623 site-years and 197,247 daily observations. Higher nighttime illumination consistently increased ecosystem respiration, whereas gross primary production showed no direct response to artificial light at the annual scale.<sup>1</sup> Because the response varied nonlinearly with light intensity and night duration, the study did not report a single universal percentage increase in CO<sub>2</sub> emissions. However, its annual analysis (605 site-years across 84 sites) confirmed that artificial light altered net ecosystem carbon exchange primarily through increased respiration.<sup>1</sup> Put simply, brighter nights mean less carbon is stored, with important consequences for climate models and the global carbon budget.

The issue is especially urgent in many developing countries, where rapid urbanization, infrastructure expansion, and growing electricity access can enlarge the footprint of artificial light at night. A recent global analysis of daily satellite imagery showed that, from 2014 to 2022, brightening added radiance equivalent to 34% of the 2014 global baseline, while dimming offset 18%, leaving a net increase of approximately 16%.<sup>2</sup> In the Middle East, the burden is already pronounced: estimates from the World Atlas of Artificial Night Sky Brightness indicate that the

Milky Way is hidden from 98% of the population in Kuwait, 97% in Qatar, 93% in the United Arab Emirates, and 83% in Saudi Arabia.<sup>3</sup>

Promising management examples show that practical intervention is possible. Abu Dhabi's Dark Sky Policy requires covered fixtures, a maximum color temperature of 4000 K for street lighting and 3000 K for public spaces and building facades, motion-sensor security lighting, midnight lighting curfews, and performance monitoring.<sup>4</sup> Al Ain has also begun applying smart public-lighting controls that reduce illumination intensity when road use declines.<sup>5</sup> In Tucson, a municipal experiment involving approximately 20,000 road luminaires found that reducing output from 90% to 30% after midnight lowered zenith sky brightness by  $5.4 \pm 0.9\%$  near the city center and  $3.6 \pm 0.9\%$  at a suburban site.<sup>6</sup>

What is particularly encouraging is that, unlike many other environmental pressures, light pollution is both manageable and reversible. Measures such as reducing unnecessary lighting, adopting dimmable and directional lamps, and selecting appropriate light spectra can yield measurable improvements in ecosystem health in a relatively short time. Beyond environmental benefits, these steps also boost energy efficiency and lower costs—especially given that lighting accounts for almost 20% of global electricity consumption and 6% of global CO<sub>2</sub> emissions.<sup>7</sup> A growing body of epidemiological evidence links excessive nighttime light exposure to sleep disruption and several adverse health outcomes, although findings across studies remain heterogeneous.<sup>8</sup> This makes the management of light pollution a “triple win” for ecosystems, energy, and well-being.

As Editor-in-Chief, I strongly believe that JAEHR plays a pivotal role in bringing attention to issues that may not always be visible, yet carry profound implications for



the health of our planet and generations to come. Light pollution exemplifies such a challenge: a silent threat, but one that can be fully addressed when public awareness and informed management converge.

In this issue, through a collection of original research and review articles, we aim to engage researchers, policymakers, and environmental managers on this critical topic. It is my hope that the knowledge shared here will meaningfully contribute to reducing sources of light pollution and promoting thoughtful, sustainable environmental management.

#### Competing Interests

None declared.

#### Ethical Approval

Not applicable.

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