How Much Light Did We Add to the Earth?

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When the night comes, our eyes fly open as street lamps burning in the darkness; when flying up to the night sky, we find billions of city lights wrinkling against the gloom. Imagine that we are wandering in space. We see the earth shining and wonder – we, humans, contribute to how much of that glow?

This is not an easy question to answer. The images transmitted from space satellites give us a sense of how bright the Earth is. The artificial light of cities, however, is not the only component of the lightness we observe. The fluctuating natural lights such as the airglow originating from the Earth's atmosphere, the persistent auroral ring near the pole, and the starry light emitted by stars keep us away from the true amount of lightness we add to the Earth.[1]

In order to approximate the pure human-generated light emission, Jacqueline Coesfeld, TeresKuester, Helga U.Kuechly, and Christopher C. M. Kyba from GFZ German Research Centre for Geosciences constructed a model to filter out from satellite imagery data the noises like the airglow.

We can understand the model as a "subtraction." Imagine we get a picture of the Earth taken from satellites, we can divide this image into many blocks and identify their illumination. Then, for each block, we find its nearest block with minimum human activities and we call them "basements." As there exists no artificial light in those basements, when we subtract the observed illumination of every block by the brightness of its nearest basement, we get an estimation of artificial light emission in that block.

This research empowers us to track the change of artificial light emission in relatively dark regions where natural lightness largely exceed human-generated one. This is because when the artificial light emission is tiny, the variation of natural lightness can easily rival the change of artificial light. Thus if we failed to extract the artificial lightness effect from the satellite data we got, we would end up with measuring the change of natural light.

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[1] Sanchez de Miguel, A., Kyba, C.C.M., Zamorano, J. et al. 2020. The nature of the diffuse light near cities detected in nighttime satellite imagery.

Moreover, as suggested in the research paper, the correction tremendously improved the measurement of light emission at the national and international levels. Nowadays, a large amount of economics research about light pollution rely on the national summation of artificial light emission.[2] This number, however, may be incorrect and thus lead to false interpretation of human impact on light pollution. This is because when we sum up the lightness of each pixel of a country in satellite images, the noises will be also accumulated and amplified, which can exceed the sum of human-generated light that we try to measure. Therefore, getting an accurate amount of light emission can help us objectively evaluate our actions and their impact on the planet.

We know exactly how bright a little lamp can light up our living room, but it is always hard to tell the exact number of lightness that billions of street lamps, luminous signs, and other forms of artificial lights have brought to our planet. With great scientific endeavour that Jacqueline Coesfeld et al. have made, we made one huge step forward to figure out the true human impact on the earth.

Reference

Coesfeld, Jacqueline & Kuester, Theres & Kuechly, Helga & Kyba, Christopher. 2020. Reducing Variability and Removing Natural Light from Nighttime Satellite Imagery: A Case Study Using the VIIRS DNB. Sensors. [accessed 2020 Jun 6]. https://www.researchgate.net/publication/342057914_Reducing_Variability_and_Removing_Natural_Light_from_Nighttime_Satellite_Imagery_A_Case_Study_Using_the_VIIRS_DNB/citation/download

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[2] Tilottama, Ghosh & Powell, Rebecca & Elvidge, Christopher & Baugh, Kimberly & Sutton, Paul. 2010. Shedding Light on the Global Distribution of Economic Activity.