Nachtlicht-BüHNE: update on the German citizen science project to create large area lighting surveys

Theme: Measurement & Modeling

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Synopsis

Nachtlicht-BüHNE is a co-designed citizen science project which investigates the proportion of different types of outdoor lighting. We are developing an app that allows citizen scientists to do lighting surveys. The two main research questions we address are: How much of the light in satellite imagery (e.g. Fig. 1) comes from which types of light sources? How does this proportion change when you change settlement context (from village to town to city center)?

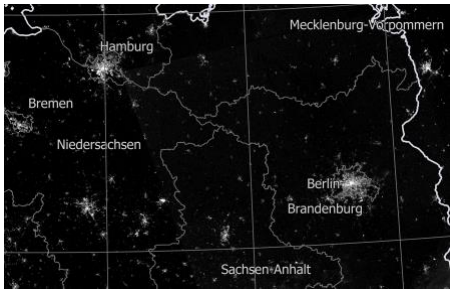

Fig. 1: Artificial lights of northern Germany, observed from Luojia-1. Image courtesy Jacqueline Coesfeld.

Background

At the moment, the relative light emissions from different source types (e.g. streetlights, advertising, façade lighting, and light escaping from windows) is not known. Several researcher groups have examined the relative fraction due to street lighting, and have come up with values ranging from 12-100% (Kyba et al. 2020). This uncertainty poses several problems for remote sensing, for example in understanding the relationship between energy and light emissions observed from space. It is also a problem for skyglow simulation, for example because light reflected from the ground and horizontal surfaces propagate in different directions.

Project overview

The app is currently in development. It is based upon initial surveys that we conducted using pen and paper in 2018 and 2019. A major challenge was to categorize the great variety of outdoor lighting into a manageable number of classes. The participation of our team of about a dozen highly-motivated citizen scientist co-designers was of great value here. Another challenge was to develop an app within a constrained budget. To avoid costly revisions after the app was already developed, the project leaders developed a detailed flowchart showing the entire app functionality, and this was improved through several rounds of constructive criticism and discussion with the citizen scientist co-design team.

During August to October, 2021, we will conduct a set of measurement campaigns in different regions of Germany covering areas ranging in size from 0.5 to 2 km^2. Within these regions, a set of street segments (generally from one corner to the next) will be predefined, based on Open Street Map

data (Fig. 2). Citizen scientists will survey all of the lights visible from each of these street segments. These local campaigns will be planned and coordinated by citizen scientists, with support from the institutional scientists. These data will then be compared to satellite imagery from Suomi NPP, Luojia-1, as well as aerial photography from Cologne from the CALEC project. In order to facilitate comparison with DNB imagery, at least three of the regions will cover 2 km^2 area. Participants from around the world will also be able to use the app by defining their own transects. However, we do not plan to analyze such data.

Fig. 2: Transects assigned to a given area (right) are developed based upon Open Street Map data (left).

The project is part of the CitizenScience@Helmholtz initiative. The German word *Bühne* means "stage", and the project name means "Network of citizen and Helmholtz researchers studying night light phenomena". Together with a sister Nachtlicht-BüHNE project studying fireballs, we aim to demonstrate the compatibility of co-designed citizen science with the overarching Helmholtz mission to solve the grand challenges of science, society and industry.

Methodological details

We have categorized outdoor lights into a set of 18 types. For most categories, we have a second attribute, for example the level of shielding for "lights mounted on buildings", or the size for "lit advertisements". Illuminated areas will estimated via proportion to human dimensions (Fig. 3). An "expert mode" for the app will allow participants to report the color of the lights (white, orange, or other), as well as their perceived brightness (exceptionally faint, normal, or exceptionally bright).

Participants will need to complete an online tutorial before they can submit data, in order to ensure standardized data collection. The tutorial is currently being developed by a team of undergraduate students from Worcester Polytechnic Institute in USA, in cooperation with our team of citizen scientists. The tutorial training is based on a large set of images of each type of lamp class, taken by our citizen scientists and other contributors from around the world. These images are all released under a CC0 (public domain) license.

Fig. 3: Example of size classes within the app.

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References

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