Casting new light on indicator values:
Regional modeling of L-values through remote sensing data

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Background:
- Ellenberg light indicator values[1] are typically available only at national or larger scales.
- Field based regional surveys are time consuming and require multiple years of data.

However, regional comparisons of light indicator values can offer valuable ecological insights.

We aim to:
- Develop a method to model light indicator values regionally.
- Use citizen science data + freely available elevation models.

Python[2] code *https://github.com/vincent-fl/Ellenberg-Lightindicator_RemoteSensingApproach.git*

Relative approach

Citizen science data comes with some statistical challenges, including clustered data by cities and popular vacation destinations. Potential clustering in areas with afternoon sun, for example, can also potentially distort results. **With a relative approach, biases in citizen science data can be effectively avoided.**

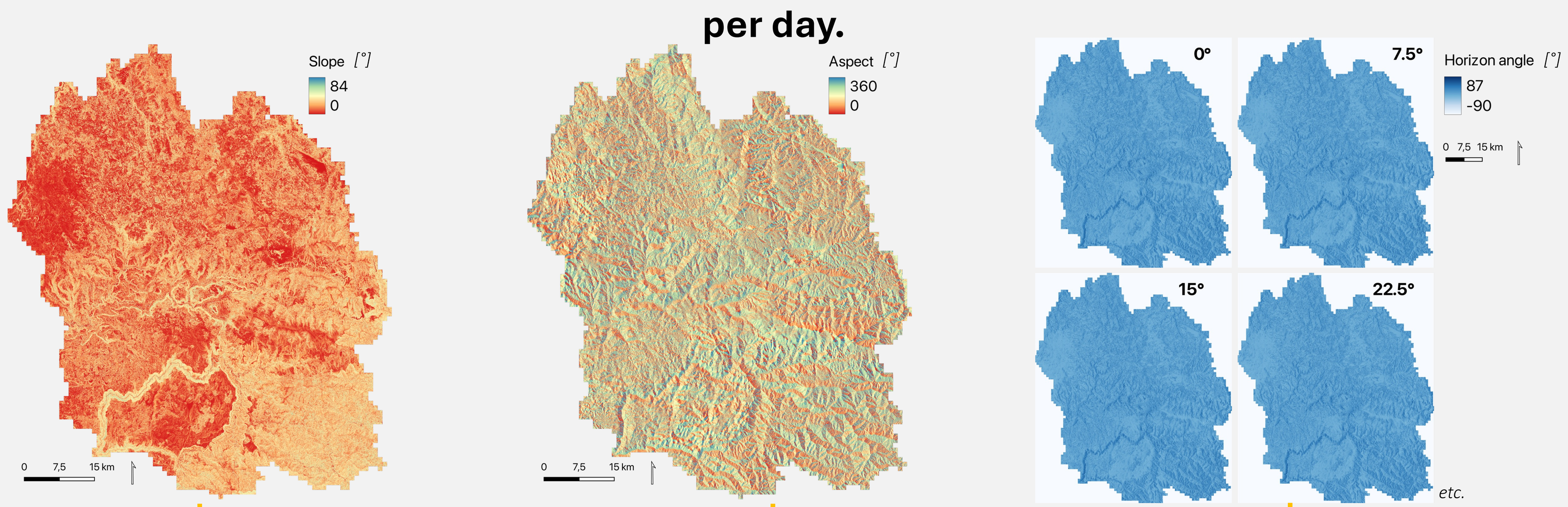
Data

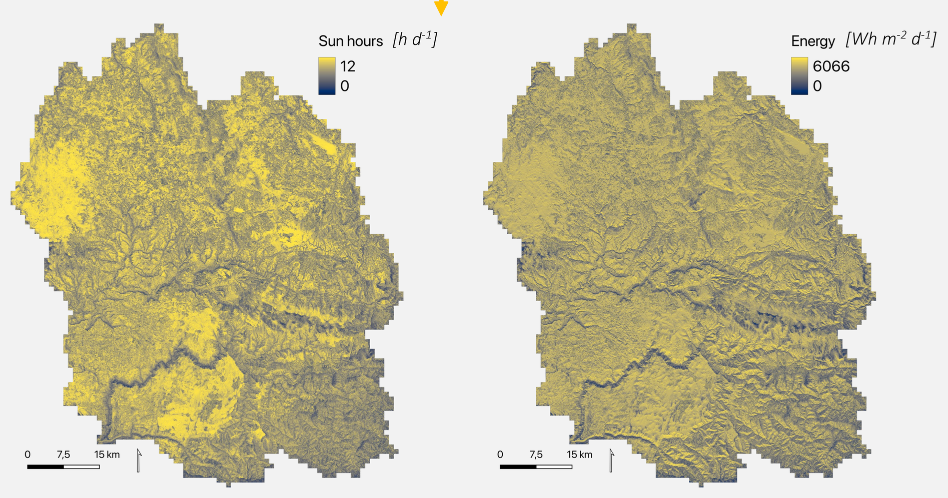
Plant occurrence data (1995–2025) were obtained from GBIF[3] for the French departments Somme (35,304 records) and Lozère (45,391 records). The test species *Plantago lanceolata* was observed 2,616 times in Somme and 1,366 times in Lozère.
Elevation data (digital elevation model (DTM)[4] & digital surface model (DSM)[5]) were sourced from French géoservices.
Ellenberg indicator values follow Lubomír et al. (2022)[6].

Workflow

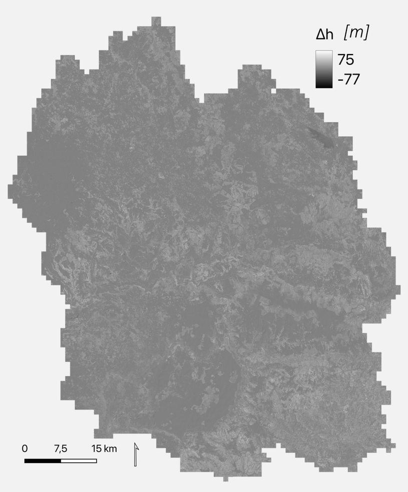
First, resample DTM and DSM to 5 m resolution to reduce file size and match smartphone GPS accuracy better.

Then, use DSM to calculate slope, aspect, and horizon angle (every 7.5°) with r.slope.aspect and r.horizon (GRASS GIS[7]). Use these layers with r.sun to compute potential sun hours and energy per day.

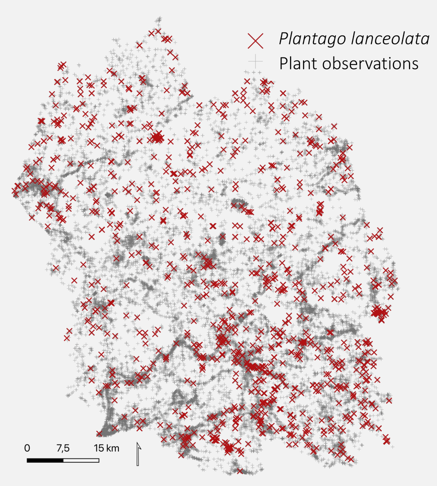




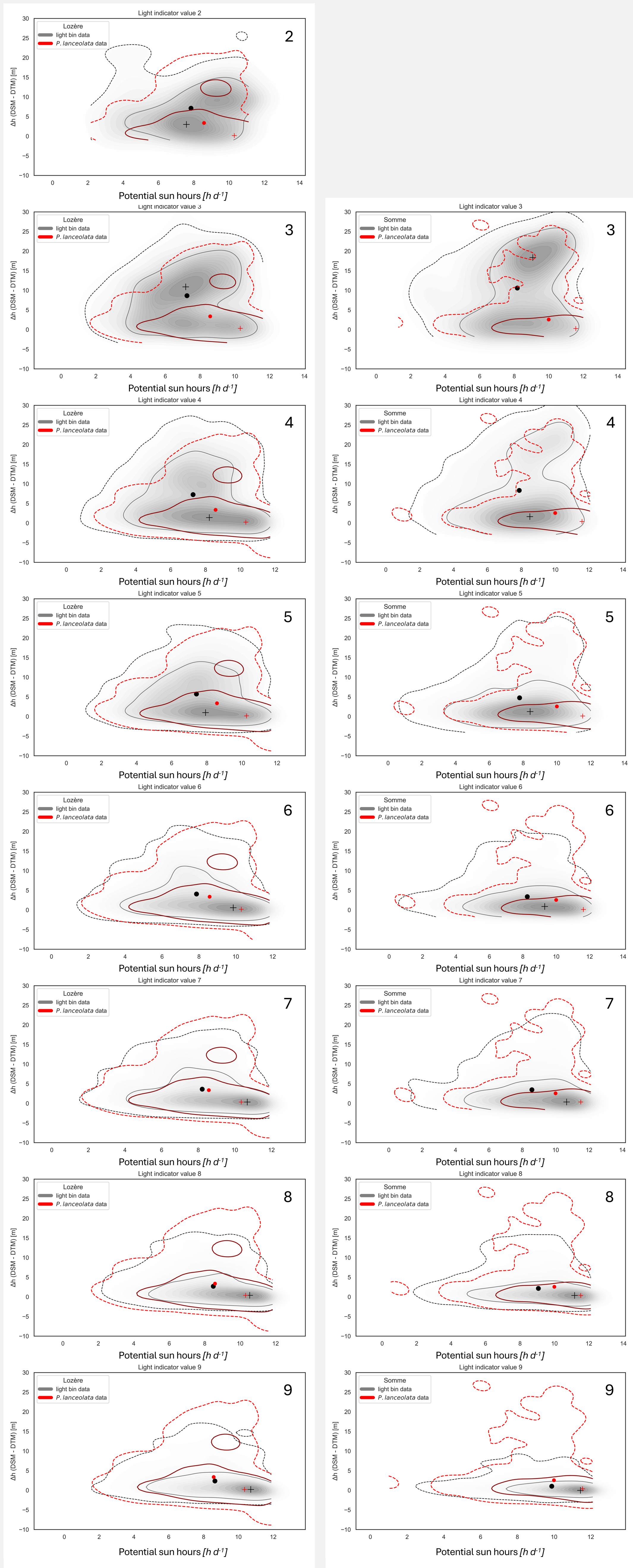
Calculate Δh (DSM – DTM) once and use it across all bins.



Round light values to the nearest integer and group plant observations into corresponding light bins.



For each bin, plot a 2D kernel density estimation (KDE) with energy per day (or potential sun hours per day) on the x-axis and Δh on the y-axis. The KDE shows the density of species observations in that bin. Add centroid (mean Δh and energy), peak density, and 68% / 95% density contours.
Repeat for Plantago lanceolata and overlay its KDE on each bin for comparison.



Use cases and limitations

- The developed method can be used to study Ellenberg light values on a regional scale using citizen science data or potentially field data collected only once.
  - This approach is able to sort species into the right Ellenberg light values.
  - It is possible to extract smaller differences between different regions.
- Species' mean indicator values must reflect the region's actual conditions.
- Experience is still needed to better understand individual aspects, such as the mismatch between the density contours of the target species and the light indicator value groups.
- A symbolic regression shows that important parameters for a prediction of light indicator values (e.g. ratio of height to width of the 68% contour) require both Δh and sun hours/energy. The input data used is therefore likely not reducible.

1) Ellenberg, H. (1992). *Indicator values of plants in Central Europe*.
2) Python Software Foundation. (2024). *Python Language Reference* (Version 3.12.2) [Computer Software]. https://www.python.org
3) *GBIF*. (n. d.). https://www.gbif.org/
4) *RGE ALTI® | GéoServices*. (n. d.). https://geoservices.ign.fr/rgealti
5) *Modèles Numériques de Surfaces corrolés | Géoservices*. (n. d.). https://geoservices.ign.fr/modeles-numeriques-de-surfaces-correles
6) Lubomír, T., Axmanová, I., Dengler, J., Guarino, R., Jansen, F., Midolo, G., Nobis, M. P., Van Meerbeek, K., Aćić, S., Attorre, F., Bergmeier, E., Biurrun, I., Bonari, G., Bruelheide, H., Campos, J. A., Čarni, A., Chiarucci, A., Ćuk, M., Ćušterevska, R., . . . Chytrý, M. (2022). Ellenberg-type indicator values for European vascular plant species. *Zenodo (CERN European Organization For Nuclear Research)*. https://doi.org/10.5281/zenodo.7427088
7) GRASS Development Team. (2020). *Geographic Resources Analysis Support System (GRASS) Software* (Version 7.8) [Computer Software]. Open Source Geospatial Foundation. https://grass.osgeo.org