

Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| ☐ | ☒ | The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| ☒ | ☐ | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☐ | ☒ | The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☒ | ☐ | A description of all covariates tested |
| ☒ | ☐ | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☐ | ☒ | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☒ | ☐ | For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☒ | ☐ | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☒ | ☐ | Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection The data were provided by DigitalGlobe within the NextView License agreement framework. There was no special software involved.

Data analysis Only free and open source software was used for data analysis: RStudio (1.2), python (3.7), GRASS GIS (7.8), QGIS (3.10), GDAL tools (3.0). The deep learning code was written in Python (3.7) using tensorflow (2.0)

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

Global tree cover maps are available at <http://earthenginepartners.appspot.com/science-2013-global-forest>. CHIRPS rainfall data is freely available at the Climate Hazard Group (<http://chg.geog.ucsb.edu/data/chirps/>). The Copernicus land use map can be downloaded at <https://land.copernicus.eu/global/>. Commercial very high resolution satellite images were acquired through the NASA under the NextView Imagery End User License Agreement (ELUA). The copyright remains at DigitalGlobe Inc. and a redistribution is not possible. However, the derived products produced by this study are made publicly available at the Oak Ridge National Laboratory at <https://doi.org/10.3334/ORNLDAAAC/1832>. Please contact the authors for more specific requests.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	The study relies on ~11,000 satellite images at 0.5 m resolution. We applied a deep learning algorithm trained by ~90,000 manually labeled tree crowns to map 1.8 billion trees in the Sahara and Sahel region.
Research sample	The study is a wall to wall assessment of all trees and shrubs within a study area of about 1.3 million km ² .
Sampling strategy	No sampling was necessary as all trees and shrubs are part of the study. We have excluded trees with a crown size <3 m ² as we cannot guarantee a correct mapping of this class.
Data collection	The satellite images were downloaded at NASA within the NextView license agreement from the DigitalGlobe archive and formed to mosaics of 25x25 km size using the highest quality images available. The persons involved were by Katherine Melocik, Jennifer Small, CJ Tucker, Erin Glennie, Scott Sinno, Jesse Meyer, Eric Romero. Images are from the GeoEye-1, QuickBird-2, WorldView-2 and WorldView-3 satellites. All band were pansharpened to 0.5 m resolution and NDVI was calculated from the red and near infrared bands. For this study we used the panchromatic band and NDVI. GDAL tools (3.0) were used for this process.
Timing and spatial scale	The images are from November to March 2005-2018 and cover UTM zones 28 and 29 in West Africa along a rainfall gradient from 0 to 1000 mm (defined by CHIRPS v2.0 rainfall data).
Data exclusions	We only used dry season images (November to March) because this is the time where only trees have green leaves. Moreover, images with an off nadir angle >25° were not used.
Reproducibility	Data were processed twice, at Blue Waters computers and a 3xGPU workstation with the same results.
Randomization	NA, because we used all 1.8 billion trees and shrubs for the analysis without subsetting samples.
Blinding	NA, because we used all 1.8 billion trees and shrubs for the analysis without subsetting samples.
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Field work was conducted in January 2018 and September 2016. The conditions were dry with temperatures around 30°C for both periods.
Location	The data collection was done in Senegal at Dahra in 2018 (-15.43559, 1536428) and Widou Thiengoly in 2016 (-15.31604, 15.95058).
Access & import/export	NA, because the data were noted digitally.
Disturbance	Measuring the crown size of the trees did not involve disturbances.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging