An unexpectedly large count of trees in the West African Sahara and Sahel

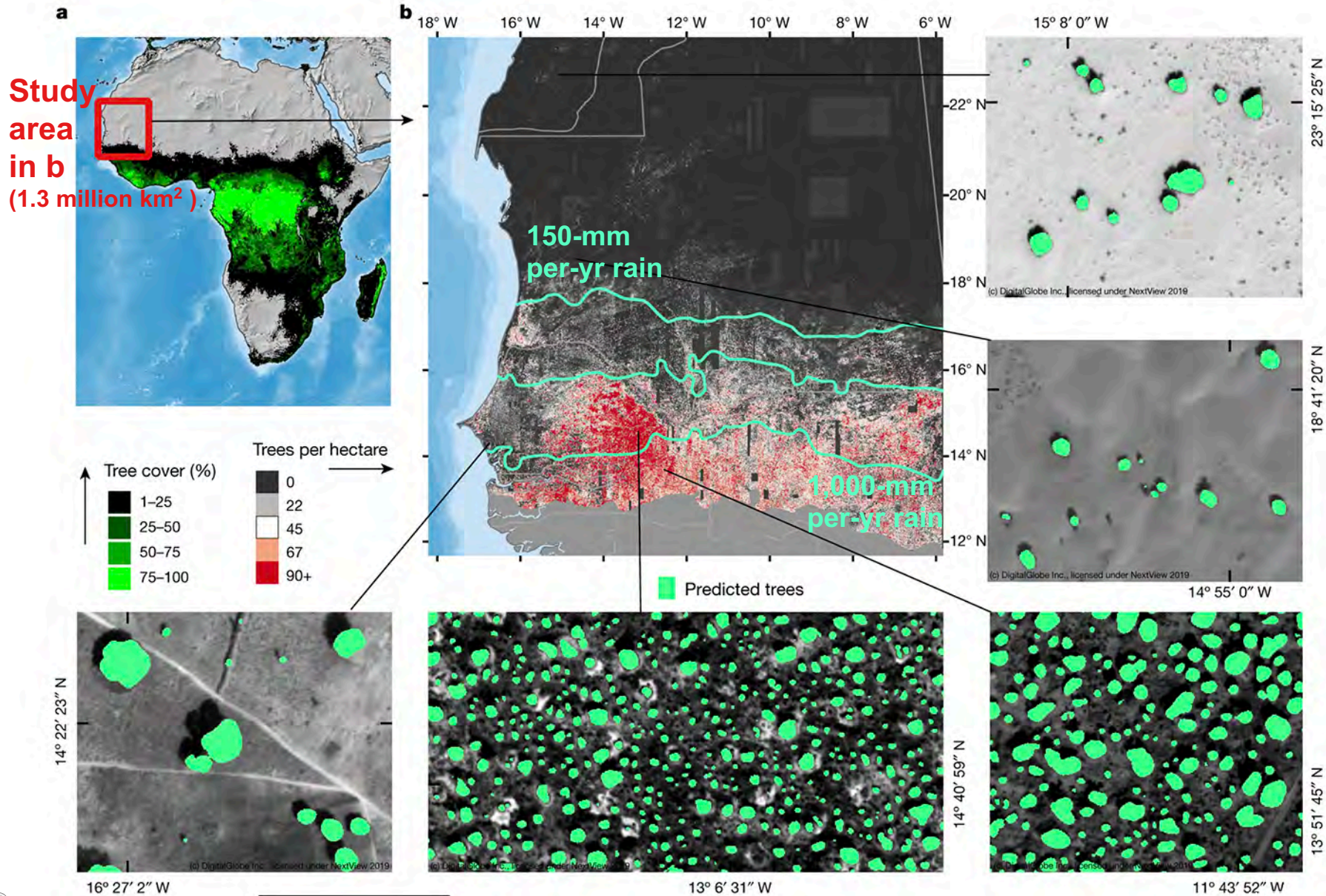M. Brandt et al., 2020 (24 authors) https://www.nature.com/articles/s41586-020-2824-5

- A large proportion of Earth's dryland trees and shrubs (hereafter 'trees') grow in isolation, without canopy closure as is common in more humid forest landscapes.

- These non-forest trees have a crucial role in biodiversity, and provide ecosystem functions like carbon storage, food resources and shelter for humans and animals.

- However, most public interest relating to trees is devoted to forests, and trees outside of forests are not well-documented.

- This novel study maps the upper tree top area or crown size when > than 3 m^2 (32 ft^2) in area over 1.3 million km^2 in the Sahara, Sahel and sub-adjacent humid zone.

- The study was possible using more than 11,000 sub-meter-resolution satellite images and deep learning (an algorithm applied by supercomputer).

- The study measured over 1.8 billion individual trees (13.4 trees per hectare), with a median crown size of 12 m^2, along a rainfall gradient from 0 to 1,000 mm per year.

- The data show ~0.7 trees per hectare in hyper-arid, ~9.9 trees per hectare in arid, ~30.1 trees per hectare in semi-arid, to 47 trees per hectare in sub-humid areas.

- Although the overall canopy cover is low, the surprisingly high density of isolated trees challenges prevailing narratives about dryland vegetation conditions.

- This assessment also suggests a way to monitor trees outside of forests globally, and to explore their role in ecosystems more broadly.

Study area in b (1.3 million km²)

150-mm per-yr rain

1,000-mm per-yr rain

Tree cover (%)
- 1–25
- 25–50
- 50–75
- 75–100

Trees per hectare
- 0
- 22
- 45
- 67
- 90+

Predicted trees

This visualization from NASA's Scientific Visualization Studio shows a close-up of 50-centimeter-resolution satellite data overlaid with machine learning-based tree crown regions, individual tree counts, and overall tree counts in a portion of the West African Sahara and Sahel. *Greg Shirah, Compton Tucker, NASA/Goddard*

Study area shown in Figure 1
(1.3 million km²)

Climate zones in the study area include hyper-arid (0-150 millimeters [mm] rainfall/year); arid (150-300 mm/year); semi-arid (300-600 mm/year); and sub-humid (600-1000 mm/year). *Greg Shirah, Compton Tucker, NASA/Goddard*

number of trees: 1,837,565,501
tree crown area: 46,649,087,418 m²

trees per hectare

0   20   40   60   80

trees

study area

MAURITANIA

SENEGAL

GUINEA-BISSAU

GUINEA
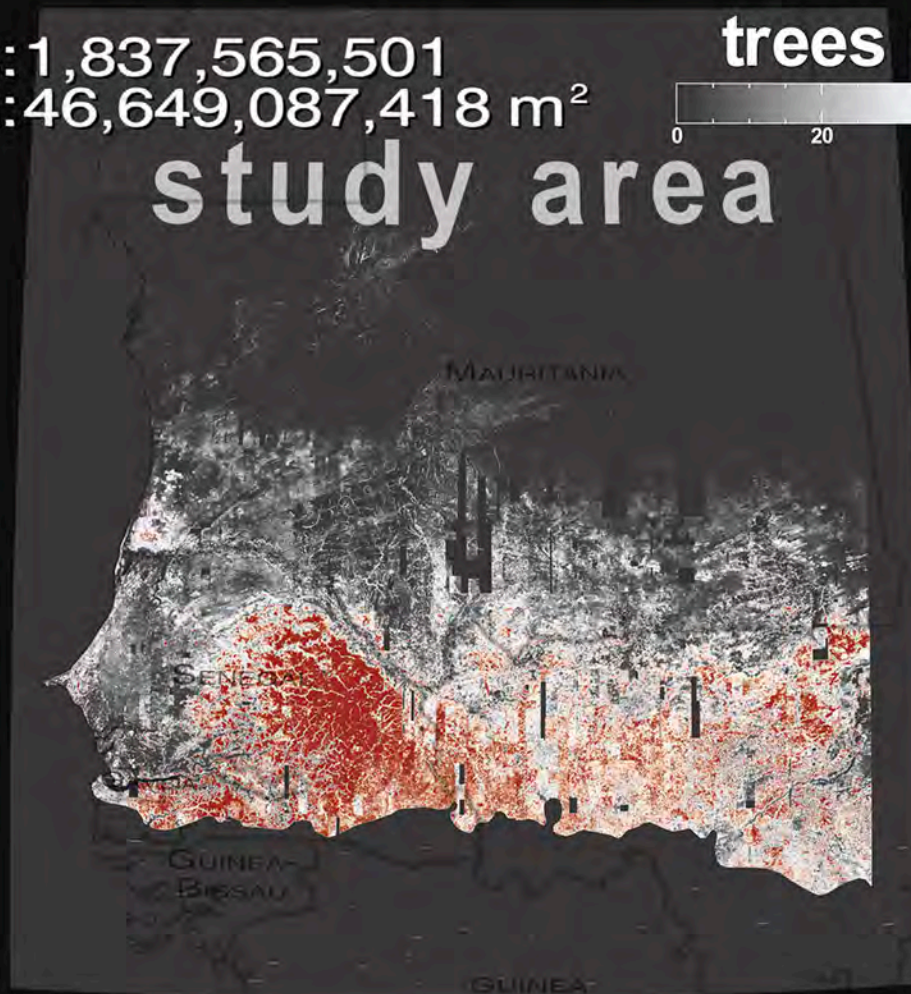
The image shows tree density per hectare for the 1.3 million-square-kilometer study area, as well as the total count of trees and the calculated tree crown area. In the color bar, 0 is dark gray, 20 is gray, 40 is light gray, 60 is light orange, and 80+ is red. *Greg Shirah, Compton Tucker, NASA/Goddard*
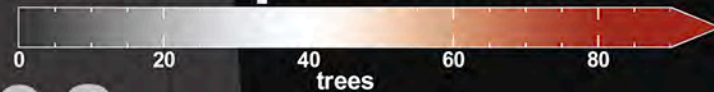
GLOBE Trees - Trees In The News

An unexpectedly large count of trees in the West African Sahara and Sahel, M. Brandt et al., 2020

- **Tree Census from Space: Quantifying Woody Biomass Using Machine Learning**
  https://www.nccs.nasa.gov/news-events/nccs-highlights/censustrees

- **Satellite Tree Enumeration Outside of Forests at the 50-Centimeter Scale**
  https://www.nas.nasa.gov/SC20/demos/demo23.html

- **NASA Supercomputing Study Breaks Ground for Tree Mapping, Carbon Research**
  https://svs.gsfc.nasa.gov/13736 Released on October 16, 2020

Extended Data Fig. 1: Predicting tree crowns
From: An unexpectedly large count of trees in the West African Sahara and Sahel

Label+prediction   Prediction only   Label only
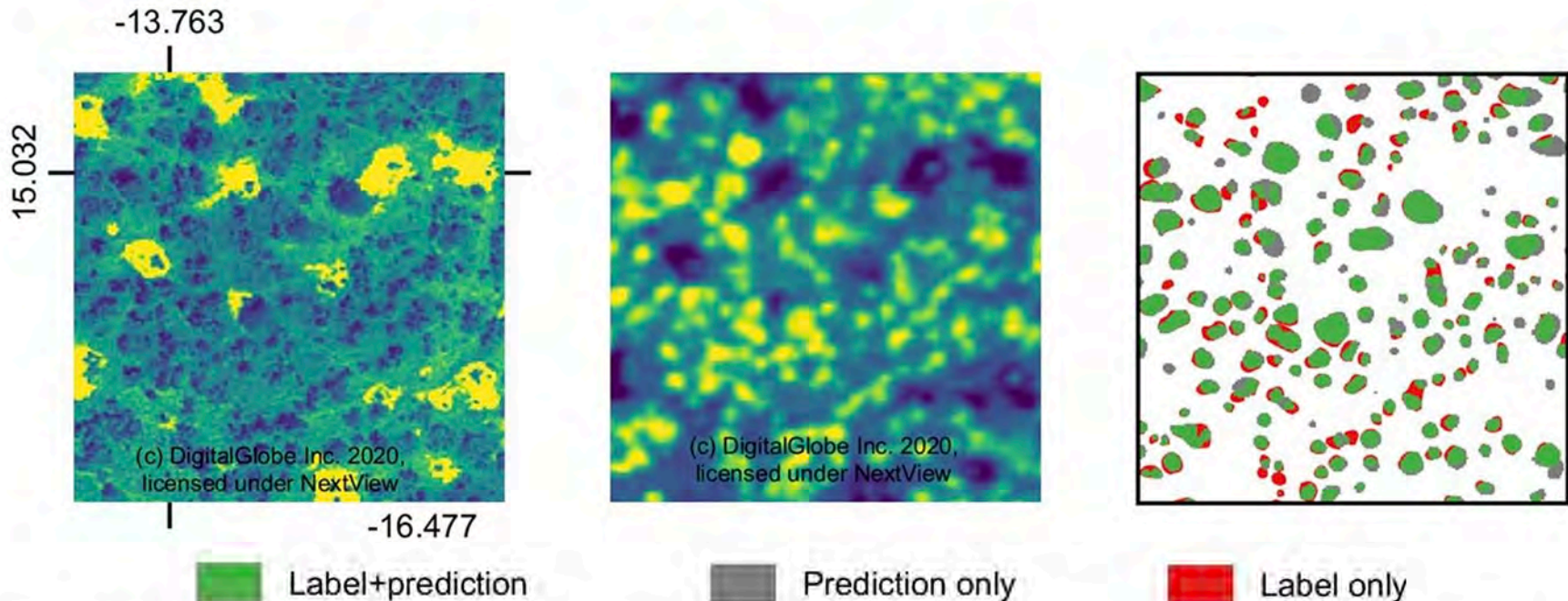
This set of 256 × 256-pixel plots from the independent test dataset shows the capabilities of the convolutional neural network model to predict trees (right column) from panchromatic images (left column) and NDVI (central column) at 0.5-m resolution.

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