Article

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

https://doi.org/10.1038/s41586-020-2824-5

Received: 26 August 2019

Accepted: 9 September 2020

Published online: 14 October 2020

Check for updates

Martin Brandt[1,2✉], Compton J. Tucker[3✉], Ankit Kariryaa[2,4], Kjeld Rasmussen[1], Christin Abel[1], Jennifer Small[2,3], Jerome Chave[5], Laura Vang Rasmussen[1], Pierre Hiernaux[2,6], Abdoul Aziz Diouf[7], Laurent Kergoat[8], Ole Mertz[1], Christian Igel[9], Fabian Gieseke[9,10], Johannes Schöning[4], Sizhuo Li[1], Katherine Melocik[2,3], Jesse Meyer[2,3], Scott Sinno[2,3], Eric Romero[2,3], Erin Glennie[2,3], Amandine Montagu[11], Morgane Dendoncker[12] & Rasmus Fensholt[1]

A large proportion of dryland trees and shrubs (hereafter referred to collectively as trees) grow in isolation, without canopy closure. These non-forest trees have a crucial role in biodiversity, and provide ecosystem services such as carbon storage, food resources and shelter for humans and animals[1,2]. However, most public interest relating to trees is devoted to forests, and trees outside of forests are not well-documented[3]. Here we map the crown size of each tree more than 3 m^2 in size over a land area that spans 1.3 million km^2 in the West African Sahara, Sahel and sub-humid zone, using submetre-resolution satellite imagery and deep learning[4]. We detected 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 canopy cover increases from 0.1% (0.7 trees per hectare) in hyper-arid areas, through 1.6% (9.9 trees per hectare) in arid and 5.6% (30.1 trees per hectare) in semi-arid zones, to 13.3% (47 trees per hectare) in sub-humid areas. Although the overall canopy cover is low, the relatively high density of isolated trees challenges prevailing narratives about dryland desertification[5–7], and even the desert shows a surprisingly high tree density. Our assessment suggests a way to monitor trees outside of forests globally, and to explore their role in mitigating degradation, climate change and poverty.

[1]Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen, Denmark. [2]Science Systems and Applications Inc., NASA Goddard Space Flight Center, Greenbelt, MD, USA. [3]NASA Goddard Space Flight Center, Greenbelt, MD, USA. [4]HCI Group, University of Bremen, Bremen, Germany. [5]Laboratoire Evolution and Diversité Biologique, CNRS, UPS, IRD, Université Paul Sabatier, Toulouse, France. [6]Pastoralisme Conseil, Caylus, France. [7]Centre de Suivi Ecologique, Dakar, Senegal. [8]Geosciences Environnement Toulouse (GET), Observatoire Midi-Pyrénées, UMR 5563 (CNRS/UPS/IRD/CNES), Toulouse, France. [9]Department of Computer Science (DIKU), University of Copenhagen, Copenhagen, Denmark. [10]Department of Information Systems, University of Münster, Münster, Germany. [11]Département de Géosciences, Ecole Normale Supérieure, Paris, France. [12]Earth and Life Institute, Environmental Sciences, Université Catholique de Louvain, Louvain-la-Neuve, Belgium. ✉e-mail: mabr@ign.ku.dk; compton.j.tucker@nasa.gov