Trees Outside Forests in Global Drylands

www.treesoutsideforests.com

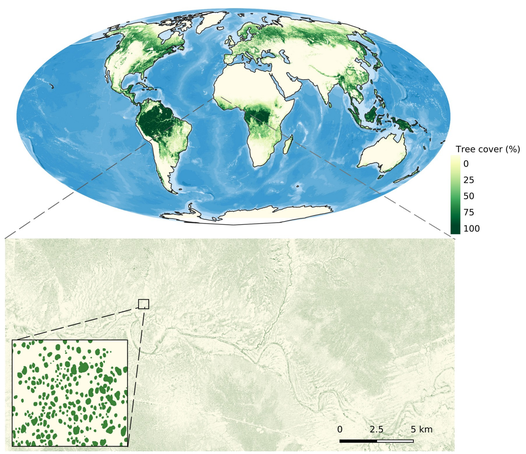
Department of Geosciences and Natural Resource Management
UNIVERSITY OF COPENHAGEN

Martin Brandt[1] (mabr@ign.ku.dk), Compton J. Tucker[2], Florian Reiner[1], Maurice Mugabowindekwe[1], Xiaoye Tong[1], Sizhuo Li[1], Ankit Kariryaa[1], Pierre Hiernaux[3], Siyu Liu[1], Yuemin Yue[4], Rasmus Fensholt[1]

Motivation:

- The number of trees growing outside forests and their role in the global carbon cycle are relatively unknown.
- New satellite images and deep learning make it possible to identify trees with an unprecedented accuracy.

Normal satellite systems cannot capture trees that grow in isolation, consequently, drylands appear as empty in previous tree cover maps. We are filling these empty areas now:

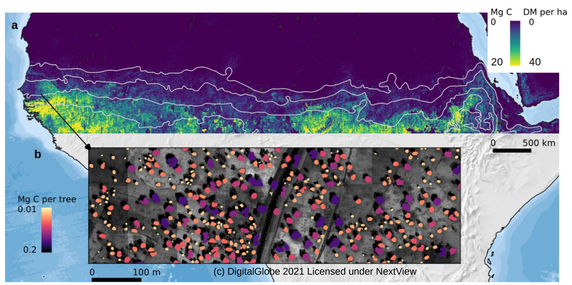


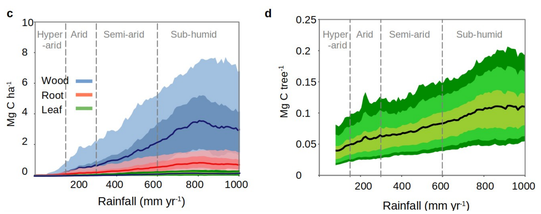
Aims:

- Mapping trees outside forest and their carbon stocks across global drylands.
- Study ecological and economic values at the tree level.
- Expand to forests and non-drylands.

Carbon stocks at tree level

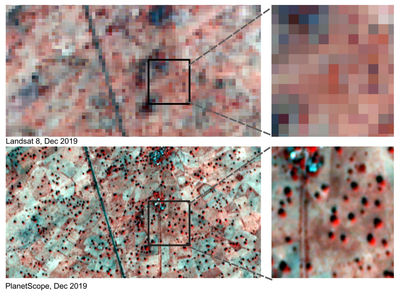
- Together with our colleagues at NASA we use hundreds of thousands of Maxar images within the NextView license agreement to map single tree crowns at 50 cm resolution.
- We train the deep learning models with hand labeled trees.
- Allometric equations from field data are used to estimate carbon stocks at tree level.
- Wood, leaf and root mass of 15 billion trees are predicted here for the Sahara, Sahel and Sudanian zone:



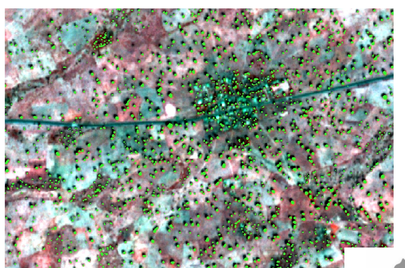


Continental scale with PlanetScope

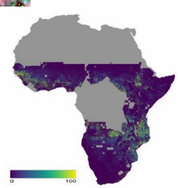
- We form global mosaics of PlanetScope images at 3 m resolution.
- Unlike Landsat and Sentinel-2, individual trees can be identified in PlanetScope images:



- We map both single trees outside forests and closed canopy areas at continental scale and 1 -m resolution (resampled).
- Tree height is added by training with LiDAR data.

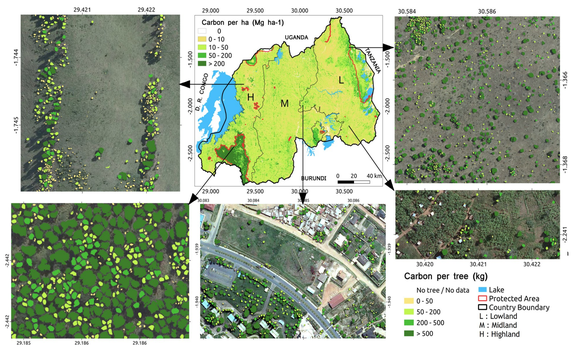


- First continental scale maps are ready

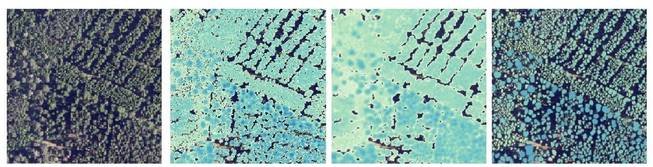


Beyond drylands

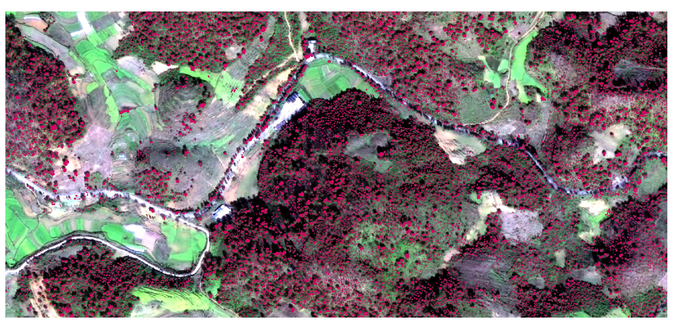
- We also work in humid tropical countries,here Rwanda using aerial images:



- We work also in the northern hemisphere. Here an example from Denmark showing, from left to right, an aerial image, a LiDAR canopy height model, predicted canopy height, and segmented tree crowns (+height) in a Danish forest:



- Another example using Gaofen-2 images from Southern China:



(1) Department of Geoscience and Natural Resourse Management, University of Copenhagen, Denmark, (2) GSFC, NASA, USA, (3) Université Paul Sabatier, Toulouse, France (4) ISRA and CAS, Changsha, China This project has received funding from European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement no. 947757