MELANOBS workshop – Noumea, April 2024

MELANOBS: forest cover change, carbon, and biodiversity data in Melanesia

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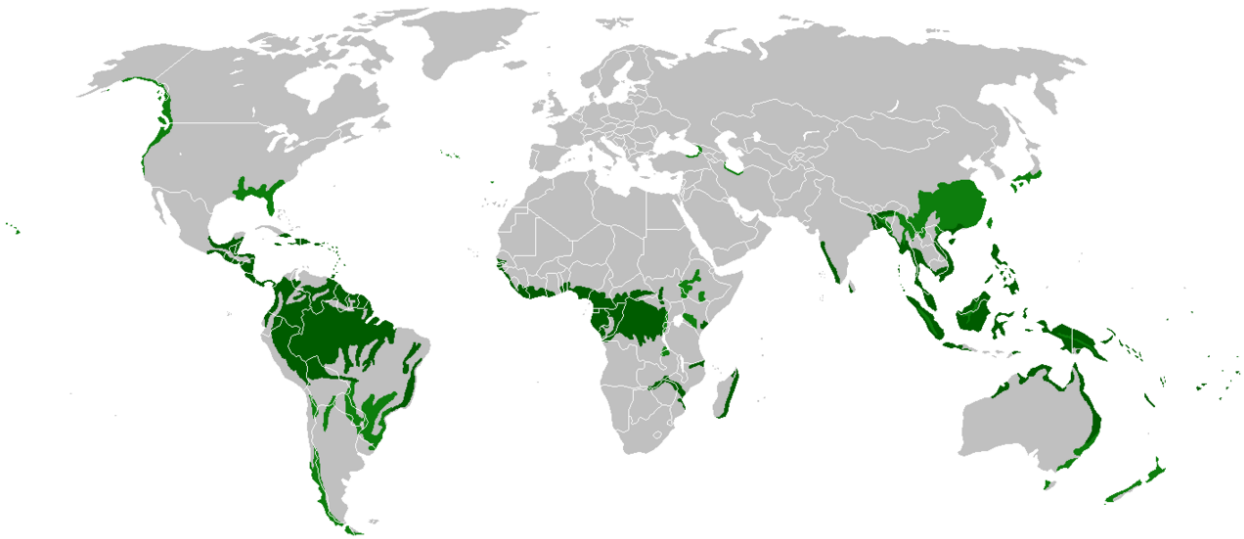
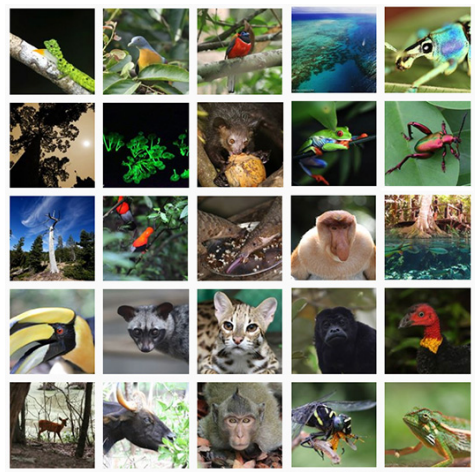
Outline

Plan

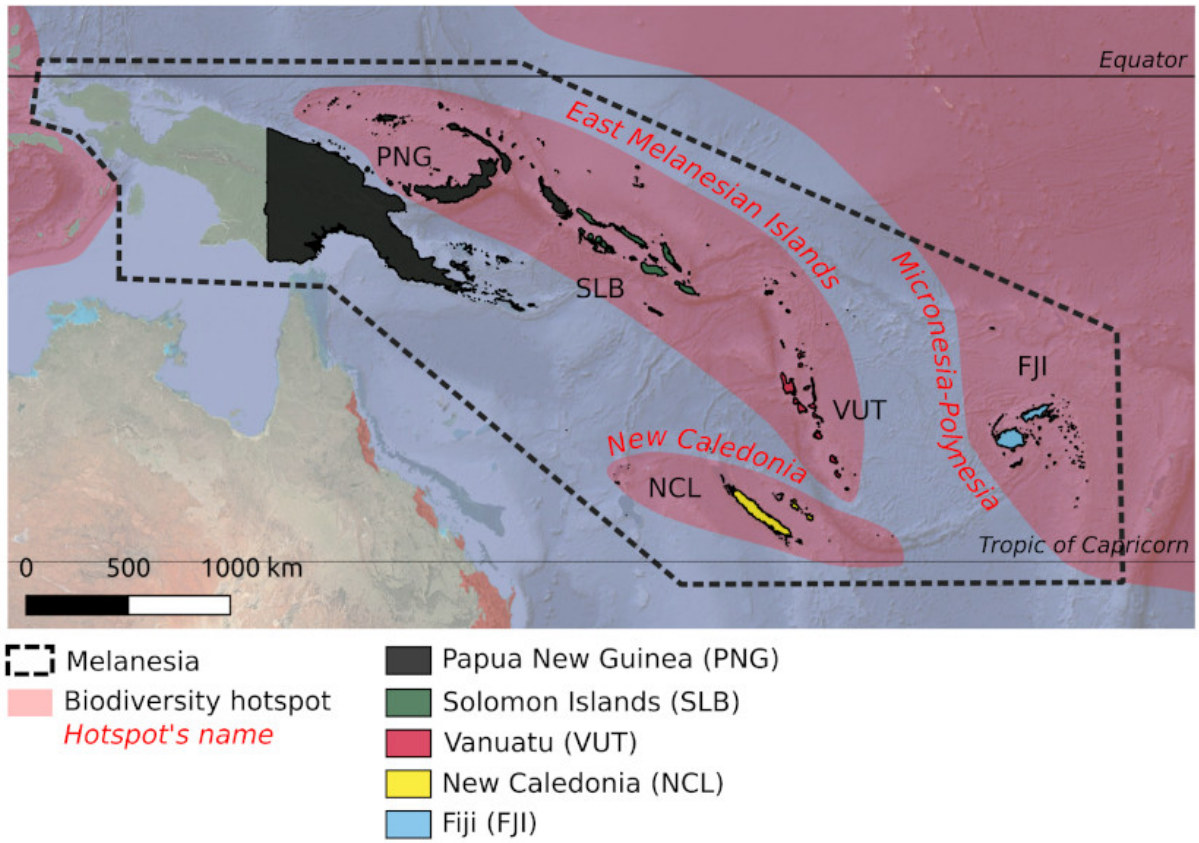
Context





- Tropical forests : ~50% of terrestrial biodiversity.
- Tropical deforestation : ~15% of anthropogenic carbon emissions.
- Carbon and biodiversity vary strongly spatially.
- Mapping forest cover, carbon and biodiversity is essential for conservation planning.

Objectives



- MELANOBS project : building a Melanesian forest observatory.
- Which data on forest cover, carbon stock and biodiversity are available for Melanesian countries ?

Plan

FAO FRA estimates, forest cover

Table – **Forest cover estimates (in % of land area).**

Country	Area (km2)	FRA 2015
PNG	462840	78%
Solomon Islands	28896	87%
Vanuatu	12189	36%
Fiji	18272	61%
New Caledonia	18575	45%

- Forest Ressources Assessment (FRA) from the Food and Agriculture Organization (FAO).
- Estimates are reported by countries to FAO.
- Differentiate forest types : forest, primary forest, plantations.
- Not frequently updated.
- Information is not spatialized.

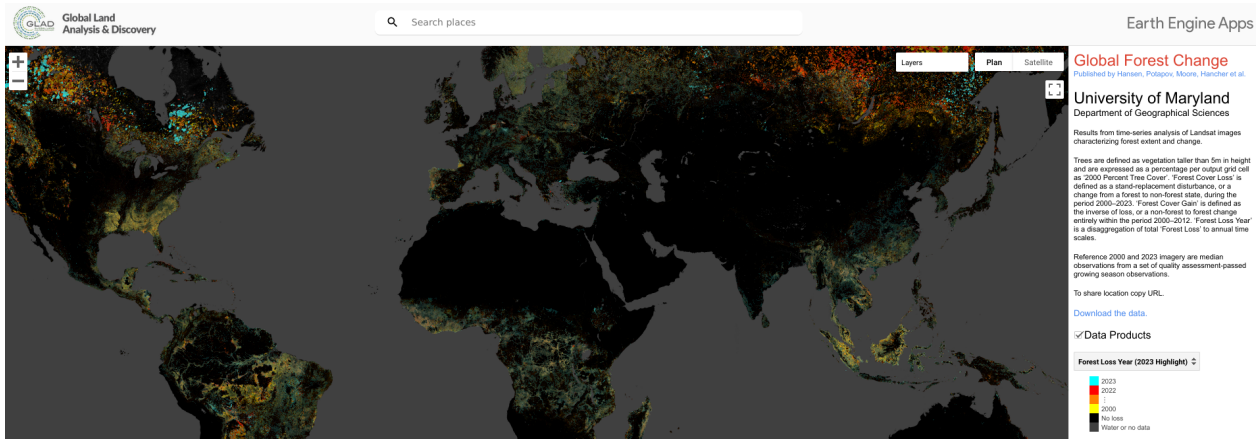
FAO FRA estimates, deforestation

Table – **Mean annual deforestation (in ha).**

Country	FRA 2015–2020
PNG	34000
Solomon Islands	
Vanuatu	
Fiji	
New Caledonia	

- Rather good estimates of forest cover but poor estimates of deforestation/regrowth.

Global Forest Change (GFC)



- Global Forest Change (Hansen et al. 2013, Univ. of Maryland).
- Used by Global Forest Watch (GFW) : platform about the world forests. GFW releases the Global Forest Review.
- It is in fact a tree cover change product. User must define a tree cover threshold to define the forest (e.g. 30%).
- Derive from Landsat images from 2000. 30m resolution. One mosaic per year.

Global Forest Change (GFC)

Table – **Forest cover estimates (in % of land area).**

Country	Area (km2)	FRA 2015	GFC30 2020
PNG	462840	78%	84%
Solomon Islands	28896	87%	81%
Vanuatu	12189	36%	81%
Fiji	18272	61%	57%
New Caledonia	18575	45%	62%

Table – **Mean annual deforestation (in ha).**

Country	FRA 2015–2020	GFC30 2010–2020
PNG	34000	104678
Solomon Islands		13460
Vanuatu		939
Fiji		2663
New Caledonia		1328

- Overestimate forest cover if low tree cover threshold (e.g. 30%).
- Underestimate small-scale deforestation (e.g. logging).

Tropical Moist Forests (TMF)

SCIENCE ADVANCES | RESEARCH ARTICLE

ENVIRONMENTAL STUDIES

Long-term (1990–2019) monitoring of forest cover changes in the humid tropics

C. Vancutsem[1]*, F. Achard[1], J.-F. Pekel[1], G. Vieilledent[1,2,3,4], S. Carboni[5], D. Simonetti[1], J. Gallego[1], L. E. O. C. Aragão[6], R. Nasi[7]

- Tropical Moist Forests (Vancutsem et al. 2021, from Joint Research Center).
- Only consider evergreen tropical forests (tropical moist forests, mangroves, evergreen dry tropical forests). Cannot be used to monitor deciduous dry forests.
- Derive from Landsat images from 1990. 30m resolution. Time-series at the pixel scale.

Tropical Moist Forests (TMF)

Table – **Forest cover estimates (in % of land area).**

Country	Area (km2)	FRA 2015	GFC30 2020	TMF 2020
PNG	462840	78%	84%	85%
Solomon Islands	28896	87%	81%	95%
Vanuatu	12189	36%	81%	95%
Fiji	18272	61%	57%	–
New Caledonia	18575	45%	62%	46%

Table – **Mean annual deforestation (in ha).**

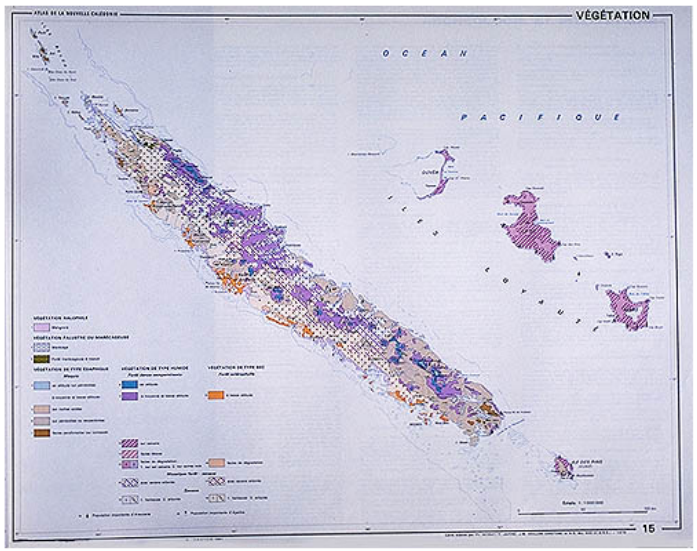
Country	FRA 2015–2020	GFC30 2010–2020	TMF 2010–2020
PNG	34000	104678	48691
Solomon Islands		13460	1751
Vanuatu		939	564
Fiji		2663	–
New Caledonia		1328	2425

- Fiji is not entirely available (beyond the 180th meridian).
- Overestimate forest cover in some areas (e.g. Vanuatu).

National data

- There is room to improve forest cover change maps at the national scale.
- MELANOBS objectives :
  - Which forest cover change data is available at the national scale ?
  - Derive up to date forest cover change maps for participating countries.

In New-Caledonia



- Coarse vegetation maps from IRD (Jaffre, Morat).
- Forest cover change map for 2000-2010-2020 derived from TMF.
- Natural forest cover map for year ~2020 derived from photo-interpretation of aerial images.

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Global maps

Name	Resolution	Reference	Epoch	Method
Saatchi	1 km	Saatchi 2011	2000	GLAS, MODIS, QSCAT, SRTM
WHRC-Baccini	500 m	Baccini 2012	2008	GLAS, MODIS, SRTM
Avitabile	1 km	Avitabile 2016	2008	fusion of Saatchi and Baccini
GFW-Baccini	30 m	Baccini 2017	2000	GLAS, Landsat, SRTM
CCI Biomass	100 m	Santoro 2019	2020	ALOS2, PALSAR 2, Sentinel 1
GEDI$\star$	1 km	Dubayah 2023	2020	LiDAR GEDI 2, ALS
more...				

- Usually a three step approach : field data, LiDAR, satellite images.
- Satellites images (optical or radar) are used for extrapolation.
- $\star$ different approach for GEDI products (see below).

Disadvantages of global products

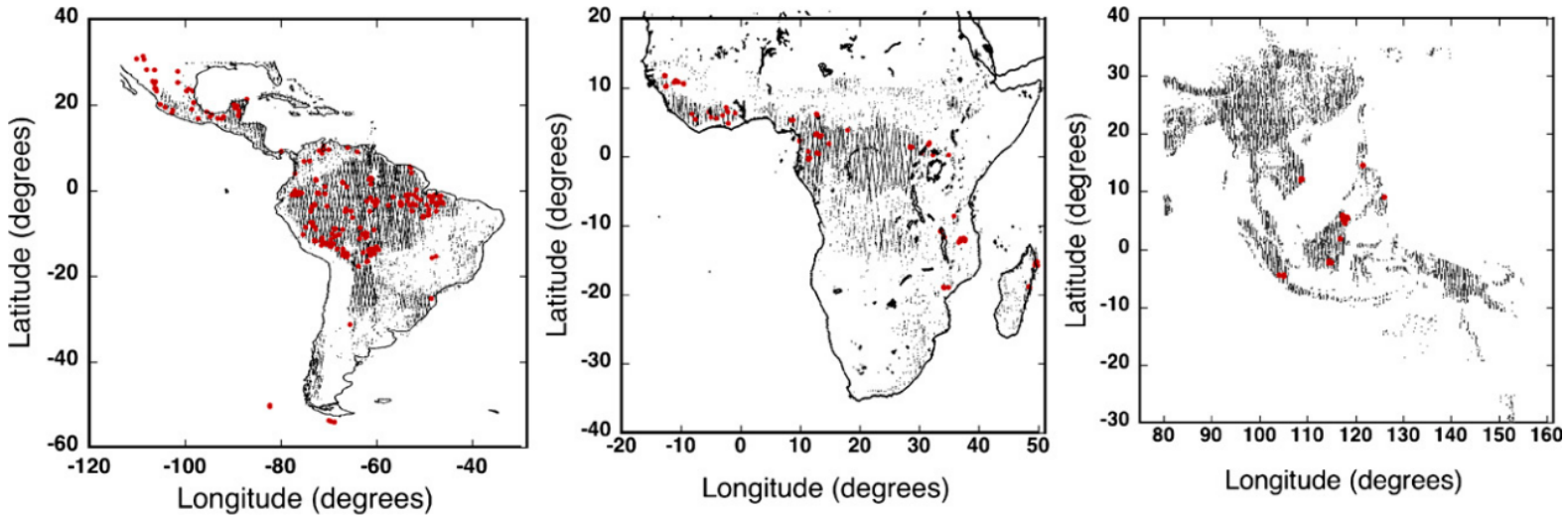
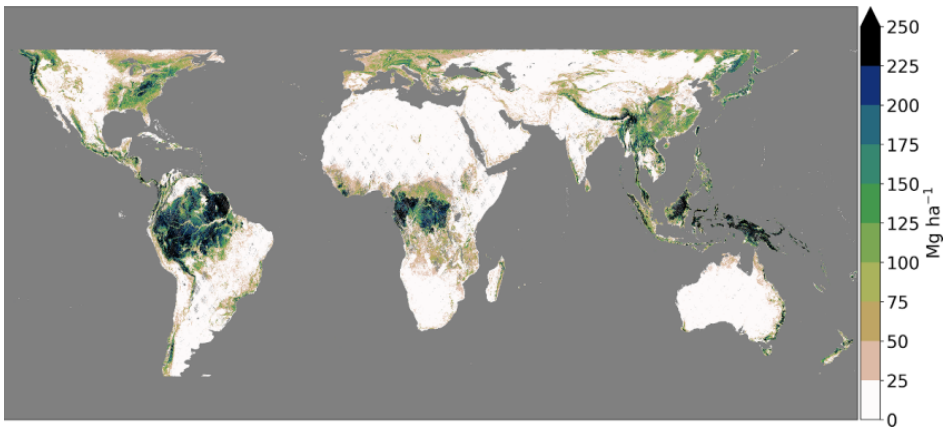
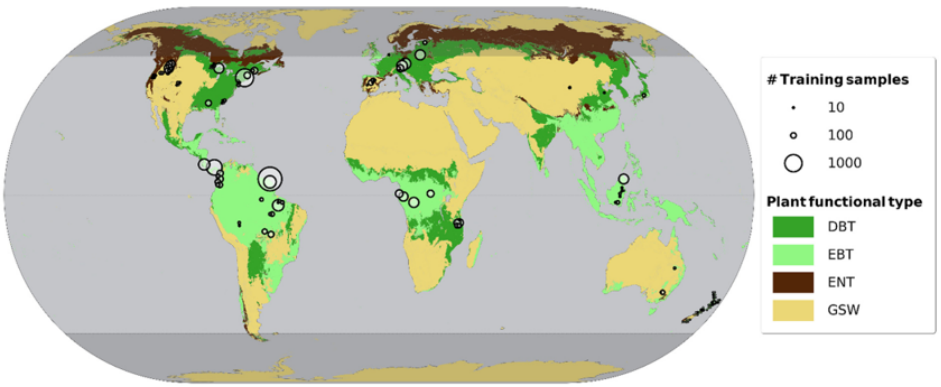


Figure – **Field plots used in Saatchi et al. 2011**

- Some countries might be absent from the final map (eg. New Caledonia for Saatchi, WHRC-Baccini and Avitabile's maps).
- Global models might not be accurate for countries with no field data for calibration.
- High discrepancies between maps.
- Resolutions might be coarse : >= 500 m.

GEDI derived AGB map



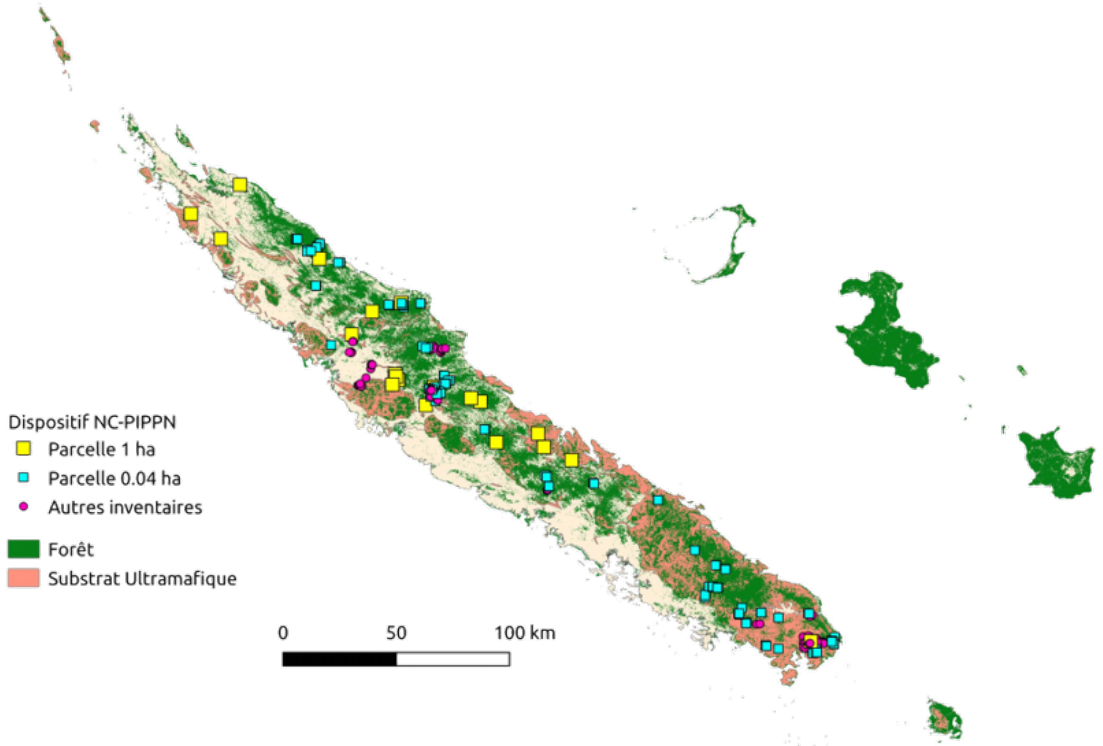


- No extrapolation using satellite images and SRTM.
- GEDI footprints are aggregated within 1 km grid cells.
- Low resolution : 1 km, location uncertainty of about 25 m.
- Same problem as for other data-sets : no field data from Melanesia for calibration.

National maps

- There is room to improve forest carbon stock maps at the national scale.
- MELANOBS objectives :
  - Which forest carbon data is available at the national scale ?
  - Derive up to date forest carbon stock maps for participating countries.

In New-Caledonia



- No existing national forest carbon stock map.
- NC-PIPPN forest inventory network + MELANOBS network of 1ha permanent forest plots.
- LiDAR data.
- Good cover by GEDI.

Plan

Global biodiversity maps

- As a first approximation of biodiversity in forests, we can focus on tree diversity.
- One objective would be to obtain tree community maps (β diversity).
- More detailed forest typology than dichotomic dry/moist forests or low-elevation/high-elevation forests.
- Global maps often represent species richness (α-diversity). A few examples below.

Global biodiversity maps

PNAS RESEARCH ARTICLE | ENVIRONMENTAL SCIENCES SUSTAINABILITY SCIENCE

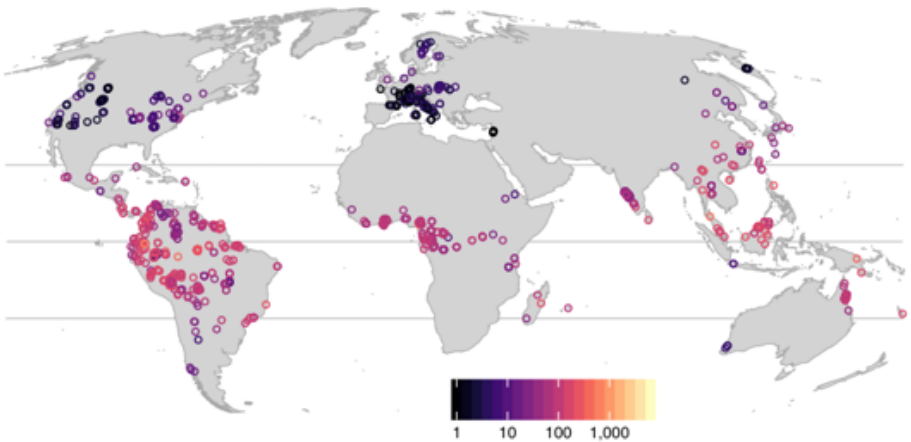
High exposure of global tree diversity to human pressure

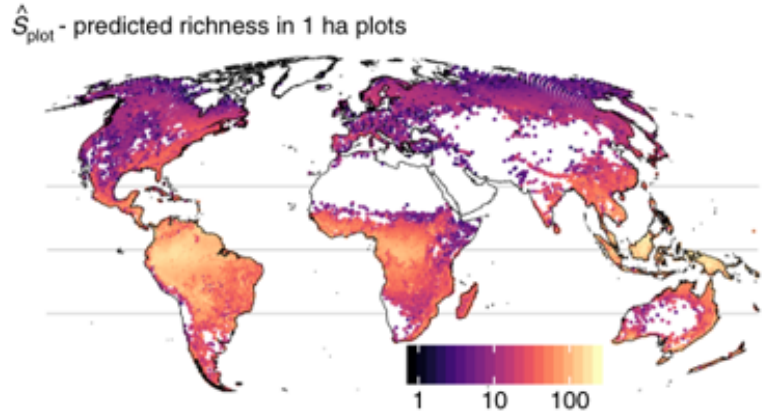
Wen-Yong Guo (郭文永)[a,b,c,d,1], Josep M. Serra-Diaz[e], Franziska Schrodt[f], Wolf L. Eiserhardt[b], Brian S. Maitner[g], Cory Merow[h,i], Cyrille Violle[j], Madhur Anand[k], Michaël Belluau[l], Hans Henrik Bruun[m], Chaeho Byun[n], Jane A. Catford[o], Bruno E. L. Cerabolini[p], Eduardo Chacón-Madrigal[q], Daniela Ciccarelli[r], J. Hans C. Cornelissen[s], Anh Tuan Dang-Le[t,u], Angel de Frutos[v], Arildo S. Dias[w], Aelton B. Giroldo[x], Kun Guo[c,d], Alvaro G. Gutiérrez[y,z], Wesley Hattingh[aa], Tianhua He (何田华)[bb,cc], Peter Hietz[dd], Nate Hough-Snee[ee], Steven Jansen[ff], Jens Kattge[v,gg], Tamir Klein[hh], Benjamin Komac[ii], Nathan J. B. Kraft[jj], Koen Kramer[kk,ll], Sandra Lavorel[mm], Christopher H. Lusk[nn], Adam R. Martin[oo], Maurizio Mencuccini[pp,qq], Sean T. Michaletz[rr,ss], Vanessa Minden[tt,uu], Akira S. Mori[vv], Ülo Niinemets[ww], Yusuke Onoda[xx], Josep Peñuelas[yy,zz], Valério D. Pillar[aaa], Jan Pisek[bbb], Bjorn J. M. Robroek[ccc], Brandon Schamp[ddd], Martijn Slot[eee], Ênio Egon Sosinski Jr.[fff], Nadejda A. Soudzilovskaia[ggg], Nelson Thiffault[hhh], Peter van Bodegom[iii], Fons van der Plas[jjj], Ian J. Wright[kkk,lll], Wu-Bing Xu[a,b,v], Jingming Zheng[mmm], Brian J. Enquist[g,nnn], and Jens-Christian Svenning[a,b,1]

Edited by Hugh Possingham, The Nature Conservancy, Sherwood, QLD, Australia; received December 29, 2020; accepted April 13, 2022

- SDM for 46,752 tree species from GBIF, BIEN, DRYFLOR, RAINBIO, and ALA datasets.
- They considered taxonomic, phylogenetic, and functional diversity but disregarded β-diversity.

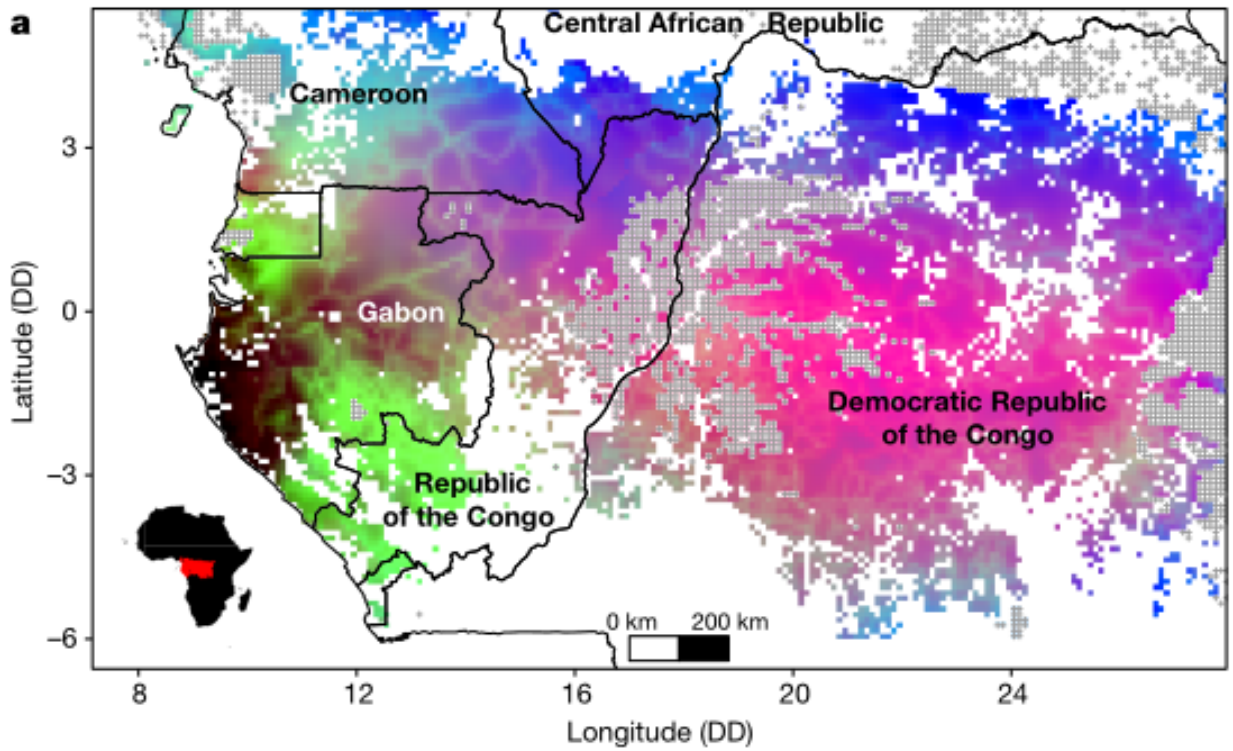
Global biodiversity maps





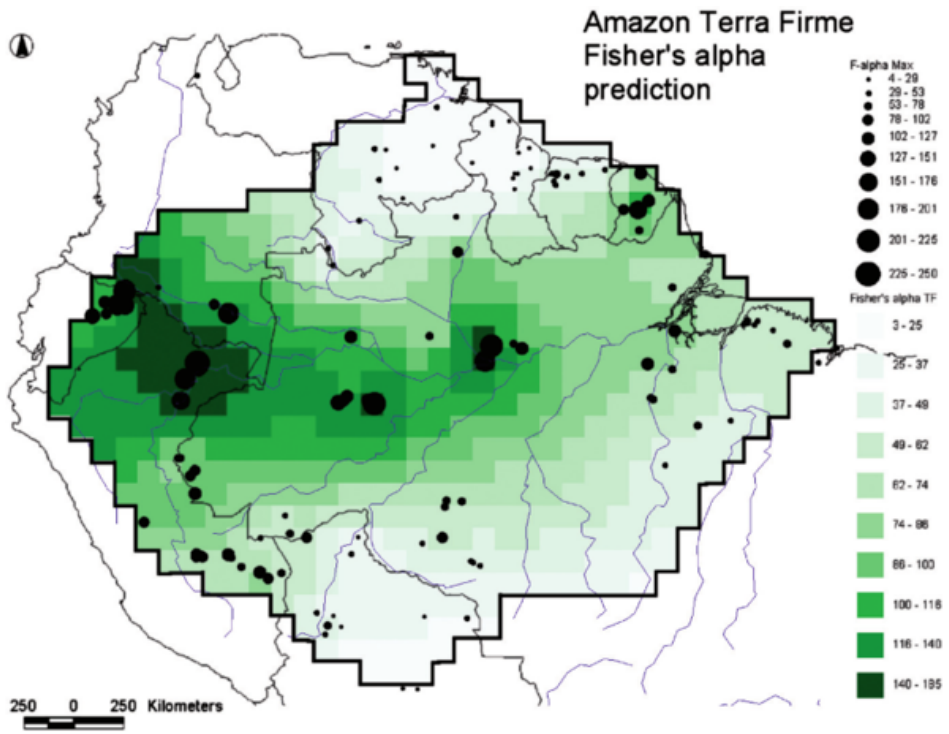
Keil & Chase. (2019). Global patterns and drivers of tree diversity integrated across a continuum of spatial grains. *Nature Ecology & Evolution*.

Continental biodiversity maps



Réjou-Méchain et al. (2021). Unveiling African rainforest composition and vulnerability to global change. *Nature*.

Continental biodiversity maps



ter Steege et al. (2003). A spatial model of tree α-diversity and tree density for the Amazon. *Biodiversity and Conservation*.

Global or continental tree data-sets

- GBIF : Global Biodiversity Information Facility.
- BIEN : Botanical Information and Ecology Network.
- DRYFLOR : Latin American Seasonally Dry Tropical Forest Floristic Network.
- RAINBIO : mega-database of tropical African vascular plants distributions.

National data-sets

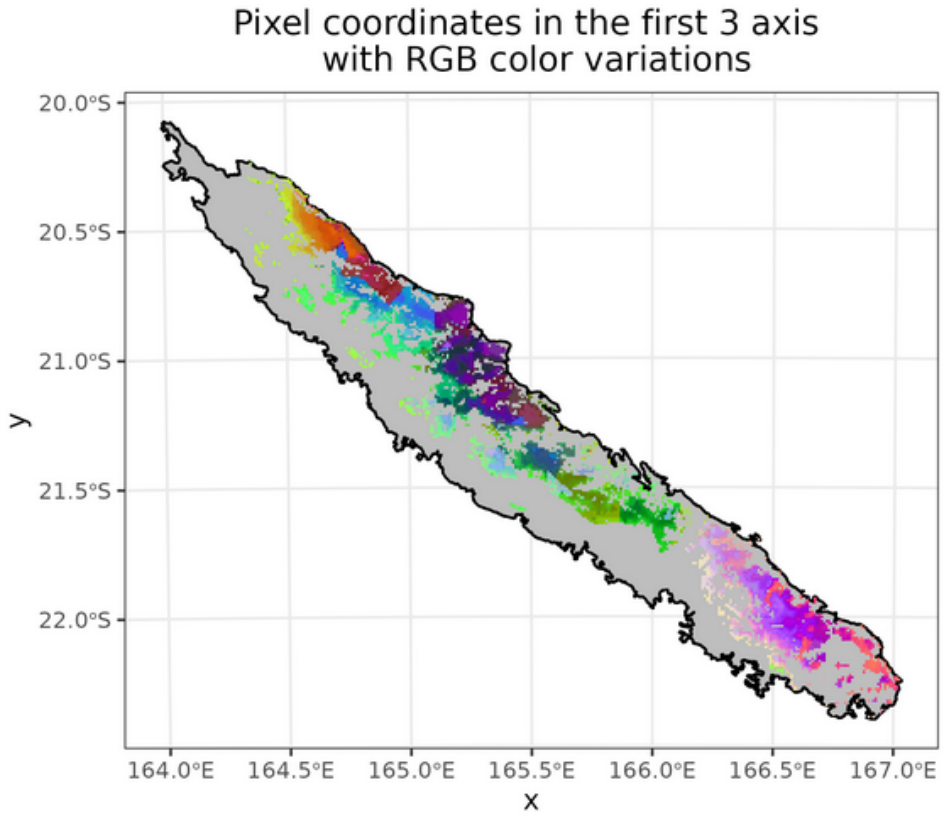
- No global or continental tree community maps that could be used at national scales.
- But there are global datasets (GBIF, BIEN) that could be used at national scales.
- MELANOBS objectives :
  - Which tree diversity data is available for each country ?
  - Derive first tree community maps for participating countries.

Tree data in New-Caledonia

endemia.nc

- NOU herbarium data.
- NC-PIPPN forest plot network with floristic data.
- Endemia (Red List Authority) data.

Mapping tree communities in New Caledonia



- Use of joint species distribution models for 878 species and 554 sites.
- JSDMs : account for species co-occurrence.
- Predicting species probability of presence for each 1km pixel.
- Clustering species to obtain tree communities.

Plan

Summary

- Melanesia is often absent from global forest cover change, carbon, or biodiversity maps.
- For carbon and biodiversity, global maps are not derived using data from Melanesia (or only a few). They do not have a high accuracy if used at the national scale.
- **Objectives** : deriving accurate maps of forest cover change, carbon stocks, and tree communities based on field data from each participating country.

Perspectives

Several perspectives for forest monitoring and conservation planning :

- How current deforestation impacts carbon emissions and biodiversity loss ?
- Identifying areas of high conservation values with regards to carbon and biodiversity.
- Anticipating the impacts of various deforestation scenarios on carbon and biodiversity.
- Potential access to carbon and biodiversity credits associated with avoided deforestation.

One example of application of forest cover change and carbon maps : the ForestAtRisk project, https://forestatrisk.cirad.fr

. . . Thank you for attention . . .

https://ecology.ghislainv.fr/presentations

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