MELANOBS workshop – Noumea, April 2024

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

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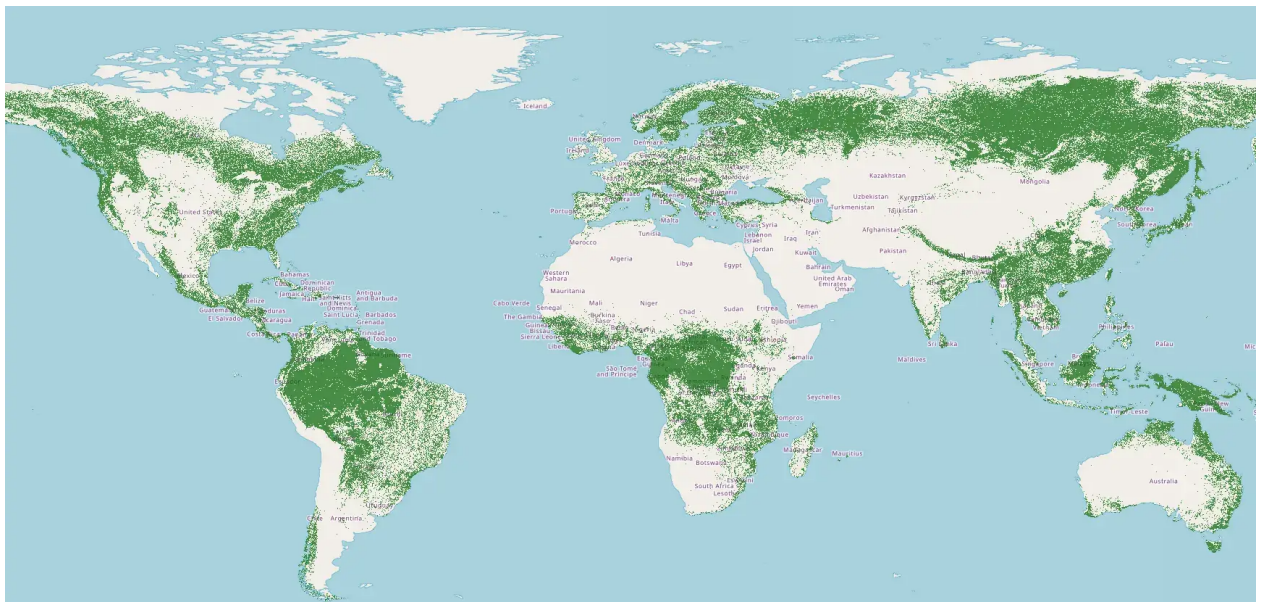
Outline

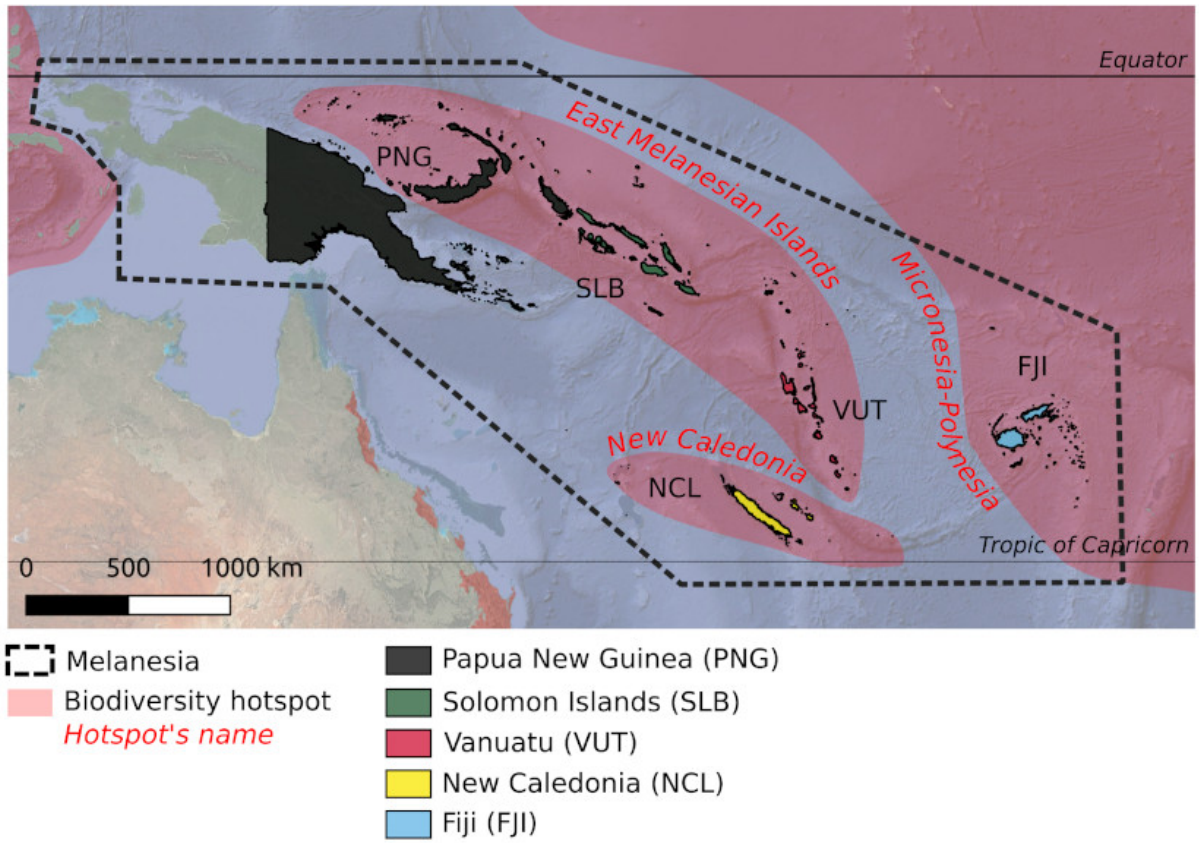
Plan

Context



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

Objectives



- MELANOBS : 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

Forest cover estimates (in Kha).

Country	FRA 2015	prim. forest	GFC30 2020	TMF 2020
PNG	36024	27200	39000	39304
Solomon Islands	2527	1738	2350	2739
Vanuatu	442	205	986	1152
Fiji	1107	0	1050	NA
New Caledonia	839	338	1150	855

- 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, forest cover

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%	NA
New Caledonia	18575	45%	62%	46%

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- Estimates are reported by countries to FAO.
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- Information is not spatialized.

FAO FRA estimates, deforestation

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

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

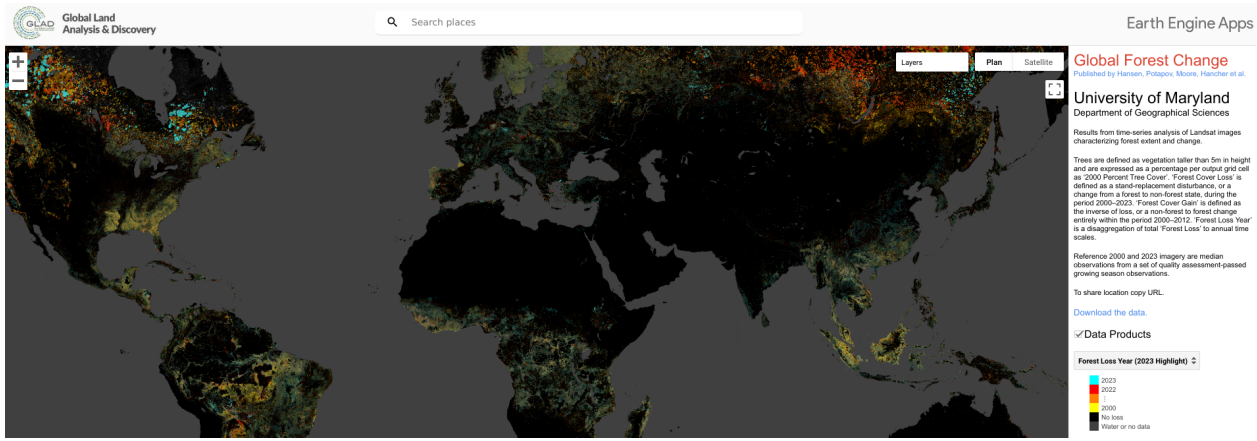
FAO FRA estimates, deforestation

Mean annual deforestation (in %/yr).

Country	FRA 2015–2020	GFC30 2010–2020	TMF 2010–2020
PNG	0.09	0.27	0.12
Solomon Islands		0.57	0.06
Vanuatu		0.1	0.05
Fiji		0.25	
New Caledonia		0.12	0.28

- 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.
- Largely overestimate forest cover if low tree cover threshold (e.g. 30%).
- Underestimate small-scale deforestation (shifting agriculture, logging).

Tropical Moist Forests (TMF)

SCIENCE ADVANCES | RESEARCH ARTICLE

ENVIRONMENTAL STUDIES

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

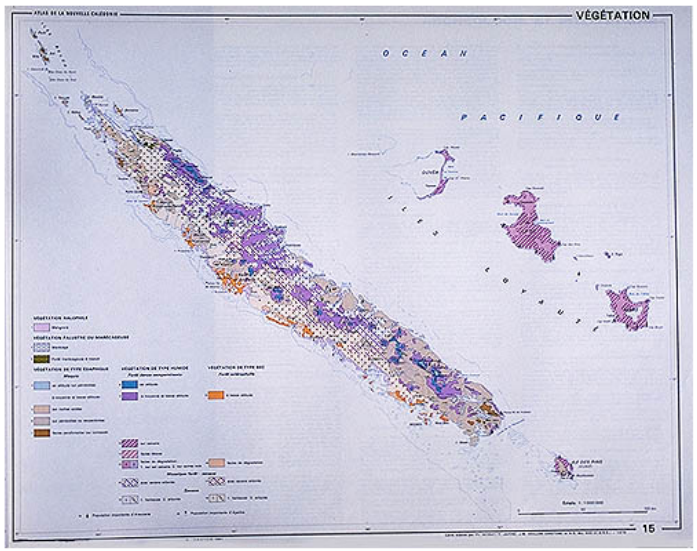
C. Vancutsem[1]*, F. Achard[1], J.-F. Pekel[1], G. Vieilledent[1,2,3,4], S. Carboni[5], D. Simonetti[1], J. Gallego[1], L. E. O. C. Aragão[6], R. Nasi[7]

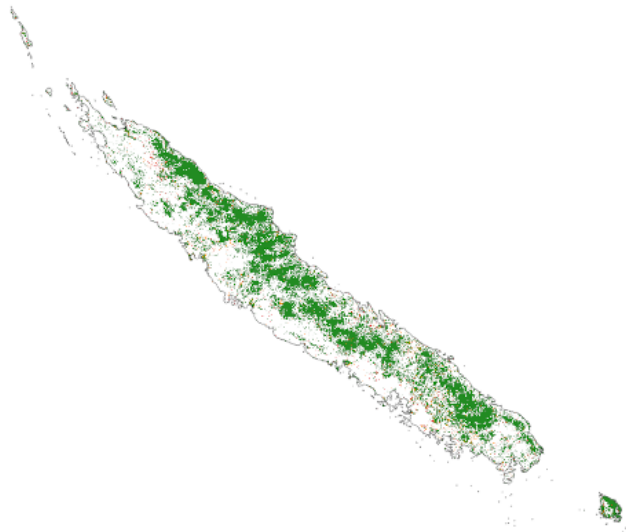
- Tropical Moist Forests (Vancutsem et al. 2021, from Joint Research Center).
- Only consider evergreen tropical forests (tropical moist forests, mangroves, evergreen dry tropical forests). Cannot be used to monitor deciduous dry forests.
- Derive from Landsat images from 1990. 30m resolution. Time-series at the pixel scale.
- Fiji is not entirely available (beyond the 180th meridian).
- Overestimate forest cover in some areas (e.g. Vanuatu, Mare island in New Caledonia).

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.

Plan

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	1 km	Dubayah 2023	2020	LiDAR GEDI 2, ALS
more...				

- Usually* a three step approach : field data, LiDAR, satellite images (optical or radar).
- $\star$ somewhat different for the GEDI product.

Disadvantages of global products

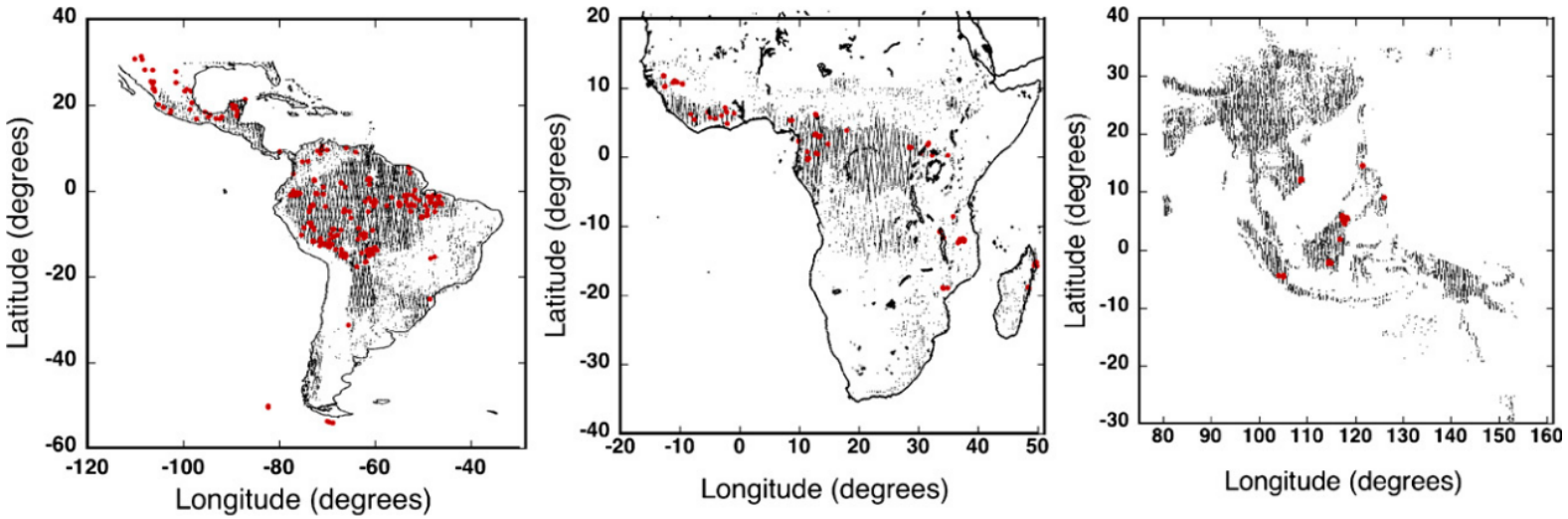
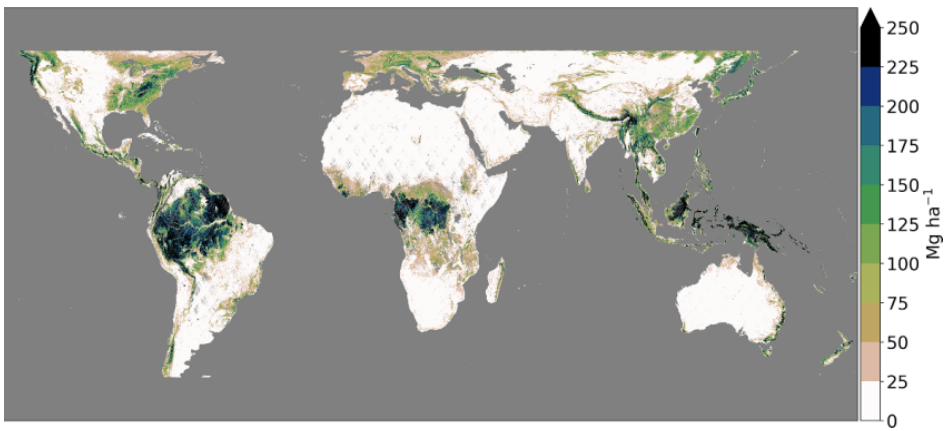
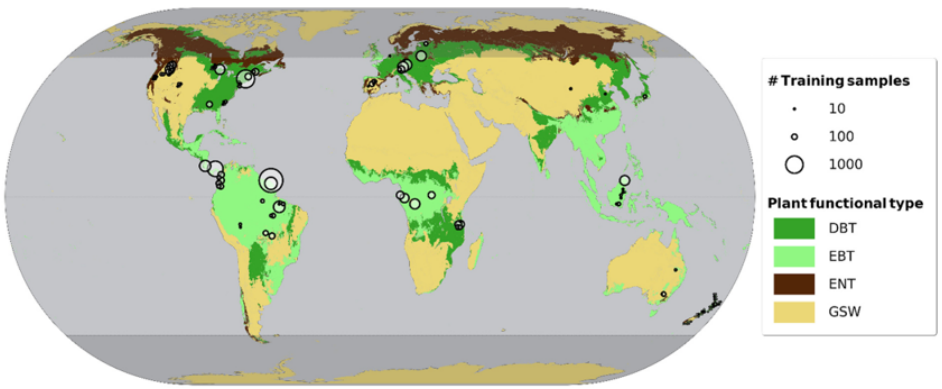


Figure – **Field plots used in Saatchi et al. 2011**

- 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



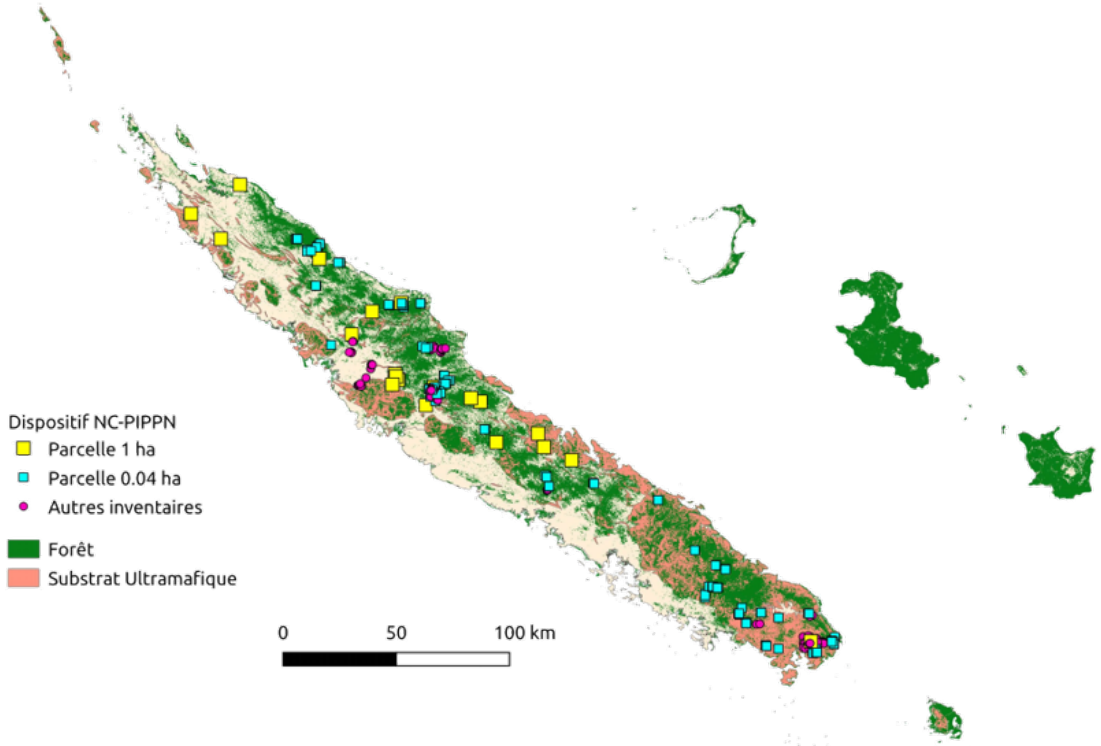


- No extrapolation using satellite images and SRTM.
- GEDI footprints are aggregated within 1 km grid cells.
- Low resolution : 1 km, location uncertainty of about 25 m.
- Same problem as for other data-sets : no field data from Melanesia for calibration.

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]

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- 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

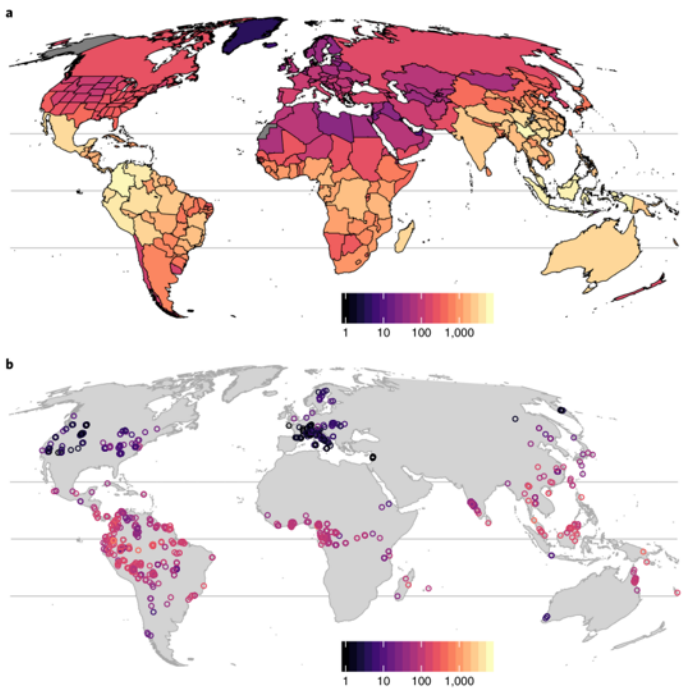
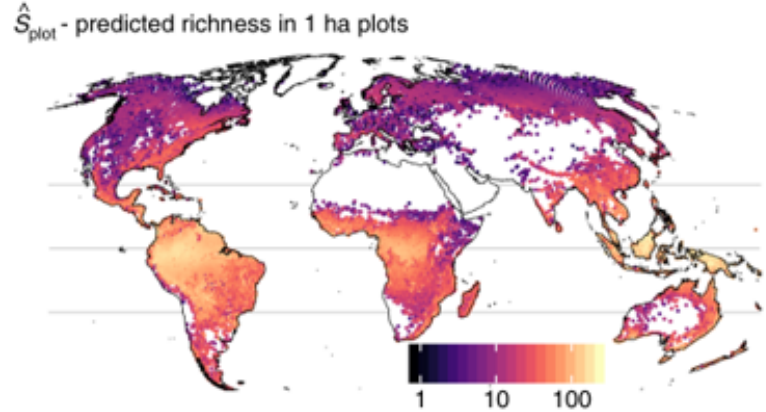
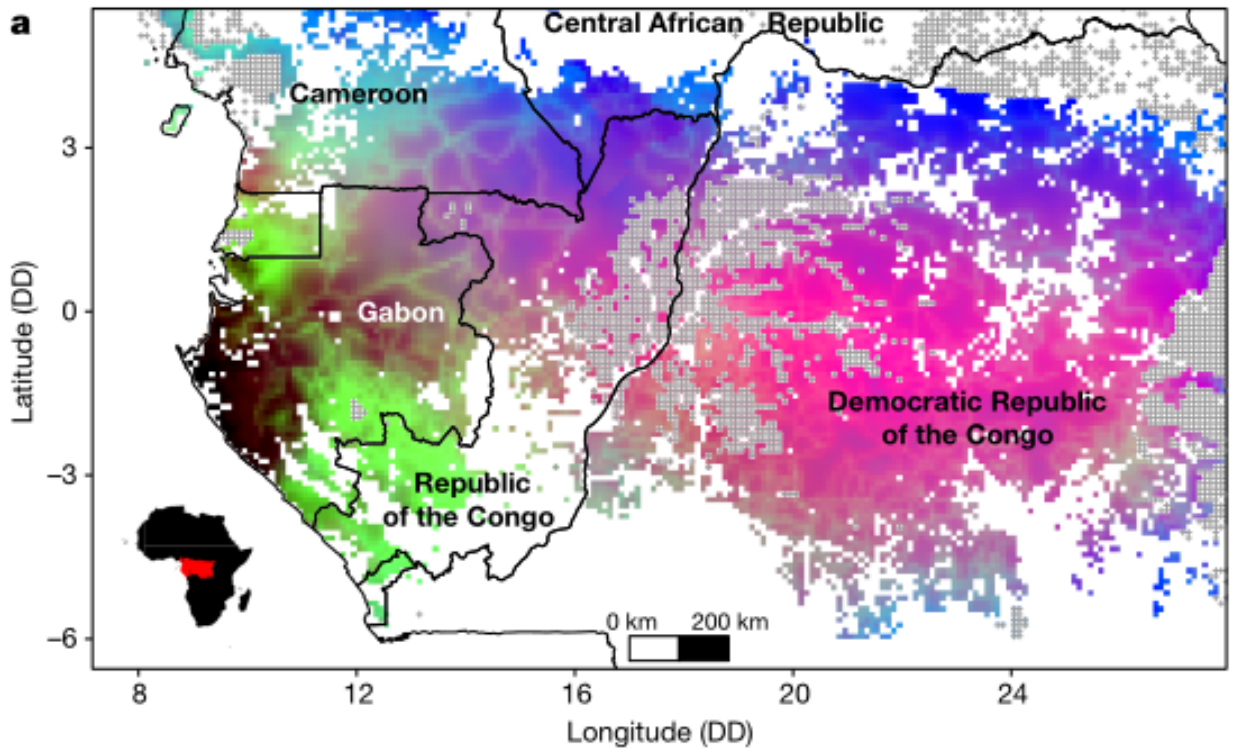


Fig. 1 | Raw data on observed tree species richness S ($\log_{10}$ scale). a, Country/states grain with 282 spatial units. **b,** Plot grain with 1,336 plots. Maps use Mollweide projection. Horizontal lines are the Equator and tropics.



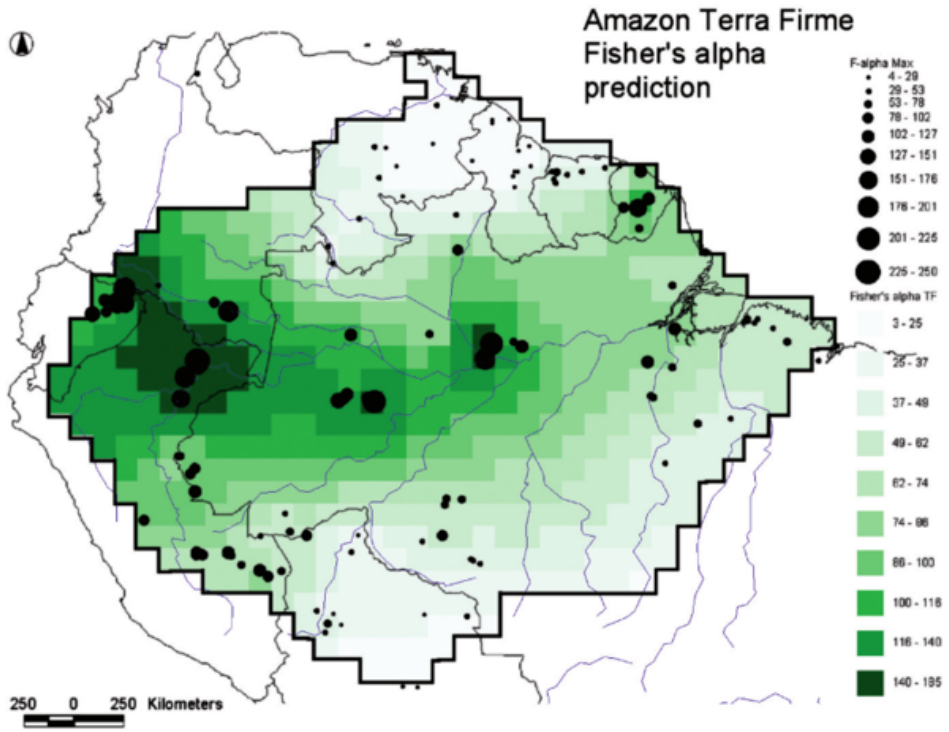
Keil & Chase. (2019). Global patterns and drivers of tree diversity integrated across a continuum of spatial grains. *Nature Ecology & Evolution*.

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.

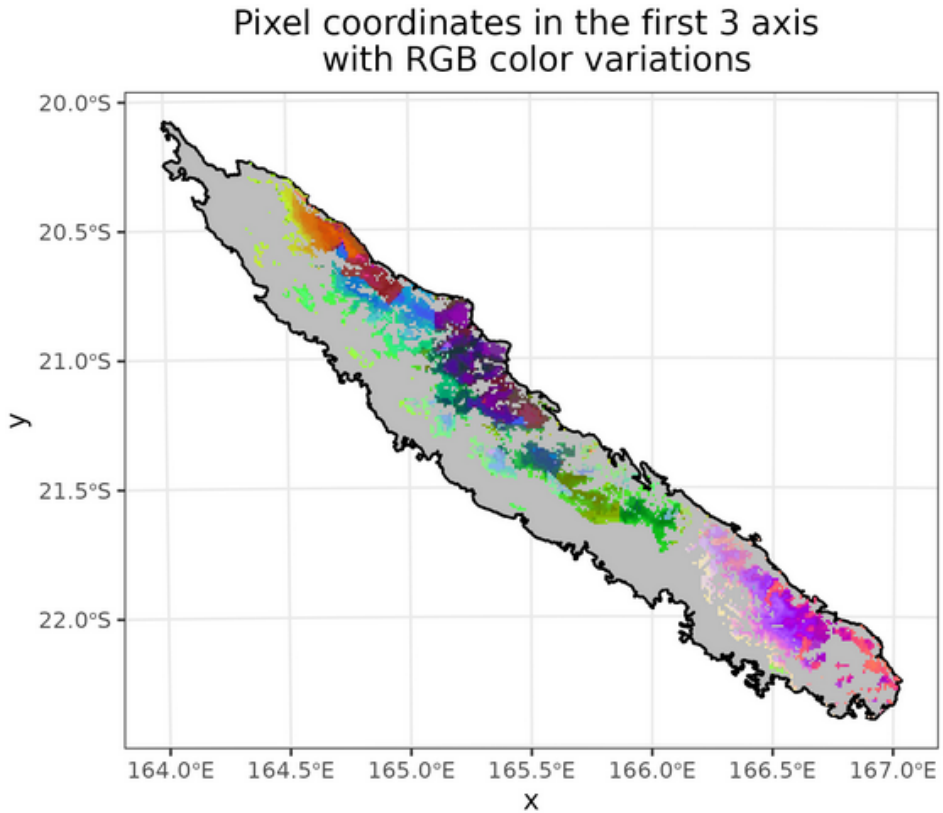
National data-sets

- 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

- 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 impact carbon emissions and biodiversity loss ?
- Identifying areas of high conservation values with regards to carbon and biodiversity.
- Anticipating impact on carbon and biodiversity of various deforestation scenarios.
- Carbon and biodiversity credits associated with avoided deforestation.

. . . Thank you for attention . . .

https://ecology.ghislainv.fr/presentations

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