SUPPLEMENTARY INFORMATION: Global forest thickening

Marqués et al.

Contents

S1 Data

To be added as text (and equations) here:

- How QMD derived if not explicitly provided in obtained dataset.

Dataset	N	Description	Filter	Reference
nfi_spain	27642	Spanish National Forest Inventory	No management intervention observed during monitoring	Restricted data (not publicly available)
nfi_norway	25156	Norwegian National Forest Inventory	No management intervention observed during monitoring	Restricted data (not publicly available)
nfi_sweeden	15954	Swedish National Forest Inventory	No management intervention observed during monitoring	Restricted data (not publicly available)
bnp	9423	Berchtesgaden National Park	Forest reserves	Restricted data (not publicly available)
fia_us	7022	Forest Inventory and Analysis, US	Forest reserves	Doser JW, Stanke H, Finley AO (2025). rFIA: Estimation of Forest Variables using the FIA Database. R package version 1.1.0, https://CRAN.R-project.org/package=rFIA
aus_plots	6259	Sustainable Timber Tasmania, Forestry Corporation of NSW, Queensland, Victoria and Australia's Terrestrial Ecosystem Research Network	No management intervention observed during monitoring	Restricted data (not publicly available)
luquillo	1993	Luquillo	No management intervention observed during monitoring	https://forestgeo.si.edu
nfi_switzerland	1972	Swiss National Forest Inventory	No management intervention observed during the last 70 years	Restricted data (not publicly available)
scbi	1572	Smithsonian Conservation Biology Institute	No management intervention observed during monitoring	https://forestgeo.si.edu
wuls	1416	Białowieża National Park	Forest reserves	Restricted data (not publicly available)
wytham	1200	Wytham Woods	No management intervention observed during monitoring	https://forestgeo.si.edu
serc	1026	Smithsonian Environmental Research Center	No management intervention observed during monitoring	https://forestgeo.si.edu

Table S1: Constituent forest dataset sizes and descriptions.

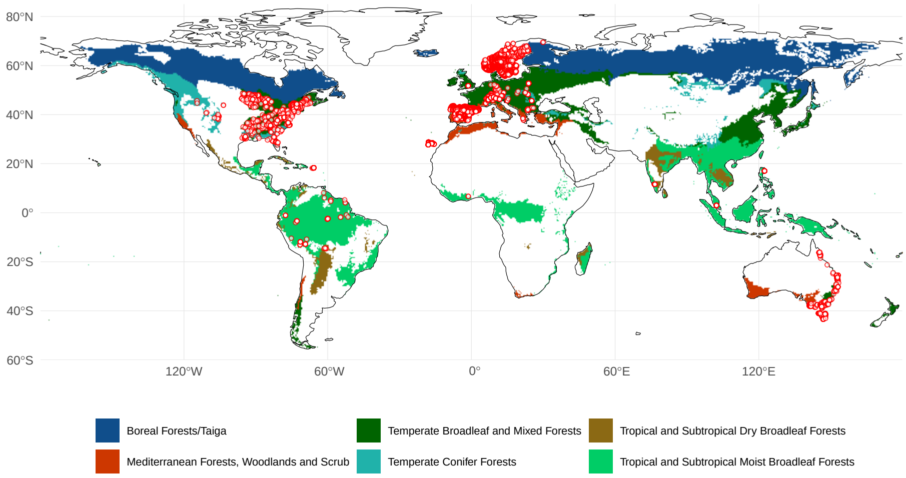

Figure S1: Distribution of forest plots (red circles) and forest biomes.

Dataset	N	Description	Filter	Reference
pasoh	1007	Pasoh	No management intervention observed during monitoring	https://forestgeo.si.edu
df_rainfor	988	Amazon Forest Inventory Network (RAINFOR)	No management intervention ocurred	Esquivel-Muelbert, A., Banbury Morgan, R., Brienen, R. et al. Increasing tree size across Amazonia. Nat. Plants 11, 2016–2025 (2025). https://doi.org/10.1038/s41477-025-02097-4
nfr_swi	729	Swiss Natural Forest Reserves	Forest reserves	Restricted data (not publicly available)
forst	537	Forest Research Institute Baden-Württemberg	Forest reserves	Restricted data (not publicly available)
palanam	484	No management intervention observed during monitoring	https://forestgeo.si.edu	
unito	311	University of Turin	Forest reserves	Restricted data (not publicly available)
uholka	200	Uholka-Shyrokyi Luh	Forest reserves	Restricted data (not publicly available)
df_forestplots	149	Forest Inventory Network	No management intervention ocurred	Restricted data (not publicly available)
mudumalai	126	Mudumalai	No management intervention observed during monitoring	Restricted data (not publicly available)
lwf_tree	114	Bavarian Institute of Forestry	Forest reserves	Restricted data (not publicly available)
nwfva_tree	84	Northwest German Forest Research Institute (NW-FVA)	Forest reserves	Restricted data (not publicly available)
incds	75	National Institute for Research-Development in Forestry “Marin Drăcea” Department of Forest	Forest reserves	Restricted data (not publicly available)
tuzvo_tree	63	Technical University in Zvolen	Forest reserves	Restricted data (not publicly available)
iberbas	57	Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Forest reserves	Restricted data (not publicly available)
efm_swi	51	Experiemental Forest Management plots	No management intervention observed during monitoring	Restricted data (not publicly available)
france	47	French plots	No management intervention observed during monitoring	Restricted data (not publicly available)
greece_stand	40	Greek plots	No management intervention observed during monitoring	Restricted data (not publicly available)
czu	24	Czech University of Life Sciences Prague	Forest reserves	Restricted data (not publicly available)
ul_tree	23	University of Ljubljana, Slovenia	Forest reserves	Restricted data (not publicly available)
urk	12	Roztocze National Park, Poland	Forest reserves	Restricted data (not publicly available)
nbw	7	NPV-BW	Forest reserves	Restricted data (not publicly available)

Table S2: Constituent forest dataset sizes and descriptions.

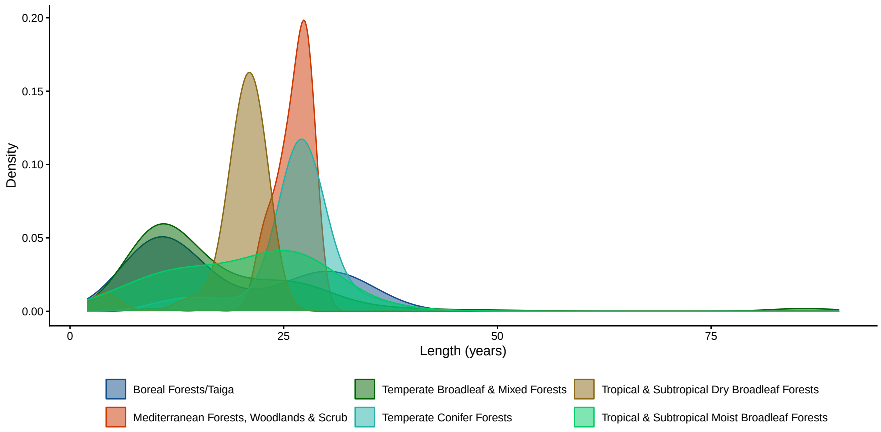

Figure S2: Distribution of the total length of the time series per forest plot, separated by biomes. The total length corresponds to the difference in the observation year of the first and last available forest inventory for each plot.

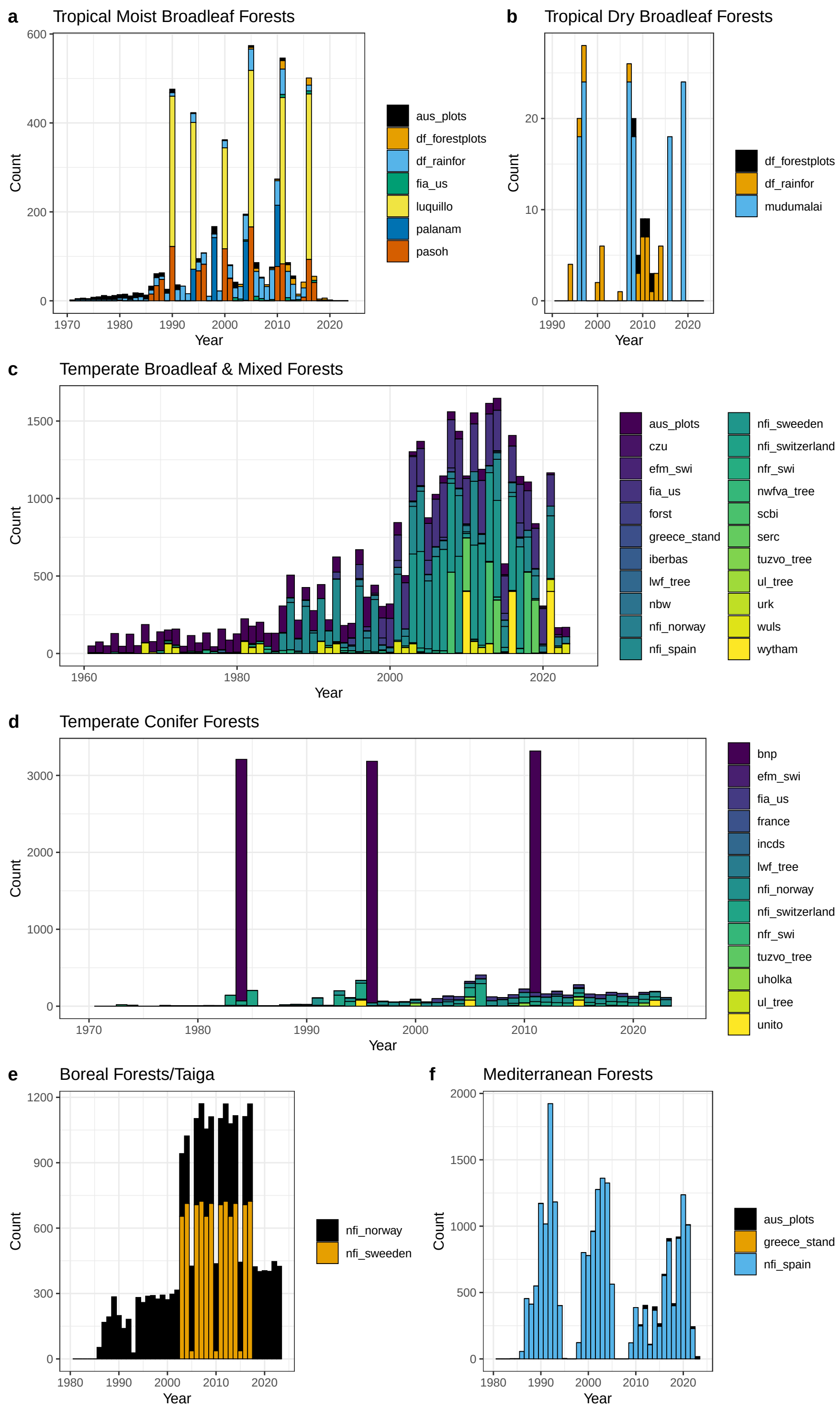

Figure S3: Distribution of forest census data over time, grouped by biome (a-f). Dataset names are explained in Tab. S1.

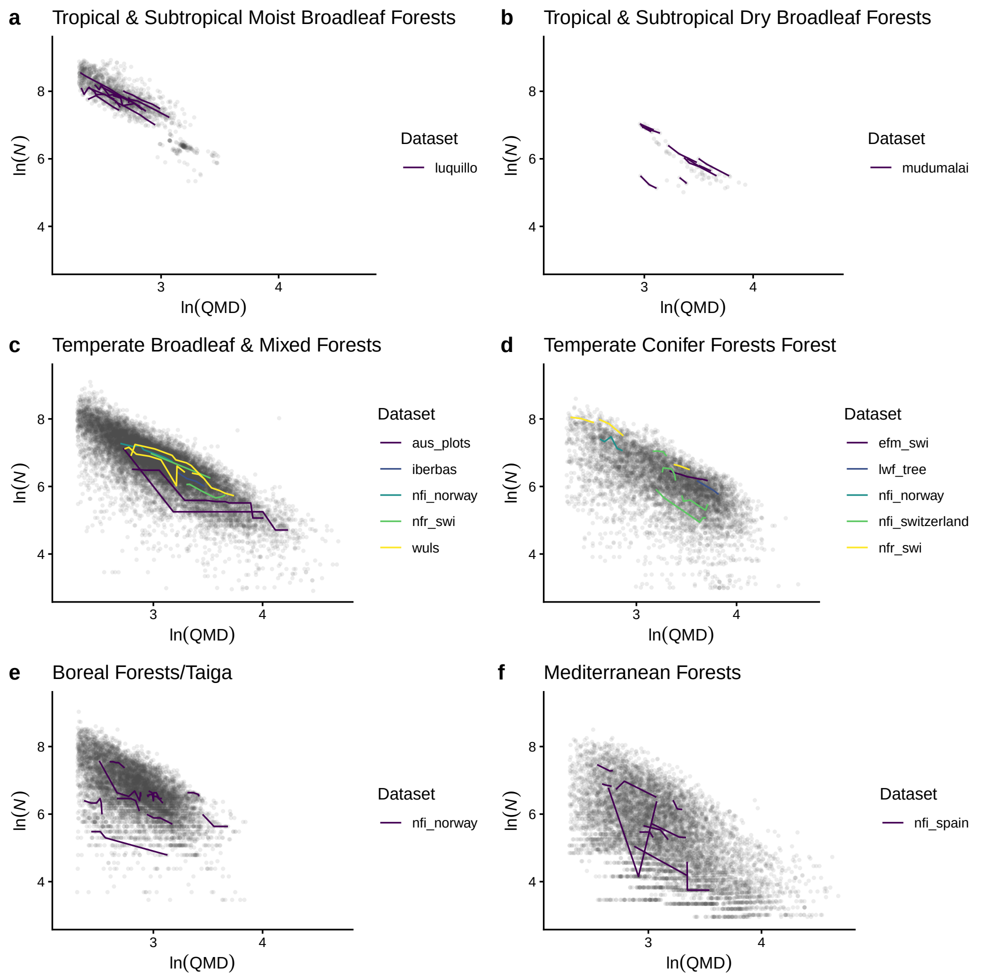

Figure S4: Self-thinning relation across biomes with example long-term forest monitoring plots highlighted.

S2 Self-thinning trends

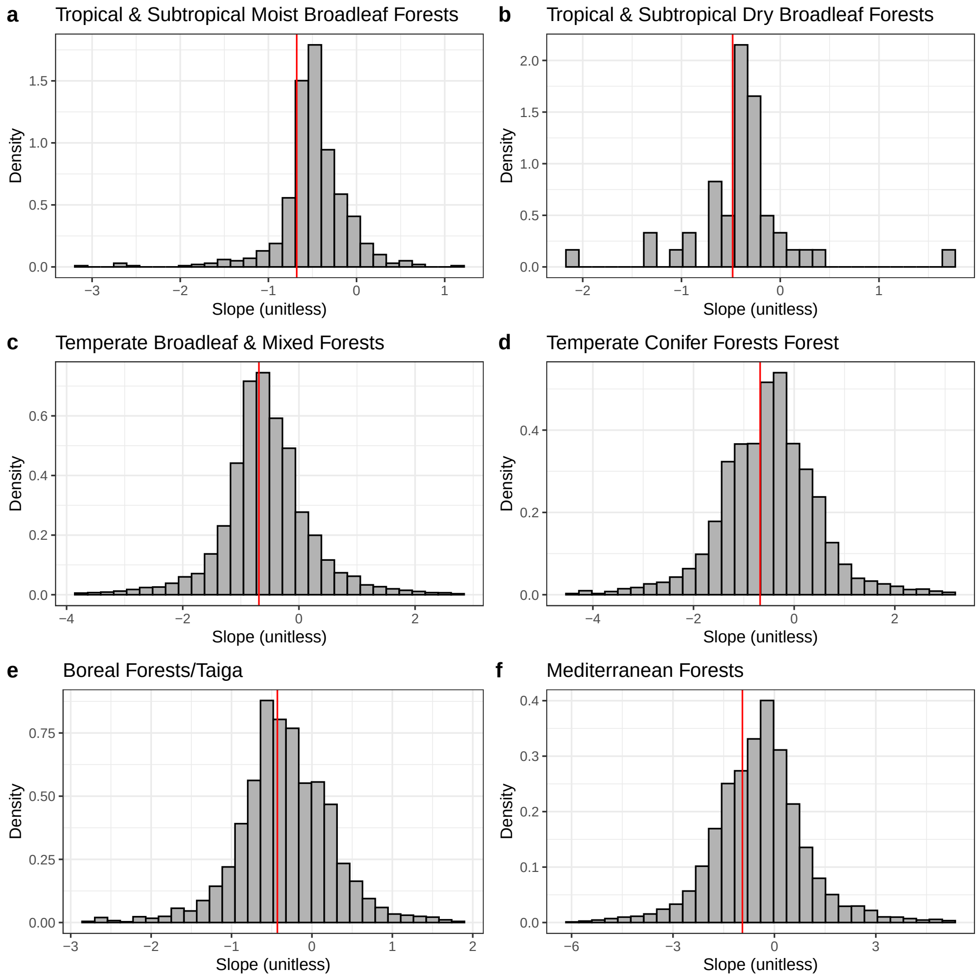

Figure S5: Distributions of model slope estimates (logQMD) across biomes.

Biome	Mean	SE
Boreal Forests/Taiga	0.30	0.06
Mediterranean Forests	2.35	0.06
Temperate Broadleaf & Mixed Forests	0.91	0.03
Temperate Conifer Forests	1.18	0.06
Tropical & Subtropical Moist Broadleaf Forests	0.16	0.07
Tropical Dry Broadleaf Forests	-0.38	0.46

Table S3: Mean estimate and standard error (SE) of percentage change (%/yr) of forest stand density (number of trees per ha) by biome, determined from quantile regressions on bootstrapped data samples.

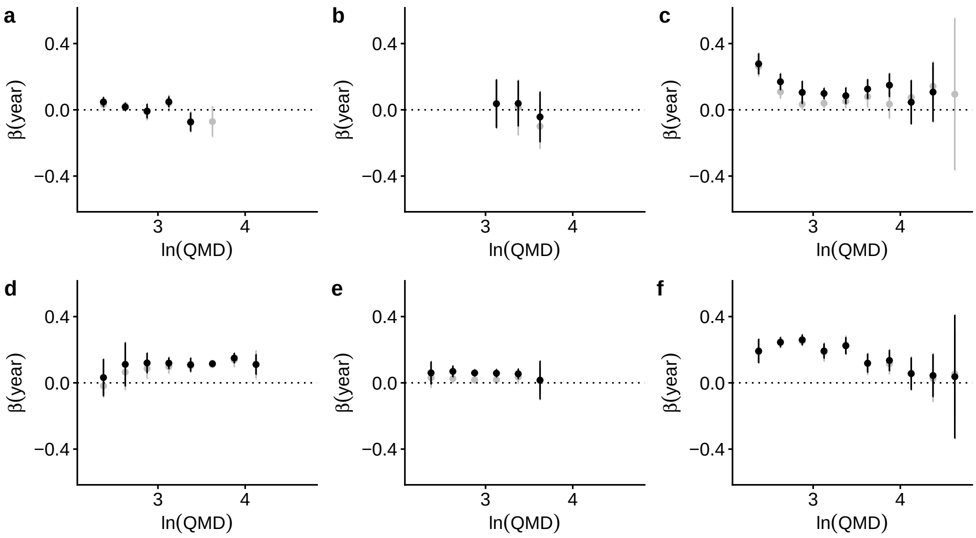

Figure S6: Effect size of 'year' within bins of quadratic mean diameter for individual biomes (a: Tropical and Subtropical Moist Broadleaf Forests, b: Tropical and Subtropical Dry Broadleaf Forests, c: Temperate Broadleaf and Mixed Forests, d: Temperate Conifer Forests Forest, e: Boreal Forests/Taiga, f: Mediterranean Forests). Grey points represent the same derived from data before the filtering of disturbance-affected plots were removed. Error bars indicate 95% confidence intervals for the coefficient.

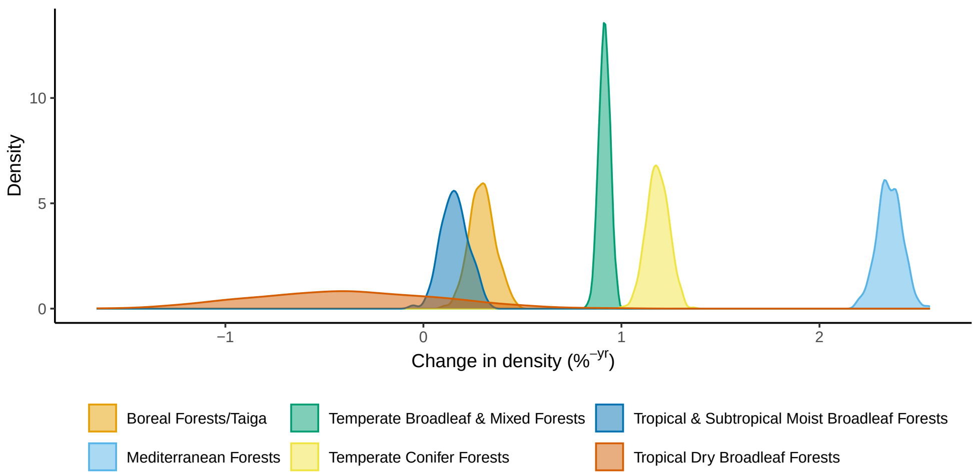

Figure S7: Distribution of percentage change (%/yr) in stand density (number of trees per ha) by biome.

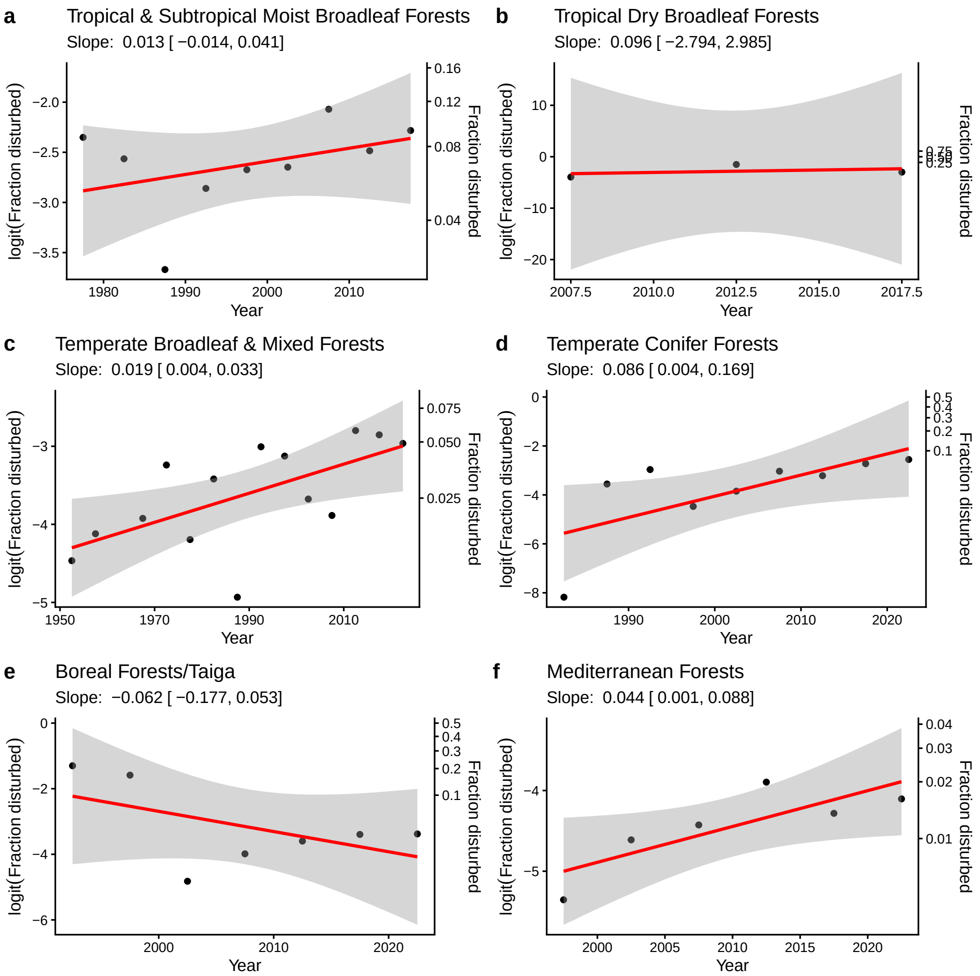

Figure S8: Trends in the fraction of disturbed forest plots, by biome. Fraction values are logit-transformed. The corresponding un-transformed values are indicated by the right y-axis in each plot. No regression fit is shown for tropical dry broadleaf forests (b) as only two points are available with non-zero values for the disturbed fraction.

S3 Environmental drivers

Table S4: Regression Results

	Complete	No PBR	No PBR, ORGC	No PBR, C:N	Complete interactions
scale(logQMD)	-0.861***	-0.862***	-0.862***	-0.864***	-0.830***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
scale(year)	0.129***	0.130***	0.130***	0.132***	0.120***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
scale(tavg)	-0.033*	-0.026+	-0.007	-0.018	-0.014
	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)
scale(ai)	0.086***	0.095***	0.097***	0.087***	0.101***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)
scale(ndep)	0.153***	0.140***	0.146***	0.131***	0.129***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
scale(ORGC)	-0.039**	-0.048***		-0.001	-0.024+
	(0.013)	(0.012)		(0.009)	(0.013)
scale(PBR)	0.004				-0.005
	(0.008)				(0.008)
scale(CNrt)	0.057***	0.060***	0.031***		0.062***
	(0.011)	(0.011)	(0.008)		(0.011)
scale(year) × scale(tavg)	0.006**	0.009***	0.013***	0.006**	-0.006*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
scale(year) × scale(ai)	-0.022***	-0.018***	-0.018***	-0.017***	-0.033***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
scale(year) × scale(ndep)	-0.016***	-0.015***	-0.015***	-0.011***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
scale(year) × scale(ORGC)	-0.012***	-0.011***		-0.028***	-0.011***
	(0.002)	(0.002)		(0.002)	(0.002)
scale(year) × scale(PBR)	0.006***				-0.001
	(0.002)				(0.002)
scale(year) × scale(CNrt)	-0.021***	-0.023***	-0.028***		-0.029***
	(0.002)	(0.002)	(0.001)		(0.002)
scale(logQMD) × scale(tavg)					0.020***
					(0.004)
scale(logQMD) × scale(ai)					0.102***
					(0.003)
scale(logQMD) × scale(ndep)					-0.021***
					(0.003)
scale(logQMD) × scale(ORGC)					-0.009*
					(0.004)
scale(logQMD) × scale(PBR)					0.017***
					(0.003)
scale(logQMD) × scale(CNrt)					0.047***
					(0.003)
SD (Observations)	0.176	0.178	0.178	0.178	0.171
Num.Obs.	36133	37652	37652	37652	36133
R2 Marg.	0.521	0.530	0.531	0.527	0.515
R2 Cond.	0.980	0.980	0.980	0.980	0.980
AIC	17693.1	19142.8	19162.9	19215.9	15842.4

S4 Global C sink

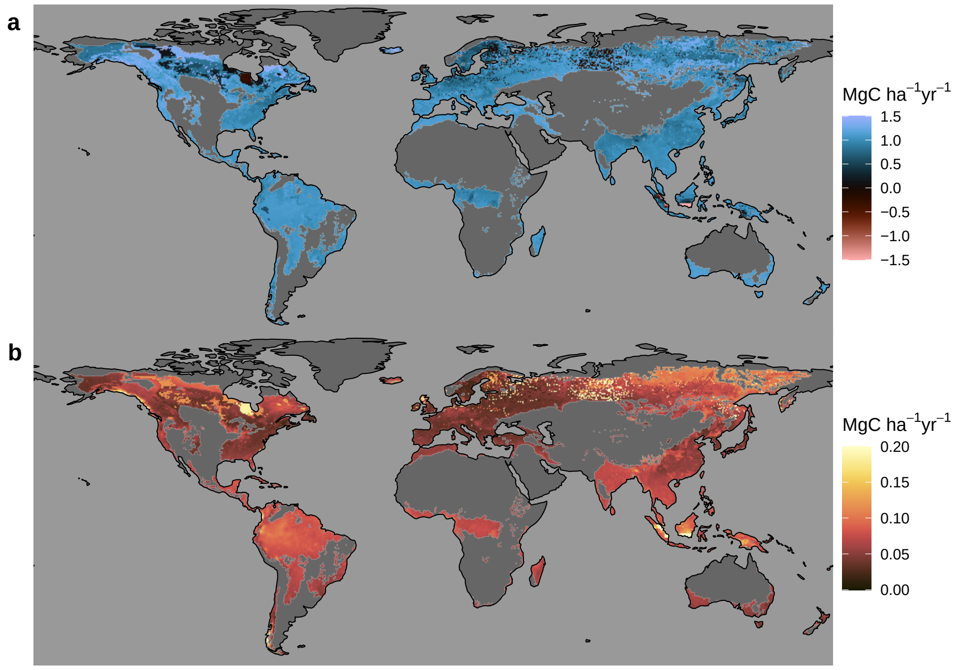

Figure S9: (a) C sink in aboveground biomass due to temporal changes in the self-thinning relationship. (b) Standard deviation of estimates across bootstraps. Values are expressed per unit forest area (gC m^{-2} yr^{-1}).

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