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Supplementary information

Functional susceptibility of tropical forests to climate change

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Functional susceptibility of tropical forests to climate change

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Supplementary Information

Supplementary Figures 1 to 4
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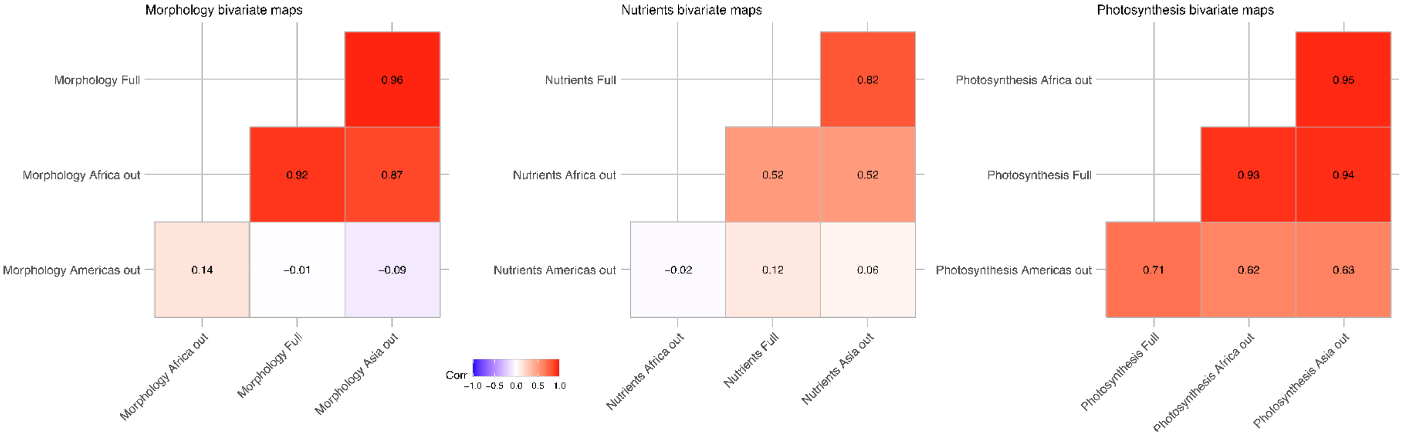
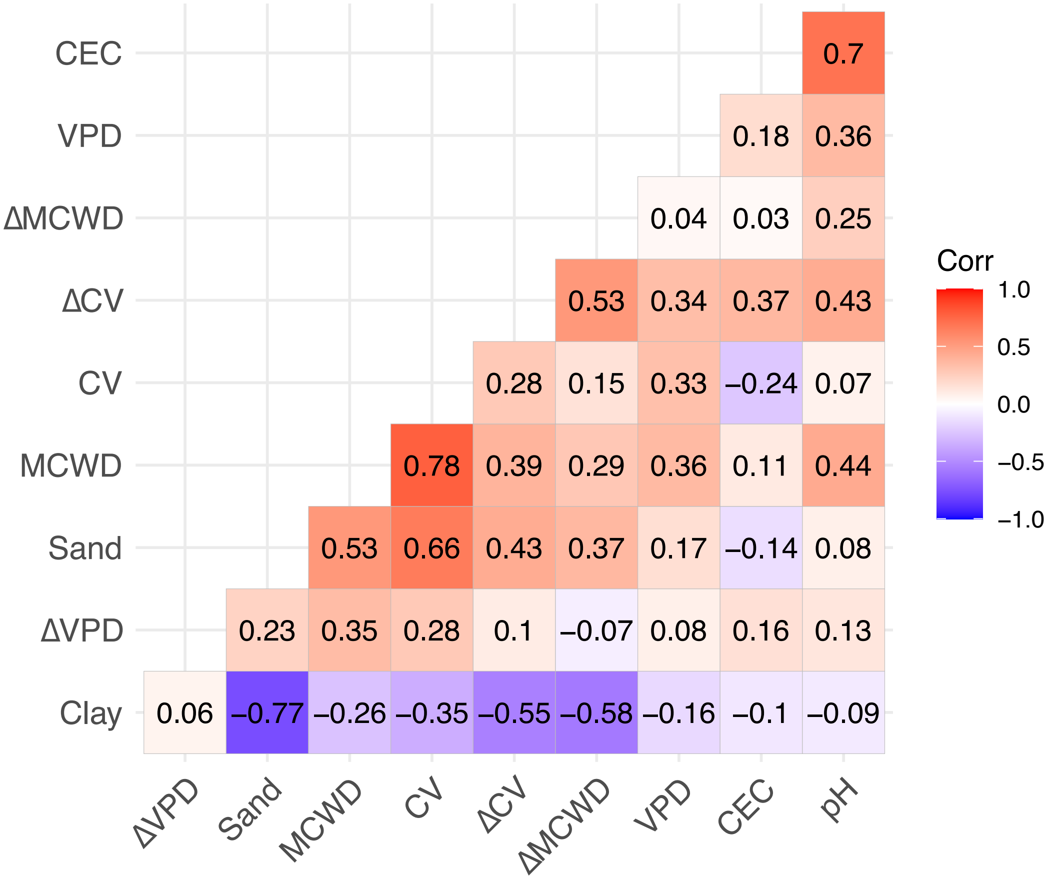
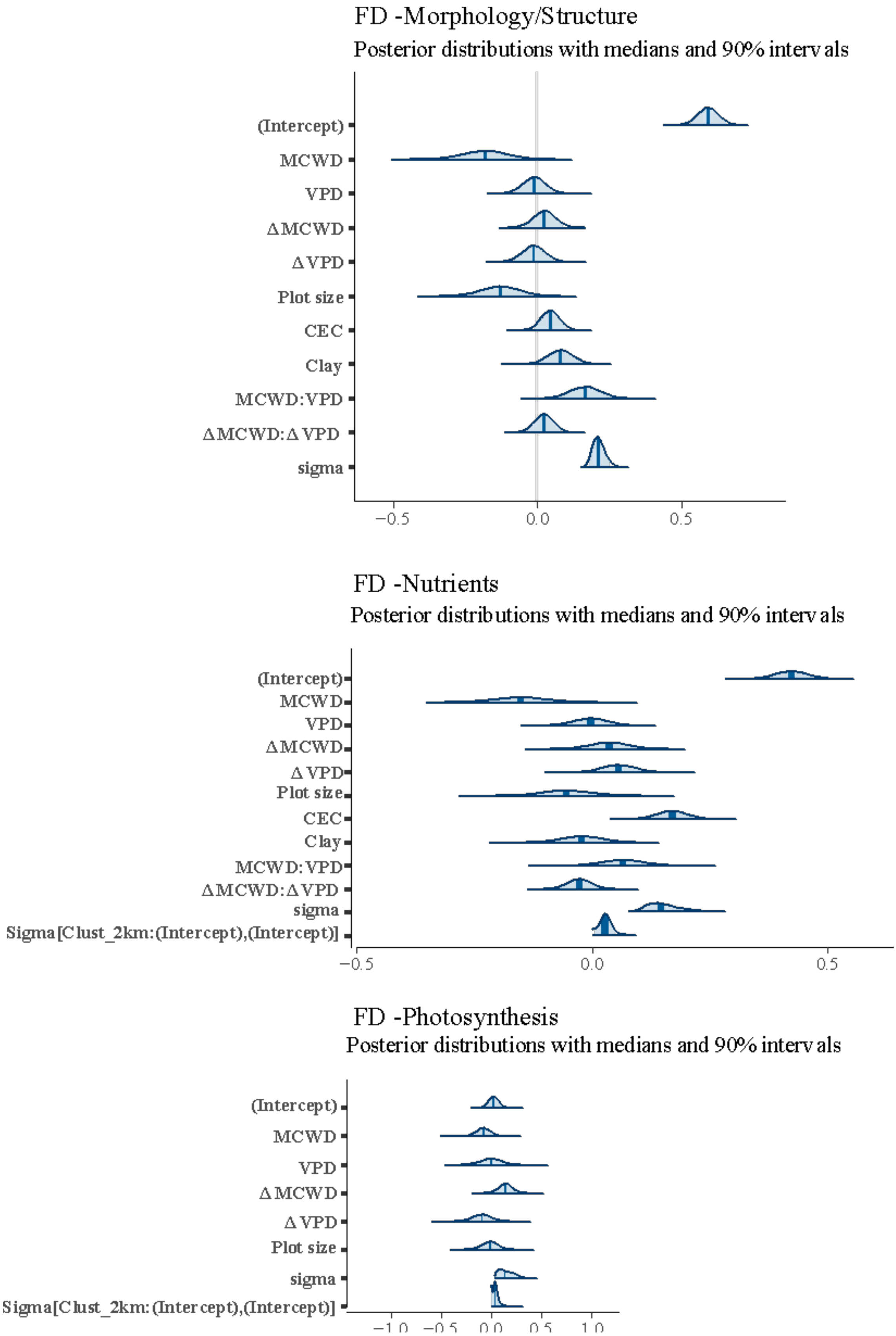


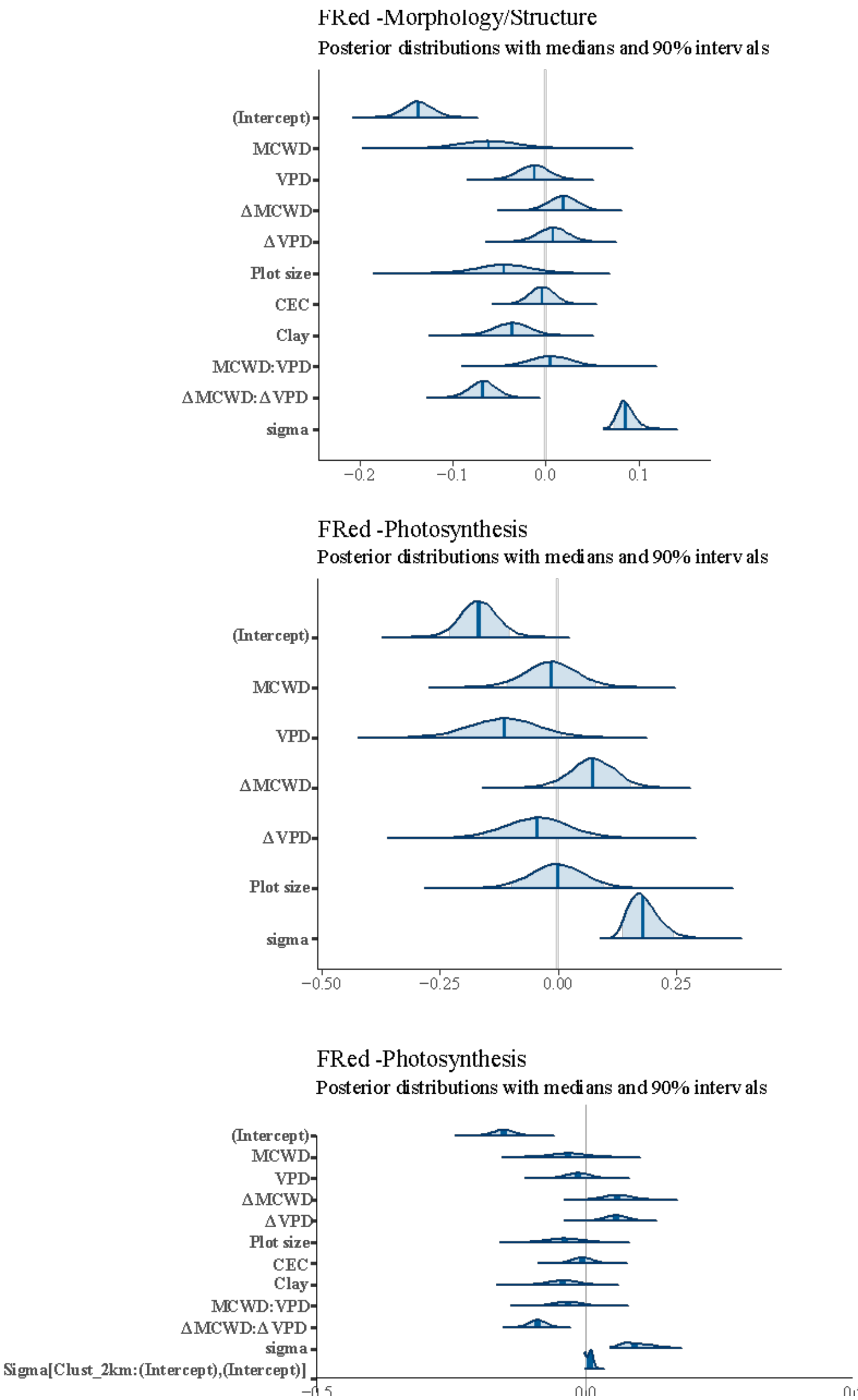
Supplementary Figure 1. Correlation coefficients between the full model FD-FRed bivariate spatial predictions and those made when plots from one continent out. Overall, when the Americas is left out of model fitting the predictions are most different with the full model predictions and this is due to the higher number of records (plots) coming from this area (see also TS4). When data from the Americas is left out from the morphological and nutrients models the correlation with the full models drops dramatically, suggesting plots in the Americas have unique morphological and nutrients composition (FD-FRed) not found in other areas but also reflects the fact that a large part of the plot data is coming from this area.



Supplementary Figure 2. Pearson's correlation coefficients between all climatic and soil variables analysed in this study. Besides the correlation between the coefficient of variation of precipitation (CV) and the maximum climatic water deficit (MCWD), cation exchange capacity (CEC) and pH and soil clay content (Clay) and soil sand content (Sand), all other pairwise comparisons had coefficients below 0.70 (our threshold selected to include or exclude a covariate in the model). VPD: vapour pressure deficit. Δ: change.



Supplementary Figure 3. The posterior density distribution of the models fitted exploring the effects of long-term and a changing climate and soil characteristics on the functional diversity (FD) of morphology/structure, nutrients(middle panel) and photosynthesis (bottom panel) traits. The posterior density distribution of the random effect (when included in the model) is not shown for clarity purposes. See Table S3 for full statistical details. MCWD: maximum climatic water deficit, VPD: vapour pressure deficit, CEC: soil cation exchange capacity, Clay: soil clay content. Δ: change.



Supplementary Figure 4. The posterior density distribution of the models fitted exploring the effects of long-term and a changing climate and soil characteristics on the functional redundancy (FRed) of morphology/structure, nutrients(middle panel) and photosynthesis (bottom panel) traits. The posterior density distribution of the random effect (when included in the model) is not shown for clarity purposes. See Table S3 for full statistical details. MCWD: maximum climatic water deficit, VPD: vapour pressure deficit, CEC: soil cation exchange capacity, Clay: soil clay content. Δ: change.

Supplementary Table 1. Plant functional traits included in the analysis, their description and their hypothesised response and importance under a drying climate. References are not exhaustive (see end of document for full details of references).

Functional group	Trait	Description	Importance and hypothesised response to a drying climate	References
Morphology and structure	Leaf area: A (cm^2)	Area of the leaf determined by scanning the adaxial side of the leaf lamina on a flatbed scanner Canon LiDE220®	Relevant as a main light capture mechanism. Higher leaf area could result in more leaf transpiration and thus water loss under a drying climate. Under a drying climate it may increase in deciduous species and expect decreases in evergreens as to limit water loss by transpiration and for increasing cooling.	1,2
	DM: leaf dry mass (g)	Leaf fresh mass calculated as the fresh weight of the recently obtained leaves.	Increasing droughts may cause decreases in leaf dry and fresh mass. Such decreases in leaf dry and fresh mass may have negative implications for biomass productivity.	3
	FM: leaf fresh mass (g)	Leaf dry mass determined after oven drying at 60 °C leaves for 72 hours or until constant weight.		
	LDMC: leaf dry matter content (mg/g)		It is an indicator if leaf defence against drying conditions. It would tend to increase as water stress increases.	4
	LWC (%)	Water content in the leaf determined by subtracting the dry mass content from the fresh mass, multiplying by 100 and dividing by the fresh mass to obtain percentage water content.	Indicator of leaf water stress which can limit photosynthesis and thus productivity. LWC is expected to decline with increasing drought conditions as to avoid leaf water loss.	5
	SLA (m^2/g)	Specific leaf area calculated as the one-sided area of a leaf divided by dry mass	Important for photosynthetic capacity, light capture, water loss, net assimilation rate, leaf life span. May increase if acquisitive species, e.g. deciduous species, become more abundant with a drying climate.	6,7,8

	T (mm)	Thickness of leaf lamina measured by taking four micrometre measurements halfway between the mid-vein and the edge of the leaf, avoiding major secondary veins.	Trade-off between decreasing water transpiration at the expense of higher construction investment. May decrease under a drying climate as a result of increasing in deciduous species which may tend to have thinner leaves. It is expected that thicker leaves become more common under larger water deficits for evergreen species but may decreases for acquisitive deciduous species.	1,2
	WD (g/cm^3).	Wood density obtained from the oven dried wood mass divided by its fresh volume	Relevant for mechanical strengths, stem vulnerability to xylem cavitation. Expected to be higher in areas with lower water resources, and thus increase with a drying climate.	8,9,10,11
	Ca: leaf calcium (%)	Leaf nutrients concentration in percentage obtained from dry leaf samples. On a different branch, all leaves were removed for bulk chemical analysis at different laboratories depending on the traits campaign.	Calcium is a regulator in processes related to growth such as stomatal function, cell division, cell wall synthesis, repair of damage from biotic and abiotic stress. Deacreases in Ca are expected under increasing droughts	12
	K: leaf potassium (%)		Important role in the regulation of water status, make a major contribution to the osmotic potential of cells and tissues and it is involved in physiological processes, such as photosynthesis, osmoregulation and stomatal movement. Based on recent literature It is expected a decreae in leaf K content with increasing drought.	13,14
	Mg: leaf magnesium (%)		Important element for plant growth and photosynthesis which can be impacted by increasing droughts. It has major role in synthesis of proteins, ATP and chlorophyll. It is	15,16

			expected that decreases in Mg may lead to decreases in plant biomass if Mg levels are disrupted by a changing climate.	
	N: leaf nitrogen (%)		Essential for metabolic reactions involved in light capture, photosynthetic capacity and growth. Restricted availabilities limit plant carbon acquisition and growth. Drought effects may be compensated if nitrogen fixing species (mainly Fabaceae) become more abundant. Following the literature it is expected that leaf nitrogen content will decrease with increasing temperature and droughts.	17,18,19,20
	P: leaf phosphorus (%)		Needed nutrient for metabolic reactions that include light capture, related to photosynthetic capacity and growth. Lack of P may limit carbon acquisition and growth. Decreases under a drying climate and possible not strong effect under short term droughts or in wet forests. May be more dependent on soil conditions than on climate.	18,19,20
Photosynthesis	Amax (μmol m^{-2} s^{-1})	Amax: Light-saturated maximum rates of net photosynthesis at saturated CO2. Asat: Light-saturated rates of net photosynthesis at ambient CO2 concentration. Photosynthetic capacity (light-saturated net assimilation rate) was measured at both saturating CO2 concentration (2000 ppm CO2; Amax), and at ambient CO2 concentration (400	Maximum CO2 assimilation. Index of leaf photosynthetic capacity. Higher for species with fast resources turnover, e.g. deciduous vs evergreens. Increase with abundance of such species.	21,22
	Asat (μmol m^{-2} s^{-1})		Saturated photosynthetic rate. Index of leaf photosynthetic capacity. Declines with higher temperatures and lower precipitation. However, Asat is also dependent on CO2 fertilization and N and P levels.	21,22

	RDark (μmol m^{-2} s^{-1})	ppm CO2; Asat) under saturating light conditions and at a temperature of 25 ◦C using a LICOR 6400-XT. RDark: Leaf dark respiration.	Component of plant carbon balance which can return 40–50% of photosynthetically fixed carbon to the atmosphere. Increases in RDark with increases in temperature and decreases in precipitation.	23,24

Supplementary Table 2. Climatic conditions for the full term period (1958-2017) , for its changes between the first (1958-1987) and second (1988-2017) time period analysed and for soil conditions. The third to fifth columns in the table describe if the plot was included (Y) or not (empty) in the FD and FRed analysis for the different functional groups.

Location	Plot	Functional indices Morphology/Structure	Functional indices Nutrients	Functional indices Photosynthesis	Plot size (ha)	MCWD (mm)	VPD (kPa)	CV (mm)	ΔVPD (kPa)	ΔCV (mm)	ΔMCWD (mm)	CEC (mmol (c)/kg)	Clay (%)	pH	Sand (%)
Australia	EP43		Y	Y	0.5	542.25	0.74	0.73	-0.01	-0.07	-40.06	13.78	42.15	5.00	32.33
Australia	AEP02		Y		0.5	671.04	0.75	0.81	-0.01	-0.06	-46.90	11.99	35.74	4.90	35.23
Australia	AEP03		Y	Y	0.5	671.04	0.75	0.91	-0.01	-0.04	-46.90	11.99	35.74	4.80	42.50
Australia	KRU01	Y	Y	Y	0.1	206.56	0.75	0.67	-0.01	-0.09	-58.22	15.34	42.74	5.10	30.70
Australia	AEP41		Y	Y	0.5	386.28	0.71	0.72	0.00	-0.08	-65.35	14.00	36.41	5.00	39.73
Australia	DRO01		Y	Y	0.9	386.28	0.71	0.69	0.00	-0.08	-65.35	14.00	36.41	5.57	38.60
Australia	ROB06		Y	Y	1	460.43	0.72	0.77	-0.01	-0.06	-85.05	13.70	37.11	5.00	33.27
Brazil -NX	VCR02	Y	Y	Y	1	541.76	1.13	0.83	-0.06	0.01	56.21	9.71	25.19	5.40	58.53
Brazil -NX	NXV01	Y	Y	Y	1	524.20	1.11	0.82	-0.06	0.01	40.41	7.77	23.80	5.40	62.50
Brazil -NX	NXV02	Y	Y		1	524.20	1.11	0.82	-0.06	0.01	40.41	7.77	23.80	5.30	63.80
Brazil -NX	NXV10	Y	Y		1	524.20	1.11	0.82	-0.06	0.01	40.41	7.77	23.80	5.37	63.73
Brazil -ST	363_6	Y	Y	Y	0.25	358.87	0.63	0.61	0.02	0.00	-89.87	9.30	36.69	4.03	51.13
Brazil -ST	363_3	Y	Y	Y	0.25	363.17	0.63	0.62	0.02	0.01	-93.20	9.65	34.03	4.07	53.97
Brazil -ST	363_7	Y	Y	Y	0.25	363.17	0.63	0.61	0.02	0.00	-93.20	9.65	34.03	4.13	46.43
Brazil -ST	261_10	Y	Y	Y	0.25	371.36	0.62	0.64	0.02	0.01	-103.91	12.27	50.40	4.07	33.50
Brazil -ST	261_9	Y	Y		0.25	371.36	0.62	0.64	0.02	0.01	-103.91	12.27	50.40	4.30	32.13
Colombia	Macuira	Y	Y		1	941.62	1.22	0.73	0.02	0.04	0.00	20.05	35.18	6.70	34.33
Colombia	Taminango				1	155.61	0.76	0.44	-0.02	0.00	-43.22	25.81	35.12	5.90	31.63
Colombia	Tuparro	Y	Y		1	204.58	1.13	0.70	-0.02	0.01	-75.96	12.61	25.50	5.23	50.37
Colombia	CardonalLoma	Y	Y	Y	1	60.97	1.00	0.41	-0.02	-0.06	-131.07	21.56	41.54	5.00	27.47
Colombia	CardonalPlana		Y		1	60.84	1.08	0.40	-0.03	-0.07	-135.37	19.48	41.67	5.00	24.97
Colombia	Jabiru	Y	Y	Y	1	60.84	1.08	0.44	-0.03	-0.06	-135.37	19.48	41.67	5.20	24.87
Colombia	Tambor	Y	Y		1	57.41	1.05	0.37	-0.03	-0.07	-140.04	18.15	39.63	5.17	26.70
Colombia	Vinculo	Y	Y		1	80.81	0.65	0.37	-0.03	-0.04	-144.66	23.85	34.67	6.03	27.77
Colombia	Cotove		Y		1	152.12	0.83	0.46	-0.06	-0.05	-152.89	19.65	39.04	5.90	34.13
Gabon	MNG04	Y	Y	Y	1	241.18	0.52	0.68	0.06	0.00	32.87	15.35	28.76	4.87	46.00
Gabon	LPG02		Y	Y	1	173.72	0.74	0.68	0.08	-0.01	0.33	13.15	31.79	5.10	56.17
Gabon	LPG01	Y	Y	Y	1	173.93	0.79	0.67	0.08	-0.01	-0.35	12.14	27.79	4.90	54.10
Ghana	KOG03	Y	Y		1	493.04	1.03	0.60	0.02	0.02	-27.55	34.00	21.10	5.53	49.77
Ghana	KOG04	Y	Y		1	493.04	1.03	0.60	0.02	0.02	-27.55	34.00	21.10	5.63	48.57
Ghana	KOG05		Y		1	493.04	1.03	0.60	0.02	0.02	-27.55	34.00	21.10	5.67	49.20
Ghana	KOG06	Y	Y		1	493.04	1.03	0.60	0.02	0.02	-27.55	34.00	21.10	5.70	50.23
Ghana	KOG02		Y		1	474.96	1.00	0.59	0.02	0.01	-29.66	34.00	21.36	5.73	56.23
Ghana	BOB01	Y	Y		1	322.92	0.84	0.52	0.02	0.01	-35.93	32.23	21.89	5.67	46.73
Ghana	BOB02	Y	Y		1	322.92	0.84	0.52	0.02	0.01	-35.93	32.23	21.89	5.73	48.90
Ghana	ANK01	Y	Y		1	149.27	0.67	0.68	0.02	-0.03	-190.69	15.76	22.87	4.77	65.33
Ghana	ANK03	Y	Y		1	149.27	0.67	0.66	0.02	-0.03	-190.69	15.76	22.87	4.80	65.10
Malaysia	MLA-01	Y	Y	Y	1	0.00	0.82	0.15	0.03	-0.01	-46.76	18.05	39.01	5.00	32.87
Malaysia	MLA-02	Y	Y	Y	1	0.00	0.77	0.16	0.03	-0.01	-54.91	20.09	41.13	5.00	32.13
Malaysia	DAN-04	Y	Y	Y	1	0.00	0.79	0.16	0.02	-0.01	-87.00	16.81	38.21	5.10	29.67
Malaysia	DAN-05	Y	Y	Y	1	0.00	0.79	0.16	0.02	-0.01	-87.00	16.81	38.21	5.07	31.10
Mexico	ME_14_00358	Y			0.25	873.77	1.05	1.12	0.07	0.07	156.99	22.89	20.57	6.10	60.37
Mexico	ME_14_00359	Y	Y		0.25	873.77	1.05	1.12	0.07	0.07	156.99	22.89	20.57	5.80	60.90
Mexico	ME_14_00360	Y	Y		0.25	873.77	1.05	1.12	0.07	0.07	156.99	22.89	20.57	6.10	64.53
Mexico	ME_14_00361	Y	Y		0.25	873.77	1.05	1.12	0.07	0.07	156.99	22.89	20.57	6.00	60.90
Mexico	ME_14_00362	Y			0.25	873.77	1.05	1.13	0.07	0.06	156.99	22.89	20.57	6.00	65.57
Mexico	ME_23_00144	Y	Y		0.25	481.96	0.86	0.57	0.03	0.01	-36.86	22.10	49.24	7.00	32.90
Mexico	ME_23_00143	Y	Y		0.25	475.67	0.85	0.57	0.03	0.00	-43.16	24.24	50.72	7.10	30.87
Mexico	ME_23_00146	Y	Y		0.25	475.67	0.85	0.58	0.03	0.01	-43.16	24.24	50.72	7.07	33.33
Mexico	ME_23_00147	Y			0.25	482.78	0.84	0.57	0.03	0.00	-43.73	23.97	50.70	7.17	33.47
Mexico	ME_23_00148	Y	Y		0.25	482.78	0.84	0.57	0.03	0.00	-43.73	23.97	50.70	7.17	34.13
Mexico	ME_23_00149	Y	Y		0.25	482.78	0.84	0.57	0.03	0.00	-43.73	23.97	50.70	7.27	34.40
Mexico	ME_23_00145	Y			0.25	468.84	0.84	0.57	0.03	0.00	-49.46	24.26	51.00	7.00	32.60
Mexico	ME_23_00151	Y	Y		0.25	470.85	0.82	0.58	0.03	-0.01	-56.44	24.81	49.25	6.93	32.07
Panama	Fortuna-AF	Y	Y		1	210.77	0.28	0.59	-0.02	-0.02	48.42	17.38	35.01	5.10	32.93
Panama	Fortuna-HOR	Y	Y		1	210.77	0.28	0.47	-0.02	-0.03	48.42	17.38	35.01	5.03	32.50
Panama	Fortuna-BON	Y	Y		1	146.78	0.25	0.35	-0.02	-0.02	40.31	17.81	31.30	5.33	38.17
Panama	Fortuna-PAS	Y	Y		1	146.78	0.25	0.39	-0.02	0.00	40.31	17.81	31.30	5.43	40.00
Panama	Fortuna-VERA		Y		1	146.78	0.25	0.39	-0.02	0.00	40.31	17.81	31.30	5.13	32.90
Panama	Fortuna-VERB	Y	Y		1	146.78	0.25	0.40	-0.02	0.00	40.31	17.81	31.30	5.20	33.20
Panama	Fortuna-CHOB		Y		1	202.26	0.28	0.35	-0.02	-0.02	39.09	16.71	33.78	5.10	34.20
Panama	Fortuna-HONA		Y		1	202.26	0.28	0.35	-0.02	-0.02	39.09	16.71	33.78	5.20	34.10
Panama	Fortuna-HONB		Y		1	202.26	0.28	0.35	-0.02	-0.02	39.09	16.71	33.78	5.10	34.47
Panama	Fortuna-PIN	Y	Y		1	202.26	0.28	0.53	-0.02	-0.03	39.09	16.71	33.78	5.00	34.23
Panama	Fortuna-SAM	Y	Y		1	202.26	0.28	0.35	-0.02	-0.02	39.09	16.71	33.78	5.20	33.33
Peru	TAM05	Y	Y		1	152.58	0.84	0.55	-0.02	0.02	104.09	12.13	25.13	4.97	36.67
Peru	TAM06	Y	Y		1	152.58	0.84	0.54	-0.02	0.02	104.09	12.13	25.13	5.07	35.33
Peru	SPD01	Y	Y		1	254.08	0.68	0.45	-0.03	0.07	17.55	26.30	28.39	5.20	32.90
Peru	TRU04	Y	Y		1	254.08	0.68	0.56	-0.03	0.07	17.55	26.30	28.39	5.80	43.80
Peru	SPD02	Y	Y		1	101.53	0.72	0.45	-0.03	0.06	15.69	23.14	33.69	5.13	33.23
Peru	PAN03	Y	Y		1	0.00	0.87	0.41	-0.03	0.06	0.30	18.99	35.94	5.00	28.80
Peru	PAN02	Y	Y	Y	1	0.00	0.87	0.41	-0.03	0.06	0.06	20.46	35.80	5.23	27.23
Peru	ESP01	Y	Y		1	371.90	0.62	0.63	-0.02	0.07	-16.96	26.47	27.07	6.17	36.40
Peru	WAY01	Y	Y		1	371.90	0.62	0.63	-0.02	0.07	-16.96	26.47	27.07	6.30	40.03
Peru	ACJ01	Y	Y		1	494.13	0.59	0.75	-0.02	0.06	-36.10	22.98	28.56	6.20	42.00

Brazil -NX: Nova Xavantina; Brazil -ST: Santarem; Malaysia: Malaysian Borneo. Y= yes, used for the FD/FRed calculations. MCWD: maximum climatic water deficit, VPD: vapour presure deficit, CEC: soil cation exchange capacity, Clay: soil clay content. Δ: change.

Supplementary Table 3. Models results testing for the relation of functional diversity (FD) and functional redundancy (FRed) with long-term (MCWD and VPD) and changes in climate (ΔMCWD and ΔVPD) and soil cation exchange capacity (CEC) and clay content (Clay). Important terms (Highest Density Interval does not overlap 0) are highlighted in grey. N refers to the number of vegetation plots used to fit the models. MCWD: maximum climatic water deficit, VPD: vapour pressure deficit, CEC: soil cation exchange capacity, Clay: soil clay content. Δ: change.

Metric	Trait	Parameter	Median	HDI-L	HDI-H	pd	ROPE (%)	Rhat	ESS	R2	N
FD	Morphology / Structure	Intercept	0.590	0.530	0.660	1.00	0.00	1.00	11776.94	0.44	59
		MCWD	-0.180	-0.310	-0.050	0.99	0.01	1.00	6078.76		
		VPD	-0.010	-0.080	0.050	0.60	0.91	1.00	9024.43		
		ΔMCWD	0.030	-0.040	0.090	0.74	0.81	1.00	13793.30		
		ΔVPD	-0.010	-0.080	0.050	0.62	0.89	1.00	11322.42		
		Plot size	-0.130	-0.240	-0.020	0.97	0.10	1.00	5927.16		
		CEC	0.050	-0.010	0.100	0.92	0.65	1.00	10472.41		
		Clay	0.080	0.010	0.160	0.96	0.27	1.00	8307.24		
		MCWD:VPD	0.170	0.080	0.260	1.00	0.00	1.00	7965.82		
		ΔMCWD:ΔVPD	0.020	-0.030	0.080	0.75	0.86	1.00	11051.42		
	Nutrients	Intercept	0.420	0.370	0.480	1.00	0.00	1.00	6860.33	0.75	70
		MCWD	-0.150	-0.240	-0.060	1.00	0.00	1.00	5386.58		
		VPD	0.000	-0.060	0.060	0.54	0.85	1.00	7137.43		
		ΔMCWD	0.040	-0.030	0.110	0.81	0.58	1.00	6996.22		
		ΔVPD	0.060	0.000	0.120	0.94	0.35	1.00	6691.61		
		Plot size	-0.050	-0.140	0.040	0.85	0.42	1.00	5531.48		
		CEC	0.170	0.120	0.220	1.00	0.00	1.00	8388.50		
		Clay	-0.020	-0.090	0.050	0.69	0.70	1.00	6807.73		
		MCWD:VPD	0.060	-0.010	0.140	0.92	0.31	1.00	6358.19		
		ΔMCWD:ΔVPD	-0.030	-0.070	0.010	0.86	0.76	1.00	8657.60		
	Photosynthesis	Intercept	0.020	-0.070	0.120	0.67	0.40	1.00	3596.67	0.75	22
		MCWD	-0.080	-0.200	0.060	0.84	0.19	1.00	3653.69		
		VPD	0.000	-0.180	0.170	0.51	0.25	1.00	2404.67		
		ΔMCWD	0.140	0.020	0.250	0.98	0.01	1.00	3617.61		
		ΔVPD	-0.090	-0.260	0.070	0.83	0.16	1.00	2635.85		
		Plot size	-0.010	-0.150	0.130	0.55	0.32	1.00	6056.06		
FRed	Morphology / Structure	Intercept	-0.140	-0.160	-0.110	1.00	0.00	1.00	10032.57	0.53	59
		MCWD	-0.060	-0.110	-0.010	0.97	0.01	1.00	5039.35		
		VPD	-0.010	-0.040	0.010	0.78	0.37	1.00	7962.77		
		ΔMCWD	0.020	-0.010	0.050	0.88	0.23	1.00	10881.27		
		ΔVPD	0.010	-0.020	0.040	0.69	0.41	1.00	8045.75		
		Plot size	-0.040	-0.090	0.000	0.94	0.07	1.00	4862.01		
		CEC	0.000	-0.030	0.020	0.60	0.53	1.00	9195.92		
		Clay	-0.040	-0.070	0.000	0.97	0.04	1.00	6962.26		
		MCWD:VPD	0.010	-0.030	0.040	0.59	0.33	1.00	6648.54		
		ΔMCWD:ΔVPD	-0.070	-0.090	-0.040	1.00	0.00	1.00	8911.43		
	Nutrients	Intercept	-0.150	-0.180	-0.120	1.00	0.00	1.00	6764.04	0.73	70
		MCWD	-0.030	-0.090	0.020	0.83	0.18	1.00	4501.18		
		VPD	-0.010	-0.050	0.020	0.72	0.37	1.00	5748.85		
		ΔMCWD	0.060	0.020	0.100	0.99	0.00	1.00	5803.23		
		ΔVPD	0.060	0.020	0.090	1.00	0.00	1.00	6924.62		
		Plot size	-0.040	-0.090	0.020	0.88	0.15	1.00	4675.90		
		CEC	0.000	-0.040	0.030	0.60	0.47	1.00	6382.34		
		Clay	-0.040	-0.080	0.000	0.94	0.08	1.00	5455.13		
		MCWD:VPD	-0.030	-0.080	0.010	0.88	0.18	1.00	5391.84		
		ΔMCWD:ΔVPD	-0.090	-0.110	-0.060	1.00	0.00	1.00	6591.10		
	Photosynthesis	Intercept	-0.170	-0.230	-0.100	1.00	0.00	1.00	11858.06	0.33	22
		MCWD	-0.010	-0.110	0.080	0.60	0.19	1.00	8177.61		
		VPD	-0.110	-0.230	0.01	0.94	0.04	1.00	7547.91		
		ΔMCWD	0.070	-0.010	0.160	0.93	0.05	1.00	9917.27		
		ΔVPD	-0.040	-0.160	0.070	0.74	0.13	1.00	7617.03		
		Plot size	0.000	-0.100	0.100	0.51	0.18	1.00	8701.47		

Supplementary Table 4. Relation between the number of records used to fit the FD and FRed models and the correlation between the resulting binary maps constructed with the full dataset and with records from the Americas, Africa or Asia left out. There is in general a high overall correlation between the number of records used the fit the models and the correlation between the full model and continent out bivariate FD-FRed maps (see Figure 5 and Figures S2-S4).

Index	Trait	Comparisons	Overal correlation	Records used	Correlation with full model
FD	Morphology/Structure	Full model	0.99	59	1.00
		Americas out		14	0.21
		Africa out		49	0.95
		Asia out		55	0.98
	Nutrients	Full model	0.81	70	1.00
		Americas out		23	0.34
		Africa out		58	0.47
		Asia out		59	0.86
	Photosynthesis	Full model	0.51	22	1.00
		Americas out		13	0.65
		Africa out		19	0.94
		Asia out		12	0.97
FRed	Morphology/Structure	Full model	0.99	59	1.00
		Americas out		14	-0.50
		Africa out		49	0.91
		Asia out		55	0.94
	Nutrients	Full model	0.99	70	1.00
		Americas out		23	-0.57
		Africa out		58	0.48
		Asia out		59	0.71
	Photosynthesis	Full model	0.65	22	1.00
		Americas out		13	0.23
		Africa out		19	0.99
		Asia out		12	0.84

Supplementary Table 5. Relationship between FD and FRed levels and taxonomic diversity at the plot level.

Index	Trait group	Taxonomical comparison	Correlation	Pval
FD	Morphology/Structure	Species	0.02	0.90
		Genus	0.06	0.64
		Family	0.12	0.37
	Nutrients	Species	0.02	0.88
		Genus	0.08	0.51
		Family	-0.04	0.74
	Photosynthesis	Species	0.30	0.18
		Genus	0.41	0.06
		Family	0.50	0.02
FRed	Morphology/Structure	Species	0.57	<0.001
		Genus	0.59	<0.001
		Family	0.56	<0.001
	Nutrients	Species	0.49	<0.001
		Genus	0.49	<0.001
		Family	0.43	<0.001
	Photosynthesis	Species	0.36	0.10
		Genus	0.36	0.10
		Family	0.19	0.39

Correlation: Pearson correlation coefficient; P-val: Significance of the correlation

Supplementary Table 6. Percentage of the study area with low, intermediate and high functional diversity and functional redundancy scores. For details about the methodology to obtain the % values show see the methods section in the main text.

Index	Trait	Low (%)	Intermediate (%)	High (%)
FD	Photosynthesis	36.8	60.7	2.4
	Nutrients	14.8	71.1	14.1
	Morphology/Structure	30.4	64.1	5.5
FRed	Morphology/Structure	5.5	92.2	2.3
	Photosynthesis	16.9	76.3	6.8
	Nutrients	3.7	89.2	7.0

Supplementary Table 7. Linear models results explaining the change in AGB after the 2015 El Niño event in African tropical forest. The original data on pre and post El Niño AGB was obtained from Bennet et al. 2021 PNAS. We modelled the change in AGB as a function of the morphological/structural, leaf nutrients and photosynthetic functional diversity (FD) and redundancy (FRed) map scores (extracted from Figures 3 and 4 in the main text) and their interaction with changes in MCWD and VPD. Several parameters using from the different trait groups have a clear effect (Highest Density Intervals (HDI) do not overlap 0) on the changes in AGB.

Trait	Parameter	Median	HDI-L	HDI-H	pd	ROPE (%	Rhat	ESS	R2	N
	Intercept	9.66	8.2	11.1	1.00	0.00	1.000	8051.41		
	FD	1.97	0.28	3.65	0.97	0.05	1.000	4014.49		
	FRed	-1.78	-3.55	0.15	0.94	0.12	1.001	3814.73		
	ΔMCWD	-0.9	-2.52	0.75	0.81	0.36	1.001	3984.14		
	ΔVPD	-1.05	-2.89	0.73	0.83	0.30	1.000	4673.00		
Morphology / Structure	Plot size	-0.25	-1.51	0.97	0.63	0.61	1.000	7001.04	0.18	
	FD:ΔMCWD	-0.43	-2.71	1.95	0.62	0.36	1.000	5010.76		
	FRed:ΔMCWD	-0.07	-3.06	3.1	0.51	0.29	1.001	3776.35		
	FD:ΔVPD	-1.42	-3.24	0.33	0.91	0.20	1.001	3358.34		
	FRed:ΔVPD	-0.46	-3.3	2.5	0.60	0.28	1.001	3876.24		
	Intercept	10.89	9.4	12.4	1.00	0.00	1.000	5441.02		
	FD	-1.79	-3.69	0.06	0.94	0.10	1.000	4233.05		
	FRed	-0.89	-2.12	0.39	0.88	0.34	1.000	7212.75		
	ΔMCWD	-2.33	-4.03	-0.57	0.99	0.00	1.001	4690.78		
Nutrients	ΔVPD	-1.03	-2.69	0.79	0.83	0.30	1.000	4371.06	0.19	86
	Plot size	-0.92	-2.21	0.39	0.88	0.33	1.000	6570.48		
	FD:ΔMCWD	2.94	0.25	5.69	0.96	0.03	1.000	5389.38		
	FRed:ΔMCWD	-1.87	-3.39	-0.09	0.96	0.08	1.000	4873.43		
	FD:ΔVPD	-0.94	-2.71	0.74	0.81	0.33	1.000	4521.17		
	FRed:ΔVPD	-0.69	-2.89	1.55	0.69	0.34	1.000	5166.57		
	Intercept	8.44	6.89	9.96	1.00	0.00	1.000	5675.56		
	FD	-4.13	-10.27	2.22	0.86	0.08	1.001	2072.73		
	FRed	2.96	0.94	5.13	0.99	0.00	1.001	2850.44		
	ΔMCWD	-0.86	-5.89	4.27	0.61	0.18	1.001	2650.77		
Photosynthesis	ΔVPD	0.25	-2.33	2.62	0.57	0.35	1.001	2689.94	0.19	
	Plot size	-0.21	-1.43	0.98	0.62	0.64	1.000	7324.20		
	FD:ΔMCWD	0.77	-0.74	2.3	0.81	0.41	1.000	3439.71		
	FRed:ΔMCWD	-0.85	-2.5	0.75	0.81	0.37	1.000	3613.87		
	FD:ΔVPD	-3.13	-6.2	-0.19	0.96	0.03	1.000	3598.22		
	FRed:ΔVPD	0.47	-1.66	2.73	0.65	0.37	1.001	3019.23		

HDI: highest density interval, l: low, h: high, pd: probability of direction, Rhat: potential scale reduction statistic, ESS: effective sample size. MCWD: maximum climatic water deficit, VPD: vapour presure deficit, CEC: soil cation exchange capacity, Clay: soil clay content. Δ: change.

Supplementary Table 8. Leave-one-out comparisons results comparing models for the same Index and trait group with and without soil data. The inclusion of soil data improved model outcome for morphology/Structural and Nutrients models but not for the Photosynthesis models. The best model was selected as the one with the lowest LOOIC.

Index	Trait	Climate	Soil	ELPD diff	ELPD LOO	SE ELPD LOO	P LOO	SE P LOO	LOOIC	SE LOOIC
FD	Morphology/Structure	Yes	Yes	0	11.35	5.56	10.93	2.70	-22.71	11.12
		Yes	No	-0.84	10.51	6.09	9.47	2.86	-21.03	12.18
	Nutrients	Yes	Yes	0	6.00	5.41	38.61	4.17	-11.99	10.83
		Yes	No	-7.49	-1.50	5.91	46.18	4.97	2.99	11.81
	Photosynthesis	Yes	Yes	-2.31	-7.29	6.91	25.49	6.41	14.57	13.82
		Yes	No	0	-4.98	7.56	28.72	7.20	9.95	15.13
FRed	Morphology/Structure	Yes	Yes	0	87.44	6.71	9.57	2.03	-174.87	13.41
		Yes	No	-4.65	82.78	7.08	7.85	1.80	-165.56	14.15
	Nutrients	Yes	Yes	-0.24	71.63	9.79	19.09	4.87	-143.27	19.57
		Yes	No	0	71.87	9.57	18.14	4.76	-143.75	19.14
	Photosynthesis	Yes	Yes	0	25.11	3.67	9.89	2.40	-50.22	7.35
		Yes	No	-0.06	25.05	4.03	7.91	2.22	-50.10	8.05

LOOIC: Leave one out information criterion; ELPD LOO: Leave one out expected log predicted density; ELPD diff: difference in expected log predicted density; P LOO: Effective number of parameters; SE LOOIC: standard error of LOOIC; SE ELPD LOO: Standard Error of ELPD; SE P LOO: Standard error of P.

Supplementary Table 9. Moran I results of model residuals of FD and FRed models fitted with (linear mixed-models) and without (linear models) a random factor. The random factor accounted for the distance between sampling locations and grouping the sampling locations based on a distance where spatial autocorrelation (if existent) diminished. See the methods section in the main text for an in full explanation.

Index	Trait	RF included	Observed	Expected	sd	P value
FD	Photosynthesis	N	-0.44	-0.05	0.22	0.08
		Y	-0.40	-0.05	0.23	0.13
	Nutrients	N	0.30	-0.01	0.11	0.00
		Y	0.06	-0.01	0.11	0.49
	Morphology/Structure	N	0.10	-0.02	0.12	0.36
		Y	0.06	-0.02	0.12	0.51
FRed	Photosynthesis	N	-0.30	-0.05	0.22	0.25
		Y	-0.33	-0.05	0.22	0.21
	Nutrients	N	-0.22	-0.02	0.11	0.07
		Y	-0.23	-0.02	0.11	0.05
	Morphology/Structure	N	-0.02	-0.02	0.12	0.98
		Y	-0.05	-0.02	0.12	0.81

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