

Online Resource 4: Additional Tables and Figures

Vegetation zones and vegetation cover

Table S4.1. Recoding of vegetation types of Sterling and Ducharne (2008), except for tree plantations and wetlands.

Sterling & Ducharne 2008	this paper
Tropical evergreen forest/woodlands	Tropical evergreen Forest
Tropical deciduous forest/woodlands	Tropical deciduous Forest
Temperate broadleaf evergreen forest/woodlands	Temperate evergreen Forest
Temperate needleleaf evergreen forest/woodlands	Temperate evergreen Forest
Temperate deciduous forest/woodlands	Temperate deciduous Forest
Boreal evergreen forest/woodlands	Boreal forest
Boreal deciduous forest/woodlands	Boreal forest
Temperate mixed forest/woodlands	Temperate mixed forest
Boreal mixed forest/woodlands	Boreal forest
Tropical savanna	Tropical woodland
Temperate savanna 100% C ₃ grass	Temperate grassland and shrubland
Temperate savanna mixed C ₃ /C ₄ ≈30% C ₃ grass	Tropical woodland
Temperate savanna mixed C ₃ /C ₄ ≈70% C ₃ grass	Temperate grassland and shrubland
C ₄ grassland	Tropical grassland
C ₃ grassland	Temperate grassland and shrubland
Mixed C ₃ /C ₄ grassland, ≈30% C ₃ grassland	Tropical grassland
Mixed C ₃ /C ₄ grassland ≈70% C ₃ grassland	Temperate grassland and shrubland
Dense shrubland	Shrubland
Open shrubland	Shrubland
Tundra	Tundra
Desert	Hot desert
Polar Desert/Rock/Ice	Bare
Built-up Land	Azonal: built-up
Cropland 0% C ₃ , 100% C ₄	Azonal: crops
Cropland 30% C ₃ , 70% C ₄	Azonal: crops
Cropland 70% C ₃ , 30% C ₄	Azonal: crops
Cropland 100% C ₃ , 0% C ₄	Azonal: crops
Grazing (censored) 0% C ₃ , 100% C ₄	Azonal: pasture
Grazing (censored) 30% C ₃ , 70% C ₄	Azonal: pasture
Grazing (censored) 70% C ₃ , 30% C ₄	Azonal: pasture
Grazing (censored) 100% C ₃ , 0% C ₄	Azonal: pasture
>50% forestry, (Erb et al., 2007)	Azonal: plantation
classes 95, 96 Global Ecosystems legend, Global Land Cover Characterization map (Loveland et al., 2000)	Azonal: plantation
swamp forest/flooded forest, coastal wetland, bog/fen/mire, or 50-100% wetland, Lehner & Döll 2004	Azonal: wetland

References

- Erb K.-H., Gaube V., Krausmann F., Plutzer C., Bondeau A., Haberl H. (2007) A comprehensive global 5min resolution land-use dataset for the year 2000 consistent with national census data. *Journal of Land Use Science* 2, 191-224. doi: 10.1080/17474230701622981
- Loveland T. R., Reed B. C., Brown J. F., Ohlen D. O., Zhu J., Yang L., Merchant J. W. (2000) Development of a Global Land Cover Characteristics Database and IGBP DISCover from 1-km AVHRR Data. *International Journal of Remote Sensing* 21, 1303-1330. doi: 10.1080/014311600210191

de Noblet-Ducoudré N., Peterschmitt J.-Y. (2008) Designing historical and future land-cover maps at the global scale for climate studies.
http://www.cnrm.meteo.fr/ensembles/public/data/LandUseMaps_Information.pdf, ENSEMBLES,
Sterling S., Ducharne A. (2008) Comprehensive data set of global land cover change for land surface model applications. Global Biogeochemical Cycles 22, GB3017. doi: 10.1029/2007GB002959

Table S4.2. Probability distribution of plant types within the intersection of land cover and vegetation type.

land cover	vegetation type	evergr. trees	decid. trees	shrubs	mosses, ferns	gramin-oids	herbs	bare
zonal	Trop. evergreen forest	0.85	0.05	0.05	0.01	0	0.04	0
	Trop. deciduous forest	0.05	0.85	0.05	0	0	0.05	0
	Tropical woodland	0	0.25	0.1	0	0.5	0.1	0.05
	Tropical grassland	0	0	0.05	0	0.65	0.2	0.1
	Hot desert	0	0	0.01	0	0.02	0.01	0.96
	Shrubland	0	0	0.65	0	0.2	0.05	0.1
	Temp. evergr. forest	0.85	0.05	0.06	0.02	0.01	0.01	0
	Temp. decid. forest	0.05	0.85	0.05	0.01	0.02	0.02	0
	Temp. mixed forest	0.45	0.45	0.05	0.01	0.02	0.02	0
	Temp. grassland	0	0.05	0.04	0.01	0.65	0.15	0.1
	Boreal forest	0.65	0.1	0.1	0.05	0.05	0.05	0
	Tundra	0	0	0.1	0.15	0.2	0.05	0.5
	Bare, ice, rock	0	0	0	0	0	0	1
built-up	all types	0	0	0	0	0	0	1
annual crops	Trop. evergreen forest	0	0	0	0	0.7	0.3	0
	Trop. deciduous forest	0	0	0	0	0.7	0.3	0
	Tropical woodland	0	0	0	0	0.95	0.05	0
	Tropical grassland	0	0	0	0	0.95	0.05	0
	Hot desert	0	0	0	0	0.95	0.05	0
	Shrubland	0	0	0	0	0.9	0.1	0
	Temp. evergr. forest	0	0	0	0	0.95	0.05	0
	Temp. decid. forest	0	0	0	0	0.95	0.05	0
	Temp. mixed forest	0	0	0	0	0.95	0.05	0
	Temp. grassland	0	0	0	0	0.95	0.05	0
	Boreal forest	0	0	0	0	0.95	0.05	0
	Tundra	0	0	0	0	0	0	1
	Bare, ice, rock	0	0	0	0	0	0	1
pasture	Trop. evergreen forest	0.01	0	0.02	0	0.77	0.2	0
	Trop. deciduous forest	0	0.01	0.02	0	0.77	0.2	0
	Tropical woodland	0	0.05	0.02	0	0.73	0.2	0
	Tropical grassland	0	0	0.02	0	0.78	0.2	0
	Hot desert	0	0	0	0	0.8	0.2	0
	Shrubland	0	0	0.05	0	0.8	0.15	0
	Temp. evergr. forest	0	0	0	0	0.8	0.2	0
	Temp. decid. forest	0	0	0.01	0	0.79	0.2	0
	Temp. mixed forest	0	0	0.01	0	0.79	0.2	0
	Temp. grassland	0	0	0.01	0	0.79	0.2	0
	Boreal forest	0.01	0.01	0.02	0	0.76	0.2	0
	Tundra	0	0	0	0	0.8	0.2	0
	Bare, ice, rock	0	0	0	0	0.8	0.2	0

plantations, secondary forests	Trop. evergreen forest	0.75	0.1	0.05	0	0	0	0.1
	Trop. deciduous forest	0.1	0.75	0.05	0	0	0	0.1
	Tropical woodland	0	0.85	0.05	0	0	0	0.1
	Tropical grassland	0	0.85	0.05	0	0	0	0.1
	Hot desert	0	0.85	0.05	0	0	0	0.1
	Shrubland	0	0.85	0.05	0	0	0	0.1
	Temp. evergr. forest	0.85	0.1	0.05	0	0	0	0
	Temp. decid. forest	0.1	0.85	0.05	0	0	0	0
	Temp. mixed forest	0.1	0.85	0.05	0	0	0	0
	Temp. grassland	0	0.95	0.05	0	0	0	0
	Boreal forest	1	0	0	0	0	0	0
	Tundra	0.3	0.3	0	0.05	0.1	0.1	0.15
	Bare, ice, rock	0	0	0	0	0	0	1
wetland	Trop. evergreen forest	0.8	0	0.08	0.02	0.06	0.04	0
	Trop. deciduous forest	0.15	0.65	0.08	0.02	0.06	0.04	0
	Tropical woodland	0	0.2	0.05	0.1	0.45	0.2	0
	Tropical grassland	0	0.25	0.05	0.2	0.3	0.2	0
	Hot desert	0.03	0.03	0.09	0.2	0.45	0.2	0
	Shrubland	0	0.05	0.35	0.1	0.3	0.2	0
	Temp. evergr. forest	0.02	0	0.05	0.2	0.43	0.3	0
	Temp. decid. forest	0	0.15	0.05	0.15	0.4	0.25	0
	Temp. mixed forest	0.02	0.14	0.04	0.2	0.35	0.25	0
	Temp. grassland	0	0.25	0.1	0.1	0.3	0.25	0
	Boreal forest	0.25	0.1	0.05	0.1	0.3	0.2	0
	Tundra	0	0	0.4	0.2	0.15	0.15	0.1
	Bare, ice, rock	0	0	0	0.001	0.001	0.001	0.997

Table S4.3. Probabilities of target land use contingent on reference land use (LU), target temperature and target aridity. Transition among crops, pastures, and other vegetation was initially calculated from ENSEMBLES maps (de Noblet-Ducoudré and Peterschmitt, 2008). These transition probabilities were modified and extended using these rules in the given order:

- when temperature = (freezing, cold, or cool) & no LUC observed, then zonal → plantation: 10%, any LU → zonal: 90%
- when temperature = (warm or hot), then plantations → crop, → pasture, → zonal: 1% each
- when temperature = (warm or hot) & aridity = (arid or dry), then wetlands → crop, → pasture: 1% each
- when temperature = (warm or hot) & aridity = (mesic or moist) [i.e., tropics], then (anything but built-up) → (any LU but wetland): at least 1%
- when temperature ≠ freezing & aridity ≠ arid [i.e., temperate and boreal], then (any LU but built-up) to any LU: at least 1% (but: zonal → wetland: 0)
- when temperature ≠ (freezing or cold), then zonal → pasture: at least 1%
- when temperature = (warm or hot), then zonal → crop: at least 1% and any LU → built-up: 1%

de Noblet-Ducoudré N., Peterschmitt J.-Y. (2008) Designing historical and future land-cover maps at the global scale for climate studies.

http://www.cnrm.meteo.fr/ensembles/public/data/LandUseMaps_Information.pdf

reference land use	temp.	aridity	target land use					
			zonal	built-up	crops	pasture	plantation	wetland
zonal	freez.	arid	1	0	0	0	0	0
		dry	0.9	0	0	0	0.1	0
		mesic	0.899	0	0	0	0.1	0.001
		moist	0.899	0	0	0	0.1	0.001
		arid	0.98	0	0.02	0	0	0
		dry	0.9	0	0	0	0.1	0
		mesic	0.869	0	0.03	0	0.1	0.001
		moist	0.759	0	0.14	0	0.1	0.001
	cold	arid	0.76	0	0.18	0.06	0	0
		dry	0.67	0	0.2	0.03	0.1	0
		mesic	0.66	0	0.23	0.01	0.1	0
		moist	0.86	0	0.03	0.01	0.1	0
	cool	arid	0.87	0	0.11	0.01	0.01	0
		dry	0.74	0	0.15	0.01	0.1	0
		mesic	0.72	0.01	0.16	0.01	0.1	0
		moist	0.73	0.01	0.15	0.01	0.1	0
	warm	arid	0.97	0	0.01	0.01	0.01	0
		dry	0.87	0	0.02	0.01	0.1	0
		mesic	0.66	0.01	0.22	0.01	0.1	0
		moist	0.74	0.01	0.14	0.01	0.1	0
	hot	arid	0.97	0	0.01	0.01	0.01	0
		dry	0.87	0	0.02	0.01	0.1	0
		mesic	0.66	0.01	0.22	0.01	0.1	0
		moist	0.74	0.01	0.14	0.01	0.1	0

built-up	freez.	arid	0	1	0	0	0	0
		dry	0	1	0	0	0	0
		mesic	0	1	0	0	0	0
		moist	0	1	0	0	0	0
	cold	arid	0	1	0	0	0	0
		dry	0	1	0	0	0	0
		mesic	0	1	0	0	0	0
		moist	0	1	0	0	0	0
	cool	arid	0	1	0	0	0	0
		dry	0	1	0	0	0	0
		mesic	0	1	0	0	0	0
		moist	0	1	0	0	0	0
	warm	arid	0	1	0	0	0	0
		dry	0	1	0	0	0	0
		mesic	0	1	0	0	0	0
		moist	0	1	0	0	0	0
	hot	arid	0	1	0	0	0	0
		dry	0	1	0	0	0	0
		mesic	0	1	0	0	0	0
		moist	0	1	0	0	0	0
crops	freez.	arid	0.01	0	0.98	0.01	0	0
		dry	0.01	0	0.98	0.01	0	0
		mesic	0.039	0	0.96	0	0	0.001
		moist	0.149	0	0.85	0	0	0.001
	cold	arid	0	0	1	0	0	0
		dry	0	0	1	0	0	0
		mesic	0	0	0.999	0	0	0.001
		moist	0	0	0.999	0	0	0.001
	cool	arid	0	0.001	0.999	0	0	0
		dry	0	0.001	0.999	0	0	0
		mesic	0	0.001	0.998	0	0	0.001
		moist	0	0.001	0.998	0	0	0.001
	warm	arid	0.05	0.001	0.899	0	0.05	0
		dry	0.06	0.001	0.889	0	0.05	0
		mesic	0.138	0.001	0.84	0.01	0.01	0.001
		moist	0.188	0.001	0.79	0.01	0.01	0.001
	hot	arid	0.089	0.001	0.86	0	0.05	0
		dry	0.019	0.001	0.93	0	0.05	0
		mesic	0.118	0.001	0.86	0.01	0.01	0.001
		moist	0.048	0.001	0.93	0.01	0.01	0.001

pasture	freez.	arid	0.2	0	0	0.8	0	0
		dry	0.1	0	0	0.9	0	0
		mesic	0	0	0	0.999	0	0.001
		moist	0	0	0	0.999	0	0.001
	cold	arid	0.1	0.01	0	0.89	0	0
		dry	0	0	0	1	0	0
		mesic	0	0	0	0.999	0	0.001
		moist	0	0	0	0.999	0	0.001
	cool	arid	0	0.001	0	0.999	0	0
		dry	0	0.001	0.05	0.949	0	0
		mesic	0.01	0.001	0.1	0.838	0.05	0.001
		moist	0.01	0.001	0.2	0.738	0.05	0.001
	warm	arid	0	0.001	0.01	0.989	0	0
		dry	0	0.001	0.02	0.979	0	0
		mesic	0.01	0.001	0.2	0.738	0.05	0.001
		moist	0.01	0.001	0.2	0.738	0.05	0.001
	hot	arid	0	0.001	0.01	0.979	0.01	0
		dry	0	0.001	0.02	0.969	0.01	0
		mesic	0.01	0.001	0.2	0.738	0.05	0.001
		moist	0.01	0.001	0.2	0.738	0.05	0.001
plantation	freez.	arid	0.01	0	0	0.01	0.98	0
		dry	0.01	0	0	0.01	0.98	0
		mesic	0.01	0	0	0.01	0.979	0.001
		moist	0.01	0	0	0.01	0.979	0.001
	cold	arid	0.01	0	0	0.01	0.98	0
		dry	0.01	0	0	0.01	0.98	0
		mesic	0.01	0	0.01	0.01	0.969	0.001
		moist	0.01	0	0.01	0.01	0.969	0.001
	cool	arid	0.01	0.001	0.01	0.01	0.969	0
		dry	0.01	0.001	0.01	0.01	0.969	0
		mesic	0.01	0.001	0.01	0.01	0.968	0.001
		moist	0.01	0.001	0.01	0.01	0.968	0.001
	warm	arid	0.01	0.001	0.01	0.01	0.969	0
		dry	0.01	0.001	0.01	0.01	0.969	0
		mesic	0.01	0.001	0.01	0.01	0.968	0.001
		moist	0.01	0.001	0.01	0.01	0.968	0.001
	hot	arid	0.01	0.001	0.01	0.01	0.969	0
		dry	0.01	0.001	0.01	0.01	0.969	0
		mesic	0.01	0.001	0.01	0.01	0.968	0.001
		moist	0.01	0.001	0.01	0.01	0.968	0.001

wetland	freez.	arid	0	0	0	0	0	1
		dry	0	0	0	0	0	1
		mesic	0	0	0	0	0	1
		moist	0	0	0	0	0	1
	cold	arid	0	0	0	0	0.01	0.99
		dry	0	0	0	0	0.01	0.99
		mesic	0	0	0	0	0.01	0.99
		moist	0	0	0	0	0.01	0.99
	cool	arid	0	0	0.01	0.01	0.01	0.97
		dry	0	0	0.01	0.01	0.01	0.97
		mesic	0	0	0.01	0.01	0.01	0.97
		moist	0	0	0.01	0.01	0.01	0.97
	warm	arid	0	0	0.01	0.01	0.01	0.97
		dry	0	0	0.01	0.01	0.01	0.97
		mesic	0	0	0.01	0.01	0.01	0.97
		moist	0	0	0.01	0.01	0.01	0.97
	hot	arid	0	0	0.01	0.01	0.01	0.97
		dry	0	0	0.01	0.01	0.01	0.97
		mesic	0	0	0.01	0.01	0.01	0.97
		moist	0	0	0.01	0.01	0.01	0.97

Decomposability

Table S4.4. Fraction (%) of the litter (above- and belowground) of a plant type belonging to a decomposability class.

plant types	decomposability				
	very low	low	medium	high	very high
evergreen trees	35	15	40	10	
deciduous trees	30	20		40	10
shrubs	10	15	5	45	25
mosses, ferns		60	40		
graminoids			80	20	
herbs				80	20
bare	20	20	20	20	20

Table S4.5. Probability (%) of a fraction of a class of organic matter of a certain decomposability class going to the slow pool.

fraction of decomposability class going to slow pool	decomposability				
	very low	low	medium	high	very high
0.0–0.10				2.5	97.5
0.10–0.35			0.5	95.0	2.5
0.35–0.65		2.5	99.0	2.5	
0.65–0.9	2.5	95.0	0.5		
0.90–1.0	97.5	2.5			

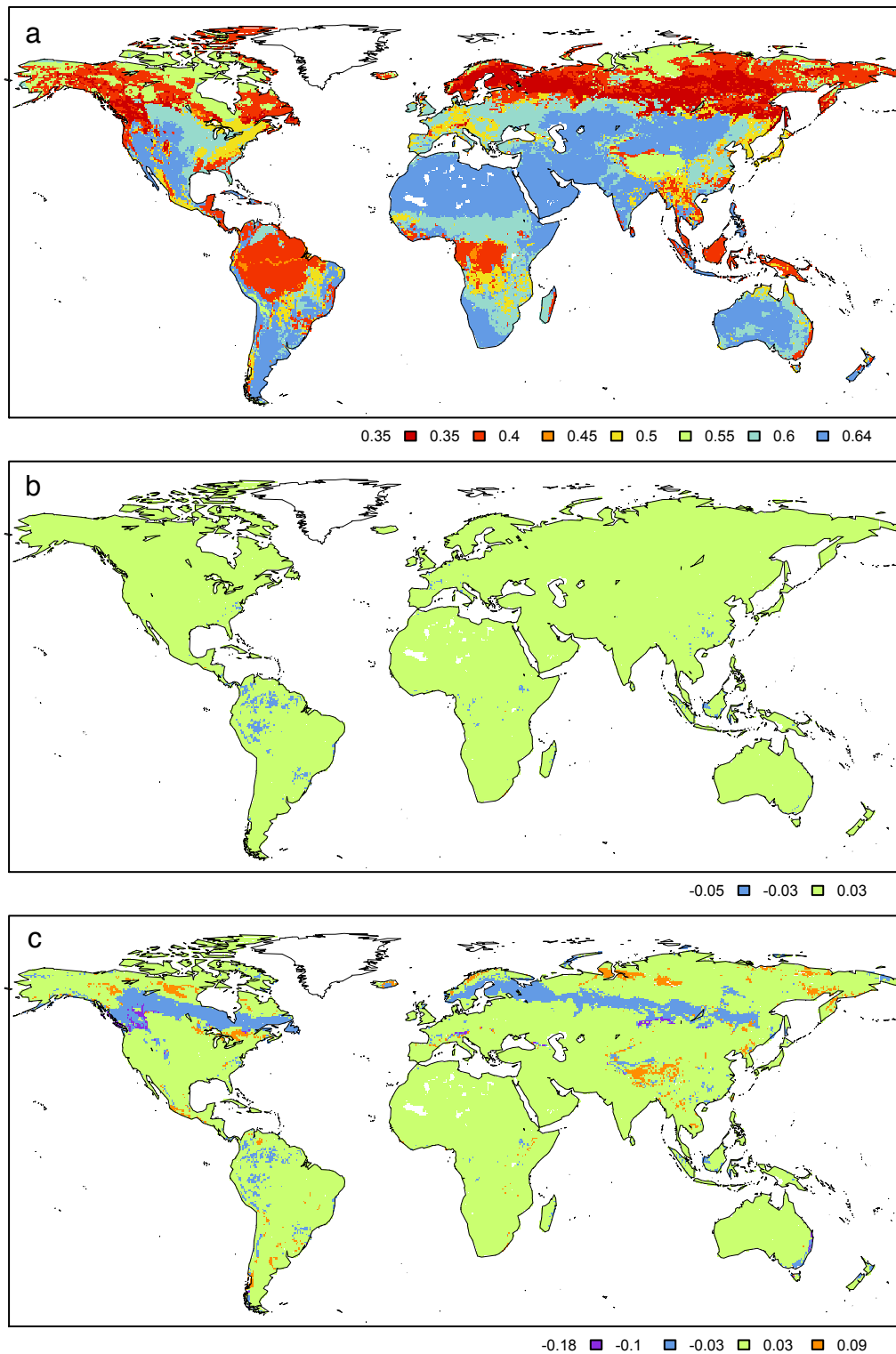


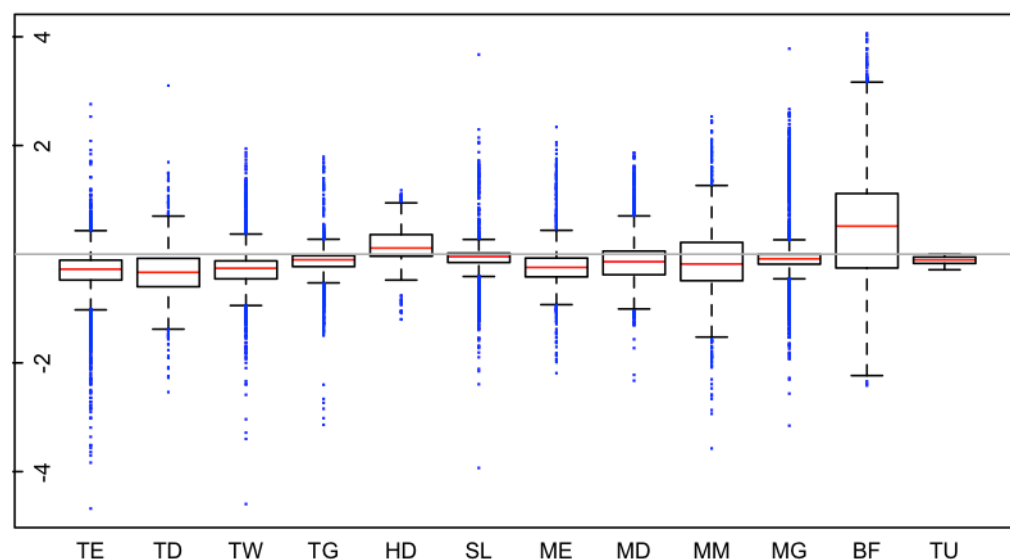
Fig. S4.1. Distribution of mean decomposability (dimensionless) of above- and belowground litter (a) under reference conditions and (b) difference in decomposability to target conditions under the NPP-limited scenario and (c) difference in decomposability to target conditions under the NPP-enhanced scenario.

Depth of water table

Table S4.6. Probabilities of the water table being in certain ranges of depth (equal to the fraction of water-logged soil) depending on land cover.

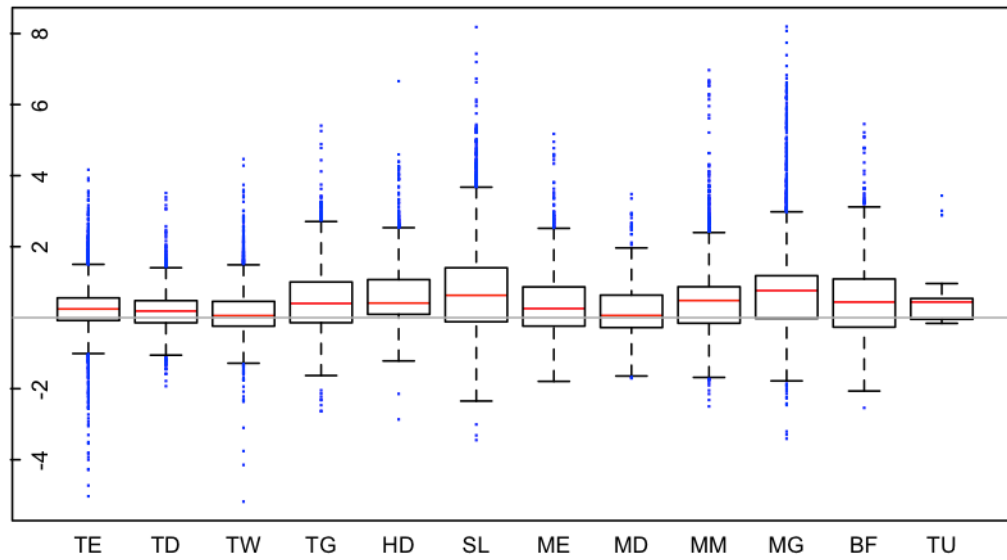
land cover	depth of water table			
	0 to <10	10 to <20	20 to <100	≥100
zonal	0	0	0.05	0.95
built-up	0	0	0.01	0.99
crops	0	0	0.01	0.99
pasture	0	0	0.05	0.95
plantation	0	0	0.02	0.98
wetland	0.80	0.15	0.05	0

Distribution of SOC stocks



	TE	TD	TW	TG	HD	SL	ME	MD	MM	MG	BF	TU
Q1-1.5·(Q3-Q1)	-1.02	-1.38	-0.94	-0.53	-0.48	-0.41	-0.93	-1.01	-1.52	-0.45	-2.23	-0.29
25%ile (Q1)	-0.48	-0.60	-0.45	-0.23	-0.04	-0.15	-0.42	-0.38	-0.49	-0.18	-0.25	-0.17
Median	-0.28	-0.33	-0.26	-0.10	0.11	-0.04	-0.24	-0.14	-0.18	-0.08	0.52	-0.11
75%ile (Q3)	-0.11	-0.08	-0.12	-0.03	0.36	0.02	-0.07	0.06	0.22	0.00	1.12	-0.05
Q3+1.5·(Q3-Q1)	0.43	0.70	0.37	0.27	0.94	0.27	0.44	0.70	1.26	0.26	3.17	0.00
soil area, 10 ⁶ km ²	16.4	5.7	14.5	6.2	9.2	14.0	4.5	4.8	4.5	12.1	17.8	6.2

Fig. S4.2. Distribution of (means per pixel of) changes in SOC stocks (kg C/m², P>0.5) within vegetation zones in the NPP-limited scenario. TE: tropical evergreen forest, TD: tropical deciduous forest, TW: tropical woodland, TG: tropical grassland, HD: hot deserts, SL: shrubland, ME: temperate evergreen forest, MD: temperate deciduous forest, MM: temperate mixed forest, MG: temperate grassland, BF: boreal forest, TU: tundra.



	TE	TD	TW	TG	HD	SL	ME	MD	MM	MG	BF	TU
Q1-1.5·(Q3-Q1)	-1.01	-1.06	-1.28	-1.63	-1.22	-2.35	-1.79	-1.64	-1.68	-1.78	-2.07	-0.16
25%ile (Q1)	-0.08	-0.14	-0.24	-0.14	0.10	-0.12	-0.24	-0.28	-0.16	-0.02	-0.27	-0.04
Median	0.24	0.19	0.06	0.40	0.41	0.63	0.26	0.06	0.48	0.76	0.44	0.44
75%ile (Q3)	0.56	0.48	0.46	1.00	1.07	1.40	0.87	0.63	0.87	1.18	1.09	0.54
Q3+1.5·(Q3-Q1)	1.50	1.41	1.49	2.71	2.53	3.67	2.52	1.96	2.40	2.98	3.12	0.96
soil area, 10 ⁶ km ²	16.4	5.7	14.5	6.2	9.2	14.0	4.5	4.8	4.5	12.1	17.8	6.2

Fig. S4.3. Distribution of (means per pixel of) changes in SOC stocks (kg C/m^2 , $P > 0.5$) within vegetation zones in the NPP-enhanced scenario. TE: tropical evergreen forest, TD: tropical deciduous forest, TW: tropical woodland, TG: tropical grassland, HD: hot deserts, SL: shrubland, ME: temperate evergreen forest, MD: temperate deciduous forest, MM: temperate mixed forest, MG: temperate grassland, BF: boreal forest, TU: tundra.