Global Biogeochemical Cycles

Supporting Information for

The temperature sensitivity (Q10) of soil respiration: controlling factors and spatial prediction at regional scale based on environmental soil classes

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Contents of this file

Figures S1 to S4
Tables S1 to S5

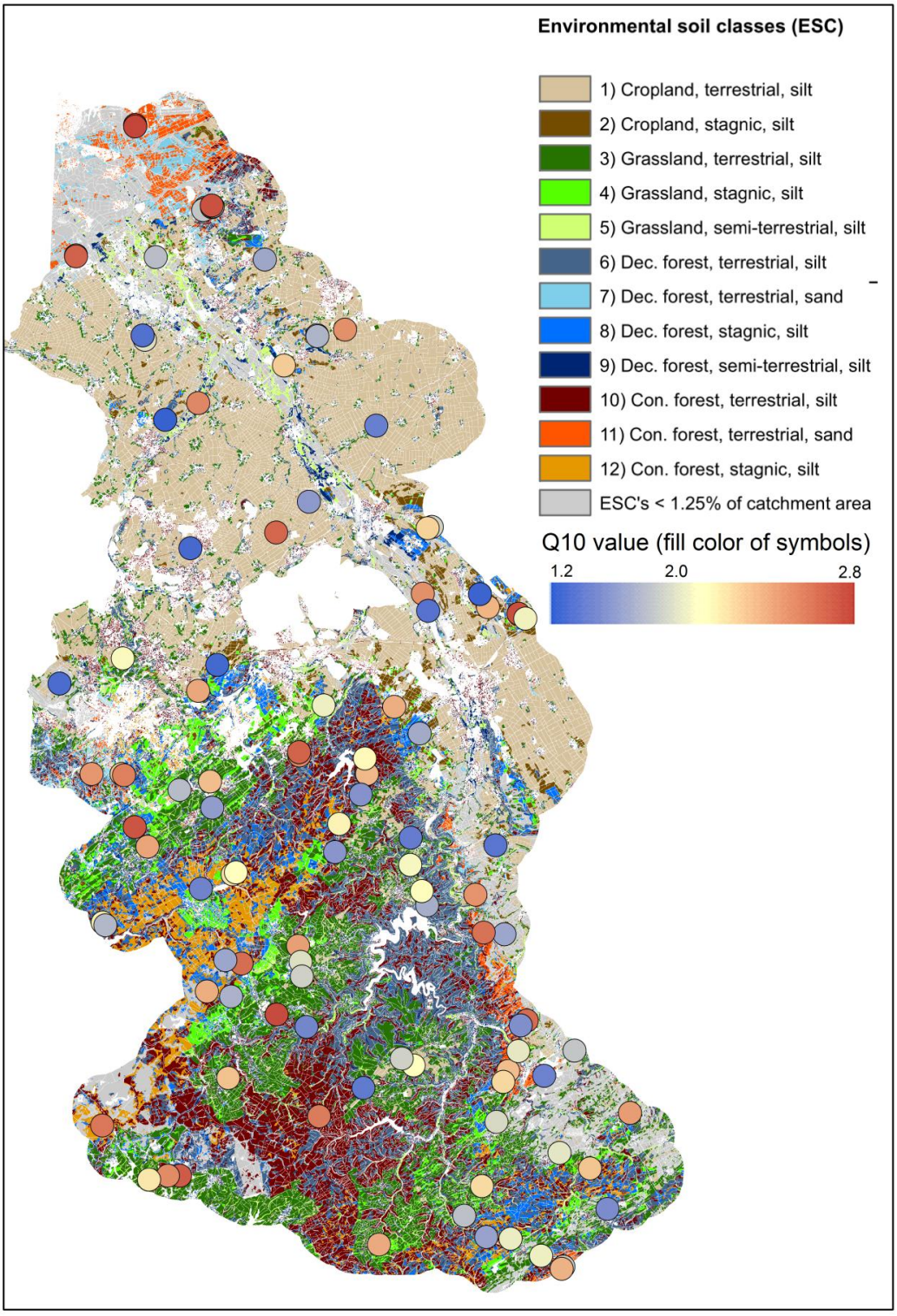

Figure S1. Site-specific Q10 values at 30% water holding capacity.

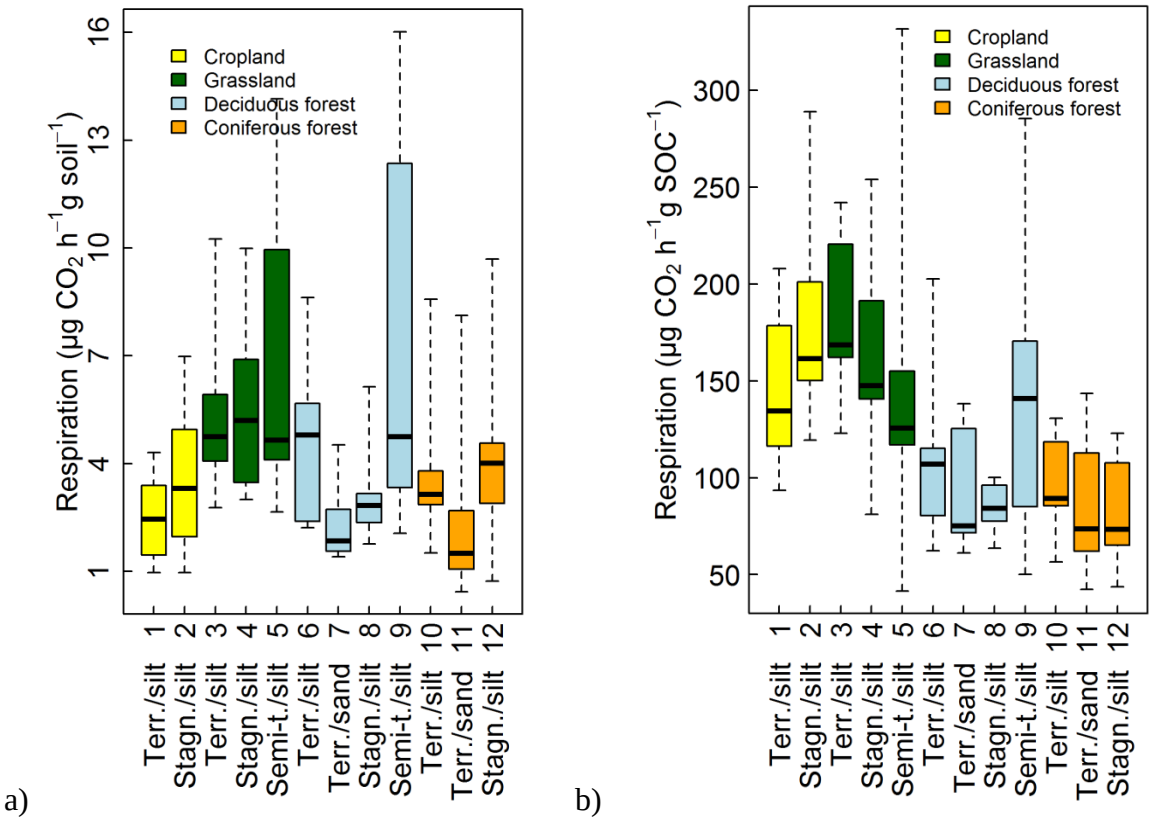

Figure S2. (a) Soil respiration at 25°C (SR_{25}) and 45% water holding capacity (WHC) across environmental soil classes (ESC), and (b) SOC degradability (i.e., relative respiration rate, ratio between SR_{25} and soil organic carbon). Environmental soil class is the combination of land use, aggregated soil group, and soil texture. ESC-1: Cropland, terrestrial, silt, ESC-2: Cropland, stagnic, silt, ESC-3: Grassland, terrestrial, silt, ESC-4: Grassland, stagnic, silt, ESC-5: Grassland, semi-terrestrial, silt, ESC-6: Deciduous forest, terrestrial, silt, ESC-7: Deciduous forest, terrestrial, sand, ESC-8: Deciduous forest, stagnic, silt, ESC-9: Deciduous forest, semi-terrestrial, silt, ESC-10: CF, terrestrial, silt, ESC-11: CF, terrestrial, sand, ESC-12: CF, stagnic, silt.

a)

	1) Crop., Terr., Silt	2) Crop., Stagn., Silt	3) Grass., Terr., Silt	4) Grass., Stagn., Silt	5) Grass., Semi-t., Silt	6) Dec. forest., Terr., Silt	7) Dec. forest., Terr., Sand	8) Dec. forest., Stagn., Silt	9) Dec. forest., Semi-t., Silt	10) Con. forest., Terr., Silt	11) Con. forest., Terr., Sand	12) Con. forest., Stagn., Silt
1) Crop., Terr., Silt	X					<0.01	<0.01	0.04		0.03	0.09	<0.01
2) Crop., Stagn., Silt		X	0.03	0.04		<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
3) Grass., Terr., Silt			X									
4) Grass., Stagn., Silt				X								
5) Grass., Semi-t., Silt					X		0.07					
6) Dec. forest., Terr., Silt						X						
7) Dec. forest., Terr., Sand							X					
8) Dec. forest., Stagn., Silt								X				
9) Dec. forest., Semi-t., Silt									X			
10) Con. forest., Terr., Silt										x		
11) Con. forest., Terr., Sand											X	
12) Con. forest., Stagn., Silt												X

b)

	1) Crop., Terr., Silt	2) Crop., Stagn., Silt	3) Grass., Terr., Silt	4) Grass., Stagn., Silt	5) Grass., Semi-t., Silt	6) Dec. forest., Terr., Silt	7) Dec. forest., Terr., Sand	8) Dec. forest., Stagn., Silt	9) Dec. forest., Semi-t., Silt	10) Con. forest., Terr., Silt	11) Con. forest., Terr., Sand	12) Con. forest., Stagn., Silt
1) Crop., Terr., Silt	X	-	-	-	-	<0.01	<0.01	-	-	-	-	0.1
2) Crop., Stagn., Silt		X	0.07	-	0.05	<0.01	<0.01	0.01	-	<0.01	0.04	<0.01
3) Grass., Terr., Silt			X	-	x	-	-	-	-	-	-	-
4) Grass., Stagn., Silt				X	-	-	-	-	-	-	-	-
5) Grass., Semi-t., Silt					X	-	-	-	-	-	-	-
6) Dec. forest., Terr., Silt						X	-	-	-	-	-	-
7) Dec. forest., Terr., Sand							X	-	-	-	-	-
8) Dec. forest., Stagn., Silt								X	-	-	-	-
9) Dec. forest., Semi-t., Silt									X	-	-	-
10) Con. forest., Terr., Silt										x	-	-
11) Con. forest., Terr., Sand											X	-
12) Con. forest., Stagn., Silt												X

c)

	1) Crop., Terr., Silt	2) Crop., Stagn., Silt	3) Grass., Terr., Silt	4) Grass., Stagn., Silt	5) Grass., Semi-t., Silt	6) Dec. forest., Terr., Silt	7) Dec. forest., Terr., Sand	8) Dec. forest., Stagn., Silt	9) Dec. forest., Semi-t., Silt	10) Con. forest., Terr., Silt	11) Con. forest., Terr., Sand	12) Con. forest., Stagn., Silt
1) Crop., Terr., Silt	X	-	-	-	-	-	-	-	-	-	-	-
2) Crop., Stagn., Silt		X	-	-	-	0.03	0.01	-	-	-	-	-
3) Grass., Terr., Silt			X	-	-	-	-	-	-	-	-	-
4) Grass., Stagn., Silt				X	-	-	-	-	-	-	-	-
5) Grass., Semi-t., Silt					X	-	-	-	-	-	-	-
6) Dec. forest., Terr., Silt						X	-	-	-	-	-	-
7) Dec. forest., Terr., Sand							X	-	-	-	-	-
8) Dec. forest., Stagn., Silt								X	-	-	-	-
9) Dec. forest., Semi-t., Silt									X	-	-	-
10) Con. forest., Terr., Silt										x	-	-
11) Con. forest., Terr., Sand											X	-
12) Con. forest., Stagn., Silt												X

d)

	1) Crop., Terr., Silt	2) Crop., Stagn., Silt	3) Grass., Terr., Silt	4) Grass., Stagn., Silt	5) Grass., Semi-t., Silt	6) Dec. forest., Terr., Silt	7) Dec. forest., Terr., Sand	8) Dec. forest., Stagn., Silt	9) Dec. forest., Semi-t., Silt	10) Con. forest., Terr., Silt	11) Con. forest., Terr., Sand	12) Con. forest., Stagn., Silt
1) Crop., Terr., Silt	X	-	-	-	-	-	-	-	-	-	-	-
2) Crop., Stagn., Silt		X	-	-	-	-	-	-	-	-	-	-
3) Grass., Terr., Silt			X	-	-	-	-	-	-	-	-	-
4) Grass., Stagn., Silt				X	-	-	-	-	-	-	-	-
5) Grass., Semi-t., Silt					X	-	-	-	-	-	-	-
6) Dec. forest., Terr., Silt						X	-	-	-	-	-	-
7) Dec. forest., Terr., Sand							X	-	-	-	-	-
8) Dec. forest., Stagn., Silt								X	-	-	-	-
9) Dec. forest., Semi-t., Silt									X	0.08	0.08	-
10) Con. forest., Terr., Silt										x	-	-
11) Con. forest., Terr., Sand											X	-
12) Con. forest., Stagn., Silt												X

Figure S3. Differences of Q10 values between environmental soil classes (ESC) (a) at 30% water holding capacity (WHC), (b) at 45% WHC, (c) at 60% WHC, (d) at 75% WHC, according to post-hoc test (Tukeys multiple comparisons of means). The p value is shown in case of $p<0.1$ between two ESCs, i.e., in case of approaching conventional significance levels ($p<0.05$). Environmental soil class (ESC) is the combination of land use, aggregated soil group, and soil texture.

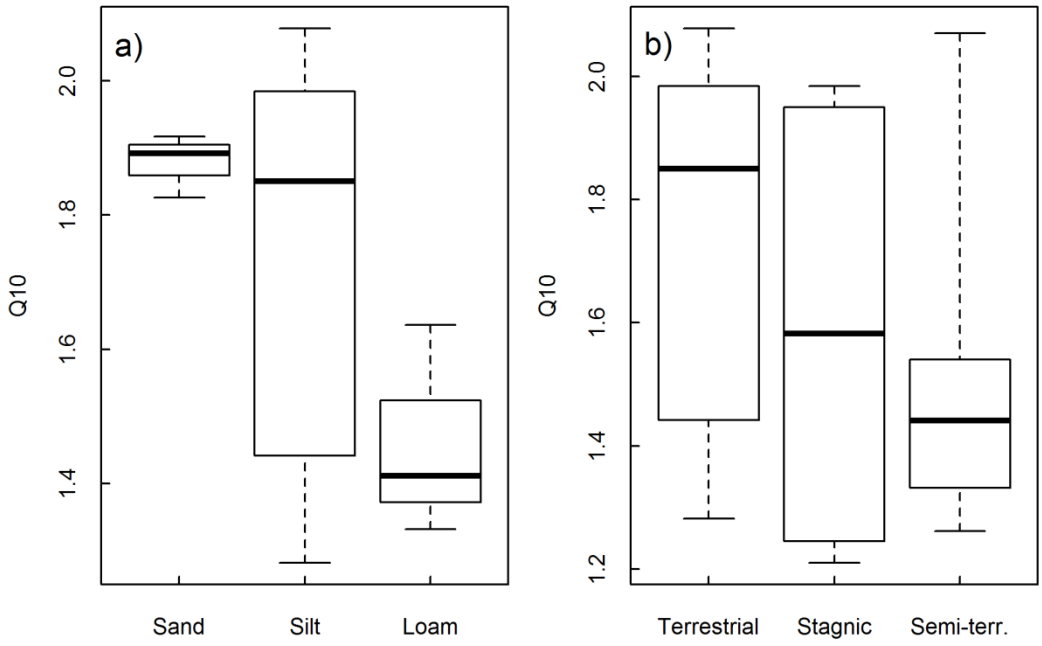

Figure S4. Effect of soil texture and soil group on Q10 values (at 30% WHC) in cropland soils, a) effect of soil texture on the Q10 value in terrestrial croplands (sand, n=3, silt, n=9, loam, n=3), b) effect of soil group on Q10 values in cropland soils with silty texture (terrestrial, n=9, stagnic, n=9, semi-terrestrial, n=5).

	SOC	N	C/N	SR_{25}/SOC	pH	MAT	MAP
All			**0.32*** **	**-0.24***	**-0.52*** †**		
Cropland			**-0.61****		**-0.81*****	**-0.74*****	**0.63****
ESC-1			-0.59°		-0.89***	-0.82**	
ESC-2			-0.79*	-0.60°	-0.73*	-0.78*	
Grassland					**-0.73*****		
ESC-3					-0.79*		
ESC-4				0.79*			
ESC-5					-0.86**		
Dec. forest	**-0.32°**	**-0.34***			**-0.41***		
ESC-6						-0.68*	0.71*
ESC-7	-0.69*	-0.71*				0.71*	0.70*
ESC-8							
ESC-9							
Con. forest	**0.42***	**0.37°**					
ESC-10							
ESC-11			0.64°				
ESC-12							

°p<0.1, *p<0.05, **p<0.01, ***p<0.001

†For this parameter, Spearman's rank correlation was used instead of Pearson because this relation deviated from linearity

Environmental soil class (ESC) is the combination of land use, aggregated soil group, and soil texture. ESC-1= Cropland, terrestrial, silt, ESC-2 = Cropland, stagnic, silt, ESC-3 = Grassland, terrestrial, silt, ESC-4 = Grassland, stagnic, silt, ESC-5 = Grassland, semi-terrestrial, silt, ESC-6 = Deciduous forest, terrestrial, silt, ESC-7 = Deciduous forest, terrestrial, sand, ESC-8 = Deciduous forest, stagnic, silt, ESC-9= Deciduous forest, semi-terrestrial, silt, ESC-10 = CF, terrestrial, silt, ESC-11 = CF, terrestrial, sand, ESC-12 = CF, stagnic, silt, SOC= soil organic carbon, N = total nitrogen, C/N = ratio between SOC and N, SR_{25}/SOC = Ratio between soil respiration at 25°C and 45% of water holding capacity and SOC, MAT = Mean annual temperature, MAP= Mean annual precipitation.

Table S1. Pearson product-moment correlation coefficient for physicochemical soil properties and Q10 values (at 45% WHC) in different ESCs. In addition, values are shown for each land use class and for the complete sample set (rows with bold letters).Only correlations which are significant ($p<0.05$) and close to significant ($p<0.1$) are shown.

	ESC	Q10			
		30% WHC	45% WHC	60% WHC	75% WHC
	All	**2.03±0.29^{a}**	**2.02±0.29^{a}**	**1.97±0.27^{a}**	**1.89±0.27^{b}**
	Cropland	**1.68±0.32^{b}**	**1.70±0.30^{b}**	**1.79±0.29^{a,b}**	**1.85±0.25^{a}**
ESC-1	Cropland, Terrestrial, Silt	1.72±0.31	1.77±0.34	1.84±0.29	1.94±0.21
ESC-2	Cropland, Stagnosol, Silt	1.63±0.34	1.63±0.24	1.74±0.30	1.76±0.27
	Grassland	**1.99±0.19^{a,b}**	**2.00±0.22^{a}**	**1.97±0.22^{a,b}**	**1.91±0.21^{b}**
ESC-3	Grassland, Terrestrial, Silt	2.02±0.20^{a}	2.00±0.25^{a,b}	2.00±0.22^{a,b}	1.89±0.19^{b}
ESC-4	Grassland, Stagnosol, Silt	2.01±0.16	1.97±0.15	1.95±0.22	1.93±0.26
ESC-5	Grassland, Semi-terr., Silt	1.95±0.23	2.02±0.26	1.98±0.24	1.90±0.20
	Dec. Forest	**2.19±0.23^{a}**	**2.14±0.23^{a}**	**2.08±0.25^{a,b}**	**2.01±0.30^{b}**
ESC-6	Dec. forest, Terrestrial, Silt	2.27±0.23^{a}	2.24±0.15^{a}	2.16±0.22^{a,b}	1.97±0.19^{b}
ESC-7	Dec. forest, Terrestrial, Sand	2.30±0.22	2.26±0.17	2.19±0.26	2.00±0.43
ESC-8	Dec. forest, Stagnosol, Silt	2.12±0.21	2.09±0.25	1.99±0.27	1.93±0.25
ESC-9	Dec. forest, Semi-terr., Silt	2.05±0.17	1.95±0.22	1.98±0.21	2.12±0.27
	CF	**2.13±0.22^{a}**	**2.09±0.27^{b}**	**1.94±0.26^{c}**	**1.74±0.22^{d}**
ESC-10	Con. forest, Terrestrial, Silt	2.11±0.14^{a}	2.12±0.20^{a}	1.98±0.27^{a}	1.73±0.14^{b}
ESC-11	Con. forest, terrestrial, Sand	2.07±0.28^{a}	2.02±0.26^{a}	1.93±0.30^{a,b}	1.72±0.28^{b}
ESC-12	Con. forest, stagnic, Silt	2.22±0.23^{a}	2.14±0.37^{a,b}	1.91±0.24^{b,c}	1.76±0.24^{c}

Environmental soil class (ESC) is the combination of land use, aggregated soil group, and soil texture. ESC-1: Cropland, terrestrial, silt, ESC-2: Cropland, stagnic, silt, ESC-3: Grassland, terrestrial, silt, ESC-4: Grassland, stagnic, silt, ESC-5: Grassland, semi-terrestrial, silt, ESC-6: Deciduous forest, terrestrial, silt, ESC-7: Deciduous forest, terrestrial, sand, ESC-8: Deciduous forest, stagnic, silt, ESC-9: Deciduous forest, semi-terrestrial, silt, ESC-10: CF, terrestrial, silt, ESC-11: CF, terrestrial, sand, ESC-12: CF, stagnic, silt. In each row, values with different letters indicate significant differences between the soil moisture levels ($p<0.05$).

Table S2. Mean Q10 value in relation to environmental soil class (ESC) and soil moisture level (% of water holding capacity, WHC).

Moisture (% WHC)	Factor	P value	Effect size (η^2)
30%	ESC	<0.001	0.44
	Land use	<0.001	0.38
	Soil group	0.791	0.005
	Texture	0.015	0.06
45%	ESC	<0.001	0.36
	Land use	<0.001	0.28
	Soil group	0.769	0.005
	Texture	0.049	0.04
60%	ESC	0.028	0.20
	Land use	0.001	0.14
	Soil group	0.959	0.001
	Texture	0.100	0.03
75%	ESC	0.035	0.19
	Land use	<0.001	0.15
	Soil group	0.071	0.05
	Texture	0.072	0.001

ESC= Environmental soil class (combination of land use, aggregated soil group, and soil texture), WHC = water holding capacity, η^2= eta squared

Table S3: Effect of ESC and individual effect of land use, soil group, and texture class on Q10 values at different soil moisture levels. The significance level and the effect size (η^2) is presented.

		SR_5		SR_{10}		SR_{15}		SR_{20}	
Moisture	Model	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE
30% WHC	$Q10_{var}$	0.73	0.36	0.93	0.24	0.97	0.27	0.99	0.25
	$Q10_{fix(1.5)}$	0.67	0.99	0.92	0.86	0.96	0.67	0.99	0.39
	$Q10_{fix(2)}$	0.67	0.40	0.92	0.26	0.96	0.28	0.99	0.26
45% WHC	$Q10_{var}$	0.77	0.41	0.89	0.37	0.96	0.38	0.98	0.39
	$Q10_{fix(1.5)}$	0.73	1.14	0.88	1.10	0.95	0.81	0.98	0.44
	$Q10_{fix(2)}$	0.73	0.44	0.88	0.39	0.95	0.42	0.98	0.41
60% WHC	$Q10_{var}$	0.77	0.38	0.90	0.34	0.96	0.36	0.97	0.44
	$Q10_{fix(1.5)}$	0.76	0.97	0.91	0.90	0.97	0.66	0.98	0.42
	$Q10_{fix(2)}$	0.76	0.39	0.91	0.33	0.97	0.36	0.98	0.45
75% WHC	$Q10_{var}$	0.74	0.18	0.84	0.17	0.93	0.15	0.97	0.14
	$Q10_{fix(1.5)}$	0.76	0.37	0.86	0.38	0.94	0.32	0.98	0.21
	$Q10_{fix(2)}$	0.76	0.19	0.86	0.17	0.94	0.16	0.98	0.15

WHC = Water holding capacity, Q10 = Increase of soil respiration per 10°C increase in temperature, SR = Soil respiration, SR_5 = Soil respiration at 5°C, SR_{10} = Soil respiration at 10°C, SR_{15} = Soil respiration at 15°C, SR_{20} = Soil respiration at 25°C, $Q10_{var}$ = Model based on the mean Q10 value of each ESC and soil moisture level, $Q10_{fix(1.5)}$ = Model based on a fixed Q10 value of 1.5, $Q10_{fix(2.0)}$ = Model based on a fixed Q10 value of 2.0, ESC = Environmental soil class (combination of land use, aggregated soil group, and soil texture).

Table S4. Coefficient of determination (R^2) and root mean square error (RMSE) for the relation between measured and estimated soil respiration rates (SR). The values are given for each temperature and soil moisture level separately based on $Q10_{var}$, $Q10_{fix(1.5)}$, and $Q10_{fix(2)}$.

Sample	Land Use[a]	Aggregated soil group[b]	Soil texture[c]	Longitude[d]	Latitude[d]	MAT (°C)[e]	MAP (mm)[f]	SOC (%)	N (%)	C/N	pH[g]	$SR_{25,30}$ (µg CO_2 h^{-1} g^{-1} soil)[h]	$SR_{25,45}$ (µg CO_2 h^{-1} g^{-1} soil)[i]	$SR_{25,60}$ (µg CO_2 h^{-1} g^{-1} soil)[j]	$SR_{25,75}$ (µg CO_2 h^{-1} g^{-1} soil)[k]	Q10 at 30% WHC[l]	Q10 at 45% WHC	Q10 at 60% WHC	Q10 at 75% WHC
1	CF	Terrestrial	Silt	310000	5597000	6.60	1185	4.25	0.26	16.16	3.58	3.29	2.89	3.10	1.92	2.27	2.08	1.82	1.62
2	G	Terrestrial	Silt	309000	5611000	7.40	1116	3.15	0.31	10.12	4.88	4.48	5.92	6.49	2.69	2.18	2.15	2.09	2.08
3	DF	Terrestrial	Sand	301000	5668000	9.96	795	2.11	0.10	20.47	3.21	1.25	1.58	1.52	0.66	2.45	2.56	2.64	1.90
4	CF	Terrestrial	Sand	301000	5668000	9.96	795	2.10	0.09	23.83	3.54	1.58	1.82	1.03	0.61	1.96	1.89	1.80	1.68
5	CF	Terrestrial	Silt	302000	5668000	9.83	809	3.34	0.14	24.54	3.27	2.20	2.86	2.40	0.91	1.78	1.69	1.70	1.46
6	CF	Stagnic	Silt	302000	5668000	9.83	809	1.90	0.09	21.75	3.51	1.25	1.42	1.61	0.80	1.97	2.25	2.08	1.63
7	DF	Terrestrial	Silt	302000	5668000	9.83	809	2.75	0.13	20.37	3.55	2.06	2.21	1.80	0.82	2.58	2.26	2.33	2.13
8	C	Terrestrial	Silt	290000	5631000	9.36	904	1.08	0.12	9.27	6.46	1.53	1.89	2.05	1.45	1.32	1.31	1.43	1.69
9	CF	Stagnic	Silt	326000	5636000	9.72	823	4.44	0.19	23.33	3.45	2.40	2.90	3.28	1.28	2.59	2.61	2.24	1.97
10	DF	Stagnic	Silt	326000	5636000	9.74	818	3.26	0.17	18.94	3.5	2.34	2.55	2.06	0.91	2.06	2.41	2.16	1.83
11	DF	Terrestrial	Silt	319000	5643000	9.87	817	2.07	0.13	16.22	3.57	2.14	2.38	1.98	1.03	1.99	1.92	1.92	1.97
12	CF	Terrestrial	Silt	319000	5643000	9.87	817	2.69	0.12	23.16	3.38	1.50	1.52	1.53	0.75	2.12	2.35	2.20	1.67
13	DF	Semi-terrestrial	Silt	311000	5618000	8.21	1007	11.86	0.84	14.12	4.5	13.00	15.49	13.93	2.89	1.83	1.80	1.85	2.35
14	CF	Terrestrial	Silt	312000	5620000	8.59	968	3.55	0.18	19.30	3.74	2.78	3.14	3.09	1.24	2.09	2.27	2.41	1.85
15	DF	Semi-terrestrial	Silt	318000	5638000	9.96	804	2.43	0.25	9.80	4.82	3.84	3.92	3.55	2.23	2.21	2.23	2.42	2.39
16	C	Terrestrial	Silt	309000	5645000	10.03	803	1.04	0.11	9.64	6.22	0.73	0.97	1.11	0.96	1.85	1.52	1.78	1.88
17	DF	Semi-terrestrial	Silt	308000	5656000	10.14	788	4.10	0.32	12.96	3.66	2.34	2.06	2.68	1.58	2.13	1.70	2.05	1.86
18	DF	Stagnic	Silt	310000	5658000	9.94	810	2.77	0.16	17.66	3.31	1.54	1.76	1.78	0.72	2.10	2.11	2.28	1.72
19	C	Stagnic	Silt	310000	5658000	9.94	810	0.81	0.08	9.66	5.95	0.79	0.97	0.97	0.60	1.92	1.61	1.81	1.64
20	G	Terrestrial	Silt	324000	5597000	7.48	1001	2.99	0.33	9.15	5.47	4.85	6.59	6.60	2.39	2.00	1.95	2.08	1.99
21	CF	Terrestrial	Silt	316000	5629000	9.56	848	2.91	0.15	18.86	3.62	2.68	3.80	2.89	1.00	2.16	2.11	1.88	1.64
22	CF	Stagnic	Silt	316000	5629000	9.56	848	4.21	0.19	22.57	3.2	4.29	5.16	2.98	1.55	NA	NA	1.50	1.50
23	DF	Terrestrial	Silt	314000	5624000	8.59	963	5.12	0.25	20.08	3.72	4.75	5.84	2.54	1.30	2.31	2.29	1.79	1.82
24	CF	Terrestrial	Silt	314000	5624000	8.59	963	7.84	0.31	25.42	3.17	7.08	8.57	2.27	2.08	2.15	2.11	2.01	1.83
25	DF	Semi-terrestrial	Silt	314000	5625000	8.70	948	2.98	0.23	13.13	3.86	2.25	3.27	2.94	1.51	2.09	2.20	1.93	2.50

26	DF	Stagnic	Silt	318000	5627000	9.62	834	2.23	0.13	17.63	3.59	1.68	2.18	2.49	2.08	1.89	2.26	2.17	2.05
27	DF	Stagnic	Silt	309000	5625000	8.67	963	3.31	0.15	21.89	3.75	3.47	2.80	1.19	1.14	2.23	2.00	1.81	1.57
28	CF	Stagnic	Silt	309000	5626000	8.67	963	1.67	0.05	31.20	3.3	0.57	0.73	0.79	0.49	2.34	1.88	2.00	1.86
29	G	Stagnic	Silt	299000	5623000	9.14	931	3.97	0.33	12.00	5.68	5.09	5.86	6.31	3.10	1.94	1.97	2.01	1.63
30	G	Semi-terrestrial	Silt	302000	5621000	9.05	935	6.91	0.70	9.92	5.75	9.88	10.71	4.55	3.24	1.86	1.97	1.97	1.93
31	G	Semi-terrestrial	Silt	309000	5604000	8.32	980	3.25	0.23	14.24	5.19	3.13	3.81	2.02	1.55	1.71	1.86	1.92	1.96
32	G	Semi-terrestrial	Silt	303000	5600000	7.19	1154	7.92	0.64	12.44	4.65	8.77	9.95	7.40	NA	2.14	2.34	2.21	NA
33	G	Terrestrial	Silt	315000	5651000	9.97	806	1.81	0.17	10.41	6.13	3.39	4.07	4.61	2.24	1.69	1.51	1.56	1.67
34	G	Terrestrial	Silt	302000	5623000	9.15	917	2.70	0.27	10.18	5.52	2.87	4.55	5.38	4.61	2.15	2.24	2.16	2.03
35	CF	Stagnic	Silt	304000	5616000	8.08	1052	5.62	0.29	19.64	3.23	2.82	4.13	4.49	2.01	2.10	2.12	1.98	1.59
36	DF	Stagnic	Silt	304000	5616000	8.08	1052	3.13	0.16	20.13	3.46	2.40	2.95	1.44	1.07	2.08	1.66	1.49	NA
37	G	Stagnic	Silt	303000	5607000	6.90	1207	12.31	0.97	12.72	5.16	8.23	9.99	11.15	2.90	1.92	1.75	1.84	1.74
38	G	Semi-terrestrial	Silt	309000	5609000	7.33	1121	9.19	0.69	13.28	5.57	9.97	14.15	13.87	4.09	2.01	2.07	2.03	2.09
39	G	Semi-terrestrial	Silt	317000	5617000	9.00	894	2.63	0.26	10.28	4.43	3.23	4.11	3.64	1.67	2.06	2.20	2.13	2.07
40	CF	Stagnic	Silt	304000	5609000	7.00	1186	14.21	0.54	26.24	3.12	5.95	9.69	5.90	1.93	2.32	2.72	2.12	2.24
41	DF	Semi-terrestrial	Silt	303000	5610000	7.23	1163	9.77	0.62	15.71	5.27	8.68	NA	4.54	3.00	1.89	NA	2.14	2.32
42	DF	Stagnic	Silt	302000	5607000	6.78	1231	7.98	0.41	19.30	3.27	4.47	6.14	6.05	2.60	2.16	2.09	2.20	2.07
43	DF	Stagnic	Silt	296000	5620000	8.99	960	3.37	0.29	11.59	4.02	2.47	3.38	1.98	1.27	2.53	2.33	1.82	2.01
44	DF	Semi-terrestrial	Silt	297000	5618000	9.17	937	2.25	0.19	12.01	4.96	3.56	3.40	2.47	2.05	2.18	2.06	1.92	1.88
45	G	Semi-terrestrial	Silt	319000	5637000	9.97	805	2.14	0.14	15.26	7.22	2.46	2.66	2.86	3.05	1.50	1.45	1.43	1.45
46	C	Stagnic	Silt	302000	5632000	9.53	874	1.15	0.11	10.80	6.99	2.50	3.31	2.42	1.17	1.25	1.38	1.52	1.54
47	DF	Semi-terrestrial	Silt	301000	5631000	9.72	855	26.42	1.95	13.53	5.3	13.32	16.02	14.72	6.07	2.17	1.89	1.79	1.99
48	DF	Terrestrial	Silt	295000	5633000	9.71	865	4.09	0.22	18.70	3.77	1.95	2.57	2.42	1.15	2.07	2.15	2.34	1.79
49	CF	Terrestrial	Sand	295000	5624000	9.23	928	3.56	0.14	26.19	2.99	1.35	1.51	1.65	1.63	2.13	2.11	2.35	1.94
50	DF	Terrestrial	Sand	295000	5624000	9.23	928	2.55	0.12	21.08	3.03	1.60	1.56	1.65	0.73	2.25	2.24	2.13	1.73
51	DF	Terrestrial	Silt	293000	5624000	8.58	1015	4.56	0.23	19.90	3.23	3.63	4.80	4.61	1.45	2.19	2.22	2.21	1.84
52	G	Terrestrial	Silt	307000	5643000	9.95	813	2.17	0.18	11.97	4.47	4.72	5.26	3.45	2.51	2.33	2.17	2.28	1.80

53	C	Stagnic	Silt	324000	5619000	8.83	899	2.79	0.29	9.80	6.96	4.51	5.62	5.82	2.55	1.57	1.48	1.64	2.04
54	C	Stagnic	Silt	330000	5603000	7.94	934	1.48	0.16	9.26	6.3	1.51	1.96	2.09	1.65	1.96	1.97	2.17	2.24
55	G	Semi-terrestrial	Silt	323000	5592000	7.28	1028	2.73	0.30	9.19	4.64	4.13	9.06	6.14	2.26	2.11	2.14	2.08	1.84
56	G	Stagnic	Silt	315000	5588000	6.68	1120	3.69	0.35	10.45	4.96	3.72	5.20	5.47	2.29	2.17	1.99	1.93	2.14
57	DF	Terrestrial	Silt	307000	5605000	7.28	1137	8.07	0.51	15.87	3.56	6.68	8.62	8.45	2.73	2.62	2.28	2.34	1.88
58	C	Terrestrial	Silt	309000	5608000	7.18	1141	3.15	0.33	9.68	5.21	2.78	3.55	4.14	1.63	1.98	1.97	1.96	2.18
59	DF	Terrestrial	Silt	299000	5593000	6.71	1228	3.86	0.25	15.20	3.94	1.78	2.40	2.65	1.96	2.44	2.47	2.38	2.22
60	CF	Terrestrial	Silt	299000	5593000	6.96	1188	4.70	0.35	13.62	3.75	3.61	5.82	5.18	1.43	2.21	2.33	2.15	1.90
61	G	Terrestrial	Silt	297000	5593000	7.08	1180	3.22	0.35	9.24	4.62	3.57	4.75	5.06	2.14	2.10	2.26	2.12	2.17
62	CF	Stagnic	Silt	293000	5597000	6.49	1293	6.40	0.36	17.87	3.58	2.44	3.09	2.62	0.97	2.27	1.93	1.72	1.70
63	CF	Terrestrial	Silt	293000	5613000	8.50	1028	4.24	0.21	20.32	3.58	2.59	3.78	3.59	1.18	2.10	2.06	2.12	1.80
64	CF	Stagnic	Silt	294000	5612000	8.50	1028	3.72	0.23	16.31	3.83	3.23	4.57	4.10	1.18	1.93	1.95	1.88	1.52
65	C	Terrestrial	Silt	300000	5642000	9.89	829	1.35	0.11	11.75	6.71	2.13	2.46	2.78	1.03	1.28	1.40	1.44	2.19
66	C	Stagnic	Silt	298000	5652000	9.98	802	0.97	0.10	10.19	6.72	1.51	1.67	1.98	0.90	1.21	1.27	1.16	1.49
67	G	Semi-terrestrial	Silt	301000	5653000	10.17	784	4.59	0.31	14.79	5.66	3.52	4.65	4.86	2.95	2.23	2.17	2.18	1.95
68	G	Terrestrial	Silt	297000	5658000	10.09	787	2.26	0.18	12.29	5.36	2.22	2.78	2.27	1.46	2.00	1.93	1.93	1.75
69	C	Terrestrial	Silt	297000	5658000	10.11	787	1.21	0.11	11.08	6.36	1.25	1.40	1.66	0.77	1.44	1.64	1.65	1.95
70	G	Semi-terrestrial	Silt	298000	5664000	10.20	769	10.58	0.38	27.95	5.6	3.52	4.39	2.48	1.60	1.94	1.96	1.86	1.95
71	G	Stagnic	Silt	312000	5659000	9.95	811	1.67	0.16	10.32	5.29	3.19	3.47	2.34	2.06	2.21	2.12	2.25	2.13
72	G	Terrestrial	Silt	313000	5622000	8.49	970	2.34	0.20	11.88	5.06	3.41	3.87	3.44	1.93	1.82	2.03	1.99	1.91
73	C	Terrestrial	Silt	325000	5612000	8.38	932	0.82	0.11	7.49	5.77	1.21	1.46	1.42	1.11	1.89	2.16	2.08	1.60
74	C	Terrestrial	Silt	318000	5601000	7.34	1063	3.21	0.35	9.21	5.3	3.28	4.31	4.59	2.01	2.08	2.12	2.15	2.13
75	C	Stagnic	Silt	317000	5602000	7.27	1078	2.84	0.31	9.17	5.47	2.84	4.41	4.20	2.59	1.98	1.84	1.97	1.77
76	C	Stagnic	Silt	314000	5600000	6.72	1153	4.65	0.47	9.85	6.33	4.98	6.98	6.71	2.81	1.58	1.72	1.79	1.83
77	G	Stagnic	Silt	325000	5588000	7.14	1016	3.72	0.36	10.36	5.24	5.25	6.90	6.18	2.92	2.03	2.04	1.99	2.18
78	G	Stagnic	Silt	311000	5629000	9.32	883	2.70	0.25	10.72	5.97	4.08	5.16	5.58	2.41	2.03	2.01	1.97	1.60
79	CF	Terrestrial	Sand	296000	5674000	9.88	789	2.09	0.09	22.03	3.66	0.42	1.11	1.23	0.63	2.63	1.98	1.99	2.14

80	DF	Terrestrial	Sand	296000	5674000	9.88	789	2.19	0.10	23.00	3.2	1.15	1.41	1.40	0.51	2.79	2.20	2.28	2.76
81	G	Stagnic	Silt	323000	5637000	9.80	817	1.33	0.11	11.96	4.96	2.55	3.37	3.46	1.85	2.16	2.15	2.25	2.26
82	C	Stagnic	Silt	323000	5638000	9.83	811	1.41	0.15	9.58	6.73	2.18	3.10	3.62	2.10	1.23	1.51	1.59	1.43
83	G	Terrestrial	Silt	319000	5614000	8.10	992	6.32	0.63	10.02	5.48	7.34	10.25	13.26	6.54	1.91	1.76	1.75	1.62
84	DF	Terrestrial	Sand	322000	5615000	8.84	894	1.33	0.11	11.73	3.71	1.63	1.85	1.64	0.98	2.21	2.31	2.06	2.25
85	CF	Terrestrial	Sand	323000	5612000	8.53	924	5.66	0.23	24.46	3.03	6.72	8.13	7.84	2.27	2.31	2.32	2.32	1.99
86	CF	Terrestrial	Sand	328000	5601000	7.33	1016	3.56	0.17	20.60	3.19	3.02	4.04	2.07	1.14	1.69	1.52	1.50	1.48
87	DF	Terrestrial	Sand	325000	5601000	7.67	985	3.61	0.19	18.71	3.52	3.78	4.52	4.98	3.30	2.15	2.19	2.15	1.90
88	C	Terrestrial	Silt	329000	5595000	7.33	1007	1.38	0.15	9.25	5.12	2.08	2.86	3.12	1.75	2.02	2.19	2.22	1.88
89	C	Stagnic	Silt	322000	5590000	6.96	1058	3.06	0.32	9.48	4.96	3.76	4.95	3.29	2.74	1.95	1.88	1.97	1.87
90	G	Stagnic	Silt	301000	5615000	8.09	1061	6.80	0.62	11.01	5.73	8.21	8.61	5.03	3.46	1.70	1.98	1.63	1.97
91	DF	Terrestrial	Sand	327000	5587000	7.04	1016	5.76	0.30	18.95	3.25	4.06	4.26	4.58	2.24	2.03	1.96	2.13	2.01
92	CF	Terrestrial	Sand	329000	5586000	7.18	988	0.59	0.02	28.53	3.12	0.24	0.43	0.21	0.21	1.98	2.26	NA	NA
93	DF	Terrestrial	Sand	329000	5586000	7.18	988	2.14	0.11	19.24	3.53	2.04	2.73	1.67	1.20	2.16	2.15	2.07	2.48
94	CF	Stagnic	Silt	323000	5588000	6.98	1042	3.73	0.16	22.77	3.48	6.95	4.01	2.15	1.75	NA	1.65	1.67	1.81
95	DF	Stagnic	Silt	323000	5588000	6.98	1042	3.43	0.15	22.62	3.68	2.44	2.88	1.68	1.32	1.88	1.86	2.01	2.30
96	C	Terrestrial	Silt	317000	5619000	8.40	970	2.70	0.28	9.52	5.98	2.36	3.39	3.17	2.13	1.65	1.66	1.89	1.93
97	DF	Terrestrial	Silt	318000	5615000	8.35	965	3.41	0.28	12.19	3.87	3.28	5.67	4.58	1.52	2.08	2.34	2.16	1.80
98	DF	Terrestrial	Sand	326000	5605000	7.83	961	2.89	0.14	21.12	3.58	1.88	2.38	1.65	0.84	2.32	2.30	1.78	1.67
99	CF	Terrestrial	Sand	326000	5605000	7.64	1002	1.41	0.06	23.42	3.13	0.75	0.90	0.93	0.45	1.79	2.17	1.80	1.54
100	CF	Terrestrial	Sand	326000	5603000	8.02	948	2.38	0.11	20.94	3.74	2.14	2.69	1.64	1.07	2.03	2.15	2.00	1.72
101	CF	Terrestrial	Silt	325000	5600000	7.74	982	2.36	0.10	23.11	4.12	2.10	2.80	1.62	0.77	2.12	2.10	1.55	1.82
102	DF	Terrestrial	Silt	334000	5598000	7.28	994	2.79	0.15	19.11	3.7	4.18	5.65	5.26	1.33	2.18	2.23	1.98	2.27
103	DF	Semi-terrestrial	Silt	331000	5593000	7.33	985	1.96	0.17	11.41	5.24	5.75	5.59	3.88	3.25	2.14	2.12	1.95	1.98
104	CF	Terrestrial	Sand	291000	5664000	10.01	777	1.72	0.08	20.51	3.66	0.88	1.06	1.70	0.47	2.11	1.77	1.69	1.31
105	DF	Terrestrial	Sand	291000	5664000	10.01	777	2.16	0.10	20.61	3.29	1.28	1.54	1.47	0.61	2.39	2.38	2.51	1.36
106	G	Stagnic	Silt	306000	5664000	9.94	806	2.07	0.18	11.45	5.77	2.45	3.00	2.50	1.83	1.89	1.71	1.65	1.75

107	DF	Semi-terrestrial	Silt	333000	5590000	7.07	985	5.11	0.47	10.94	6.75	7.60	9.21	8.33	2.20	1.78	1.66	1.74	1.77

Table S5. Dataset. NA = not available, [a] Information on land use was derived from enhanced land use classification of the Rur catchment [Lussem and Waldhoff, 2014], C = cropland, G = grassland, DF = deciduous forest, CF = coniferous forest, [b] derived from Information System Soil Map NRW (BK 50, Geologischer Dienst Nordrhein-Westfalen, 2009). Soil units were aggregated as "terrestrial", "stagnic", and "semi-terrestrial", [c] derived from Information System Soil Map NRW (BK 50, Geologischer Dienst Nordrhein-Westfalen, 2009). Soil texture was aggregated into main classes "silt", "sand", "clay", "loam", "organic". Samples were taken only from silt and sand classes, [d] based on UTM, WGS84, for reasons of data privacy, the last three digits were replaced by "0", [e] Mean annual temperature (°C), derived from the Worldclim dataset [*Hijmans et al*., 2005], [f] mean annual precipitation, derived from the Worlclim dataset [*Hijmans et al*., 2005], [g] The pH value was measured in a 0.01 M $CaCl_2$ solution with a soil:solution ratio of 1:2.5, [h] $SR_{25,30}$ = Soil respiration at 25°C and 30% WHC (water holding capacity), [i] $SR_{25,45}$ = Soil respiration at 25°C and 45% WHC (water holding capacity), [j] $SR_{25,60}$ = Soil respiration at 25°C and 60% WHC (water holding capacity), [k] $SR_{25,75}$ = Soil respiration at 25°C and 75% WHC (water holding capacity), [l] WHC = Water holding capacity.