Supplementary Information

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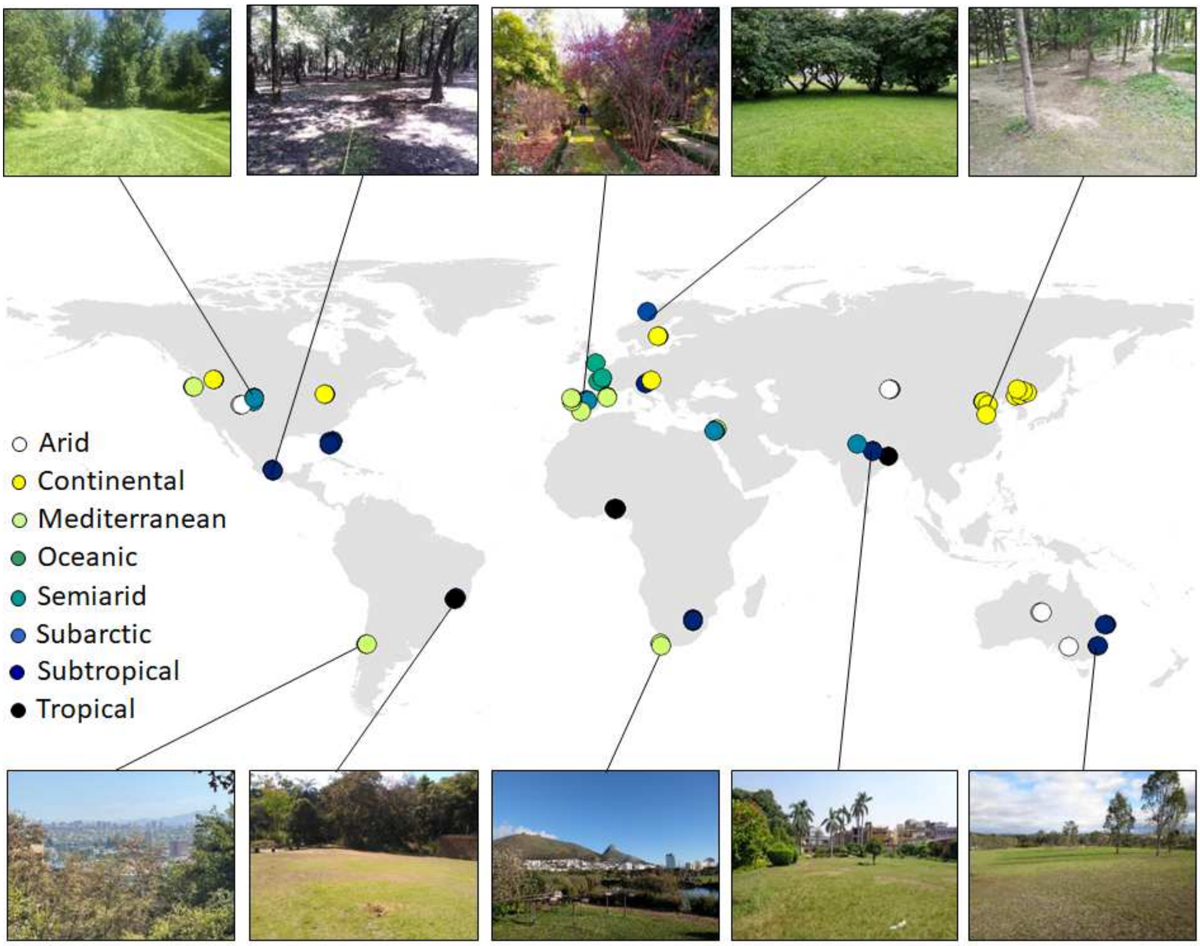
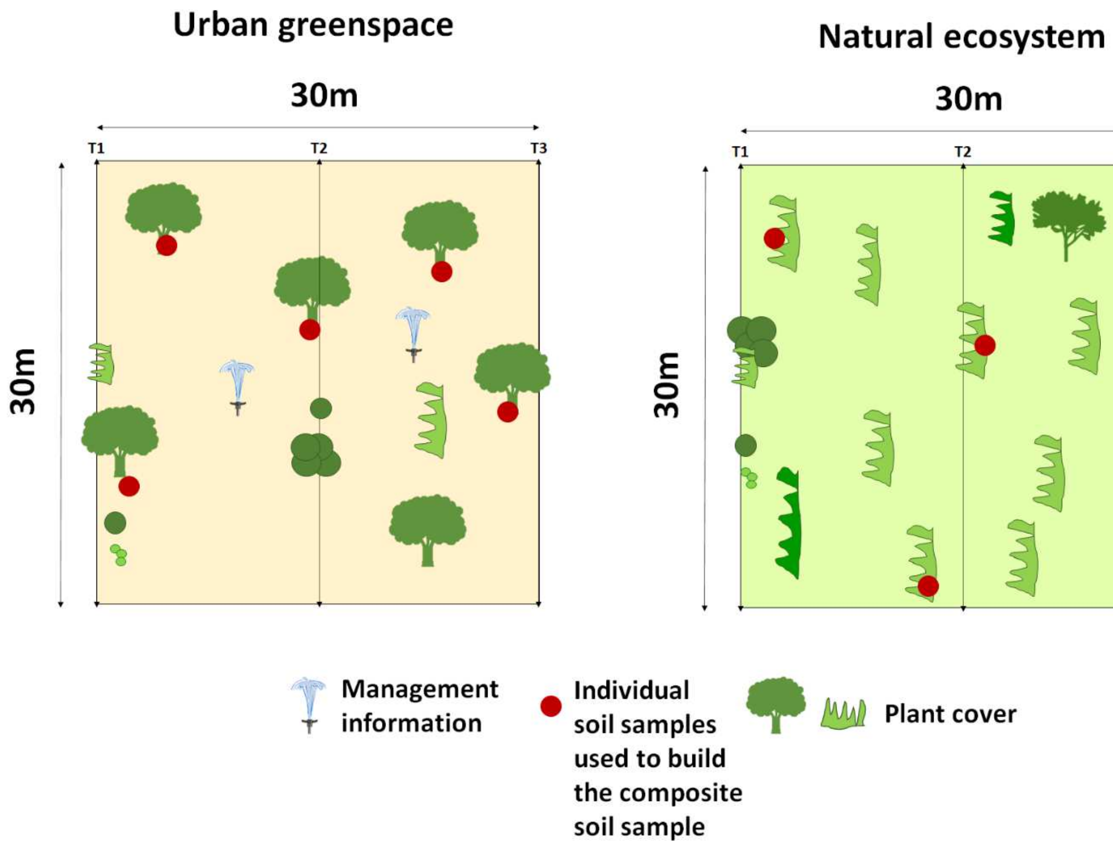
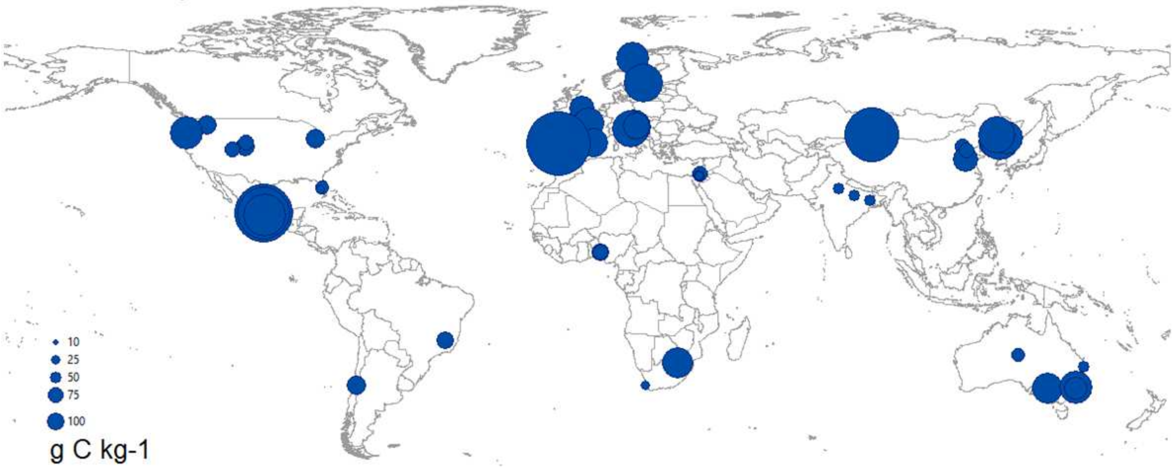


Supplementary Figure 1 | Location of the 112 ecosystems surveyed in this study. These ecosystems include 56 paired urban greenspaces and adjacent natural ecosystems. Pictures show examples of urban greenspaces.



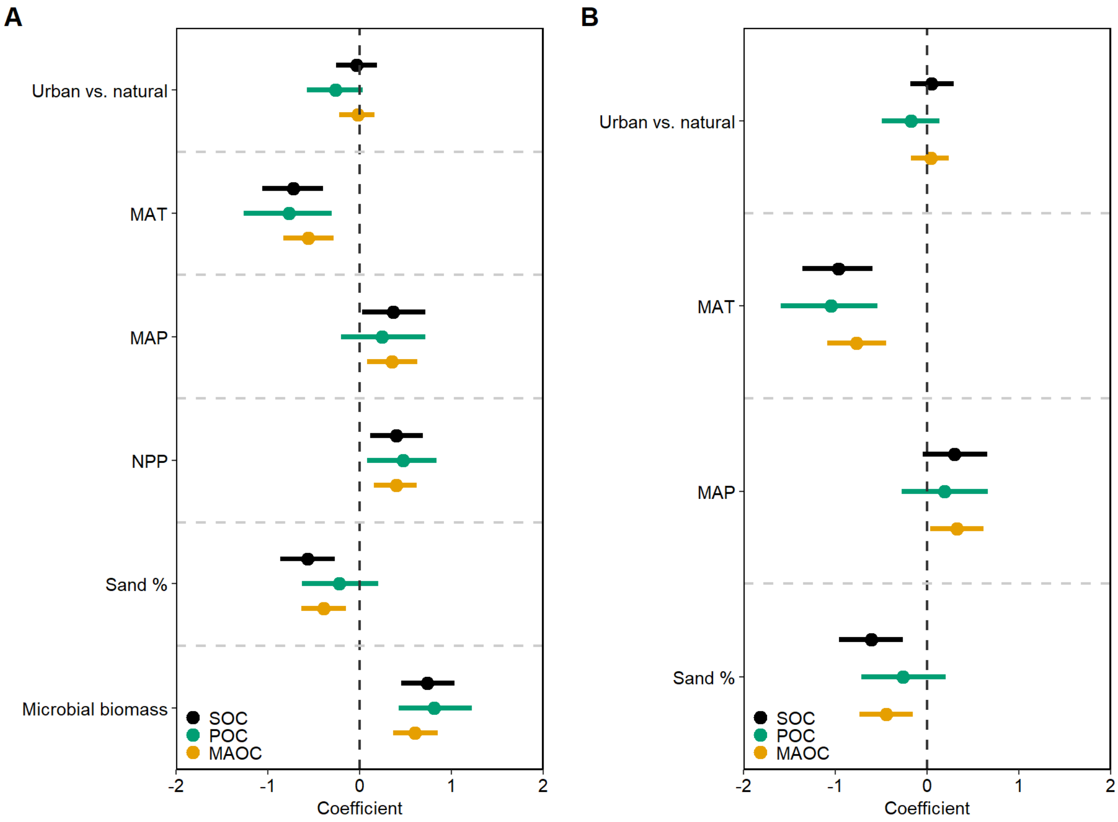
Supplementary Figure 2 | Summary of the survey design for each of the 56 natural and urban paired ecosystems used in this study. This figure is a visual example of our survey design.

Urban greenspaces

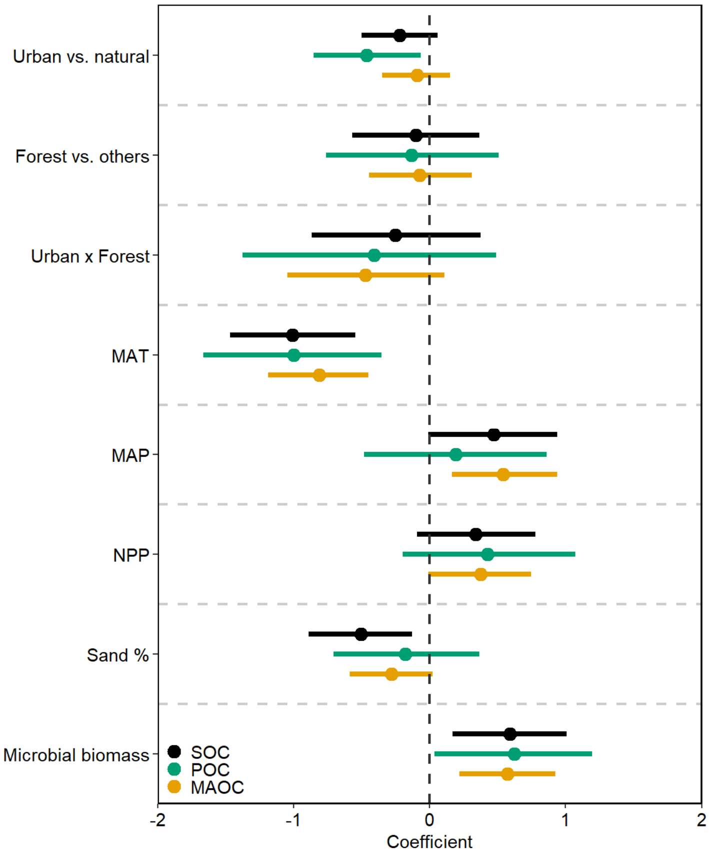


Natural ecosystems

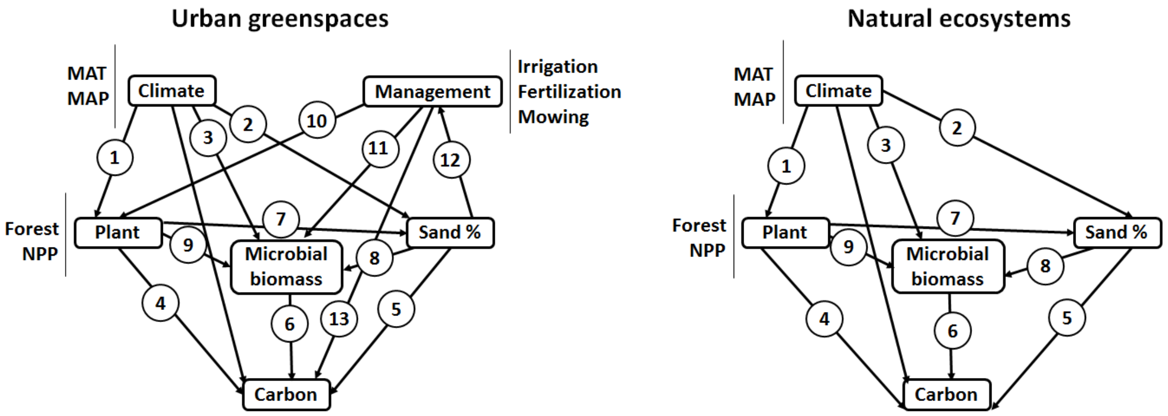
Supplementary Figure 3 | Global distribution of soil C concentrations in natural and urban greenspaces (n = 56 per ecosystem type).



Supplementary Figure 4 | Linear mixed model testing the influence of ecosystem, climate, texture, plant and microbial data on soil carbon concentrations. Panel A shows effects of urban greenspaces versus natural ecosystems on the concentration of total, particulate and mineral-associated soil organic C (SOC, POC, MAOC) controlling for mean annual temperature (MAT), mean annual precipitation (MAP), net primary productivity (NPP), and content (Sand %) and soil microbial biomass (n = 112; 56 urban and 56 natural ecosystems). Dots and bars represent standardized coefficients and 95% confidence intervals for fixed effects obtained by mixed-effects modeling and bootstrapping. Panel B shows effects of urban greenspaces versus natural ecosystems on total soil organic C and C fractions controlling for MAT, MAP and Sand %, but not for NPP and microbial biomass (n = 112; 56 urban and 56 natural ecosystems). Dots and bars represent standardized coefficients and 95% confidence intervals for fixed effects obtained by mixed-effects modeling and bootstrapping.



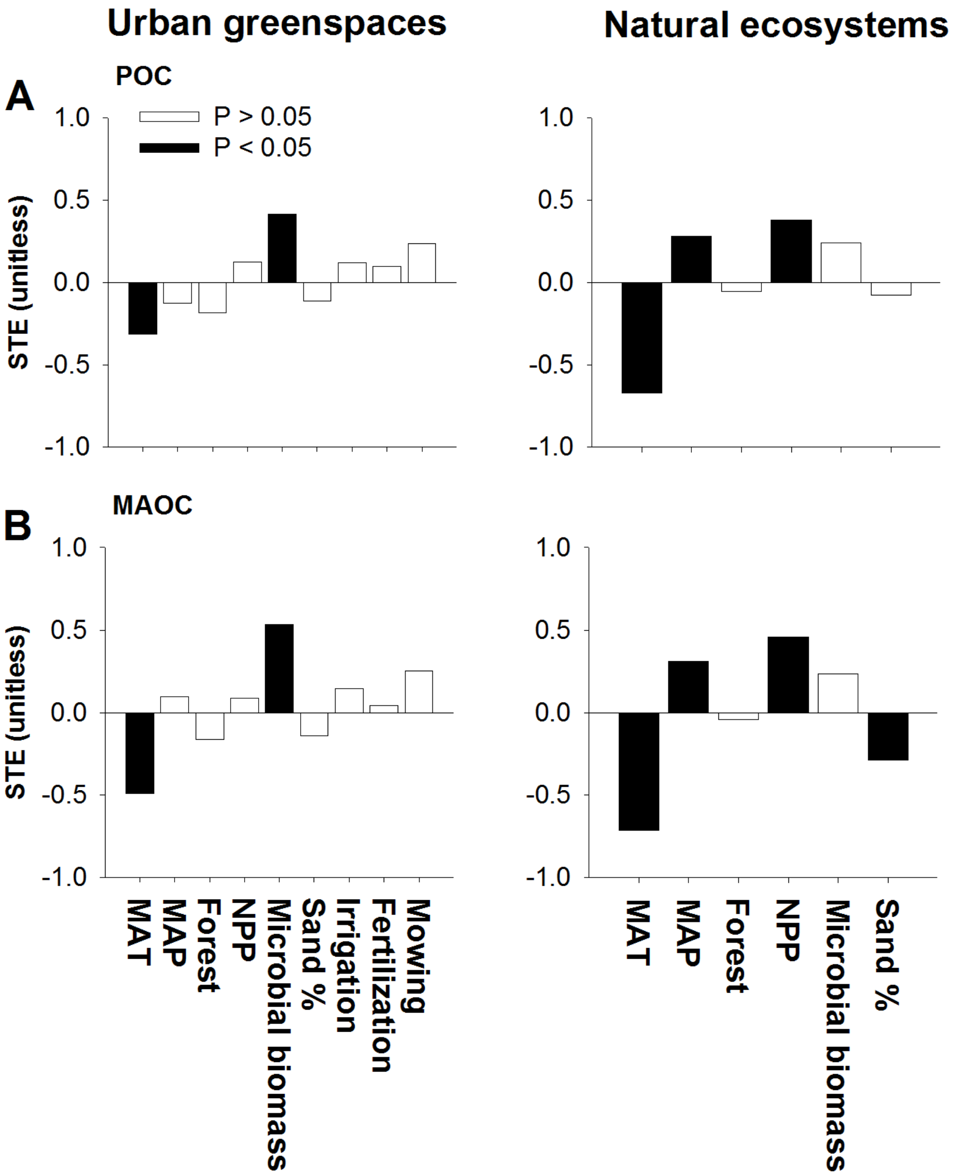
Supplementary Figure 5 | Linear mixed model testing the influence of ecosystem, climate, texture, plant and microbial data on soil carbon concentrations after accounting for vegetation interactions. Effects of urban greenspaces versus natural ecosystems on the concentration of total, particulate and mineral-associated soil organic C (SOC, POC, MAOC) controlling for climate, plant and soil variables (n = 112; 56 urban and 56 natural ecosystems). Dots and bars represent standardized coefficients and 95% confidence intervals for fixed effects of urban greenspaces, mean annual temperature (MAT), mean annual precipitation (MAP), net primary productivity (NPP), sand content and soil microbial biomass obtained by mixed-effects modeling and bootstrapping.



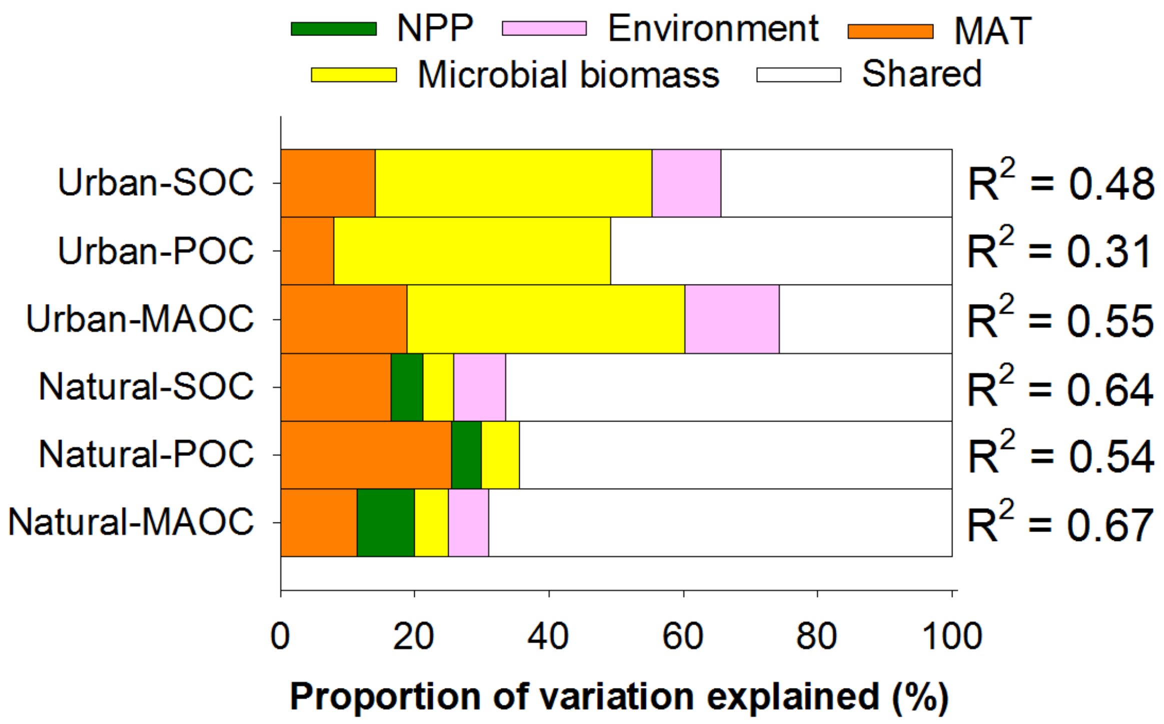
#	Factor	Rationale
1	Climate → Plant	Mean annual precipitation and temperature is well known to control the development of vegetation structure (e.g., forests) and plant productivity in terrestrial ecosystems
2	Climate → Sand %	Climate is known to control soil texture through weathering
3	Climate → Microbial biomass	Mean annual precipitation and temperature drives the biomass of soil organisms. Drier and hotter terrestrial ecosystems often support lower microbial biomass
4	Plant → Carbon	Plant structure and productivity control the storage of soil carbon by fixing carbon from the atmosphere and incorporating this carbon to the soil through important processes such as litter decomposition and rhizodeposition. This link could be strongly altered (lessen or broken) in managed urban greenspaces: no litter, no deadwood generally is available as input of organic matter for soils because they are systematically removed.
5	Sand % → Carbon	Soil texture is fundamental in the sequestration of carbon. Soils with sandy texture are known to retain less carbon than those with fine texture
6	Microbial biomass → Carbon	Microbes drive the concentration of soil carbon through important processes such as organic matter decomposition and in being an important part of the living and dead biomass of soils
7	Plant → Sand %	Plant structure influences soil texture by regulating key processes such as soil erosion that negatively affects the percentage of small soil particles

8	Sand % → Microbial biomass	Soil texture is known to influence microbial biomass. Sandy soils, for example, have a reduced capacity to build soil microbial biomass
9	Plant → Microbial biomass	Plant structure and productivity drive the biomass of microbial communities by constituting an important source of energy (e.g., litter) and habitat for soil microbes. Forest often supports larger microbial biomass than non-forested ecosystems
10	Management → Plant	Management types such as irrigation, mowing and fertilization can influence plant productivity and vegetation structure by changing resource availability and through anthropogenic disturbance. For example, irrigation and fertilization are expected to promote plant productivity
11	Management → Microbial biomass	Management types such as irrigation, mowing and fertilization can influence microbial biomass by disturbing soils and changing resource accessibility (e.g., water and nutrient availability)
12	Sand % → Management	Soil texture can largely influence the type of management. For example, sandy soils, often poor in nutrients and water holding capacity, would require more irrigation and fertilization than soils with fine texture
13	Management → Carbon	Management can influence the amount of carbon in the soil through processes such as fertilization and irrigation, but also through anthropogenic disturbance

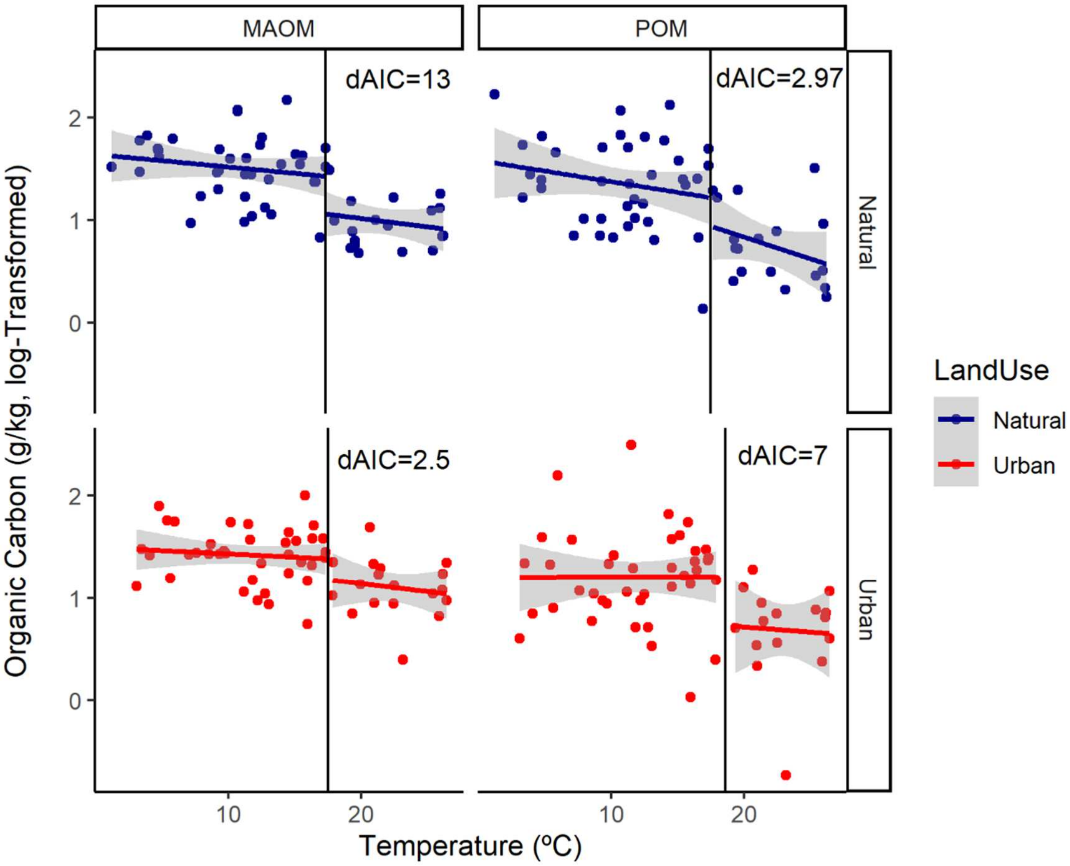
Supplementary Figure 6 | *A priori* structural equation modelling including the direct and indirect effects of environmental factors on soil carbon concentrations.



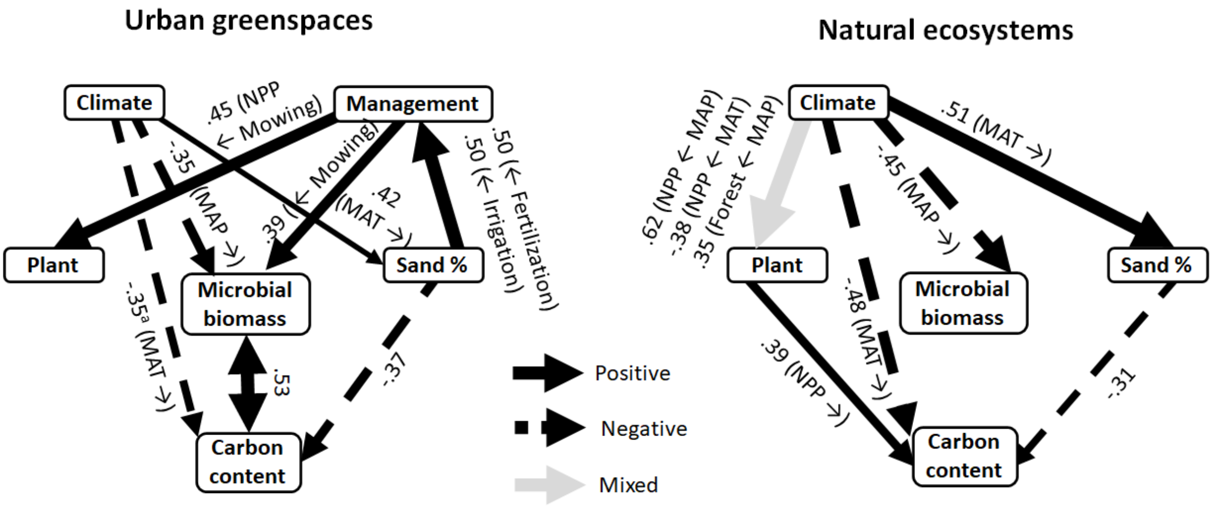
Supplementary Figure 7 | Standardized total effects (sum of direct and indirect effects) of environmental factors on the concentration of mineral (MAOM) and particulate soil carbon (POM) (n = 56 urban and 56 natural ecosystems).



Supplementary Figure 8 | The unique contribution of mean annual temperature (MAT) to explaining soil carbon concentrations in urban greenspaces and natural ecosystems. The environment includes location (latitude and longitude), mean annual precipitation, sand content, forest ecosystems, and management (i.e., in the case of urban greenspaces: mowing, irrigation, and fertilization) (n = 56 urban and 56 natural ecosystems). NPP, Plant productivity; SOC, soil organic carbon; POM, particulate organic matter; MAOM, mineral-associated organic matter. Shared variation is attributed to more than one group of predictors and cannot be distinguished to what group this variation belongs to.

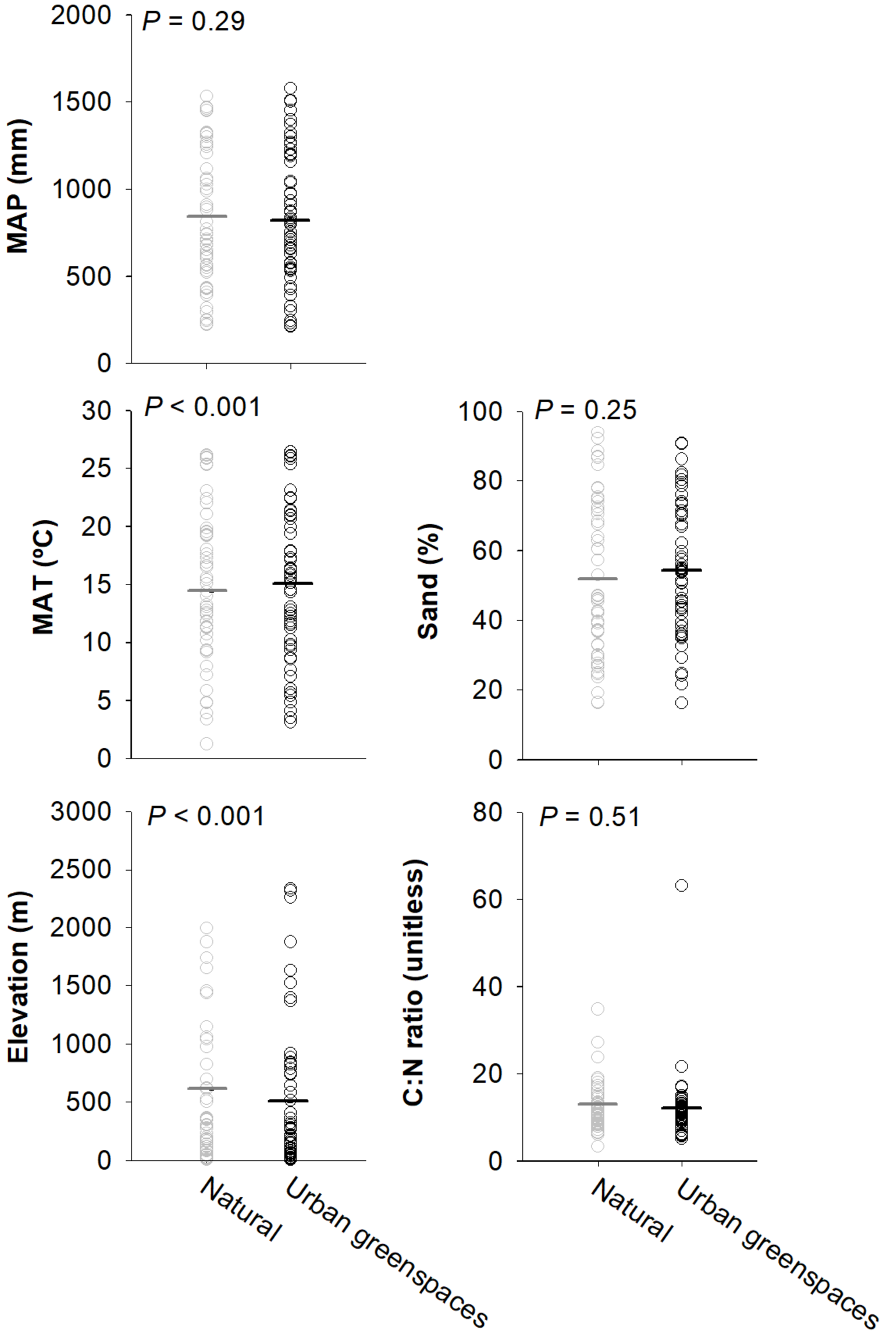


Supplementary Figure 9 | Mean annual temperature thresholds associated with soil C concentrations in natural and urban greenspaces. dAIC represents the difference in AIC between segmented (showed in this figure) and linear models (see Supplementary Table 5) (n = 56 urban and 56 natural ecosystems). The shade in these panels corresponds to the 95% confidence interval.

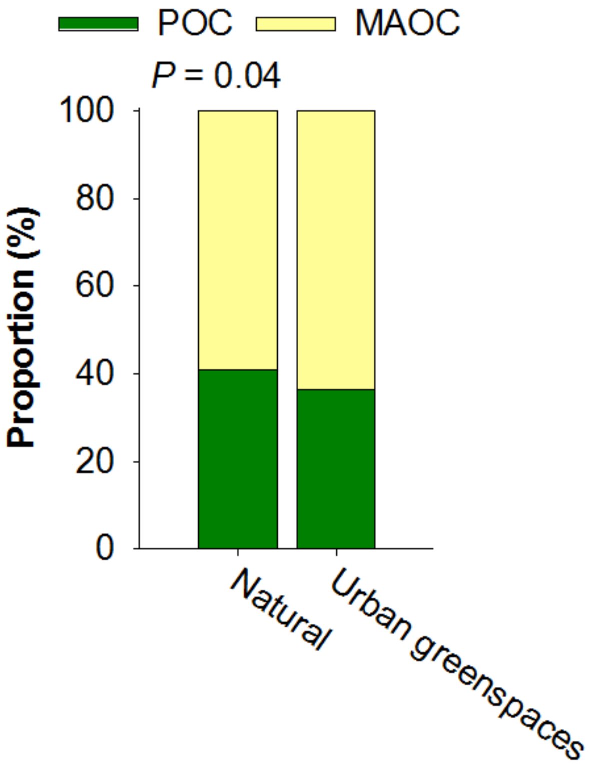


Supplementary Figure 10 | Alternative structural equation model (SEM) to that showed in Fig. 3 considering a two-path association between soil microbial biomass and C in our a priori model (Supplementary Fig. 6) (n = 56 urban and 56 natural ecosystems). $^{a}P = 0.05$. Numbers adjacent to arrows indicate standardized effect size of the relationship. The rest of the caption as in Fig. 3.

Supplementary Figure 11 | Location for the 54 ecosystems (27 paired urban and adjacent natural ecosystems) including soil metagenomic data.



Supplementary Figure 12 | Environmental variables in urban and natural ecosystems (n = 112; 56 natural greenspaces and 56 natural ecosystems). Significance is determined from a nested Permanova considering our paired design. Horizonal lines indicate mean values.



Supplementary Figure 13 | Proportion of particulate (POC) and mineral (MAOC) soil organic C in natural and urban greenspaces (n = 112; 56 urban and 56 natural ecosystems). P = Permanova P.

Supplementary Table 1 | Information of the 56 municipalities included in this study.

Site	City	Latitude	Longitude
1	Tonghua City, Jilin, China	41.74	125.94
2	Baishan City, Jilin, China	42.18	127.5
3	Yanji City, Jilin, China	42.91	129.49
4	Dunhua City, Jilin, China	43.38	128.22
5	Jilin City, Jilin, China	43.84	126.52
6	Santiago, Santiago Metropolitan Region, Chile	-33.37	-70.61
7	Belo Horizonte, Minas Gerais State, Brazil	-19.87	-43.97
8	Contagem, Minas Gerais State, Brazil	-19.94	-44.04
9	Betim, Minas Gerais State, Brazil	-19.94	-44.18
10	Longmont, CO, USA	40.16	-105.12
11	Grand Junction, CO, USA	39.11	-108.61
12	Cheyenne, WY, USA	41.16	-104.83
13	South Lyon, MI, USA	42.44	-83.68
14	Oxford, England, UK	51.75	-1.29
15	Bodø, Norway	67.28	14.39
16	Uppsala, Sweden	59.85	17.63
17	Poitiers, France	46.58	0.34
18	Niort, France	46.33	-0.47
19	Tours, France	47.4	0.68
20	Ljubljana, Slovenia	46.05	14.48
21	Koper, Slovenia	45.54	13.73
22	Maribor, Slovenia	46.57	15.65
23	Pretoria, South Africa	-25.76	28.22
24	Germiston, South Africa	-26.16	28.13
25	Cape Town, South Africa	-33.9	18.4
26	Durgapur, West Bengal, India	23.56	87.3
27	Mirzapur, Uttar Pradesh, India	25.14	82.56
28	Agra, Uttar Pradesh, India	27.2	78.01
29	Beijing, China	40.01	116.39
30	Tai'an, Shandong, China	36.22	117.02
31	Tianjin, China	39.08	117.69
32	Ürümqi, Xinjiang, China	43.83	87.66
33	Alice Springs, Northern Territory, Australia	-23.71	133.87
34	Brisbane, Queensland, Australia	-27.5	153.02
35	Mildura, Victoria, Australia	-34.19	142.17
36	Cecil Hills, Sydney, New South Wales, Australia	-33.88	150.85
37	Heathcote, Sydney, New South Wales, Australia	-34.08	151.01
38	Barcelona, Catalunya, Spain	41.42	2.15

39	Pullman, Washington, USA	46.74	-117.18
40	Corvallis, Oregon, USA	44.53	-123.26
41	Coyoacán, Mexico City, Mexico	19.31	-99.18
42	Tlalpan, Mexico City, Mexico	19.29	-99.19
43	Miguel Hidalgo, Mexico City, Mexico	19.42	-99.19
44	Madrid, Comunidad de Madrid, Spain	40.41	-3.69
45	Esa-Odo, Osun state, Nigeria	7.76	4.81
46	Obafemi Awolowo University, Osun state, Nigeria	7.52	4.53
47	Ife city, Osun state, Nigeria	7.49	4.59
48	Lakeland, Florida, USA	28.04	-81.97
49	Sebring, Florida, USA	27.48	-81.42
50	Punta Gorda, Florida, USA	26.93	-82.06
51	Utrera, Andalusia, Spain	37.19	-5.77
52	Coimbra, Portugal	40.21	-8.42
53	Porto, Portugal	41.17	-8.68
54	Jerusalem, Israel	31.77	35.22
55	Be'er Sheva, Israel	31.23	34.79
56	Ofakim, Israel	31.31	34.63

Supplementary Table 2 | Correlation (Pearson; two-tailed) between the concentration of total soil organic C and C fractions (POC, particulate organic C; MAOC, mineral-associated organic C) in natural and urban greenspaces.

		Natural	**Urban greenspaces**
POC	r	.914	.930
	P	<0.001	<0.001
	n	56	56
MAOC	r	.918	.724
	P	<0.001	<0.001
	n	56	56

Supplementary Table 3 | Correlation (Pearson; two-tailed) between mean annual temperature (BIO1; MAT; average of the last 50 years; 1-km resolution; WorldClim v2) and soil mean annual temperature (1-km resolution; Lembrechts et al. 2022), maximum temperature (BIO5; WorldClim v2), and recent (2016-2020) mean surface temperatures (30-m resolution; Landsat) in natural and urban greenspaces.

	Natural	**Urban**
Soil mean annual temperature (SBIO1)	0.973	0.981
	< 0.001	< 0.001
	56	56
Maximum temperature (BIO5)	0.711	0.699
	< 0.001	< 0.001
	56	56
Land surface temperature_(2016-2020)	0.674	0.692
	< 0.001	< 0.001
	52	50
Mean air temperature (2016-2020)	0.825	0.843
	< 0.001	< 0.001
	56	56

Supplementary Table 4 | Correlation (Spearman; two-tailed) between maximum temperature and concentrations of soil organic C (SOC), microbial, bacterial and fungal biomass, particulate organic C (POC) and mineral-associated organic C (MAOC) in natural and urban greenspaces.

Soil carbon	Parameter	Natural	Urban
SOC	ρ	-.709	-.541
	P-value	<0.001	<0.001
	n	56	56
Microbial biomass	ρ	-.352	-.361
	P-value	.008	.006
	n	56	56
Bacterial biomass	ρ	-.382	-.456
	P-value	.004	.000
	n	56	56
Fungal biomass	ρ	-.343	-.346
	P-value	.010	.009
	n	56	56
POM	ρ	-.598	-.441
	P-value	<0.001	.001
	n	56	56
MAOM	ρ	-.687	-.589
	P-value	<0.001	<0.001
	n	56	56

Supplementary Table 5 | Akaike index associated with the models included in Supplementary Figure 9 (n = 56 urban and 56 natural ecosystems).

Ecosystem	Variable	AIC Lineal model	AIC Segmented model	Delta AIC	Selected model
Natural	MAOC	30.98	19.14	11.85	*Segmented*
Natural	POC	63.28	56.90	6.39	*Segmented*
Urban	MAOC	20.91	18.49	2.42	*Segmented*
Urban	POC	80.22	72.94	7.28	*Segmented*

Supplementary Table 6 | Correlation (Pearson; two-tailed) between total microbial biomass with bacterial and fungal biomass in natural and urban greenspaces.

		Natural	**Urban**
Bacterial biomass	r	.929	.925
	P-value	< 0.001	< 0.001
	N	56	56
Fungal biomass	r	.999	.999
	P-value	< 0.001	< 0.001
	N	56	56

Supplementary Table 7 | Variance inflation factors (VIF) calculated for the saturated SEMs (see Supplementary Figure 6), for urban greenspaces (left row) and natural ecosystems (right row). Values with VIF < 5 indicate low multicollinearity[45].

	Urban	**Natural**
NPP	1.25	2.79
Sand	1.79	1.37
Microbial biomass	1.16	1.12
Precipitation	1.37	1.83
Temperature	1.7	1.79
Forest	1.13	2.09
Irrigation	1.99	NA
Fertilization	1.51	NA
Mowing	1.8	NA