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Original Research

Response of Soil Organic Carbon and Its Active Fractions to Restoration Measures in the Karst Rocky Desertification Ecosystem, SW China

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Abstract

Soil organic carbon (SOC) is the dynamic medium of carbon transfer and the main way of carbon circulation in karst ecosystem, SOC and soil labile organic carbon (LOC) is essential for karst soil C cycling. There has been very little research about the differentiation of SOC and LOC in karst ecosystem. In this study, six typical restoration measures were investigated in the karst rocky desertification ecosystem, southwest China, including: restoration with *Zanthoxylum bungeanums* (HJ), restoration with *Hylocereus undulates* (HL), restoration with *Pennisetum sinese* (HZ), restoration with *Medicago sativa* (MX), restoration with *Sabina chinensis* (YB), and abandoned and natural recovery (LH). The SOC contents, SOC stocks, LOC contents (water soluble organic carbon (WSOC), easily oxidizable organic carbon (EOC), particulate organic carbon (POC), light fraction organic carbon (LFOC)), and the carbon pool management index (CPMI) were investigated. The results indicated that the SOC contents, SOCS and LOC contents of the six measures were the highest in YB, followed by the LH, and the two were significantly higher than the other four measures. The soil CPMI contents of 0-20 cm layer under the different restoration measures decreased in the following order: YB > HJ > MX > HL > HZ. Correlation analysis showed that SOC was positively correlated with soil LOC ($P<0.01$), and LOC was positively correlated with each other ($P<0.01$). These findings suggest that restoration with *Sabina chinensis*, abandoned and natural recovery are more conducive to the management and protection of karst ecological environment. Restoration with *Zanthoxylum bungeanums* can be used as a priority economic species for karst rocky desertification and mountain agricultural development in southwest China. Soil WSOC, EOC, POC, and LFOC can be used as effective indicators to reflect SOC pools, and soil CPMI can also be used as a sensitive indicator to reflect soil management.

Keywords: karst ecosystem, restoration measures, soil organic carbon, soil labile organic carbon, carbon pool management index

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Introduction

Soil is a crucial part of the terrestrial ecosystem and the carrier of many ecological processes in the ecosystem [1]. Soil carbon is a core component of the terrestrial carbon pool and an essential foundation for soil fertility. The soil carbon pool is about twice that of atmospheric and three times that of vegetation carbon pool, in which the soil organic carbon (SOC) contents accounts for more than 50% of the total soil carbon [2-4], and small changes in SOC storage will have a significant impact on atmospheric CO_2 concentrations [5-8]. However, SOC content is only a result of long-term balanced mineralization of soil organic carbon, and it is difficult to respond to short-term land use changes, and it cannot well reflect the changes of soil quality and conversion rates in a short time [9-12]. Previous studies have found that soil labile organic carbon (LOC) was more sensitive to land use change than SOC [13-19]. Although it accounts for a minor part of total SOC pools, it can reflect small changes in SOC pools caused by soil management measures and environmental changes [20-24]. According to different measurement methods, soil LOC can mainly be characterized as water-soluble organic carbon (WSOC), easily oxidizable organic carbon (EOC), particulate organic carbon (POC), and light fraction organic carbon (LFOC), which can all reflect SOC availability and soil quality in different degrees [25-27]. The soil carbon pool management index (CPMI) considers SOC pools and LOC comprehensively, which can more sensitively reflect the degree of soil quality degradation or regeneration caused by various land use or management measures [28-30].

Karst refers to the geological process that is mostly carried out by the chemical dissolution action of water on water-soluble rocks (usually limestone, dolomite, or marble), and supplemented by the mechanical actions of erosion or latent erosion of flowing water and rock avalanche which is from above ground and underground landscape [31-32]. Karst landforms are distributed in soluble rock regions around the world, with a total area of approximately 510 million km^2, accounting for 10% of the total area of the earth [31, 33]. The karst area in southwest China centered on Guizhou, with an area of about 540,000 square kilometers, is one of the three largest karst areas in the world [31, 34-35]. Karst rocky desertification means that the process or result of rocky desert landscape on the surface under the fragile ecological environment of karst, which is caused by the unreasonable social and economic activities of human beings [31, 36]. Karst rocky desertification has become the most severe eco-environmental problem restricting sustainable development in Southwest China [32]. Since the 1990s, Chinese governments at all levels have launched a series of major ecological restoration projects to control rock desertification. Artificial vegetation restoration is an essential ecological management measure. Due to the different tree species and their configurations under different models, it will inevitably lead to the law, quantity, and composition of litter, as well as differences in forest land environments, which will affect the SOC pools [18, 37-39]. In recent years, studies on the impact of different rock desertification control measures on the eco-environment have mainly focused on plant community structure, soil phy-chemical properties, the nutrient cycling of carbon, nitrogen, and phosphorus, and the characteristics of ecological stoichiometry [18, 32, 37-42]. However, there is an unusual lack of research on SOC, LOC, and CPMI.

In this study, the typical karst rocky desertification area, Huajiang Town, Guanling County, Guizhou Province, in Southwest China was selected as the study area to investigated six typical karst rocky desertification vegetation restoration measures, i.e., (1) restoration with *Zanthoxylum bungeanum* (HJ), (2) restoration with *Hylocereus undulates* (HL), (3) restoration with *Pennisetum sinese* (HZ), (4) restoration with *Medicago sativa* (MX), (5) restoration with *Sabina chinensis*(YB), and (6) abandoned and natural recovery as reference (LH) and their impacts on SOC, LOC (WSOC, EOC, POC, LFOC), and CPMI. The objectives of our study were to: (1) ascertain the amounts of SOC (including contents and stocks) under different vegetation restoration measures; (2) assess the differences of characteristics of LOC and CPMI under different vegetation restoration measures; (3) reveal the relationships between SOC, LOC, CPMI, and phy-chemical indicators. Our results will provide the scientific and theoretical basis for vegetation restoration and reconstruction of karst rocky desertification control and carbon cycle management in Southwest China.

Materials and Methods

Study Areas

The study site was located on both sides of the Beipanjiang River, with a distance of 10 km from Huajiang Town, Anshun City of Guizhou Province, China (25°38′19″-25°41′32″N, 105°38′31″-106°40′51″E). It is a typical karst plateau gorge with large reliefs and deep valleys. The greatest relative height is approximately 1000 m, with an altitude ranging from 450 m to 1450 m. (Fig. 1). The average annual precipitation is approximately 1100 mm, mainly distributed in the period of May to October and accounting for 83% of the annual precipitation. The rock is mainly composed of dolomite, argillaceous dolomite, and shale of Triassic origin. The soil is mainly composed of yellow soil and yellow limestone. The vegetation is subtropical evergreen deciduous coniferous forest and broad-leaved mixed forest. Most of the original vegetation was destroyed, and now it is mainly secondary vegetation. The overall coverage of vegetation in this area is less than 3%, and the rate of

Fig. 1. Location of the study site in Huajiang Town, China.

exposed rocks is above 70%. Since the 1990s, several ecological restoration projects, such as Grain for Green and Comprehensive control of rocky desertification have been carried out. *Sabina chinensis*, *Pinus massoniana* and *Toona sinensis* were the main species in arbor, *Zanthoxylum bungeanum* was the main species in shrub, and *Medicago sativa* and *Pennisetum sinese* were the main species in grassland. The study area is a public demonstration area for rocky desertification control during the period from the Ninth Five-Year Plan to the Twelfth Five-Year Plan. The governance model, restoration, and reconstruction of vegetation have different characteristics at different time stages.

Study Sites and Soil Analysis

Soil samples were collected from six typical karst rocky desertification restoration measures (HJ, HL, HZ, MX, YB, and LH). The six study sites were in one background, which was according to local farmer interviews. Before the plots were withdrawn from cultivation, the land was cultivated land with long-term continuous cultivation history. Besides, the natural environment factors in six study sites such as mother rock, soil, altitude, slope position and aspect of the plot are similar. HJ, the recovery period is about 20 years, the average plant height is about 2.3 m, the maximum crown diameter is about 4 m, no fertilizer, no tillage. In addition to *Zanthoxylum bungeanum* there are a few herbs on the surface, such as *Setaria viridis*, *Epimeredi indica*. HL, the planting period is about 20 years, the average plant height is about 1.8 m, one year ripe, the planting density is low, no fertilization, tillage and other measures, the surface is accompanied by a small amount of *Epimeredi indica*, *Alopecurus aequalis*, and other growth. HZ and MX, the restoration period is about 18 years, and there is no fertilization or plowing measures. YB is closed for a long time, with less human interference, the tree height is more than 7 m, and there is no fertilization activity. LH, formed by returning cultivated land or sloping land, to a desolation age of about 20 years, without human disturbance, and shrubs has been formed. The main species are *Digitaria sanguinalis*, *Setaria viridis*, and *Oplismenus compositus*.

In March 2019, we established three representative 20 × 20 m plots for each restoration measures, and three sampling points were selected according to the S-shaped point distribution method in each sample [30, 32]. Before collecting soil samples, we removed the litter on the soil surface, the sampling depth is 20 cm, and each sampling point divides the soil profile into three layers according to 0-5, 5-10, and 10-20 cm. The soil bulk density of each soil layer was measured by ring cutter soil. The soil samples at each sampling point in each quadrant are mixed into a soil sample according to the soil layer, and then sealed and brought back to the laboratory. Roots, stones, and other debris were removed carefully, and the samples were sieved through a 2-mm mesh sieve. In the laboratory, each soil was divided into two subsamples: one was stored at 4ºC for measurement of the WSOC, the other was air-drying for determination of SOC, EOC, POC, LFOC, and other soil properties.

Sample Analyses

The determination of soil sample index is repeated three times. The soil bulk density was measured by the cutting ring method, and the pH values were measured by pH meter (solid-water ratio of 1:2.5). SOC was determined by the potassium dichromate ($K_2Cr_2O_7$) oxidation-heating method. Soil TN was assayed by the Kjeldahl digestion method. The volume of soil gravel is determined by the drainage method. After the soil bulk density is measured, the soil in the cutting ring is sieved through a 2 mm soil sieve, the soil particles on the surface of the gravel are washed with clean water, and dried in a measuring cup (accuracy 0.5 mL). The volume of gravel is determined by the drainage method, and the volume content of soil gravel is calculated [43].

Soil WSOC was determined as described by Jones [44]. In short, 5 g fresh soil samples were mixed with 25 mL (soil-water ratio of 1:5) deionized water in centrifuge tube, shaken for 30 min and then centrifuged at 8000 rpm for 10 min. After the supernatant was filtered with 0.45 um filter membrane, the total organic C concentration of this sample was analyzed on the Multi N/C analyzer (Analytik Jena 3100, Germany). The soil EOC was measured using oxidation with 0.333 mol L^{-1} $KMnO_4$ [29]. Shortly, a soil sample containing about 15 mg of C was added into 50 mL centrifuge tubes and was reacted with 25 mL 0.333 mol L^{-1} $KMnO_4$ for 1 h on a shaker, and then centrifuged at 4000 rpm for 5 min. After being diluted with ultrapure water, supernatant's absorbance was read at 565 nm spectrophotometry. The POC was separated from 2 mm soil following the method of Camberdella [45]. Portions (10 g) of air-dried soil were poured into 30 mL of sodium hexametaphosphate $(NaPO_3)_6$ (5 g L^{-1}), with shaking on a reciprocating shaker for 18 h. Pass a 53 μm sieve and rinse with distilled water into an aluminum box to ensure separation. All material remaining on the box was washed into a dry dish, oven-dried at 60ºC for 48 h, and ground to determine the C content. The LFOC was measured based on density fractionation described by Janzen [46]. Briefly, 10 g of air-dried soil sample was added in a plastic centrifuge tube and reacted with 50 mL of NaI solution (1.7 g cm^{-3}). After shaking and centrifuging, the suspension with the floating particles was vacuum filtered. In the process of filtration, ultrapure water was used to rinse the remanent NaI on the floating particles, and then, C contents of the particles was analyzed.

Calculation and Statistical Analysis

In this study, SOC stocks in the soil profile were calculated based on the following equations [18, 21]:

$$SOCS = C \times D \times E \times (1 - G) / 100 \quad (1)$$

$$G = D_g / D_s \quad (2)$$

...where SOCS is the SOC stock (kg/m²), C represents the SOC concentrations (g/kg), D is the soil bulk density (g/cm³), E is the thickness of the soil layer (cm), G is the volume proportion of soil and sediment >2 mm (%), D_g is the dry weight of gravel, and D_s is the dry weight of total soil.

LOC/SOC in the soil profile were calculated based on the following equations [32]:

$$F_W = LOC/SOC \quad (3)$$

...where LOC stands for WSOC, EOC, POC, LFOC.

The Soil CPMI comprehensively considers SOC and LOC, and can more sensitively reflect the degree of soil quality degradation or regeneration caused by various land use or management measures [29-30]. Since all vegetation restoration measures are based on sloping farmland, the calculation of the soil CPMI is based on the slope farmland which is naturally restored:

$$NLC = SOC - EOC \quad (4)$$

...where NLC is Non-labile C.

$$L = LOC / NLC \quad (5)$$

...where L is Lability of C.

$$LI = L_s / L_r \quad (6)$$

...where LI is the lability index. L_s and L_r are the C lability of the sample soil and reference soil, respectively.

$$CPI = SOC_s / SOC_r \quad (7)$$

...where CPI is Carbon pool index. SOC_s and SOC_r are the SOC of the sample soil and reference soil, respectively.

$$CPMI = CPI \times LI \times 100 \quad (8)$$

...where CPMI is Carbon pool management index.

All data collected were statistically analyzed by SPSS version 22.0 (SPSS Incorporated, USA) and given as the average±standard error (SE) based on three repeated processing. We used one-way ANOVA to examine differences of measured parameters (SOC, SOCS, WSOC, EOC, POC, LFOC, CPMI, and the ratios of LOC to SOC) among the vegetation restoration measures, with separation of means-tested by the least significant difference method (LSD) at the 95% confidence level. Pearson's correlation coefficients were computed to investigate the relationships between SOC, LOC, CPMI, and phy-chemical indicators.

Results

Changes in SOC and SOCS under Different Restoration Measures

The SOC contents of the six restoration measures ranged from 8.96 to 53.32 g/kg, the maximum value appeared in 0-5 cm of YB which was 53.32 g/kg, and the minimum value appeared in 10-20 cm of HZ, which was 8.32 g/kg (Fig. 2a). The different vegetation restoration measures and soil depths had significant effects on SOC contents. The SOC contents of different restoration measures showed the highest YB in each soil layer, followed by LH, both of which were significantly higher than the other four restoration measures. In the 0-20 cm soil layer, the changing trend of SOC contents was YB>LH>HJ>MX>HL>HZ. In the whole soil profile, the SOC contents of each measures decreased with the increase of soil depth, and each soil layer showed a significant difference. The proportion of SOC in the 0-5 cm layer was 38.96%~47.23%, with visible surface aggregation.

The SOCS of the six restoration measures ranged from 0.57 to 2.04 kg/m^2, the maximum value appeared in 0-5 cm layer of YB which was 2.04 kg/m^2, and the minimum value appeared in 10-20 cm layer of HZ which was 0.57 kg/m^2 (Fig. 2b). The SOCS of each vegetation restoration measures in the same soil layer has the same trend as the SOC contents. It also showed the highest in YB, followed by LH and significantly greater than the other four measures. The variation trend of SOCS in different vegetation restoration measures was different among different soil layers. In the 0-5, 5-10, and 10-20 cm layer, the SOCS was reduced in different measures and arranged in the following order respectively: YB>LH>MX>HJ>HZ>HL, YB>LH>HJ>MX>HZ>HL, and LH>YB>HJ>MX>HL>HZ. In the 0-20 cm layer, the SOCS under different measures decreased in the following order: YB>LH>HJ>MX>HL>HZ. In the vertical soil profile, the SOCS of all the restoration measures decreased with the increase of soil depth, and significant differences were discovered among all the soil layers except 5-10 and 10-20 cm of HJ. The 0-5 cm SOCS accounted for 35.67%~45.28% of each measures, showing a consistent change pattern with SOC, and has obvious surface aggregation.

Changes in Soil Labile Organic Carbon under Different Restoration Measures

Water-Soluble Organic Carbon

The soil WSOC contents of the six restoration measures ranged from 59.44 to 180.29 mg/kg, the maximum value occurring in 0-5 cm depth of YB which was 180.29 mg/kg, and the minimum value occurring in 10-20 cm depth of HL which was 59.44 mg/kg (Fig. 3a). Except for MX and LH of 10-20 cm layer,

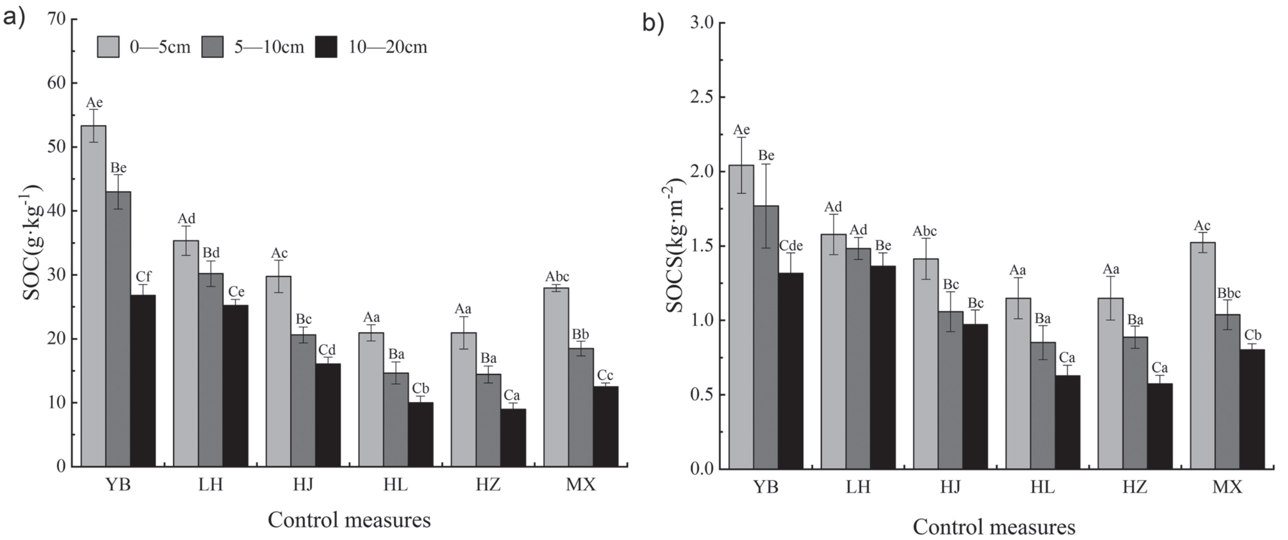

Fig. 2. Differences in a) soil organic carbon (SOC) content, b) soil organic carbon stocks at three soil depths of study measures: restoration with *Sabina chinensis*(YB); Abandoned and natural recovery (LH); restoration with *Zanthoxylum bungeanum* (HJ); restoration with *Hylocereus undulates* (HL); restoration with *Pennisetum sinese* (HZ); restoration with *Medicago sativa* (MX). Bars indicated ±SD. Different lower case letters indicated a significant difference among different soil layers in the same forest type at 0.05 level, and different capital letters indicated a significant difference among different forest types in the same soil layer at 0.05 level. The same below.

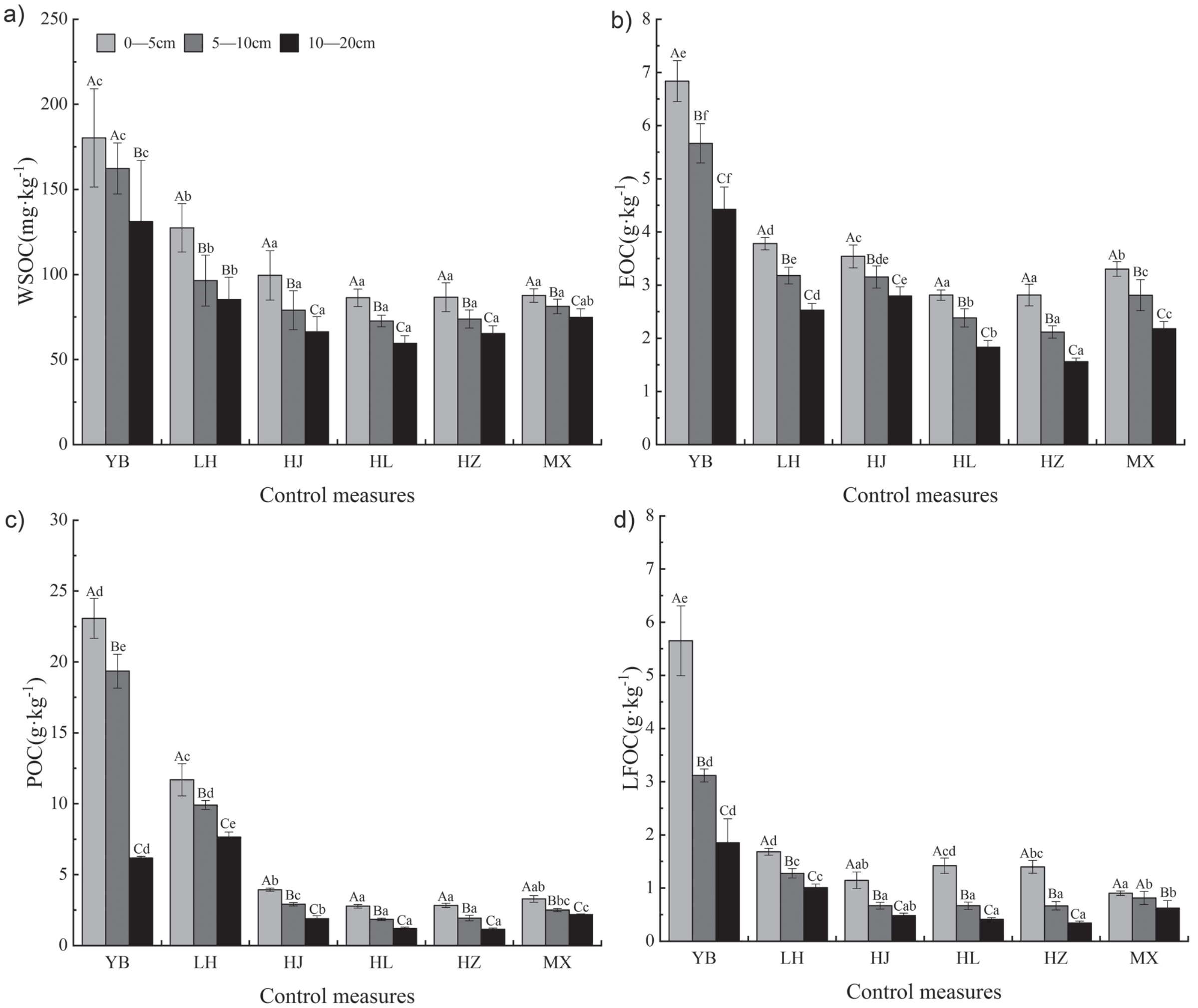

Fig. 3. Differences in LOC at three soil depths of study measures. a) water-soluble organic carbon (WSOC); b) easily oxidizable organic carbon (EOC); c) particulate organic carbon (POC); d) and light fraction organic carbon (LFOC). The same below.

the soil WSOC contents in the same soil layer of each measure were significantly higher than the other four measures, and there was no significant difference between the four measures. On the whole soil profile, the WSOC contents of each restoration measures decreased with the increase of soil depths, which was consistent with the change rule of SOC. The soil WSOC/SOC of all vegetation restoration measures ranged from 0.31% to 0.74%, the maximum value occurring in 10-20 cm depth of HZ which was 0.74%, and the minimum value occurring in 0-5 cm depth of MX which was 0.31% (Fig. 4a). On the soil profile, except for LH, the soil WSOC/SOC of each restoration measures showed an increase with the increase of the soil layer, which was opposite to the trend of soil WSOC content. The WSOC/SOC of LH soil showed a trend of falling first and then rising.

Easily Oxidizable Organic Carbon

The soil EOC contents of each vegetation restoration measures were 1.80~6.83 g/kg (Fig. 3b). Different restoration measures and soil layers have significant effects on soil EOC contents. There were significant differences in soil EOC contents of different restoration measures in the same soil layer. Among 0-5 cm soil layers, YB is the highest, followed by LH, HJ, and MX, which were significantly higher than HZ and HL, and there was no significant difference between HZ and HL. In the 5-10 cm depth, there were significant differences between the various measures except for HJ and LH, and in the 10-20 cm depth, there were significant differences. The average value of the EOC contents of the 0-20 cm soil layer in each restoration measures was YB>LH>HJ>MX>HL>HL. In the vertical profile, the soil EOC contents of each restoration measures showed a tendency to decrease with the increase of soil layer depth, and each soil layer had significant differences. The soil WSOC/SOC of all vegetation restoration measures is between 0.31% and 0.74%, with the maximum value occurring in 10-20 cm of HZ at 0.74%, and the minimum value occurring in 0-5 cm of MX at 0.31% (Fig. 4b). In the soil profile, except for LH, the soil EOC/SOC of each restoration measures increased

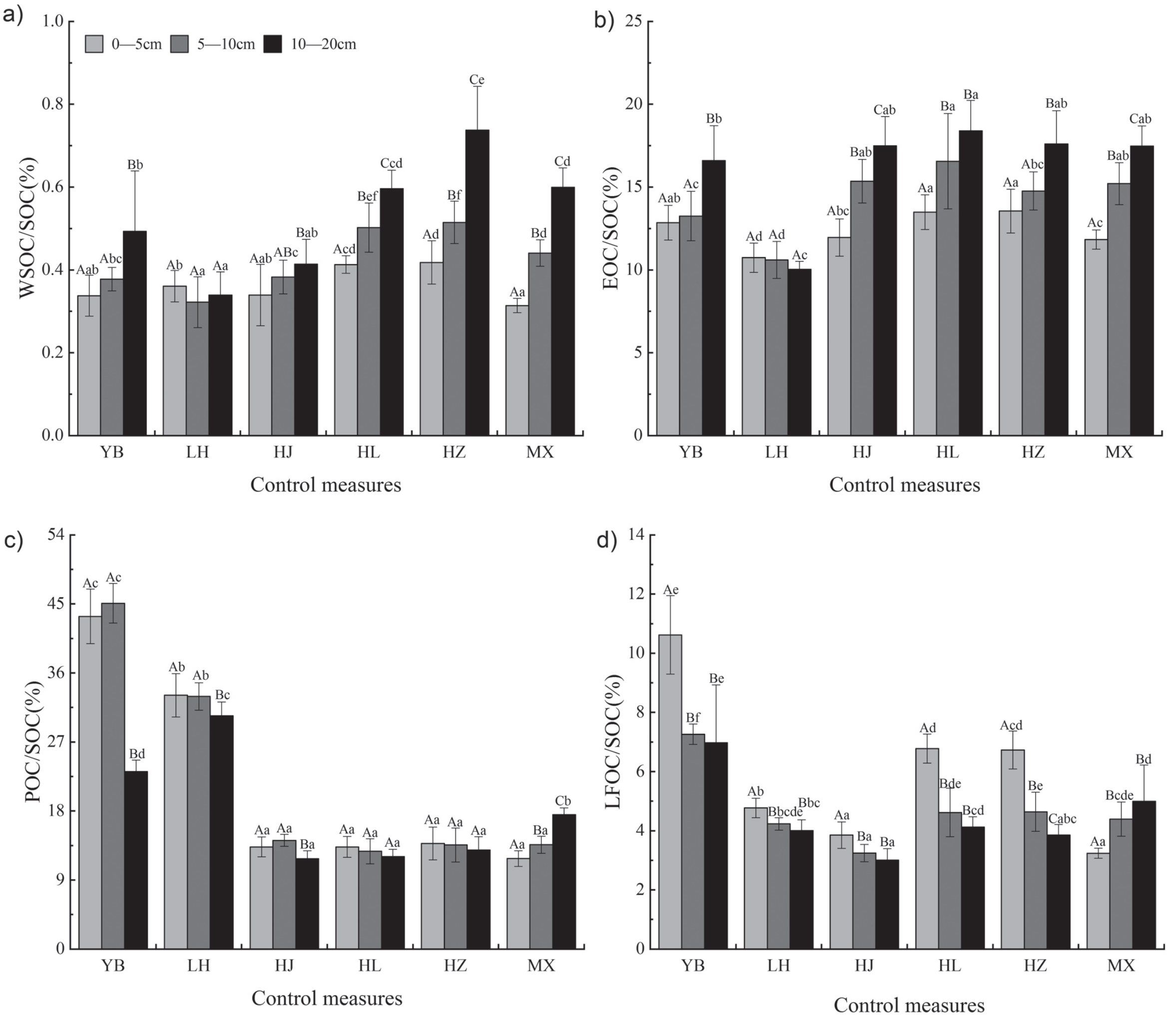

Fig. 4. Differences in LOC/SOC at three soil depths of study measures.

with the increase of depth, while LH decreased with the increase of soil layer.

Particulate Organic Carbon

It can be known from Fig. 3c) that the soil POC contents of each vegetation restoration measures were 1.14 to 23.07 g/kg. Different restoration measures and soil layers have significant effects on soil POC contents. The soil POC contents of each restoration measure showed the highest YB in any soil layer, followed by LH and the two were significantly higher than other measures. In the vertical profile, the variation of POC contents in each restoration measure was consistent with WSOC and EOC content, which decreased with the increase of soil layer, and there were significant differences among soil layers. In the 0-20 cm soil layer, the variation of soil POC contents in each restoration measure was YB>LH>HJ>MX>HZ>HL. The POC/SOC range of each restoration measure was 11.79% to 45.08%, in which 5-10 cm layer of YB is the largest at 45.08%, and 10-20 cm layer of HJ is the smallest at 11.79% (Fig. 4c). In the vertical profile of soil, the regularity of soil POC/SOC changes was poor for each measure. As the soil layer increased, HL, HZ, and LH decreased, HJ and YB increased first and then decreased, and MX increased with the soil layer increased. In the 0-20 cm layer, the soil POC contents under the different restoration measures decreased in the following order: YB>LH>MX>HZ>HJ>HL.

Light Fraction Organic Carbon

The soil LFOC contents of the six vegetation restoration measures were 0.45 to 5.65 g/kg (Fig. 3d). Similar to the SOC, WSOC, EOC, and POC, the soil LFOC contents of each restoration measure in the same soil layer also showed that YB and LH were significantly higher than other restoration measures. In the 0-20 cm layer, the soil LFOC contents under the different restoration measures decreased in the following order: YB>LH>HL>HZ>HJ>MX. In the vertical profile of soil, the soil LFOC contents of the six restoration measures showed a trend of decreasing with the increase of soil depths, and all showed significant differences except for 0-5 and 5-10 cm layer of MX.

The LFOC/SOC range of each restoration measure was 3.01% to 10.62%, in which 0-5 cm layer of YB was the largest at 10.62%, and 10-20 cm layer of HJ was the smallest at 3.01% (Fig. 4d). In the soil profile, except MX increased with the increase of the soil layer, all the restoration measures showed a decrease with the increase of the soil layer.

Changes in Soil Carbon Pool Management Index under Different Restoration Measures

Soil carbon pool management index (CPMI) was calculated with the reference of LH (Table 1). The soil Non-labile organic carbon (NLC) contents of each restoration measures decreased with the increase of soil layer depths, and there were significant differences in each soil layers. The variation of soil NLC showed YB and LH were significantly higher than the other four measures, which was consistent with the soil SOC. In the 0-20 cm layer, the soil NLC contents under the different restoration measures decreased in the following order: YB>LH>HJ>MX>HL>HZ. Except for LH, the soil Lability of C (L) of each measure increased with the increase of soil depth, and LH decreased with the increase of soil depth. The soil L was higher than LH under different restoration measures in different soil layers. In the vertical profile of soil, the soil Lability index (LI) of YB, HJ, HL, HZ, and MX increased with the increase of soil layer, and LH decreased first and then increased with the increase of soil layer depth. Soil LI was higher than LH in any layer of restoration measures. The soil carbon pool index (CPI) of each restoration measures decreased with the depth of the soil layer. The soil CPI of the other four restoration measures was less than LH except for YB. The soil CPMI of different restoration measures showed different trends in the vertical profile. Among them, HJ and MX showed an increase with the increase of soil depth, while HL increased first and then decreased, YB decreased first and then increased, and HZ decreased with the increase of soil layers. Except for the soil CPMI of YB and HJ under 5-10 and 10-20 cm soil layers, which were higher than LH, the other measures were less than LH. In the 0-20 cm layer, the soil CPMI contents under the different restoration measures decreased in the following order: YB (186.25)>HJ (107.16)>MX (92.28)>HL (79.36)>HZ (71.58).

Table 1. Non-labile C (NLC), Lability of C (L), Lability index (LI), Carbon pool index (CPI), Carbon pool management index (CPMI) of different vegetation restoration measures.

Soil layer (cm)	Restoration measures	NLC	L	LI	CPI	CPMI
0—5	LH	31.57±2.37Ad [1]	0.12±0.01Ad	1.00±0.00Ad	1.00±0.00Ab	100.00±0.00Abc
	YB	46.48±2.64Ae	0.15±0.01Aab	1.23±0.09Aabc	1.51±0.10Aa	185.15±6.72Aa
	HJ	26.23±2.50Ac	0.14±0.01Abc	1.13±0.12Abc	0.84±0.08Acd	95.01±6.13Ac
	HL	18.12±1.29Aa	0.16±0.01Aa	1.31±0.20Aa	0.59±0.05Aef	76.96±5.67Af
	HZ	18.12±2.40Aa	0.16±0.02Aa	1.31±0.13Aa	0.59±0.06Af	77.04±7.62Aef
	MX	24.62±0.59Abc	0.13±0.01Ac	1.13±0.15Ac	0.79±0.05Ad	88.7±6.82Ad
5—10	LH	27.01±2.12Bd	0.12±0.01Ad	1.00±0.00Ac	1.00±0.00Ab	100.00±0.00Acd
	YB	37.33±2.94Be	0.15±0.02Ac	1.30±0.20Ab	1.43±0.12Aa	183.99±15.75Aa
	HJ	17.45±1.25Bc	0.18±0.02Bab	1.56±0.33Bab	0.69±0.09Bc	105.21±12.05Abc
	HL	12.27±1.84Ba	0.20±0.04Ba	1.71±0.43Ba	0.49±0.08Bef	80.93±11.04Aef
	HZ	12.30±1.29Ba	0.17±0.02Abc	1.48±0.24Aab	0.48±0.05Bf	70.10±6.83Bf
	MX	15.67±0.98Bb	0.18±0.02Bab	1.54±0.31Bab	0.61±0.06Bd	93.88±15.23Ad
10—20	LH	22.67±0.91Ce	0.11±0.01Ac	1.00±0.00Ac	1.00±0.00Ab	100.00±0.00Acd
	YB	22.36±1.86Cde	0.20±0.03Bb	1.80±0.32Bb	1.07±0.09Ba	189.6±23.10Aa
	HJ	13.28±1.12Cc	0.21±0.03Cab	1.91±0.29Cab	0.64±0.05Bc	121.27±12.88Bb
	HL	8.19±0.96Ca	0.23±0.03Ba	2.03±0.28Ca	0.40±0.03Cef	80.20±8.87Ae
	HZ	7.40±1.01Ca	0.21±0.03Bab	1.92±0.25Bab	0.36±0.05Cf	67.59±4.01Bf
	MX	10.32±0.60Cb	0.21±0.02Cab	1.91±0.19Cab	0.50±0.04Cd	94.26±7.20Ad

[1] Different lower case letters indicated the significant difference between different soil layers of the same vegetation restoration measure at α = 0.05, and different capital letters indicated the significant difference between different soil layers of the same vegetation restoration measure at α = 0.05.

Relationship between SOC, LOC, and Soil Phy-Chemical Properties

The results of the correlation between SOC and LOC were shown in Fig. 5. The soil SOC was significantly positive correlated with WSOC, EOC, POC, and LFOC ($P<0.01$), indicating that the soil LOC was mostly dependent on the SOC contents. Besides, the soil LOC also showed significant positive correlations with each other ($P<0.01$), indicating that the labile fractions were closely related. Although their measurement methods and expressions were different, the results can reflect the changes in SOC.

The results of the correlation between SOC, LOC, CPMI, and other soil Phy-chemical properties were shown in Table 2. Soil SOC was positively correlated with soil TN, C/N, CPMI, and G ($P<0.01$), and negatively correlated with soil BD ($P<0.01$), but no correlation with pH. Except for the soil EOC and pH were extremely significantly correlated ($P<0.01$), there was no significant correlation between the LOC (WSOC, POC, LFOC) and pH. Each LOC had a significant positive correlation with soil TN, C/N, CPMI, and G ($P<0.01$), had a extremely significant negative correlation with soil BD ($P<0.01$). Soil CPMI was positively correlated with soil pH, TN, C/N, and G ($P<0.01$), and negatively correlated with soil BD ($P<0.01$).

Discussion

Impact of Different Vegetation Restoration Measures on SOC and SOCS

Soil organic carbon (SOC) is a crucial indicator of soil quality evaluation in the process of vegetation restoration and reconstruction in karst ecosystems [16, 40]. Under natural conditions, the type of vegetation in a particular climatic area determines the quantity and quality of litter and root exudates returned to the soil. Differences in vegetation types will lead to differences in SOC and SOCS [5, 22, 34]. In this study, we found that there were significant differences in SOC contents and SOCS under different vegetation restoration measures for rocky desertification, among which YB was the highest, and LH was the second, both of which were significantly higher than the other four measures. These differences could be rationally attributed to the fact that these measures have less human disturbance and more litter on the surface. This is consistent with the results of Lu [47], who believe that in karst areas,

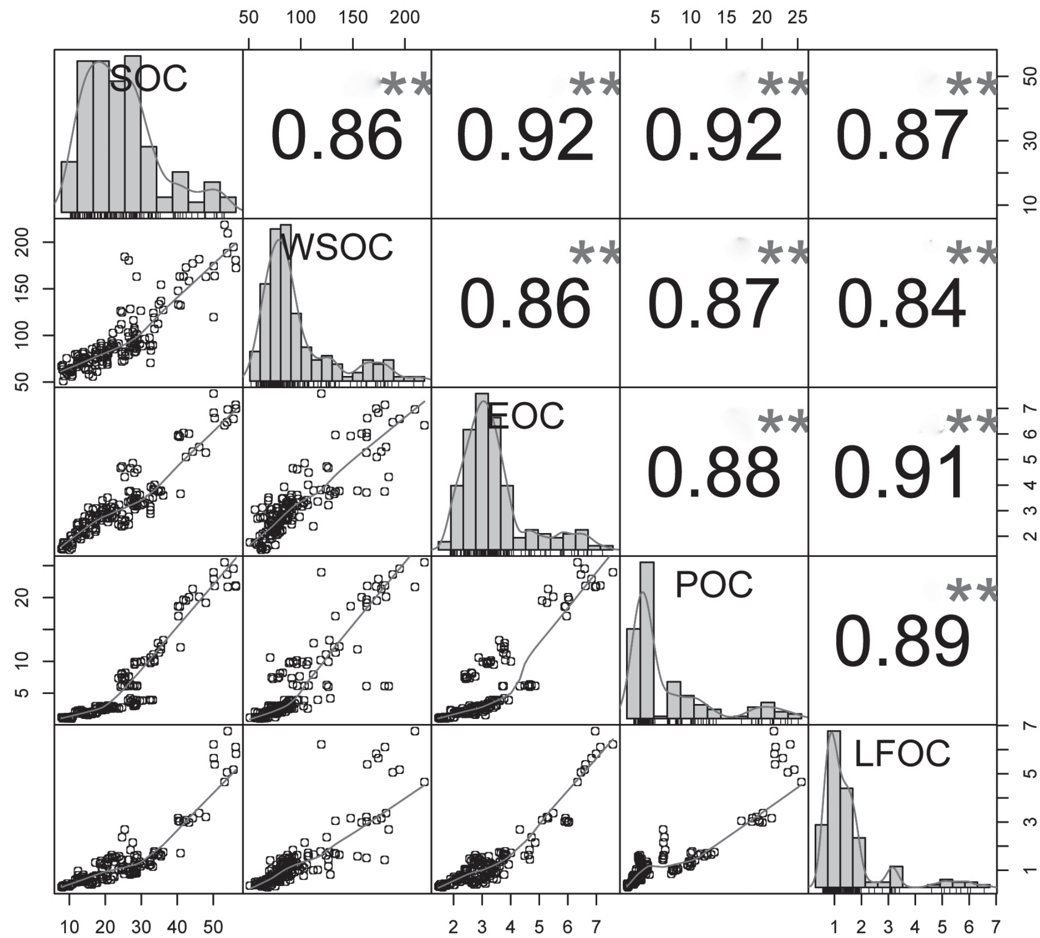

Fig. 5. Relationships between SOC and LOC (WSOC, EOC, POC, LFOC). ** Correlation is significant at the 0.01 level.

Table 2 Correlation analysis between soil SOC, LOC, CPMI, and soil phy-chemical properties.

Items	BD	PH	TN	C/N	CPMI	G
SOC	-0.688**1	0.108	0.956**	0.803**	0.685**	0.813**
WSOC	-0.532**	0.140	0.854**	0.600**	0.731**	0.785**
EOC	-0.642**	0.206**	0.871**	0.722**	0.864**	0.803**
POC	-0.515**	0.102	0.907**	0.610**	0.725**	0.883**
LFOC	-0.516**	0.105	0.832**	0.596**	0.730**	0.753**
CPMI	-0.399**	0.259**	0.639**	0.551**	—	0.753**

1** indicate the significant difference at α = 0.01.

reducing human disturbance and natural restoration were effective ways to improve soil quality. The SOC and SOCS decreased with soil depth in the soil profile, and the reduction range was different due to different types of vegetation. The proportion of SOC and SOCS in 0-5 cm soil under different restoration measures was 38.96%~47.23% and 35.67%~45.28% respectively, which were consistent with previous research results and showed visible surface aggregation [32-33, 48]. The main reason was that plant litter and roots were mostly distributed in the surface soil, and humus formed after decomposition was accumulated in the surface soil. On the other hand, this also shows that the stability of SOC in karst areas is reduced. Excessive human interference and unreasonable human activities are likely to cause soil erosion and rocky desertification. Therefore, it is vital to optimize the allocation and protection of forest and grass vegetation in karst areas and reduce unreasonable human activities for carbon management of rocky desertification soil.

Impact of Different Vegetation Restoration Measures on LOC

Soil LOC mainly comes from humic organic matter, plant litter, root exudates, and microbiome exudates. Compared with SOC, it has a faster turnover rate in soil and stronger sensitivity to the outside world, and it is more susceptible to the impact of vegetation types [30-31]. This study shows that the changes of soil LOC (WSOC, EOC, POC, and LFOC) and SOC under different restoration measures were consistent, and YB was the highest, followed by LH, both of which were significantly higher than the other four measures. This rule is mainly because SOC is the main factor affecting soil LOC, and the contents of soil LOC largely depends on the contents of SOC, When SOC is high, its labile carbon fractions are often high [18, 41]. In the soil profile, the changing trend of LOC in each soil is consistent with SOC, which decreased with the deepening of soil depths, mainly due to the concentration of litter in the surface soil, the distribution of plant roots, and the more sufficient light, which were conducive to the growth and reproduction of microorganisms. With the deepening of soil layers, the increase of soil bulk density leads to the worse ventilation condition, the decrease of soil organic matter contents, and the decrease of underground biomass, resulting in a significant reduction of the labile organic carbon fractions in the subsoil [19, 30, 38]. Correlation analysis also showed that SOC and its labile fractions (WSOC, EOC, POC, LFOC) were significantly positive correlated ($P<0.01$), which was consistent with previous research results [12, 18, 30]. The results show that WSOC, EOC, POC, and LFOC can be used as effective indicators to characterize soil organic carbon pool in the karst area [30, 49]. However, since soil LOC is extremely sensitive to environmental changes, it is difficult to keep the changes of each fraction utterly consistent with the SOC. For example, the degree of vertical decline of the LOC in the soil profile was different, among which the EOC of each restoration measures shows a significant difference in different soil layers, while the soil WSOC shows no significant difference in the 0-5 and 5-10 cm soil layers of YB. All of these indicate that the change of soil LOC is affected by a variety of factors. Therefore, research on soil LOC should fully consider the complexity and diversity of its influencing factors [38].

The LOC/SOC is more reflective of the effect of vegetation on soil behavior than LOC [11, 50]. This study showed that the soil WSOC/SOC of the six control measures ranged from 0.31% to 0.74%. In the vertical profile of soil, the soil WSOC/SOC showed a characteristic of increasing with the increase of soil depths, which is opposite to the trend of soil WSOC contents. The reason is that soil WSOC activity is high, has certain mobility and solubility, and is prone to dissolution and migration [13, 18], which also indicate that deep soil SOC is better protected and more stable than surface soil [38]. Soil EOC/SOC is an indicator of soil carbon stability. When it is higher, which means that the soil carbon activity is greater and the stability is worse [22]. In this study, the soil EOC/SOC of various restoration measures ranged from 10.03% to 18.39%. Among them, HL and HZ accounted for a large proportion, and LH was the smallest, indicating that the activity of SOC in LH is low, which is beneficial to the accumulation of SOC. Previous studies have pointed out that soil POC and LFOC represent unprotected fractions of SOC, and their ratios (POC/SOC, LFOC/SOC) reflect the relative soil amount of non-protective or unstable SOC in China [21]. This study showed that the change trend of soil POC/SOC and LFOC/SOC is consistent with the change trend of soil POC and LFOC contents, both of which are higher under YB and LH management measures. The reason may be that YB and LH have less human disturbance, and there are more animal and plant residues on the surface. However, other management measures have less surface litter due to more human disturbance, especially HJ and HZ, thus soil POC/SOC and LFOC/SOC are low.

Responses of Soil CPMI to Different Restoration Measures and Their Implications for Rocky Desertification Vegetation Restoration Practices

The soil CPMI can comprehensively and dynamically reflect the impact of different vegetation types and management measures on SOC pools from the quantity and quality of soil LOC. It is often used as an indicator of the change and renewal degree of SOC pools. When the value of CMPI is higher, it indicates that the soil management and management is more reasonable, and the soil quality develops to benign. On the contrary, it indicates that soil management is unreasonable, and the soil quality develops to malignant [13, 22]. This study shows that the soil CPMI of each measure in the 0-20 cm layer is YB (186.25)>HJ (107.16)>LH (100.00)>MX (92.28)>HL (79.36)>HZ (71.58). Among them, the soil CPMI of each soil layer YB is greater than LH, indicating that YB is an effective carbon sequestration measure of karst rocky desertification control, which is beneficial to the karst ecological environmental management and protection in Southwest China. The soil CPMI of HJ 0-5 cm is less than LH, which may be caused by more human interference. After the harvest of *Zanthoxylum bungeanums*, local farmers chose to remove all its litter, such as branches and leaves, resulting in less litter on the soil surface and lower soil nutrients. The soil CPMI of HJ 5-10 and 10-20 cm layer is higher than LH, indicating that HJ has a positive effect on the accumulation of SOC in deep soil, which is consistent with the results of Liao [16]. Soil CPMI of 0-20 cm layer HJ is larger than that of LH, and the economic benefit of HJ is higher than other measures. In Guanling region of Guizhou, a unique "*Zanthoxylum bungeanums* model" has been formed. Therefore, this article believes that *Zanthoxylum bungeanums* can be used as a priority economic species for the ecological restoration of karst rocky desertification and the development of mountain agriculture in Southwest China. The soil CPMI of HL, HZ, and MX are low than that of LH, indicating that the ecological effects of the three restoration measures are worse than that of natural recovery. Also, the change rule of soil CPMI of various control measures is more consistent with SOC, and the correlation analysis also shows that there is significantly correlations between soil CPMI and various soil indicators ($P<0.01$), which indicates that soil CPMI can be used as a sensitive indicator of soil management in karst areas.

Conclusions

(1) The SOC contents, SOCS, and soil LOC (WSOC, EOC, POC, LFOC) contents of different vegetation restoration measures for karst rocky desertification control were the highest in restoration with *Sabina chinensis*, followed by the natural recovery of abandoned land, which was significantly higher than the other four measures. From the vertical distribution of soil profile, the contents of each indexes decreased with the increase of soil depth.

(2) Taking the abandoned and natural recovery as a reference, in the 0-20 cm layer, the soil carbon pool management index under the different restoration measures decreased in the following order: restoration with *Sabina chinensis*>restoration with *Zanthoxylum bungeanums*>restoration with *Medicago sativas*>restoration with *Hylocereus undulates*>restoration with *Pennisetum sineses*.

(3) Returning cultivated land to forests (*Sabina chinensis*) and abandonment of natural recovery are more conducive to karst ecological environment management and protection. *Zanthoxylum bungeanums* can be used as a priority economic species for karst rocky desertification and mountain agricultural development in Southwestern China.

(4) Soil WSOC, EOC, POC, and LFOC can be used as effective indicators to reflect SOC pools, and soil CPMI can also be used as a sensitive indicator to reflect soil management.

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Conflict of Interest

The authors declare no conflict of interest.

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Supplementary Material

Table S1. Data of soil basic physical and chemical properties and soil carbon pool management index.

Serial number	Soil layer	No. of sample plot	BD (g/cm^3)	PH	TN (g/kg)	C/N	G (%)	NLC	L	LI	CPI	CPMI
1	0-5	I-1-1	0.92	7.16	2.23	13.60	0.02	27.07	0.12	1.23	0.74	90.87
2		I-1-2	0.91	7.16	2.15	13.38	0.01	25.15	0.14	1.20	0.82	98.55
3		I-1-3	0.90	7.12	2.28	12.97	0.01	25.96	0.14	1.26	0.82	102.91
4		I-2-1	0.97	7.11	1.94	13.58	0.01	23.00	0.15	1.18	0.76	89.82
5		I-2-2	0.96	7.06	2.02	13.77	0.02	24.46	0.14	1.07	0.83	88.93
6		I-2-3	1.06	7.05	2.05	13.14	0.00	23.16	0.16	1.21	0.80	96.45
7		I-3-1	0.99	7.16	2.16	15.37	0.02	29.68	0.12	0.91	0.99	90.18
8		I-3-2	1.01	7.13	2.09	15.45	0.00	28.83	0.12	1.01	0.91	91.87
9		I-3-3	0.92	7.09	2.17	15.05	0.00	28.74	0.14	1.15	0.92	105.49
10	5-10	I-1-1	0.99	7.13	1.64	11.67	0.07	16.17	0.18	1.71	0.59	100.81
11		I-1-2	1.03	7.17	1.66	11.66	0.05	16.32	0.19	1.82	0.59	108.34
12		I-1-3	1.05	7.21	1.59	12.08	0.05	15.81	0.21	2.21	0.59	130.61
13		I-2-1	1.15	7.10	1.48	15.21	0.06	19.41	0.16	1.25	0.80	100.27
14		I-2-2	1.15	7.17	1.61	13.42	0.07	18.45	0.17	1.29	0.77	98.98
15		I-2-3	1.2	7.11	1.46	15.15	0.03	18.83	0.17	1.27	0.79	99.56
16		I-3-1	1.03	7.13	1.66	12.28	0.03	17.33	0.18	1.43	0.71	101.06
17		I-3-2	1.01	7.12	1.58	12.99	0.00	17.65	0.16	1.36	0.66	90.04
18		I-3-3	1	7.16	1.61	12.79	0.00	17.08	0.21	1.70	0.69	117.27
19	10-20	I-1-1	1.15	7.18	1.30	10.98	0.00	11.51	0.24	2.35	0.54	126.74
20		I-1-2	1.13	7.13	1.31	12.47	0.00	13.61	0.20	1.86	0.66	123.31
21		I-1-3	1.2	7.10	1.29	11.82	0.00	12.13	0.26	2.30	0.60	137.57
22		I-2-1	1.18	7.19	1.23	12.64	0.00	12.74	0.22	1.93	0.61	117.49
23		I-2-2	1.21	7.05	1.25	13.84	0.00	14.67	0.18	1.48	0.70	104.42
24		I-2-3	1.39	7.06	1.27	12.84	0.01	13.66	0.19	1.67	0.61	102.64
25		I-3-1	1.16	7.11	1.33	11.61	0.00	12.75	0.21	1.81	0.65	118.12
26		I-3-2	1.19	7.02	1.28	13.82	0.00	14.95	0.18	1.72	0.70	120.58
27		I-3-3	1.28	7.08	1.36	12.15	0.01	13.48	0.23	2.08	0.68	140.53
28	0-5	II-1-1	1.04	7.05	1.79	11.56	0.04	17.79	0.16	1.66	0.51	84.24
29		II-1-2	1.08	7.04	1.75	12.59	0.03	19.20	0.15	1.23	0.63	77.52
30		II-1-3	1.16	7.07	1.81	12.02	0.04	18.78	0.16	1.43	0.60	86.25
31		II-2-1	1.17	7.01	1.77	12.00	0.04	18.54	0.15	1.19	0.61	72.69
32		II-2-2	1.13	7.00	1.76	12.75	0.02	19.72	0.14	1.08	0.67	72.03
33		II-2-3	1.26	6.93	1.72	12.65	0.01	18.99	0.15	1.08	0.65	69.46
34		II-3-1	1.12	7.00	1.83	10.77	0.00	16.86	0.17	1.29	0.59	76.12
35		II-3-2	1.16	7.02	1.80	11.27	0.00	17.57	0.15	1.30	0.57	74.15
36		II-3-3	0.96	7.04	1.74	10.63	0.02	15.62	0.18	1.54	0.52	80.18
37	5-10	II-1-1	1.17	7.10	1.35	11.44	0.04	13.01	0.19	1.74	0.47	82.69
38		II-1-2	1.11	7.11	1.33	10.77	0.04	11.93	0.20	1.96	0.44	86.18
39		II-1-3	1.2	7.09	1.29	11.37	0.03	12.13	0.21	2.15	0.45	96.96

Table S1. Continued

40		II-2-1	1.13	7.14	1.35	12.76	0.02	15.05	0.14	1.14	0.61	69.61
41		II-2-2	1.16	7.13	1.27	13.03	0.00	14.24	0.16	1.22	0.59	72.06
42		II-2-3	1.34	7.15	1.25	12.31	0.00	13.33	0.15	1.12	0.55	61.31
43		II-3-1	1.16	7.14	1.21	10.02	0.00	9.66	0.25	2.06	0.42	86.63
44		II-3-2	1.15	7.10	1.37	9.04	0.00	9.87	0.26	2.13	0.40	85.36
45		II-3-3	1.18	7.14	1.39	9.90	0.00	11.18	0.23	1.90	0.46	87.56
46	10-20	II-1-1	1.19	7.10	1.09	9.72	0.02	8.71	0.22	2.11	0.40	84.30
47		II-1-2	1.22	7.04	1.02	10.13	0.02	8.32	0.24	2.25	0.42	94.29
48		II-1-3	1.21	7.08	.99	10.66	0.00	8.52	0.24	2.14	0.41	88.39
49		II-2-1	1.24	7.11	.86	12.38	0.00	8.90	0.20	1.72	0.42	71.73
50		II-2-2	1.28	7.14	.92	11.87	0.01	9.03	0.21	1.73	0.44	76.95
51		II-2-3	1.4	7.08	.97	11.20	0.00	9.19	0.18	1.56	0.41	64.04
52		II-3-1	1.25	7.11	.95	8.76	0.00	6.56	0.27	2.30	0.35	80.94
53		II-3-2	1.22	7.04	1.08	8.69	0.00	7.65	0.23	2.14	0.37	79.43
54		II-3-3	1.32	7.06	1.03	8.31	0.00	6.83	0.25	2.34	0.35	81.73
55	0-5	III-1-1	1.09	7.09	2.14	10.81	0.03	20.15	0.15	1.51	0.57	85.42
56		III-1-2	1.06	6.95	2.11	11.69	0.02	21.80	0.13	1.09	0.71	77.24
57		III-1-3	1.21	7.03	2.09	11.39	0.01	20.58	0.16	1.41	0.66	93.24
58		III-2-1	1.12	6.99	1.99	9.42	0.03	16.13	0.16	1.32	0.54	71.57
59		III-2-2	1.11	7.01	2.03	9.21	0.05	15.99	0.17	1.33	0.56	73.75
60		III-2-3	1.14	7.02	2.01	8.57	0.00	14.44	0.19	1.43	0.51	73.05
61		III-3-1	1.15	7.00	1.89	10.87	0.06	17.71	0.16	1.23	0.62	75.72
62		III-3-2	1.14	7.01	1.91	10.90	0.02	18.08	0.15	1.27	0.59	74.49
63		III-3-3	1.12	7.03	1.85	11.22	0.01	18.20	0.14	1.18	0.58	68.90
64	5-10	III-1-1	1.20	7.12	1.53	11.40	0.02	15.18	0.15	1.39	0.54	74.45
65		III-1-2	1.26	7.12	1.49	8.99	0.02	11.38	0.18	1.73	0.41	71.05
66		III-1-3	1.21	7.15	1.55	8.98	0.00	11.69	0.19	1.96	0.43	83.84
67		III-2-1	1.22	7.04	1.58	9.87	0.00	13.54	0.15	1.19	0.55	66.20
68		III-2-2	1.22	7.11	1.56	8.81	0.00	11.58	0.19	1.41	0.49	69.16
69		III-2-3	1.33	7.11	1.61	9.07	0.00	12.50	0.17	1.21	0.52	63.03
70		III-3-1	1.25	7.03	1.74	7.87	0.00	11.49	0.19	1.55	0.48	73.96
71		III-3-2	1.21	7.14	1.65	8.61	0.02	12.06	0.18	1.48	0.46	67.99
72		III-3-3	1.27	7.06	1.63	8.10	0.01	11.31	0.17	1.38	0.44	61.21
73	10-20	III-1-1	1.26	7.15	1.25	7.17	0.02	7.33	0.22	2.17	0.34	73.48
74		III-1-2	1.28	7.13	1.26	7.66	0.00	8.06	0.20	1.84	0.39	71.93
75		III-1-3	1.29	7.13	1.19	7.76	0.00	7.57	0.22	1.96	0.36	70.77
76		III-2-1	1.28	7.03	1.24	6.28	0.00	6.28	0.24	2.11	0.30	64.16
77		III-2-2	1.26	7.02	1.17	6.98	0.00	6.55	0.25	2.05	0.33	68.03
78		III-2-3	1.27	7.06	1.21	6.68	0.00	6.54	0.24	2.04	0.30	62.09
79		III-3-1	1.25	7.10	1.25	8.52	0.01	9.12	0.17	1.44	0.45	64.78
80		III-3-2	1.27	7.11	1.24	8.10	0.01	8.57	0.17	1.61	0.40	64.05
81		III-3-3	1.43	7.14	1.16	6.98	0.01	6.61	0.23	2.08	0.33	69.02

Table S1. Continued

82	0-5	IV-1-1	1.09	7.14	2.11	13.20	0.05	24.54	0.14	1.38	0.68	93.77
83		IV-1-2	1.12	7.19	2.09	13.61	0.03	24.96	0.14	1.17	0.81	94.97
84		IV-1-3	1.14	7.09	2.07	13.58	0.03	24.64	0.14	1.27	0.78	98.62
85		IV-2-1	1.16	7.14	2.06	13.69	0.05	25.14	0.12	0.99	0.81	80.66
86		IV-2-2	1.13	7.12	2.05	14.01	0.02	25.47	0.13	1.00	0.85	85.28
87		IV-2-3	1.2	7.15	2.03	13.78	0.04	24.79	0.13	0.95	0.83	79.00
88		IV-3-1	1.07	7.11	1.99	13.97	0.01	24.59	0.13	1.00	0.83	83.67
89		IV-3-2	1.09	7.13	2.11	12.76	0.04	23.58	0.14	1.19	0.76	90.39
90		IV-3-3	1.14	7.06	2.06	13.25	0.02	23.88	0.14	1.20	0.77	91.92
91	5-10	IV-1-1	1.15	7.05	1.85	9.41	0.07	14.31	0.22	2.02	0.53	107.74
92		IV-1-2	1.11	7.04	1.86	10.88	0.02	17.13	0.18	1.78	0.62	110.39
93		IV-1-3	1.18	7.07	1.89	10.21	0.02	16.17	0.19	1.99	0.59	118.00
94		IV-2-1	1.19	7.11	1.76	11.05	0.02	16.62	0.17	1.34	0.69	92.37
95		IV-2-2	1.15	7.13	1.72	10.98	0.02	15.92	0.19	1.41	0.67	94.59
96		IV-2-3	1.3	7.08	1.74	10.96	0.05	16.33	0.17	1.21	0.68	82.35
97		IV-3-1	1.1	7.14	1.69	10.37	0.03	14.90	0.18	1.42	0.61	86.47
98		IV-3-2	1.13	7.10	1.82	9.44	0.04	14.67	0.17	1.43	0.55	79.32
99		IV-3-3	1.15	7.16	1.66	10.42	0.04	15.00	0.15	1.27	0.58	73.70
100	10-20	IV-1-1	1.28	7.21	1.39	8.73	0.05	9.97	0.22	2.13	0.46	97.44
101		IV-1-2	1.26	7.14	1.35	9.50	0.01	10.56	0.21	1.99	0.52	103.67
102		IV-1-3	1.33	7.16	1.42	8.73	0.00	9.96	0.24	2.18	0.49	105.90
103		IV-2-1	1.27	7.11	1.42	8.19	0.00	9.48	0.23	1.99	0.46	90.35
104		IV-2-2	1.31	7.12	1.32	9.75	0.00	10.72	0.20	1.66	0.52	86.91
105		IV-2-3	1.35	7.10	1.34	9.11	0.02	9.99	0.22	1.91	0.46	88.05
106		IV-3-1	1.3	7.02	1.30	10.62	0.05	11.57	0.19	1.65	0.58	96.44
107		IV-3-2	1.34	7.05	1.22	10.16	0.00	10.31	0.20	1.90	0.49	93.48
108		IV-3-3	1.28	7.09	1.18	10.34	0.00	10.28	0.19	1.73	0.50	86.08
109	0-5	V-1-1	0.91	7.08	3.40	15.84	0.29	47.39	0.14	1.39	1.32	182.62
110		V-1-2	0.94	7.16	3.37	16.51	0.12	49.04	0.13	1.12	1.59	178.47
111		V-1-3	0.94	7.12	3.35	15.87	0.25	46.81	0.14	1.22	1.47	179.67
112		V-2-1	0.97	7.11	3.38	14.83	0.20	43.31	0.16	1.28	1.45	185.81
113		V-2-2	0.99	7.13	3.41	14.78	0.18	43.78	0.15	1.18	1.50	177.35
114		V-2-3	1.1	7.15	3.39	14.78	0.24	42.51	0.18	1.32	1.49	196.36
115		V-3-1	0.99	7.11	3.40	16.56	0.31	49.33	0.14	1.09	1.69	183.36
116		V-3-2	1.02	7.12	3.37	16.69	0.23	49.10	0.15	1.22	1.59	193.87
117		V-3-3	1.03	7.13	3.43	15.75	0.19	47.07	0.15	1.24	1.52	188.84
118	5-10	V-1-1	1.01	7.17	3.15	13.25	0.33	35.70	0.17	1.58	1.28	202.50
119		V-1-2	1.05	7.15	3.06	14.14	0.21	37.25	0.16	1.58	1.33	209.68
120		V-1-3	1	7.06	2.99	14.18	0.26	37.31	0.14	1.41	1.30	183.53
121		V-2-1	0.99	7.05	3.18	12.80	0.29	34.81	0.17	1.33	1.45	192.08
122		V-2-2	1.06	7.11	3.03	13.28	0.20	34.31	0.17	1.30	1.43	186.31
123		V-2-3	1.1	7.08	3.01	13.39	0.23	34.35	0.17	1.26	1.43	180.37

Table S1. Continued

124		V-3-1	1.11	7.16	3.10	15.47	0.17	42.68	0.12	1.00	1.67	166.19
125		V-3-2	1.08	7.14	3.00	14.76	0.15	38.98	0.14	1.14	1.43	162.80
126		V-3-3	1.13	7.20	3.08	14.96	0.21	40.59	0.14	1.12	1.54	172.48
127	10-20	V-1-1	1.16	7.11	2.28	10.64	0.27	19.59	0.24	2.33	0.92	213.28
128		V-1-2	1.18	7.19	2.22	12.93	0.15	24.99	0.15	1.38	1.16	160.99
129		V-1-3	1.15	7.11	2.19	12.11	0.10	22.76	0.16	1.48	1.04	153.19
130		V-2-1	1.13	7.11	2.02	14.30	0.11	24.26	0.19	1.67	1.13	188.40
131		V-2-2	1.17	7.05	1.97	14.26	0.18	23.60	0.19	1.58	1.14	179.94
132		V-2-3	1.09	7.07	2.01	13.43	0.21	22.32	0.21	1.80	1.02	182.76
133		V-3-1	1.06	7.13	2.20	12.56	0.10	22.77	0.21	1.83	1.17	213.83
134		V-3-2	1.19	7.10	2.14	11.52	0.08	19.92	0.24	2.23	0.98	217.68
135		V-3-3	1.21	7.14	2.17	11.70	0.10	21.07	0.20	1.89	1.04	196.34
136	0-5	VI-1-1	1.07	7.07	2.85	14.35	0.15	37.25	0.10	—	—	—
137		VI-1-2	1.03	7.06	2.80	12.47	0.15	31.17	0.12	—	—	—
138		VI-1-3	1.11	7.14	2.81	12.85	0.16	32.51	0.11	—	—	—
139		VI-2-1	0.98	7.11	2.78	12.46	0.19	30.86	0.12	—	—	—
140		VI-2-2	1.02	7.16	2.75	12.22	0.12	29.80	0.13	—	—	—
141		VI-2-3	1.11	7.09	2.73	12.34	0.14	29.67	0.14	—	—	—
142		VI-3-1	1.06	7.14	2.88	11.58	0.15	29.51	0.13	—	—	—
143		VI-3-2	1.05	7.01	2.76	12.85	0.15	31.70	0.12	—	—	—
144		VI-3-3	1.03	7.02	2.69	13.19	0.15	31.70	0.12	—	—	—
145	5-10	VI-1-1	1.12	7.04	2.51	12.97	0.23	29.41	0.11	—	—	—
146		VI-1-2	1.07	7.04	2.26	14.41	0.12	29.54	0.10	—	—	—
147		VI-1-3	1.1	7.07	2.30	14.16	0.13	29.68	0.10	—	—	—
148		VI-2-1	1.14	7.07	2.55	11.03	0.11	24.95	0.13	—	—	—
149		VI-2-2	1.18	7.02	2.48	11.34	0.12	24.84	0.13	—	—	—
150		VI-2-3	1.16	7.00	2.59	10.86	0.10	24.72	0.14	—	—	—
151		VI-3-1	1.09	7.03	2.72	10.57	0.10	25.59	0.12	—	—	—
152		VI-3-2	1.19	7.09	2.65	11.69	0.12	27.67	0.12	—	—	—
153		VI-3-3	1.14	7.08	2.61	11.44	0.14	26.65	0.12	—	—	—
154	10-20	VI-1-1	1.22	7.02	2.13	12.45	0.10	24.05	0.10	—	—	—
155		VI-1-2	1.24	7.03	2.04	12.08	0.10	22.26	0.11	—	—	—
156		VI-1-3	1.32	6.99	2.10	12.16	0.10	22.97	0.11	—	—	—
157		VI-2-1	1.23	7.02	2.15	11.89	0.10	22.94	0.11	—	—	—
158		VI-2-2	1.16	7.00	2.07	11.88	0.10	21.94	0.12	—	—	—
159		VI-2-3	1.12	7.11	2.00	13.27	0.10	23.77	0.12	—	—	—
160		VI-3-1	1.14	7.06	2.03	11.66	0.10	21.19	0.12	—	—	—
161		VI-3-2	1.17	7.05	1.96	12.88	0.10	22.81	0.11	—	—	—
162		VI-3-3	1.22	7.04	1.93	12.67	0.10	22.06	0.11	—	—	—

Note: I, *Zanthoxylum bungeanums*; II, *Hylocereus undulates* III, *Pennisetum sinese* IV, *Medicago sativa;* V, *Sabina chinensis;* VI, abandoned and natural recovery. I-1-1, The first sample point of the first sample plot of *Zanthoxylum bungeanums*; I-2-1, The first sample point of the second sample plot of *Zanthoxylum bungeanums*. BD, Bulk density; Ph, Soil Ph; TN, Total nitrogen; C/N, Ratio of carbon and nitrogen; G, >2 mm gravel ratio; NLC, Non-labile C; L, Lability of C; LI, lability index; CPI, Carbon pool index; CPMI, Carbon Pool Management Index.

Table S2. Soil organic carbon content and stock, and Soil labile organic carbon content.

Serial number	Soil layer	No. of sample plot	SOC (g/kg)	SOCS (kg/m^2)	WSOC (mg/kg)	EOC (g/kg)	POC (g/kg)	LFOC (g/kg)	WSOC/SOC (%)	EOC/SOC (%)	POC/SOC (%)	LFOC/SOC (%)
1	0-5	I-1-1	30.33	1.37	88.63	3.26	3.85	1.26	0.29	10.75	12.69	4.15
2		I-1-2	28.76	1.30	96.51	3.61	3.92	1.17	0.34	12.55	13.63	4.07
3		I-1-3	29.58	1.32	91.00	3.62	3.81	1.35	0.31	12.23	12.87	4.57
4		I-2-1	26.34	1.26	103.14	3.34	3.88	1.09	0.39	12.67	14.73	4.14
5		I-2-2	27.82	1.31	116.27	3.36	3.96	1.02	0.42	12.08	14.23	3.67
6		I-2-3	26.93	1.43	128.40	3.77	4.19	0.82	0.48	14.01	15.54	3.04
7		I-3-1	33.19	1.61	89.66	3.51	3.94	1.15	0.27	10.58	11.87	3.46
8		I-3-2	32.29	1.63	97.53	3.46	3.97	1.21	0.30	10.72	12.29	3.75
9		I-3-3	32.67	1.50	84.00	3.93	3.91	1.24	0.26	12.03	11.98	3.81
10	5-10	I-1-1	19.14	0.88	78.65	2.97	2.83	0.63	0.41	15.52	14.79	3.29
11		I-1-2	19.36	0.95	72.01	3.04	2.79	0.66	0.37	15.70	14.41	3.41
12		I-1-3	19.21	0.96	68.70	3.40	2.75	0.66	0.36	17.69	14.31	3.45
13		I-2-1	22.51	1.22	85.36	3.10	2.85	0.72	0.38	13.77	12.66	3.20
14		I-2-2	21.60	1.16	89.77	3.15	2.92	0.61	0.42	14.58	13.52	2.82
15		I-2-3	22.12	1.29	102.70	3.29	2.99	0.77	0.46	14.87	13.54	3.47
16		I-3-1	20.39	1.02	71.24	3.06	2.99	0.75	0.35	15.01	14.66	3.68
17		I-3-2	20.52	1.04	73.68	2.87	3.04	0.59	0.36	13.99	14.81	2.88
18		I-3-3	20.59	1.03	69.00	3.51	3.06	0.62	0.34	17.06	14.89	2.99
19	10-20	I-1-1	14.28	0.82	65.47	2.77	1.63	0.52	0.46	19.40	11.41	3.64
20		I-1-2	16.33	0.92	63.65	2.72	1.72	0.41	0.39	16.66	10.53	2.51
21		I-1-3	15.25	0.91	63.10	3.12	1.58	0.45	0.41	20.47	10.36	2.98
22		I-2-1	15.55	0.92	72.21	2.81	2.01	0.41	0.46	18.07	12.93	2.64
23		I-2-2	17.30	1.05	71.50	2.63	1.99	0.48	0.41	15.20	11.50	2.77
24		I-2-3	16.31	1.12	85.40	2.65	2.11	0.53	0.52	16.26	12.91	3.28
25		I-3-1	15.44	0.90	58.39	2.69	1.95	0.53	0.38	17.42	12.63	3.43
26		I-3-2	17.69	1.05	61.07	2.74	1.97	0.48	0.35	15.49	11.14	2.71
27		I-3-3	16.52	1.05	56.00	3.04	2.10	0.51	0.34	18.40	12.71	3.12
28	0-5	II-1-1	20.70	1.03	88.62	2.91	2.64	1.46	0.43	14.06	12.75	7.05
29		II-1-2	22.03	1.15	91.36	2.83	2.71	1.52	0.41	12.85	12.30	6.90
30		II-1-3	21.77	1.21	93.60	2.98	2.59	1.54	0.43	13.69	11.92	7.09
31		II-2-1	21.24	1.19	85.46	2.70	2.75	1.51	0.40	12.71	12.95	7.11
32		II-2-2	22.44	1.24	88.13	2.72	2.73	1.36	0.39	12.12	12.17	6.06
33		II-2-3	21.75	1.36	87.30	2.76	2.85	1.63	0.40	12.69	13.10	7.49
34		II-3-1	19.70	1.10	76.58	2.84	2.88	1.22	0.39	14.40	14.62	6.19
35		II-3-2	20.28	1.18	81.64	2.71	2.82	1.27	0.40	13.36	13.91	6.26
36		II-3-3	18.49	0.87	84.00	2.87	2.98	1.26	0.45	15.51	16.13	6.83
37	5-10	II-1-1	15.44	0.87	77.32	2.43	1.84	0.61	0.50	15.74	11.92	3.95
38		II-1-2	14.32	0.76	76.51	2.39	1.76	0.65	0.53	16.69	12.29	4.54
39		II-1-3	14.67	0.85	75.60	2.54	2.04	0.63	0.52	17.29	13.92	4.33
40		II-2-1	17.23	0.95	67.83	2.18	1.83	0.61	0.39	12.65	10.62	3.54

Table S2. Continued

41		II-2-2	16.55	0.96	73.86	2.31	1.85	0.73	0.45	13.96	11.18	4.41
42		II-2-3	15.39	1.03	70.60	2.06	1.80	0.67	0.46	13.39	11.68	4.35
43		II-3-1	12.12	0.70	68.75	2.46	1.82	0.58	0.57	20.30	15.02	4.79
44		II-3-2	12.39	0.71	71.29	2.52	1.88	0.79	0.58	20.34	15.17	6.38
45		II-3-3	13.76	0.81	72.50	2.57	1.78	0.73	0.53	18.69	12.96	5.27
46	10-20	II-1-1	10.59	0.62	63.42	1.88	1.15	0.42	0.60	17.75	10.86	3.97
47		II-1-2	10.33	0.62	60.56	2.01	1.20	0.39	0.59	19.46	11.62	3.78
48		II-1-3	10.55	0.64	65.20	2.03	1.28	0.40	0.62	19.28	12.10	3.76
49		II-2-1	10.65	0.66	55.96	1.75	1.24	0.41	0.53	16.43	11.64	3.85
50		II-2-2	10.92	0.69	64.31	1.89	1.36	0.44	0.59	17.31	12.45	4.03
51		II-2-3	10.86	0.76	57.90	1.67	1.28	0.45	0.53	15.39	11.78	4.18
52		II-3-1	8.32	0.52	51.12	1.76	1.17	0.36	0.61	21.15	14.06	4.33
53		II-3-2	9.39	0.57	59.77	1.74	1.04	0.45	0.64	18.53	11.08	4.79
54		II-3-3	8.56	0.56	56.70	1.73	1.10	0.38	0.66	20.20	12.81	4.46
55	0-5	III-1-1	23.14	1.22	88.76	2.99	2.65	1.52	0.38	12.92	11.45	6.57
56		III-1-2	24.66	1.28	82.49	2.86	2.77	1.43	0.33	11.60	11.23	5.80
57		III-1-3	23.81	1.43	106.60	3.23	2.60	1.58	0.45	13.55	10.92	6.65
58		III-2-1	18.75	1.02	91.62	2.62	2.81	1.39	0.49	13.97	14.99	7.41
59		III-2-2	18.70	0.99	86.47	2.71	2.86	1.31	0.46	14.49	15.29	7.01
60		III-2-3	17.23	0.98	82.30	2.79	2.95	1.32	0.48	16.17	17.14	7.66
61		III-3-1	20.55	1.11	81.33	2.84	2.93	1.20	0.40	13.82	14.26	5.84
62		III-3-2	20.81	1.16	80.40	2.73	2.89	1.35	0.39	13.12	13.89	6.49
63		III-3-3	20.76	1.15	80.20	2.56	3.07	1.48	0.39	12.32	14.78	7.13
64	5-10	III-1-1	17.44	1.03	76.41	2.26	1.85	0.74	0.44	12.96	10.61	4.24
65		III-1-2	13.39	0.83	71.26	2.01	1.92	0.73	0.53	15.01	14.34	5.45
66		III-1-3	13.92	0.84	82.10	2.23	1.99	0.81	0.59	16.00	14.32	5.84
67		III-2-1	15.60	0.95	77.48	2.06	1.77	0.62	0.50	13.21	11.35	3.97
68		III-2-2	13.75	0.84	76.53	2.17	1.89	0.66	0.56	15.78	13.75	4.80
69		III-2-3	14.60	0.97	63.40	2.10	1.74	0.57	0.43	14.35	11.95	3.88
70		III-3-1	13.70	0.86	71.95	2.21	2.06	0.63	0.53	16.13	15.04	4.60
71		III-3-2	14.20	0.84	74.52	2.14	1.83	0.60	0.52	15.07	12.89	4.23
72		III-3-3	13.20	0.83	70.60	1.89	2.37	0.63	0.53	14.34	17.94	4.77
73	10-20	III-1-1	8.96	0.55	61.42	1.63	1.17	0.37	0.69	18.19	13.06	4.13
74		III-1-2	9.65	0.62	62.53	1.59	1.21	0.34	0.65	16.48	12.54	3.52
75		III-1-3	9.23	0.60	75.50	1.66	1.26	0.34	0.82	17.94	13.69	3.72
76		III-2-1	7.79	0.50	66.79	1.51	1.23	0.31	0.86	19.38	15.79	3.98
77		III-2-2	8.17	0.51	68.25	1.62	1.14	0.29	0.84	19.83	13.95	3.55
78		III-2-3	8.09	0.51	63.40	1.55	1.05	0.33	0.78	19.16	13.02	4.12
79		III-3-1	10.65	0.66	61.34	1.53	1.02	0.42	0.58	14.37	9.58	3.94
80		III-3-2	10.04	0.63	62.10	1.47	1.13	0.33	0.62	14.64	11.25	3.29
81		III-3-3	8.10	0.57	65.90	1.49	1.07	0.36	0.81	18.42	13.26	4.43
82	0-5	IV-1-1	27.86	1.44	86.19	3.32	2.99	0.96	0.31	11.92	10.73	3.45

Table S2. Continued

83		IV-1-2	28.45	1.55	82.94	3.49	3.05	0.87	0.29	12.27	10.72	3.06
84		IV-1-3	28.10	1.55	82.00	3.46	3.08	0.92	0.29	12.32	10.97	3.27
85		IV-2-1	28.20	1.55	91.31	3.06	3.21	0.91	0.32	10.85	11.38	3.23
86		IV-2-2	28.72	1.59	85.73	3.25	3.36	0.88	0.30	11.32	11.70	3.06
87		IV-2-3	27.98	1.61	94.20	3.19	3.41	0.93	0.34	11.39	12.19	3.33
88		IV-3-1	27.81	1.47	88.19	3.22	3.27	0.86	0.32	11.58	11.76	3.09
89		IV-3-2	26.92	1.41	87.00	3.34	3.55	0.95	0.32	12.41	13.19	3.53
90		IV-3-3	27.29	1.52	91.10	3.41	3.71	0.85	0.33	12.48	13.60	3.13
91	5-10	IV-1-1	17.40	0.93	76.59	3.09	2.45	0.71	0.44	17.76	14.08	4.08
92		IV-1-2	20.24	1.10	82.48	3.11	2.41	0.75	0.41	15.37	11.91	3.71
93		IV-1-3	19.30	1.12	77.30	3.13	2.34	1.04	0.40	16.20	12.14	5.37
94		IV-2-1	19.45	1.13	80.62	2.83	2.47	0.80	0.41	14.55	12.70	4.11
95		IV-2-2	18.89	1.06	88.73	2.97	2.52	0.74	0.47	15.72	13.34	3.92
96		IV-2-3	19.07	1.18	81.40	2.74	2.71	1.01	0.43	14.35	14.22	5.28
97		IV-3-1	17.52	0.93	87.14	2.62	2.53	0.76	0.50	14.95	14.44	4.34
98		IV-3-2	17.18	0.93	79.64	2.51	2.49	0.73	0.46	14.61	14.49	4.25
99		IV-3-3	17.31	0.96	77.10	2.31	2.61	0.78	0.45	13.33	15.07	4.49
100	10-20	IV-1-1	12.14	0.74	66.36	2.17	2.15	0.62	0.55	17.87	17.71	5.11
101		IV-1-2	12.82	0.80	71.45	2.26	2.18	0.55	0.56	17.63	17.00	4.29
102		IV-1-3	12.39	0.82	69.80	2.43	2.28	0.97	0.56	19.60	18.40	7.86
103		IV-2-1	11.63	0.74	79.71	2.15	2.09	0.61	0.69	18.49	17.97	5.25
104		IV-2-2	12.87	0.84	75.36	2.15	2.17	0.60	0.59	16.71	16.86	4.66
105		IV-2-3	12.21	0.81	80.10	2.22	2.17	0.68	0.66	18.20	17.81	5.60
106		IV-3-1	13.80	0.85	80.21	2.23	2.16	0.52	0.58	16.16	15.65	3.77
107		IV-3-2	12.40	0.83	77.51	2.09	2.22	0.53	0.63	16.85	17.90	4.27
108		IV-3-3	12.20	0.78	72.40	1.92	2.24	0.50	0.59	15.75	18.40	4.12
109	0-5	V-1-1	53.85	1.74	188.31	6.46	23.61	5.06	0.35	12.00	43.84	9.40
110		V-1-2	55.63	2.30	194.92	6.59	24.52	5.17	0.35	11.85	44.08	9.29
111		V-1-3	53.15	1.87	218.70	6.34	25.52	4.66	0.41	11.92	48.01	8.78
112		V-2-1	50.14	1.95	174.42	6.83	22.91	5.65	0.35	13.62	45.69	11.27
113		V-2-2	50.40	2.05	163.81	6.62	21.82	5.39	0.33	13.13	43.29	10.69
114		V-2-3	50.09	2.09	119.70	7.58	23.96	6.22	0.24	15.14	47.83	12.42
115		V-3-1	56.32	1.92	172.35	6.99	21.74	5.83	0.31	12.41	38.60	10.35
116		V-3-2	56.24	2.21	180.83	7.14	21.89	6.11	0.32	12.70	38.92	10.86
117		V-3-3	54.03	2.25	209.60	6.96	21.66	6.77	0.39	12.89	40.09	12.53
118	5-10	V-1-1	41.74	1.41	163.24	6.04	19.66	3.01	0.39	14.47	47.10	7.21
119		V-1-2	43.26	1.79	158.42	6.01	20.05	2.98	0.37	13.89	46.35	6.89
120		V-1-3	42.41	1.57	172.90	5.10	19.52	3.08	0.41	12.03	46.03	7.27
121		V-2-1	40.70	1.43	163.24	5.89	18.57	3.02	0.40	14.47	45.63	7.42
122		V-2-2	40.23	1.71	147.89	5.92	18.64	3.16	0.37	14.72	46.33	7.85
123		V-2-3	40.32	1.71	133.20	5.96	17.09	3.05	0.33	14.79	42.38	7.58
124		V-3-1	47.95	2.21	162.98	5.27	19.18	3.21	0.34	10.99	40.00	6.69

Table S2. Continued

125		V-3-2	44.29	2.03	177.31	5.31	21.35	3.16	0.40	11.99	48.21	7.13
126		V-3-3	46.08	2.06	181.80	5.49	20.12	3.37	0.39	11.91	43.67	7.31
127	10-20	V-1-1	24.26	1.03	126.42	4.67	6.02	1.45	0.52	19.25	24.81	5.98
128		V-1-2	28.70	1.44	163.10	3.71	6.11	1.51	0.57	12.93	21.29	5.26
129		V-1-3	26.51	1.37	180.50	3.75	6.13	1.43	0.68	14.15	23.12	5.39
130		V-2-1	28.88	1.45	96.41	4.62	6.17	1.63	0.33	16.00	21.36	5.64
131		V-2-2	28.09	1.35	107.49	4.49	6.21	1.60	0.38	15.98	22.11	5.70
132		V-2-3	26.99	1.16	92.40	4.66	6.40	1.84	0.34	17.29	23.72	6.80
133		V-3-1	27.63	1.32	103.67	4.86	6.15	2.15	0.38	17.59	22.26	7.78
134		V-3-2	24.65	1.35	124.83	4.73	6.28	2.37	0.51	19.19	25.48	9.61
135		V-3-3	25.39	1.38	184.40	4.32	6.11	2.69	0.73	17.01	24.06	10.60
136	0-5	VI-1-1	40.91	1.86	132.19	3.66	12.19	1.71	0.32	8.95	29.80	4.18
137		VI-1-2	34.91	1.53	133.44	3.74	11.38	1.68	0.38	10.71	32.60	4.81
138		VI-1-3	36.11	1.68	127.40	3.60	13.31	1.75	0.35	9.98	36.86	4.85
139		VI-2-1	34.65	1.38	112.37	3.79	12.85	1.65	0.32	10.94	37.09	4.76
140		VI-2-2	33.61	1.51	119.00	3.81	10.19	1.78	0.35	11.34	30.32	5.30
141		VI-2-3	33.68	1.61	107.00	4.01	9.98	1.72	0.32	11.90	29.64	5.10
142		VI-3-1	33.36	1.50	124.15	3.85	11.08	1.62	0.37	11.54	33.21	4.86
143		VI-3-2	35.47	1.58	136.96	3.77	12.33	1.64	0.39	10.63	34.76	4.62
144		VI-3-3	35.48	1.55	154.40	3.78	11.88	1.58	0.44	10.66	33.50	4.46
145	5-10	VI-1-1	32.56	1.40	88.65	3.15	9.73	1.37	0.27	9.67	29.88	4.21
146		VI-1-2	32.56	1.53	89.71	3.02	9.92	1.35	0.28	9.28	30.47	4.15
147		VI-1-3	32.56	1.56	70.60	2.88	10.59	1.41	0.22	8.85	32.51	4.33
148		VI-2-1	28.13	1.43	96.13	3.18	9.61	1.21	0.34	11.30	34.16	4.30
149		VI-2-2	28.13	1.46	92.65	3.29	9.91	1.30	0.33	11.70	35.23	4.62
150		VI-2-3	28.13	1.47	105.60	3.41	9.50	1.23	0.38	12.12	33.78	4.38
151		VI-3-1	28.76	1.41	101.37	3.17	9.90	1.16	0.35	11.02	34.42	4.03
152		VI-3-2	30.98	1.62	96.21	3.31	10.14	1.28	0.31	10.68	32.73	4.13
153		VI-3-3	29.87	1.46	126.50	3.22	9.93	1.17	0.42	10.79	33.23	3.92
154	10-20	VI-1-1	26.51	1.46	79.18	2.46	7.56	0.96	0.30	9.28	28.52	3.62
155		VI-1-2	24.65	1.38	72.05	2.39	7.48	1.05	0.29	9.70	30.34	4.26
156		VI-1-3	25.54	1.52	77.80	2.57	7.36	1.02	0.30	10.05	28.83	4.01
157		VI-2-1	25.56	1.41	82.63	2.62	8.21	1.04	0.32	10.25	32.12	4.07
158		VI-2-2	24.59	1.28	80.09	2.65	8.10	1.11	0.33	10.78	32.94	4.51
159		VI-2-3	26.53	1.34	98.90	2.76	7.64	0.99	0.37	10.42	28.81	3.74
160		VI-3-1	23.66	1.21	91.24	2.47	7.36	1.03	0.39	10.44	31.11	4.35
161		VI-3-2	25.24	1.33	73.31	2.43	7.25	0.85	0.29	9.63	28.72	3.37
162		VI-3-3	24.45	1.34	112.00	2.39	7.93	1.00	0.46	9.78	32.42	4.07

Note: SOC, Soil organic carbon content; SOCS, Soil organic carbon stock; WSOC, water-soluble organic carbon; EOC, easily oxidizable organic carbon; POC, particulate organic carbon; LFOC, light fraction organic carbon; WSOC/SOC, Ratio of WSOC to SOC; EOC/SOC, Ratio of EOC to SOC; POC/SOC, Ratio of POC to SOC; LFOC/SOC, Ratio of LFOC to SOC.