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EVALUATION OF SOC IN A PINE AND BROADLEAVED MIXEDFOREST SOIL OF A NATURE RESERVE IN GUANGDONG PROVINCE CHINA

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ABSTRACT: *The concern on the role of soil in the global carbon budget and effects of SOC decline on soil quality has been incorporated in international treaties. In Article 3.4 of the Kyoto protocol, soil and forests has been identified as a potential sink of carbon (SOC) that nations tends to establish greenhouse gas inventories and carbon management authorities. Sanchading Nature Reserve Forest Ecosystem and Wildlife study site covers a total area of 2044.2 hectares covering high specie richness of about 1,100 kinds of plants. Soil chemical analysis of the reserve site was conducted at specific depth (0-25cm and 25–50cm). Effect of plant stand types based on broad pine and broadleaved mixed forest (30.24±1.35, 11.71 of 4.49 coefficient variations at 0-25cm depth, while 25–50cm was 26.65±2.49, 21.53 at 9.33). Correlation analysis of NMC, BD, pH, EC and chemical properties showed highest at 51g*kg and 49g*kg at both depths. Duncan's critical evaluation of SOC(105.62) and heavy metals revealed Zn to be highest (58.20±3.37). Analytical approaches of SOC and associated factors were comparatively reviewed while the study site shows that correlation analysis of the influence of soil properties on SOCc and SOCd (0-50cm) indicated less disturbances and good forest management regime were in place. SOC concentration and effect of pollution and other forest soil environmental disturbances shows negative impact on terrestrial ecosystems. Cumulative evaluation of SOC distribution further supports that pine and broadleaved mixed forest stand exhibits high potential of carbon sequestration*.

KEYWORDS: SOC, analytical approaches of SOC, pine and broadleaved mixed forest, nature reserve, carbon management

INTRODUCTION

Regional and national evaluation of Soil Organic Carbon density, its concentration and distributions among forest regimes is crucialfor tropical and sub-tropical forest ecosystems management. Soil Organic Carbon and its influencing factors have become of interest to both

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soilscientists and policymakers at recent times for their ability to mitigate CO2. Climate change concerns have resulted to a greater interest in terrestrial ecosystems management. This raises the question of how good forest and soil management can be used to sequester C.It has been documented that the mass of organic carbon in soils exceeds the mass of organic carbon in living vegetation by two or three times [1], which amounted to 1500 Pg in soil globally [2];[3]. It becomes an interesting area of investigation on how forest management regimes at regional and spatial scale can be sustained. Recently, the concern on the role of soil in the global carbon budget and effects of SOC decline on soil quality has been incorporated in international treaties. The decline of soil organic matter (SOM) is considered as one of the eight threats to soil degradation. In line with Article 3.4 of the Kyoto protocol, soil and forests has been identified as a potential sink of carbon (SOC) for which most nations are beginning to establish greenhouse gas inventories and carbon management authorities. It is anticipated that climate change and climate variability will trigger some vulnerability frontline challenges.Soil organic matter is a key and an active attribute of soil quality [4][5]because it influences nutrient cycling, soil structure, water availability, and other important soil properties [6]and [7]. Increase in soil C and the basic constituent of soil organic matter is important in forest soil management. It has been accounted that soil store a significant fraction of the carbon (C) involved in carbon cycle. Global soils contain approximately 1,500 Pg C (1 Pg = 1*x*1015 g) and can act either as net sources or net sinks of atmospheric CO2 [8]. Considering existing scientific studies on terrestrial ecosystems management and total carbon accumulation; more investigations need to be conducted on soils as a significant component of carbon storage that has been observed also by [9][10]; [11]and [12].SOC density and concentration evaluated at regional assessment among forests primarily raises the understanding for terrestrial ecosystems and good management practices in soil and forest management. Strategies for organic carbon management in soils and forests are areas that have been studied by [13] [14] [15]. The rate of SOC density and concentration varies with the vegetation stand type and management history and conditions. It becomes an important venture to further study organic carbon in Deqing Sanchading Nature Reserve South China, which has been considered very vital in the function of ecosystems and agro-ecosystems. Furthermore, [15]reported that loss of SOC may result in reduction to soil fertility, forest health, land degradation and larger extent desertification. Soil organic carbon content in any forest regime can be increased in three major ways, such include (a) by improved forest management regime within a land use system, (b) by introduction and conversion of a particular land use to another land use that has higher potential of carbon stocks, and (c) by increasing and improve carbon content in harvested forest products. An assemblage of major terrestrial ecosystems, carbon sequestration, in the essence of this study, terrestrial biosphere refers to living and dead plants and soils. Significant progress has been made to estimate the potential for C sequestration on site, regional, and national scales for agricultural land [16] [17] [18] [19]; [20] forests [21]; [22]; [23], and grasslands and pasture [24] and [25];[26]. Terrestrial ecosystems are reported by [27], in [28], to remove approximately a net of 60 billion tons of carbon from the atmosphere each year referred as “Net Primary Productivity” (NPP). Jonathan [29] had documented and in graphics reported changes in the C cycle of terrestrial ecosystems directly affect the atmosphere. Currently, the terrestrial biosphere is a net sink of atmospheric CO2. Variations in climate and atmospheric chemistry, however, could alter this process. The terrestrial biosphere feedback mechanisms explains the absorption of CO2 through photosynthesis and accumulates C in living biomass, though some is released back to the atmosphere through plant respiration, and the rest is used to build biomass.

METHODOLOGY

Site description and experimental designofDeqing Sanchading Nature Reserve

Deqing County is located in Zhaoqing city, Guangdong Province. The site is a nature reserve buffer zone, at longitude 112°01'E and latitude 23°26'N (fig. 1). The county is surrounded by villages and towns. The county covers a total area of 2044.2 hectares and where Sanchading Nature Reserve forest ecosystem and wildlife nature reserve is located. The nature reserve location consists mainly of granite soil and sandstone rock in a medium to low mountainous landscape. The highest elevation is 700 m, lowest elevation is 120m, relative elevation 580 m, and the general mountain slope is 30 - 40° though some parts of the upper slope peak reaches 60 - 70°. There is high specie richness at the site with more than 1100 kinds of plants. The forest site has state protection of both rare and endangered plant species. Such plant species include the camphor tree *Cinnamomum camphora*, wood frame *Erythrophloeum fordii, Cibotium barometz, Cyatheaceae Cyltbee spinuldosa, and Cyatheaceae Cyathea podophylla, Camptotheca acuminata decne, Taiwan Cycas Cycas taiwaniana carruth cedar* and bald *Taiwania flousiana Gaussen.* At the provincial level, forest types are designated as follows: 1) subtropical evergreen broad-leaved forest (mainly at the core area that forms the rich subtropical plant species); 2) The mixed conifer forest mainly located in the buffer zone within the pine and subtropical evergreen broad leaved forest tree species.

Site characteristics and management history

The selected forest location across the province provided a geographical coverage across the region. The site was selected to achieve specific and regional SOC assessment among the forest management regime and plant vegetation species. The background of the site, forest regime, stand types and geographical location is described and furthermore, the forest site and history of management that gave an insight of the present forest stand type is shown in Table 1 and Figure 1 showing the location of Sanchading Nature Reserve Forest.

Table 1 Forest site description, characteristics and summary of the management history

Forest Site	*Stand type*	*Management regime*	*Geographic location*
Deqing Sanchading Nature Reserve	Pine and broadleaved mixed forest	Formerly a tree farm, now protected, less disturbance	23.28N;111.9E

	Management history
Deqing Sanchading Nature Reserve	• Nature reserve for forest ecosystems and wild life nature reserve • 1.100 kinds of plant under state protection • Sub - tropical evergreen broad leaved forest and mixed conifers.

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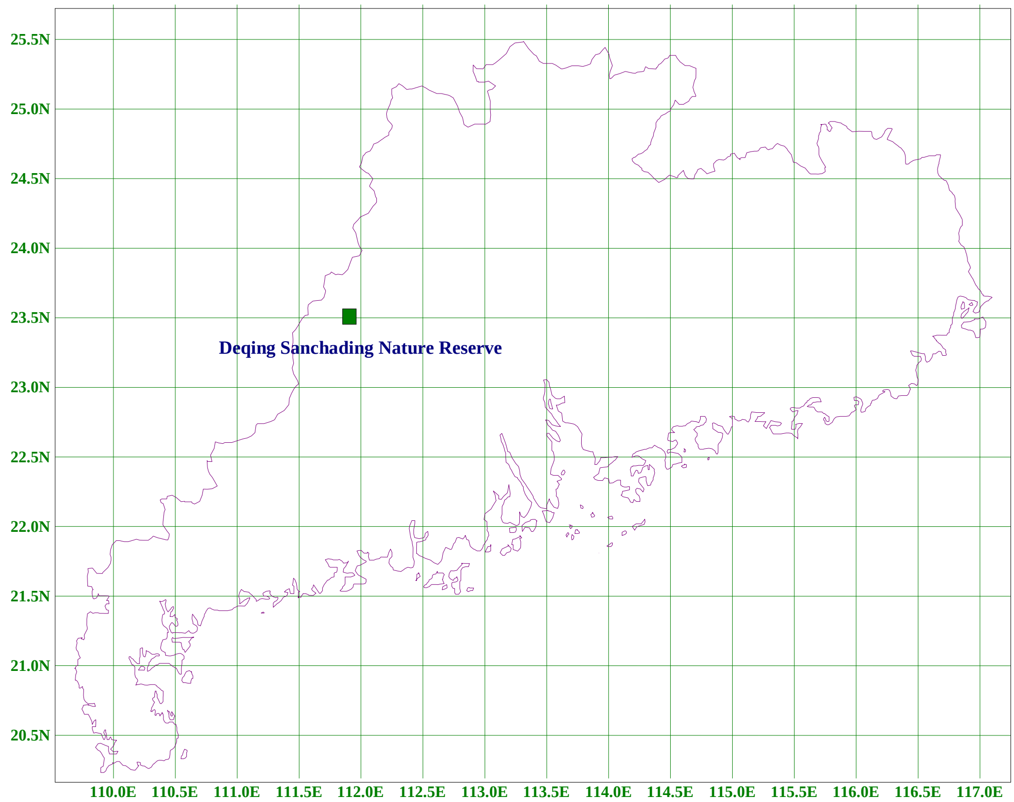

Figure 1 showing the location of Sanchading Nature Reserve Forest in Guangdong Province of China

Soil sampling and chemical analysis

After establishing forest soil sites according to stand type classification and forest management regimes in the region, soil samples were collected. The soil samples were taken in Denqing forest site whereby a 20 x 20 m plot was marked out that is considered in the regional forest sites while a ten 5 x 5 m (0.025) quadrants was established comprising five randomly selected soil samples in the study forest site. The surface referred as mineral soil level was categorized below O horizon while deep soil was considered for sampling at 0 - 25 cm depth (surface level) also 25 - 50 cm (deep level) using a standard 2-cm diameter stainless steel sampling probe. A total of 10 cores of each quadrant were considered. Furthermore, a two 5 x 5 cm cores (strata) designated for surface and inner depth were taken within the forest site so as to determine bulk density. Soil samples at both depth samples were separated and finely mixed, air dried, grounded, and sieved as recommended [30]. The collected soil samples were finely mixed up, bagged in transparent bags, labeled and transported to the laboratory for analysis. The samples were air-dried for 48 hours, crushed with pestle and mortar then sieved to separate whole soil (<2mm). Ground floor soil aggregates, plant/biomass materials (tree) components (live vegetation/roots) and stones were sieved out and removed. Soil bulk density (P_b) was determined by the core method [31].

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Soil physical data

Table 2 Laboratory methods applied in determination of soil physical parameters

Physical properties	*Method applied*	*Reference*
Natural moisture content	Gravimetric method	[32] Gardner 1986
Electrical conductivity	Conductivity method	[33]1992 manual
pH values	$Cacl_2$ solution by electrode/meter	[34]McLean 1982
Bulk Density	Measured by method described	[34] Mclean 1982

Statistical analysis

The statistical analyses conducted in this research arewith SPSS 11.5. A three-way analysis of variance (ANOVA) was used to testthe effects of forest type, sampling season, and soil depth on soil microbial biomass and soil chemical properties. Pearson'scorrelation analysis was used to determine whether there were significant interrelationships among the measured properties of forest soil.

Statistical Review: SOC analysis applicable in soil, chemical and plant analysis

Considering the need for testing the difference of SOC chemical composition of among three vegetation typesMultiple-response permutation procedures analysis (MRPP) was performed to test SOC chemical composition. To this, the relationship between SOC chemical composition, tree diversity, and soil physicochemical characteristics are analyzed by non-multidimensional scaling (NMDS). Also, Pearson correlation tests are usually applied to explore the impacts of the chemical composition of SOC, tree diversity, and soil physicochemical characteristics variables on SOC chemical composition assemblages of NMDS axes. This can be achieved by calculating Pearson correlation coefficients between all of the variables and NMDS. To examine the chemical compositions of SOC, tree diversity, and soil physicochemical characteristics variables, which influenced the chemical composition of SOC. SOC evaluation parameters require assemblages, linear regressions tests to be performed which helps to further discover the potential impact of tree diversity and soil physicochemical characteristics especially on SOC chemical composition, Pearson correlations analysis is also conducted between all components of SOC chemical composition, tree species diversity, and soil physicochemical characteristics. .

RESULTS AND DISCUSSION

Table 3 Effects of plant stand types on SOC at depths (0-25 and 25-50cm), while further evaluation using soil bulk density, physical and chemical was presented at 0-50cm and correlation evaluation 0 – 25cm and 25 – 50cm as presented respectively. Also correlation analysis of major physical properties (NMC, BD, pH, and EC) in Deqing site (0-25, 25-50) was presented, though soil bulk density (Mg m-3) under mixed broadleaved forest management regimes. However, SOC correlation analysis was also measured over TotN, AvK, AvP and TotP

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Table 3 correlation evaluation of chemical properties in Deqing site

Stand type	0-25 cm SOC (g/kg) Mean±SE	0-25 cm SOC (g/kg) Sdv	0-25 cm CV %	25-50 cm SOC (g/kg) Mean±SE	25-50 cm SOC (g/kg) Sdv	25-50 cm CV %
Pine and broadleaved mixed forest (Dq)	30.24±1.35	11.71	4.47	26.65±2.49	21.53	9.33

(0-50cm)

Site	*BD Mean*	*BD Sdv*
Deqing	1.39±0.02	0.14

SOC	*NMC*		*BD*		*pH*		EC	
	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50
Deqing0-25	0.06	-0.20	-0.03	0.27	0.02	-0.01	-0.40*	0.60**
Deqing25-50	-0.48*	0.03	0.25	-0.39	-0.02	-0.06	0.10	0.22

* Correlation is significant at the 0.05 level ** Correlation is significant at the 0.01 level (2-tailed).

SOC	*Vann*		*TotN*		*AvK*		*AvP*		*TotP*	
	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50
Deq0-25	0.14	0.38	0.63**	-0.17	0.57**	-0.16	-0.12	-0.43*	0.14	0.50*
Deq25-50	-0.11	-0.03	0.04	0.39	-0.12	0.34	-0.03	-0.38	-0.07	0.09

* Correlation is significant at the 0.05 level ** Correlation is significant at the 0.01 level (2-tailed). Deq - Deqing forest site

Influence of forest soil properties on SOC under pine and broadleaved mixed forest soil

Evaluation of the influences of forest soil properties on organic carbon density and concentration pattern in table 4 showed that there were strong influences on forest soil organic carbon (0-50cm) in the region. This trend is in conformity with the earlier results on specific assessment and SOC concentration pattern on each depth, forest management practices and vegetation stand types.

Table 4 Correlation analysis of the influence of forest soil properties on SOCc (0-25cm) and Correlation analysis of the influence of forest soil properties on SOCd (0-50cm)

	SOCd	*NMC*	*BD*	*pH*	*EC*	*SOM*	*AvN*	*TotN*	*AvK*	*AvP*	*TotP*
Deq	0.97**	0.01	-0.19	-0.07	0.00	1.00**	0.07	0.46**	0.41**	-0.24	0.12

* Correlation is significant at the 0.05 level ** Correlation is significant at the 0.01 level (2-tailed).

	NMC	*BD*	*pH*	*EC*	*SOM*	*SOCc*	*AvN*	*TotN*	*AvK*	*AvP*	*TotP*
Deq	-0.09	0.03	-0.12	0.07	0.97**	0.97**	0.13	0.42**	0.37**	-0.25	0.16

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The distribution and concentration pattern of SOC indicated even distribution in the mixed broadleaved forest of Deqingforest soils because of the management condition in place whereby considering suchsite with little and restricted disturbances as well as other anthropogenic influences on the soil properties.

SOC concentration of specific Pine and broadleaved mixed forest soil site status

SOC concentration evaluated at the Deqing site had 30.24±1.35 (0-25cm) and 26.65±2.49 (25-50cm), as shown in table 5, and by site status, it was observed that sources of pollution (however the site is classified as highly protected with no or little interference i.e. disturbance and other forms of pollutants). This is to say, that the impact of pollutants in turn may pose some constrains to nutrient status, chemical and physical soil properties, as well as forest management change.

Table 5SOC concentration evaluation in Deqing forest reserved site for pH and heavy metals evaluated across soil samples in the forest site, while Duncan's critical evaluation of SOC under among the forest site status were measured respectively. The effect of pollution and other forms of forest soil environment disturbances has negative impact on terrestrial ecosystems, as usually indicated critical significance using Duncan's critical statistical assessment in table 5 and evaluation of pH and heavy metals within the forest site as indicated in table 5.

Table 5: Duncan's critical statistical assessment and evaluation of pH and heavy metals within the forest site

Depth	*SOC(g/kg)*	*SOC(g/kg) Sdv*	*SOC(g/kg) Min.*	*SOC(g/kg) Max.*
0-25 cm	30.24±1.35	11.71	12.59	56.97
25-50 cm	26.65±2.49	21.53	4.22	105.62

Site	*SOC(g/kg) Sde*	*SOC(g/kg) Sdv*	*SOC(g/kg) Min*	*SOC(g/kg) Max*
Deqing	28.44±1.42	17.37	4.22	105.62

** Highly significant difference within the forest site with reference to location

Site	*pH*	*Cu /mg kg^{-1}*	*Zn mg/kg^{-1}*	*Cd mg/kg^{-1}*	*Pb mg/kg^{-1}*
Deqing	4.53±0.03	6.07±0.77	58.20±3.31	0.10±0.02	30.61±0.46

Further analysis using Pearson correlation, multiple comparisons and multiple comparisons of major chemical factors were presented in the site as in table 6.

Table6 Pearson correlation analysis of SOC against physical properties in Deqing site

Deqing	NMC		BD		pH		EC	
	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50
0-25	0.056	-0.20	-0.03	0.27	0.02	-0.01	-0.40*	0.60**
25-50	-0.478*	0.03	0.25	-0.39	-0.02	-0.06	0.10	0.22

** Correlation (2-tailed) is critical significant at 0.01 level, * Correlation (2-tailed) significant at 0.05 level

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Site	NMC	BD	pH	EC	SOM
Deqing 0-25	230.703±7.512bc	1.41±0.03bc	4.65±0.05 **a**	98.55±11.4107 **a**	30.238±2.356 **a**
Deqing 25-50	248.103±9.137ab	1.38±0.02bc	4.82±0.06 **a**	67.16±9.122 **b** 8	26.651±4.338 **a**

Means with the same letters in a column are not significantly different (P>0.05)

Table 7 Multiple comparisons of major chemical factors within the site and evaluation mean acidic value within the Pine and broad mixed forest regime

Site	SOM g/kg	SOC g/kg	AvN mg/kg	TotN g/kg
Deqing 0-25	52.130±4.0622 **a**	30.238±2.356 **a**	109.951±10.408 **a**	2.020±0.217 **a**
Deqing 25-50	45.946±7.4785 **a**	26.651±4.338 **a**	59.844±10.602 **bc**	1.423±0.189 **b**

Site	*pH Mean*	*pH Sdv*
Deqing	4.74±0.04	0.29

Estimates of soil organic matter under Pine and broad mixed forestmanagement regimes

Soil Organic Matter (SOM) in table 8, evaluated within the forest site by mean value indicated that Deqing forest site (Pine and broad mixed forest) was highest (49.04±4.23), followed by Nanling nature reserve (Secondary forest) 38.96±4.4 and Changtan nature reserve (non-commercial ecological forest) 35.71±2.63 as documented by [35]. To this assertion SOM mean value (table 8) and SOC stocks (table 8) by concentration within the site showed some revealing uniqueness.

Table 8 Soil organic matter mean evaluation among the forest regimes as well as Mean SOC stocks by concentration and density among the forests sites

Site	*SOM Mean (g/kg)*	*SOM Sdv (g/kg)*
Deqing	49.04±4.23	29.94

Site	*SOC Mean (g/Kg)*	*SOC Sdv (g/Kg)*	*SOC density Mean (t/hm2)*	*SOC density Sdv (t/hm2)*
Deqing	28.44±2.46	17.37	0.98±0.08	0.57

Comparative analysis of SOC in Deqing Sanchading Nature Reserve (Pine and Broad mixed forest)under different depth

Deqing Sanchading nature reserve forest site in fig.2, indicated at 0-25 cm, SOC (g/kg): N = 75, mean = 30.237, Stdv = 11.714, max = 56.97, min = 12.59 and at 25-50 cm SOC (g/kg$^-$): N = 75, mean = 26.651, Stdv = 21.529, max = 105.62, min = 4.22

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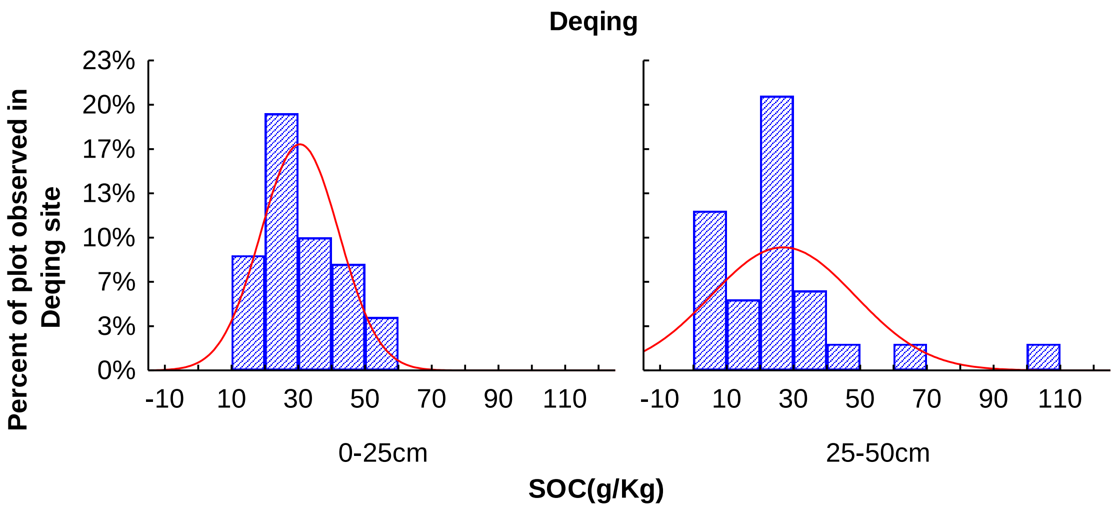

Figure 2 Deqing Sanchading nature reserve site cumulative evaluation of SOC distribution (0-25, 25-50cm

Further comparative analysis as in fig 4[35],SOC stocks evaluated by three management sites compared on environmental factors of physical parameters of NM, BD,EC, and pH and documented evidences revealed that SOC and climatic variables are considerable factors among forests as in fig 3 where [36] reported SOC density (SOC amount in a particular area) during a period related to an actual measurements during another periodand was predicted on the basis of an updated ANN model where both MAT and MAP were excluded as input variables (MAT: mean annual temperature, and MAP: mean annual precipitation). In the research presentation, the thick line is the regression line, and the thin lines are the 95% confidence interval, with linear function, goodness of fit and *P* values described above the line as in fig 3 below.

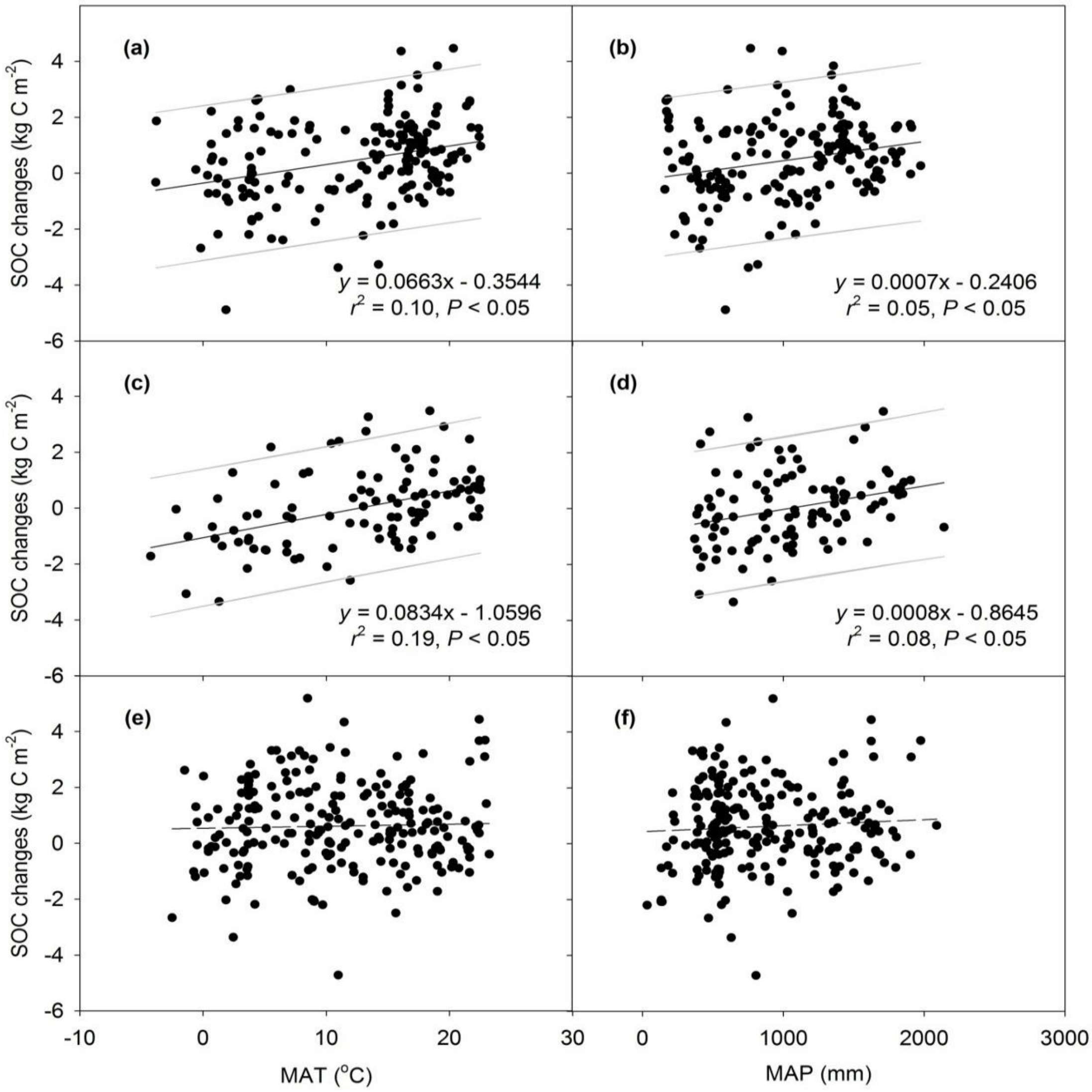

Fig. 3 Relationships between SOC changes and climatic variables across coniferous forests a-b), coniferous/broadleaved mixed forests (c-d), and broadleaved forests (e-f).
Source: Guo, X. et al. Vegetation change impacts on soil organic carbon chemical composition in subtropical forests. Sci. Rep. **6**, 29607; doi: 10.1038/srep29607 (2016).

Estimated forest age, stand types and pine broad leaved mixed forest regime

The estimated forest age according to available regional forest management policies and systems which is identified that the comparative forest sites have undergone some land use and forest changes over the estimated age as shown in table 9.

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Table 9 Estimated forest age and management information

Forest site/location	*Stand type*	*Soil sampling depth*	*Forest stand age*	*Management regimes*
Deqing	Pine/broadleaved mixed forest	0 -25, 25-50 cm	20	Protected and less disturbance and formally a tree farm

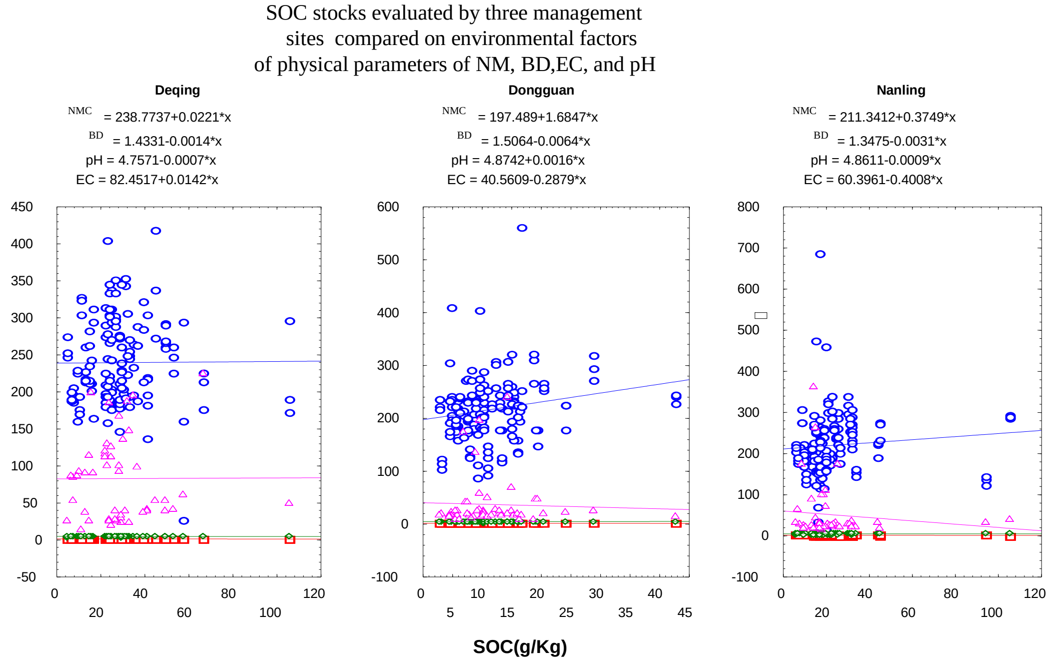

Fig 4SOC stocks evaluated by three management sites compared on environmental factors of physical parameters of NM, BD,EC, and pH

Table 10 Soil pH, natural moisture, bulk density and electrical conductivity in secondary forest, nature reserve and mixed forest plantation

Depth/stand type	*pH Mean*	*Sdv*	*Bulk density ($g\ cm^{-3}$) Mean*	*Sdv*	*Soil moisture (%) Mean*	*Sdv*	*EC Mean*	*Sdv*
0-25 cm								
Nature reserve	4.81±0.06	0.55	1.44±0.02	0.13	218.76±6.49	56.21	34.73±4.25	36.77
Mixed plantation	4.65±0.03	0.26	1.41±0.03	0.23	230.7±6.22	53.89	98.55±6.7	58.00
25-50 cm								
Secondary forest	4.86±0.04	0.34	1.33±0.02	0.18	202.57±9.63	83.42	45.46±8	69.25
Nature reserve	6.25±1.28	11.09	1.43±0.02	0.13	215.6±7.64	66.18	39.66±6.48	56.12
Mixed plantation	4.82±0.04	0.34	1.38±0.02	0.15	248.1±6.98	60.48	67.16±5.52	47.83

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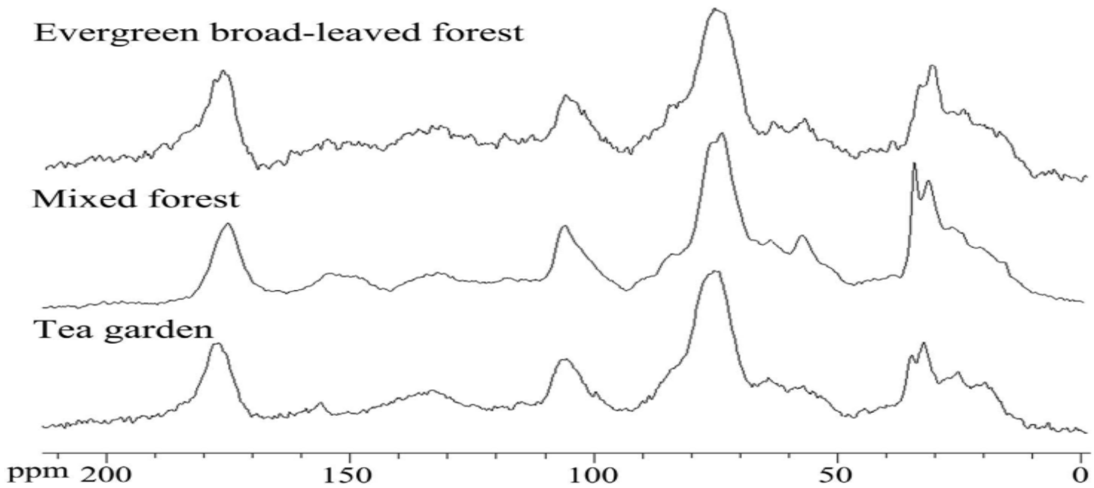
Effect of chemical composition of soil organic carbon (SOC) on forest ecosystems

Globally, soil organic carbon (SOC) amounts to the largest terrestrial carbon (C) pool. Changes in SOC pool decomposition corresponds to significant changes in the atmospheric carbon (C) concentration. This may influence and lead to strong positive feedback to climate change. SOC decomposition rates greatly associate with its chemical composition thus shifts in SOC chemical composition that affects SOC stabilization.The changes in vegetation may be as a result of the corresponding management and this factor may alter soil aggregates, and thereby which influences SOC chemical composition. Vegetation change affects and results to forest and soil degradation through alterations in a particular soil though diverse management objectives in forest ecosystems is a strong factorthat influences and affects the chemical composition of SOC. Forest soils evaluated in different forests as supported by various researches in different regions of China [35], [36] under spatial SOC from native broadleaf forests, mixed evergreen broadleaved and coniferous forests, and tea gardens shows various impact of vegetation change and anthropogenic disturbance resulting to succession and reduction on the chemical composition of SOC.SOC chemical compositions are enhanced in native broadleaf forests and mixed broadleavedand coniferous forests since vegetation (plants) play an importantrolein SOCdynamicswhile the conversion from different forests ecosystems to others has greater impactson the chemical composition of SOC than the conversion to mixed forests[36]which has been identified as a result of more intensive disturbance than conversion from native forests tomixed forests through selective deforestation as depictedin fig. 5 and fig. 6below:

Figure 5.Solid-state 3 C NMR spectra for soil organic carbon (SOC) in three vegetation types. Source: Guo, X. et al. (2016)



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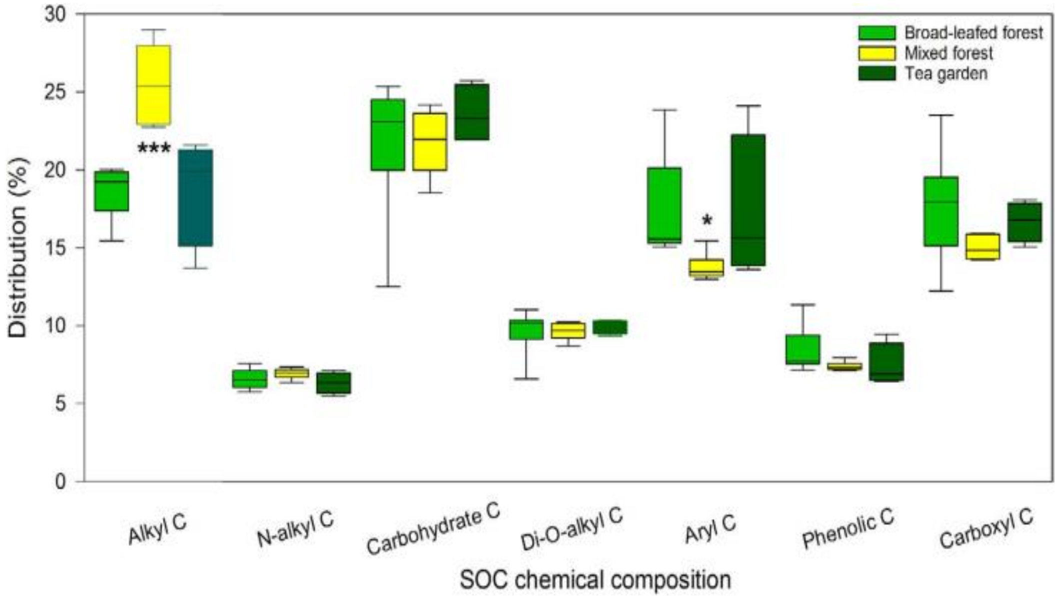

Figure 6.The chemical composition of soil organic carbon in three vegetation types
For each chemical shift range, different letters refer to a significant difference ($p < 0.05$) (Guo, X. et al. (2016).Generallychemical composition of soil organic carbon (SOC) affect the global carbon cycle because it is a controlling factor in SOC decomposition rate wile forest/vegetation change is associated with long-term land use changes and correspondingly result to strong impact on the chemical composition of SOC.

SOC, terrestrial ecosystems and forest management
It has been documented that terrestrial biosphere plays greater and important role in the global carbon cycle in which the 1994 Intergovernmental Panel Assessment on Climate Change (IPCC), had made concerted efforts to improve the quantification of terrestrial exchanges and potential feedbacks from changes in global climate, changing CO_2, and other emission factors. this chapter presents the key results from mixed broad forest assessment in Guangdong region of China, together with expanded discussions on SOC, forest soils, and carbon evaluation in mixed forests.Generally, it is accepted that both DOC and fragments are identified to go belowground, which makes thecontributionto SOC accumulation different while the fragments pileup on surface soil and thereby further decompose. In furtherance to this knowledge, the DOC is considered mobile across the entire soil profile and has been an important process for carbon transport within the ecosystems and the formation of SOC and in assertion to [37] [38].The effects of forest management on soil carbon (C) and nitrogen (N) are important to understand as it is considered and has overbearing variable in the determination of soil fertility, though soil has a greater role as a source or carbon sink at a global scale. The net carbon exchange of terrestrial ecosystems provides the balance between uptake and loss mechanisms generally referred as photosynthesis and respiration under factors of diurnal, seasonal and annual variability. Available literatures confirmed that under favourable conditions, the net ecosystem flux is dominated by photosynthesis during daytime, and by respiration at night and for deciduous ecosystems in leafless periods. It is also noted that the influence of climate and growing-season period and length do in some cases shift a terrestrial ecosystem from a sink to a source of carbon,the concern on the role of soil in the

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global carbon budget and effects of SOC decline on soil quality has been incorporated in international treaties. Effect of plant stand types based on broad pine and broadleaved mixed forest (30.24±1.35, 11.71 of 4.49 coefficient variations at 0-25cm depth, while 25 – 50cm was 26.65±2.49, 21.53 at 9.33). Correlation analysis of NMC, BD, pH, EC and chemical properties showed highest at 51g*kg and 49g*kg at both depths. Correlation analysis of the influence of soil properties on SOCc and SOCd (0-50cm) showed that less disturbances and good forest management regime were in place. SOC concentration and effect of pollution and other forest soil environmental disturbances shows negative impact on terrestrial ecosystems. Duncan's critical evaluation of SOC (105.62) and heavy metals revealed Zn to be highest (58.20±3.37). Cumulative evaluation of SOC distribution further supports that pine and broadleaved mixed forest stand exhibits high potential of carbon sequestration. This study calls for cautions in large-scale conversions of the native forests to any plantations as a forest management practice on concerns of sustaining soil productivity.

Impact of the study on forest management in general and carbon management in the light of Kyoto protocol

This study has positioned a strong background that the Kyoto protocol includes rules for the accounting of GHG emissions from Land use, Land-use Change and Forestry (LULUCF) whereby this study is in line to such Kyoto targets. To this accounting of the advantage of good forest management regime, forest policy for afforestation, reforestation, and deforestation whereby countries especially developing countries can be credited for the net GHG flow from afforestation, reforestation and deforestation. This study in Deqing Sanchading nature reserve provides an enhancement of carbon storage in forests. Generally, planting forests and management of forest regime absorb excess CO_2 in the atmosphere which is an option in the context of harnessing forests for curbing climate change. This study strongly supports and enhancing carbon storage in forests and their products. Planting and managing forests with the interest to absorb excess CO_2 in the atmosphere is the good option that has been for curbing climate change. Generally, carbon offset plantings is a focal projection and globally implemented under the Kyoto Protocol.Forest management schemes and tree planting goes beyond climate change rather plantations, agroforestry systems, urban forests, silvicultural and management options exists and clamored in developing nations for the purpose of enhancing carbon uptake and storage in forest ecosystems. Broad pine and broadleaved mixed forest as well as even-aged forests are considered to attain high sequestration rates thereby immature forests is accounted to act as carbon sinks especially in East Asia and Europe. Kyoto protocol encourages forests and forest management. Forest management provides option in which carbon accounting under the Kyoto Protocol the monetary equivalent of carbon stocks will favor the developing and less industrialized nations referred as carbon offset.

CONCLUSION

SOC and SOM are major and vital source and sink of atmospheric CO2 on several time scales. Carbon is largely stored in organic forms that rapidly exchanges with atmospheric CO2 mostly in soils (forest soils) and other mediums. Generally, C turnover and its control are mostly influenced by such factors as temperature, moisture, vegetation and forest

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management. This is to say, that soils and forest management are not sinks of carbon in which the medium gain and loss C. The main factors of C disturbance and cycling include forest management, fires, floods, deforestation, reforestation, agricultural practices and drainage. The disturbances and affects of C inputs and losses to soil occur as a result of changing vegetation, soil structure, temperature, water balance, nutrient availability and forest management. Rates of organic C stocks are responses to these factors. Vegetation and plant species control C storage in which net primary productivity of vegetation will determine the rate of C input to SOM. This chapter of broad pine and broadleaved mixed forest strongly supports that vegetation and plant species also controls the structure and determine the decomposability of OM that is added to soils. This study recommends and opens further studies in forest management models under different forest regimes and carbon accumulations.

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