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Soil Organic Carbon Stock and Soil Quality under Four Major Agroecosystems in the Eastern Flank of Mount Bambouto (West-Cameroon)

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Abstract

Assessing soil organic carbon stock (SOCS) and soil quality (SQ) helps design better agricultural practices to improve environmental sustainability and productivity. The purpose of the study is to assess SOCS and soil quality SQ in the main agroecosystems (AES) of the eastern flank of Mount Bambouto (West, Cameroon). Using multiple statistics tests and principal component analysis (PCA), SOCS and Soil Quality Index (SQI) were computed for each AES. SOCS and SQI were computed based on soil chemical properties and analysis of variance. Topsoil samples (0 - 30 cm) were collected in a different AES and analyzed in the laboratory. The four AES identified and selected are cultivated land (CL), forest areas (FA), mixed areas (MA), and bush areas (BA). Further, multiple comparison tests were used to compare soils from different AES. PCA was used to select the most appropriate indicators that control SOCS and SQ. Several soil properties showed high to very high coefficient of variation within the AES. Organic matter (OM) was significantly high in FA. SOCS and SQ differ significantly ($p = 0.000$) between the AES. The study further indicates that the main variables controlling SQ within the eastern flank of Mount Bambouto are OM, pHw, N, C/N, and CEC. While the main soil parameters controlling SOCS are OM, OC, BD, C/N, S, and pHKCl.

Keywords

Soil Organic Carbon Stock, Soil Quality, Agroecosystems, Principal Component Analysis, Mount Bambouto

1. Introduction

Organic carbon in soil plays a crucial role in soil productivity as well as in a wide range of ecosystem services. Because of its multifunctional role and sensitivity to land management, SOC is selected as one of three indicators of land degradation neutrality. As a key indicator of ecosystem health, the SOC presents unique challenges related with to predicting potential changes in the SOC associated with sustainable land management interventions and monitoring changes in SOC over time, due to temporal and spatial variability (Batjes, 2004). The SOC is the potential centerpiece of collaborative action to improve soil health and function through sustainable land management (Eaton et al., 2008, Kenye et al., 2019). SOC is recognized as a key component in soils in natural and managed AES (Manlay et al., 2007). SOM is consequently the central element of soil fertility, productivity, and quality. A reduction in SOM, likely creates an array of negative effects on crop production (Ramesh et al., 2015). Thus, maintaining and improving the SOM level in soil are a prerequisite for ensuring good and sustainable soil quality (Ramesh et al., 2015).

Land degradation is defined as the decrease or loss of biological or economic productivity and complexity of non-irrigated cropland, irrigated cropland, pasture, forest, or woodland as a result of one or more phenomena, including land use and management practices (UNEP, 2019). Adapting regenerative agricultural practices can therefore help avoid soil disturbance and leave room for natural soil-forming processes. SOC variability depends on soils forming factors. It is greatly influenced by vegetation. Land use change is one of the most influencing SOCS variabilities (Eaton et al., 2008; Silatsa et al., 2020). Extensive management practices in agricultural lands increase the turnover and lead to the destabilization of SOM compounds (Kenye et al., 2019). Soil in natural ecosystems, such as forests, is less disturbed due to reduced land use management practices (Tiwari, 2015).

Agroecosystems are those ecosystems where humans have deliberately selected the living organisms that comprise them. Agroecosystems differ from unmanaged ecosystems in that they have been intentionally modified and are often intensively exploited for food, fiber, and other products; therefore, they have inherent human, economic, environmental, and ecological dimensions (Fournier, 2020). Sustainable management of AES can provide many solutions to global challenges. These include food challenges, health challenges, social challenges, and environmental challenges (FAO, 2006). Environmental challenges include maintaining water quality, conserving soils, contributing to climate mitigation, contributing to biodiversity conservation, and maintaining ecosystem health. Knowledge of the soils in each AES and specifically the SOCS and SQ of the soils is essential for the sustainable management of these AES (Raitif et al., 2019).

The soil database Camsodat 0.1 provided first estimates of SOCS in Cameroon (Silatsa et al., 2020). The SOCS estimates indicate that 50% of the total SOCS stored in the topsoil (upper first meter) is likely stored with the upper 30 cm. In Silatsa et al. (2020) the spatial distribution of SOCS showed a pronounced correlation with the agroecological zones across the country. Several other works on

SOCS and SQ have been done recently with the newly collected data. These works do not cover the whole country, but well-delimited geographic areas. Most of these works highlighted the influence of land use types, the influence of altitudinal gradient, and other soil-forming factors on SOCS and SQ (Ngo-Mbogba et al., 2015; Tsozué et al., 2019; Kome et al., 2021). Meanwhile, others highlighted the influence of these soil-forming factors on the spatiotemporal distribution of SOCS and soil quality (Silatsa et al., 2014; Nguemezi et al., 2020; Nguemezi et al., 2021). At Mount Bambouto, Tsozué et al. (2019) showed that SOC and SOCS contents decrease with depth and increase uphill along the elevation gradient. However, there is lack information concerning the influence of land use and agroecosystems on SOCS and SQ in this area. The eastern flank of Mount Bambouto has a diversity of soils. It is characterized by a wide diversity of land use systems. Hence, identifying the effect of agroecosystems or land use management practices on SOCS and SQ is vital. Additionally, this information has a national significance and can highly contribute to sustainable land use planning and adapted soil management within the area. Identifying the effect of agroecosystems on SOCS and SQ further sheds light on the origins or sources of climate change and landscape degradation. This paper aims to assess SOCS and SQ under the main ESAs in a volcanic area in a humid tropical environment, in order to have the fundamental elements for long-term management of land use systems in this environment.

2. Study Area Setting and Research Design

The eastern flank of the Mount Bambouto is located between latitudes 5˚28'48" and 5˚43'08"N, and longitudes 10˚06'12" and 10˚20'32"E. It belongs to the West Cameroon Highlands agro-ecological zone (IRAD, 2008) under a humid tropical climate with 2201 mm of annual rainfall. In this area, the landscape varies from flat to hilly; with altitudes ranging between 1156 and 2555 m (a.s.l.) (**Figure 1**). The reference soil groups are Andosols, Ferralsols, and Ferralsols (Tematio et al., 2009). Space occupation is progressive and accelerated. It is accompanied by agricultural practice. This modernization entails a significant increase in the use of fertilizers and pesticides. The various activities and agricultural practices in this area do not respect soil and environmental conservation measures. This is the cause of a decrease in soil fertility and therefore responsible for the overall decrease in SOCS and SQ (Tsozué et al., 2019).

The following major AES identified in the eastern flank of Mount Bambouto were factored into the research design: cultivated lands (Farming system) (CL), Forest areas (FA), Mixed farmings (MA), and Bushes areas (BA).

3. Methods of Study

3.1. Data Collection and Analysis

Thirty-two composite soil samples were randomly collected on the topsoil (0 - 30

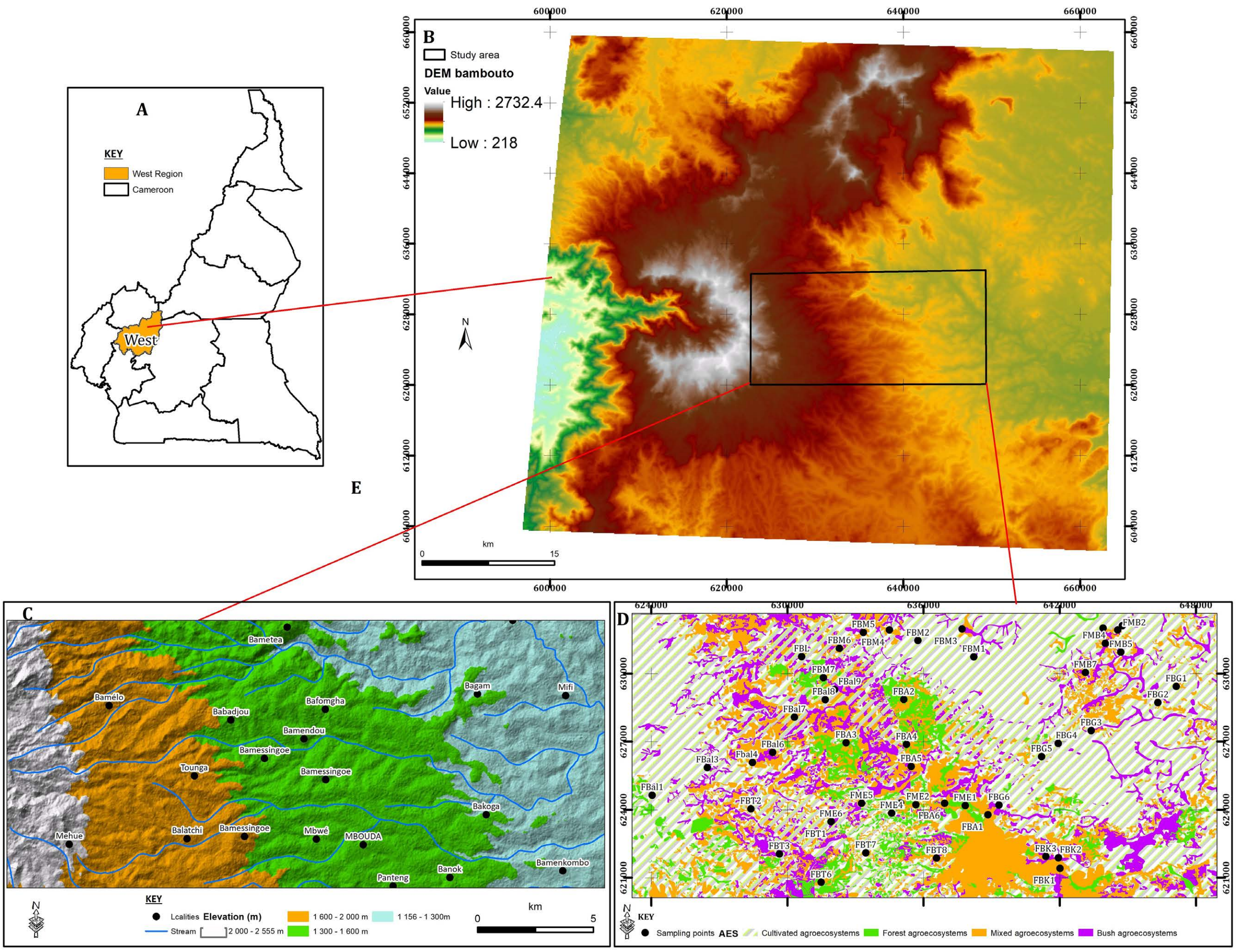

Figure 1. Regional setting of the northwestern slopes of the Bambouto Mountains. (A) Region of Cameroon. (B) Digital Elevation Model of Mont Bambouto. (C) Digital Elevation Model. (D) Agroecosystem map.

cm) of different AES using an Edelman hand-auger. Fifteen are collected in cultivated lands, four in forest areas, eight in mixed farmings, and seven in bush areas. Physical analyses included particle size distribution using the hydrometer method (Beverwijk, 1967). Analyses of OC, N, P, Ca, Mg, K, Na, CEC, Al, and pH were performed. SOC was calculated using chromic acid digestion and spectrometry (Heanes, 1984). N was evaluated using a UV-VIS spectrophotometer, and total N was calculated using a wet acid digest (Buondonno et al., 1995). The bray II process was used to extract P, and Murphy and Riley's molybdate blue to procedure was used to evaluate the resultant extract. The CEC at pH 7 was obtained using the ammonium acetate technique. Ammonium acetate was used to extract Ca, Mg, K, and Na at pH 7, and ASS flame atomic absorption spectrometry was used to examine the results (Mehlich, 1984).

3.2. Soil Organic Carbon Estimation

Bulk density (BD), were estimated using a pedotansfer function (Equation (1)), as defined by Adams (1973) for application in tropical soils and recommended by Minasny and Hartemink (2011). The same equation was recently applied for countrywide SOCS estimation in Cameroon (Silatsa et al., 2020) and spatial variation and temporal decline (1985-2017) of SOCS in relation to land use types in Tombel area (Nguemezi et al., 2021).

$$\mathrm{BD} = \frac{100}{\frac{\mathrm{OM}}{\mathrm{BD}_{\mathrm{OM}}} + \frac{100 - \mathrm{OM}}{\mathrm{BD}_{\mathrm{Min}}}}, \quad (1)$$

BD: bulk density ($g \cdot cm^{-3}$); OM: organic matter (%); BD_{OM}: organic matter bulk density (BD_{OM} =0.224 $g \cdot cm^{-3}$), and BD_{Min} the mineral bulk density ($g \cdot cm^{-3}$), defined in Equation (2) as follow:

$$\mathrm{BD}_{\mathrm{Min}} = 0.935 + 0.049 \log(\mathrm{depth}) + 0.0055\mathrm{Sa} + 0.000065(\mathrm{Sa} - 38.96)^2, \quad (2)$$

Sa: sand content (%), and Log (depth): natural log of the corresponding depth (cm).

The SOCS was calculated for each location using Equation (3) as follows:

$$\mathrm{SOCS}(\mathrm{MgHa}^{-1}) = C * \mathrm{BD} * h * 10, \quad (3)$$

C: SOC concentration content ($g \cdot kg^{-1}$); h: thickness of soil layer (m).

3.3. Computation of the Soil Quality Index (SQI)

In order to calculate SQ, soil's readily modifiable biological and physicochemical properties are combined (Brejda et al., 2000). The methods taken to determine the SQI were described by Ngo Mbogba et al. (2015). Nine indicators were selected for this study based on prior research in Southern Cameroon elsewhere. The available dataset indicators have focus on soil chemical parameters because some of authors have argued that they have the greatest influence (Yemefack et al., 2006).

$$\mathrm{SQI} = \sum_{i=1}^{n} W_i X_i \quad (4)$$

3.4. Statistical Analysis

Descriptive statistics were calculated on 18 variables because some soil properties are less dynamic than others. Nine variables cited in Section 4.4, showing significant variation were selected for further analyses. One-way ANOVA was performed to assess the influence of different AES on chemical soil properties. The separation of means between the different AES was made using Turkey's test. By applying PCA, the most appropriate SQ indicators were selected. Excel and R were used to perform these analyses.

4. Results and Discussion

4.1. Summary Statistics

The statistics of 18 soil variables obtained on the main AES are summarized in Table 1. Most of them show a positive skewness (0.35 to 4.48); meaning that the mean is typically greater than the median, which is additionally greater than

Table 1. Summary statistics of the original soil variables (sample population n = 32 samples).

Stats	Min	Mean	Max	Sd	CV	skewness	Kurtusis
pH water	4.90	5.84	6.50	0.49	8	−0.45	−1.03
pH KCl	4.20	4.87	5.70	0.36	7	−0.12	−0.48
P (ppm)	2.59	7.95	32.47	6.26	79	2.00	6.15
CEC (cmol (+)/kg)	3.20	22.34	38.88	10.27	46	−0.47	−0.81
CO (%)	1.07	3.18	5.51	1.27	40	0.27	−1.08
MO (%)	1.84	5.48	9.50	2.19	40	0.27	−1.08
N (%)	0.04	0.14	0.31	0.06	43	0.51	0.57
C:N	8.20	27.29	87.50	17.90	66	1.96	4.12
Ca (cmol (+)/kg)	0.40	1.22	5.36	0.97	79	2.75	10.01
Mg (mol (+)/kg)	0.00	0.54	2.00	0.38	71	1.62	5.32
K (cmol (+)/kg)	0.01	0.19	1.43	0.29	151	2.91	10.27
Na (cmol (+)/kg)	0.00	0.08	0.46	0.09	125	2.53	7.67
S (cmol (+)/kg)	0.71	2.02	6.30	1.05	52	2.16	7.65
S:CEC (%)	3.59	12.27	67.48	11.90	97	3.50	14.62
Clay (%)	1.00	9.89	32.00	9.01	91	1.41	0.90
Silt (%)	5.00	13.36	26.50	4.55	34	1.24	2.55
Sand (%)	48.50	76.74	90.00	11.47	15	−0.98	−0.12
BD ($g\cdot cm^{-3}$)	0.98	1.16	1.40	0.11	9.2	0.53	−0.3

Min: minimum; Max: maximum; Sd: standard deviation; CV: coefficient of variation; S: sum of exchangeable cations; BD: Bulk density.

mode; except for pH and sands showing negative skewness (−0.98 to −0.12). For positive symmetry, the right tail of the distribution is longer than the left, and for negative symmetry, the opposite is true. This is because the variables with skewness −1 or 1 are skewed. Kurtosis is also highly variable, with some values of 1 or 1. The deviation of the skewness and thus the kurtosis from zero indicates that most of these variables have a slightly abnormal distribution.

Except for pHw, pHKCl, and BD, which have coefficients of variation (CV) of 8%, 7%, and 9.2%, respectively, all other variables have high to very high CV, indicating that soil parameters within AES in this area are highly variable.

4.2. Variability of Soil Properties across AES

Except for pHw, pHKCl, and BD, which have low coefficients of variation (CV 10%), indicating low variability, all other variables have high to very high CV, indicating high variability of soil parameters within AES in the study area. The most variables are P, OM, OC, S, CEC, Sand, Clay, Silt, S, Na, were used for ANOVA and mean separations (Turskey's HSD). Table 2 present the variability of significant differences from on AES to another.

Table 2. Soil physico-chemical properties of the surface layer (0 - 30 cm) sampled under the main AES (n = 32).

AES	pHw	pH KCl	P	OC	OM	N	C/N	CEC	Ca	Mg	K	Na	S	S:CEC	Clay	Silt	Sand	BD
Unit			(ppm)	---------- % ----------				------------------ (cmol(+)/kg) ---------------							-------------- % --------------			(g·cm^{-3})
CL	5.8 ± 0.4	4.8 ± 0.3	8.1 ± 8.2	2.8 ± 1.2	4.7 ± 2.0	0.1 ± 0.1	24.5 ± 11.7	21.2 ± 10.6	1.0 ± 0.6	0.5 ± 0.5	0.2 ± 0.4	0.03 ± 0.0	1.8 ± 0.7	10.3 ± 5.8	11.7 ± 10.7	13.6 ± 5.9	74.6 ± 13.3	1.2 ± 0.1
FA	6.2 ± 0.5	4.9 ± 0.4	10.7 ± 5.4	4.1 ± 1.8	7.0 ± 3.2	0.2 ± 0.01	21.8 ± 9.3	24.9 ± 9.5	1.2 ± 1.1	0.5 ± 0.4	0.3 ± 0.4	0.2 ± 0.2	2.1 ± 1.0	8.4 ± 1.9	5.9 ± 2.2	14.4 ± 2.8	79.7 ± 5.0	1.1 ± 0.2
MA	5.9 ± 05	4.9 ± 0.4	8.4 ± 4.6	3.4 ± 1.2	5.8 ± 2.1	0.1 ± 0.1	31.1 ± 22.3	24.2 ± 10.7	1.1 ± 0.4	0.5 ± 0.3	0.2 ± 0.2	0.1 ± 0.1	1.8 ± 0.5	14.4 ± 21.5	8.1 ± 9.9	11.9 ± 4.1	80.1 ± 13.1	1.2 ± 0.1
BA	5.7 ± 0.6	5.1 ± 0.3	5.7 ± 3.8	3.3 ± 1.1	5.7 ± 1.9	0.2 ± 0.1	31.6 ± 26.7	21.1 ± 11.2	1.9 ± 1.6	0.6 ± 0.2	0.1 ± 0.1	0.1 ± 0.1	2.7 ± 1.8	15.9 ± 9.2	10.6 ± 6.6	14.0 ± 2.6	75.4 ± 8.6	1.1 ± 0.1

Values followed by the same color are not statistically different ($p < 0.05$) according to least significative difference (Turkey's test). CL = Cultivated lands; FA = Forests; MA = Mixed farmings; BA = Bushes.

P, OM, OC, C/N, S/CEC, Clay and sand contents showed a significant difference between FA and other AES namely CL, MA, and BA (Table 2). This difference between FA and others AES can be explained by the accumulations of OC in the biomass of three, shrubs, and herbaceous plants, as well as in soil horizons (Reyna-Bowen et al., 2019).

Clay, silt, sand, and BD do not present significant changes among the different AES. Those parameters may not have been modified into the soil essentially by different activities in AES but probably by the weathering of fresh rocks. Under Farming system, soil chemical quality is improved by the rapid mineralization of plant material left on the surface after clearing.

4.3. Soil Organic Carbon Stocks (SOCS)

4.3.1. Soil Organic Carbon Stocks under the Different AES

According to the results of statistics (Table 3), the soils in FA have a very best SOCS compared to the other AES. The highest FA can be related to the presence of vegetation more litter falls which are returned to the soils as OM (Tiwari, 2015; Kenye et al., 2019). Skewness ranges from −0.3 to 1.5. It is positive in soil from all AES, except within the MA soils. The positive skewness means the mean is usually greater than median, which is additionally greater than the mode. The right tail of the distribution is longer than the left for positive symmetry and the reverse for negative symmetry. This is because the variables with skewness < −1 or >1 are skewed. The kurtosis is additionally highly variable, with some values > 1 or <−1. The departure of the skewness and therefore the kurtosis for zero means that most of these variables have a slightly abnormal distribution.

4.3.2. Correlating SOCS with Soil Parameters

Classification of soil properties in (OM, OC, N, available P, CEC, S:CEC; Ca, Mg, Na, C:N ratio, pHw, pHKCl, silt, sand, clay, BD) in space was defined by two principal axes. To select the most appropriate indicators that determine SOCS in the eastern flank of Mount Bambouto, the values of OM, OC, N, P, CEC, S/CEC, Ca, Mg, Na, pHw, pHKCl, Silt, sand, and clay were subjected to PCs explained

Table 3. SOCS under different agroecosystems (AES).

AES	Min	Mean	Median	Max	SD	CV	Skewness	Kurtosis
CL	55.7	96.0	84.2	169.5	33.8	35.3	0.9	0.1
FA	142.8	149.7	147.0	162.1	8.6	5.8	1.5	2.3
MA	37.7	115.8	115.3	157.0	37.6	32.4	−1.3	2.3
BA	71.5	110.5	104.7	147.1	28.3	25.6	0.1	−1.2

CL = Cultivated lands; FA = Forests; MA = Mixed farmings; BA = Bushes; SD: Standard deviation; CV: Coefficient of variation.

around 48.09% of total variation: 31.94% explained by PC1 and 16.15% by PC2. PC1 had loading by clay, OM, OC, pHKCl, and S, while PC2 had loading by C:N and BD (**Figure 2**).

A strong correlation has been noted between Ca, Mg, and pHw (group 1) on one hand, and between OM, P, and CEC (group 2) on the other hand (**Figure 2**). The sum of vectors that represent the two correlated groups gives the third vector which is loading by SQI. These results suggested that the main indi.ctors controlling SOCS in the study area are OM, OC, BD, C:N, S, and pHKCl. OM from land cover types appears as the main SOCS indicator within these sandy soils because it is the one able to retain and make available nutrient elements.

4.4. Soil Quality Index of Different AES

SQI was used here as chemical parameter. As compared to the index obtained under FA and other results in similar areas (Ngo-Mbogba et al., 2015; Nguemezi et al., 2020), this parameter has the relative classification of soil from different AES according to their chemical quality.

4.4.1. Computing the SQI Parameter

The soil was good quality if its SQI is equal to or greater than that of FA, inversely it was of mediocre quality if its SQI is lower than that of FA-AES. Base on OM, pHw, available P, Ca, Mg, K, N, C:N ratio, CEC, SQI9 has been obtained.

SQI4 and SQI2 were calculated using PCA. Based on one of the two correlated groups in the variable map factors, SQI4 and SQI2 were calculated based on the available indicators respectively (OM, pHw, available P, and Ca, and OM, pHw) (**Figure 3**). These SQI (SQI9, SQI4, and SQI2) have been computed to understand the absolute difference between them (**Figure 4**), allowing us to evaluate the quality of soil by combining a few parameters.

Soils under CL-AES (SQI9 = 15.83; SQI4 = 11.67; SQI2= 3.92); MA-AES (SQI9 = 16.95; SQI4 = 10.64; SQI2 = 3.51) and BA-AES (SQI9 = 13.70; SQI4 = 8.49; SQI2 = 3.42) are not of good quality compared with control FA-AES (SQI9 = 22.44; SQI4 = 17.30; SQI2 = 4.31). Conversely, those under CL-AES and MA-AES which SQI9 > 15 are of average quality. The higher quality of these soils may be attributed to the higher OM content supply by the corresponding AES. These

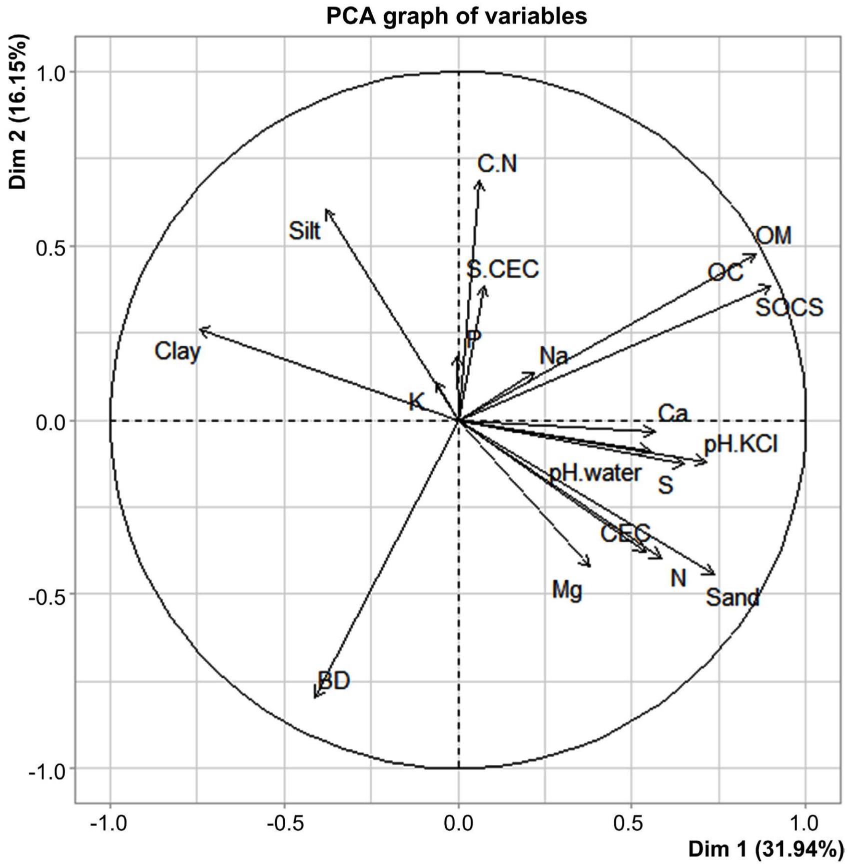

Figure 2. Principal component analysis graphs of physico-chemical variables. SOCS: Soil organic carbon stock; OM: Organic Matter; OC: organic carbon; N: total nitrogen; C:N: turnover; CEC: Cation exchange capacity; S:CEC: base saturation; P: available phosphorous; BD: bulk density; S: sum of exchangeable cations.

results corroborate with studies of Andrews et al. (2002); Yemefack et al. (2006) and Ngo-Mbogba et al. (2015) which showed that OM and CEC significantly improve soil quality.

The lower SQI observed under BA-AES (SQI9 = 13.70; SQI4 = 8.49; SQI2= 3.42) is due to the post-burn effect which has induced loss of OM and nutrient elements by leaching, and soil erosion. Thus, SQ varies according to the characteristics of AES.

4.4.2. Correlating SQI with Soil Parameters

Classification of soil properties (OM, N, C:N ratio; CEC, Mg, pHw, P, Ca, K) in space was defined by two principal axes. To select the most appropriate indicators, that determine soil quality in the eastern flank of Mount Bambouto, the values of OM, N, C:N, CEC, Mg, pHw, P, Ca, and K subjected to PCs explained around 51.2% of total variation: 32.75% explained by PC1 and 18.45% by PC2. PC1 had loading by OM, N, pHw, and CEC, while PC2 had loading by C:N (**Figure 3**).

A strong correlation has been noted between OM and pHw (group 1) on one hand and between N, and CEC (group 2) on the other hand (**Figure 3**). The third

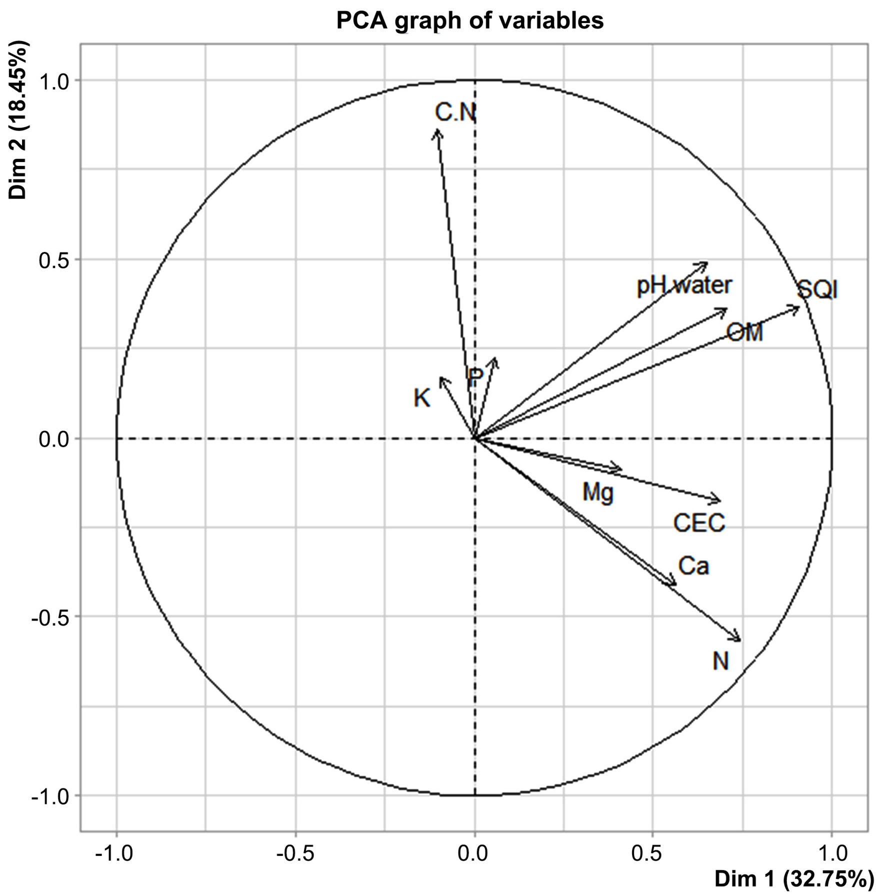

Figure 3. Principal component analysis graphs of chemical variables SQI: Soil quality index carbon; OM: Organic Matter; N: total nitrogen; C:N ratio; CEC: Cation exchange capacity; Mg: Magnesium; pHw: pH water; P: available phosphorous; Ca: calcium; K: potassium.

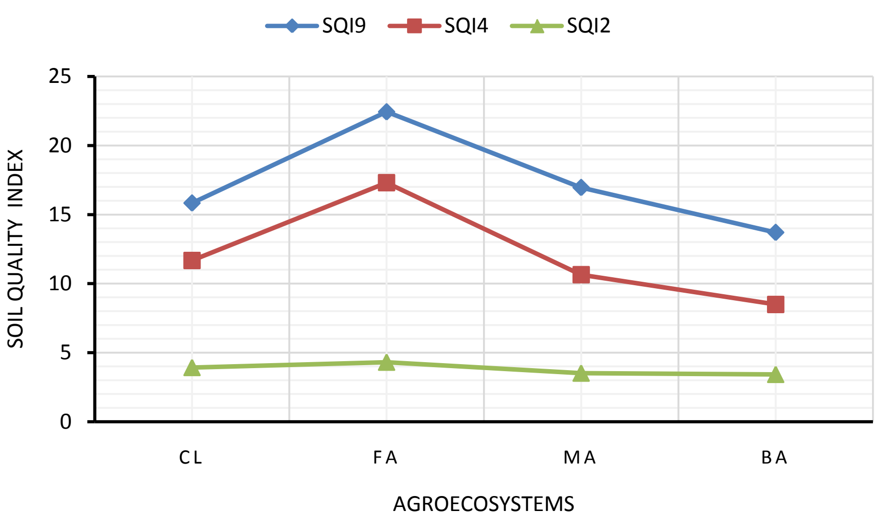

Figure 4. Assessing soil quality according to the number of indications used in combination. CF: Cultivated lands; FA: Forests; Mixed farmings; Bushes; SQI9: soil quality index from combination of nine parameters; SQI4: soil quality index from combination of four parameters; SQI2: soil quality index from combination of two parameters.

Table 4. Soil quality index under different agroecosystems (AES).

SQI	CL	FA	MA	BA
SQI9	15.83	22.44	16.95	13.70
SQI4	11.67	17.30	10.64	8.49
SQI2	3.92	4.31	3.51	3.42

CF: Cultivated lands; FA: Forests; Mixed farmings; Bushes; SQI9: soil quality index from combination of nine parameters; SQI4: soil quality index from combination of four parameters; SQI2: soil quality index from combination of two parameters.

vector loaded by the SQI is derived from the sum of the vectors that represent the two correlated groups. These results suggest that the main indicators controlling SQ in eastern flank of Mount Bambouto are OM, pHw, N, C:N, and CEC.

The minimum dataset concept consists of selecting the most appropriate indicators that indicate good soil functioning. The decision was made based on the indicator's vector's length in the multidimensional space it spans as well as the proximity of its OM and P in associated group 2. When calculating SQI4 and SQI2, they were combined (**Table 4**).

4.4.3. Comparing SQ According to the Number of Indicators Used in Combination

Between SQI9, SQI4, and SQI2, the remarkable changes were noted (**Figure 4**). However, SQI9 and SQI4 showed the same trend with two poles controlled by OM and exchangeable cations along hand (CL, FA, MA, and BA). The number of indicators influences the SQI results. With a low number of indicators, the SQI results are low. These results are like those of Ngo-Mbogba et al. (2015) in South Cameroon. However, these indicators may change according to the area (Andrews et al., 2002; Ngo-Mbogba et al., 2015).

5. Conclusion

This study assesses SOCS and SQ in the eastern flank of Mount Bambouto (West Cameroon). In the same vein, this study analyzed and examined the influence of different AES on SOCS and SQ. Topsoil samples were collected in the main AES for routine laboratory analysis. This study used multiple statistics tests and PCA to compute SOCS and SQI in the main AES. Based on chemical soil properties and analysis of variance, SOCS and SQI were computed. PCA was used to select the most appropriate indicators that control SOCS and SQ. Within the AES, several soil properties showed high to very high coefficient of variation. OM was significantly high in FA. SOCS and SQ differ significantly between the AES. In the eastern flank of Mount Bambouto, the best soils are those under FA with high OM, SOCS, and SQI. OM, pHw, N, C:N, and CEC are the main indicators controlling soil quality in the eastern flank of Mount Bambouto. OM, OC, BD, C:N, S, and pHKCl are the main indicators controlling the SOCS in the eastern flank of Mount Bambouto. The soil quality and SOCS appeared to be highly influenced by the OM supplied by the forest ecosystem.

Results of this study can serve as baseline information to be used for monitoring soil quality changes in the humid tropical volcanic mountains, especially in areas subjected to intensive agricultural practices. Future studies aimed at detailed soil classification and mapping are recommended. In addition, digital soil mapping is recommended to guide decision making for sustainable soil management in tropical volcanic mountains.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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