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Effects of Human Generated Fires on Soil Organic Carbon Stocks under Different Vegetation Types in Northern Ghana

Emmanuel Nyadzi[1], Benjamin K. Nyarko[2] & Mathew I. S Ezenwa[3]

[1] WASCAL CC&ALU, Federal University of Technology, Minna, Nigeria

[2] Department of Geography and Regional Planning, University of Cape Coast, Cape Coast, Ghana

[3] Department of Soil Science, Federal University of Technology, Minna, Nigeria

Correspondence: Emmanuel Nyadzi, WASCAL Coordinating Unit, Federal University of Technology, Minna, Nigeria. Tel: 233-266-413-676. E-mail: enyadzi@yhoo.com

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Abstract

This study examined the effect of fires on the distribution of SOCS under different vegetation types. Soil samples were randomly collected on 34 plots and 24 sample points at depths 0–10 cm, 10–20 cm and 20–30 cm per plot in Northern Region of Ghana. Experimentally, 50m x 50m plots were marked out on burnt and unburnt lands under four different vegetation types. % C and bulk density were estimated using Walkley Black and core methods respectively. Results show that SOCS insignificantly ($P>0.05$) varied under the vegetation types with close savanna woodland (CSW) recording the highest of ~16.7t/ha on unburnt sites and ~19.4 t/ha on burnt sites while Grass/herbs with scattered trees and shrubs (GHST) recoded ~7.9 t/ha and ~9.4 t/ha on unburnt and burnt sites, respectively. The difference in % C and bulk density across depth were statistically significant ($P<0.05$). A strong negative correlation existed between bulk density & %C and bulk density & SOCS. We conclude that contrary to previous studies fire significantly ($P<0.05$) increased SOCS on fallow lands depending on fire temperature. However, vegetation types in the savannah of Ghana were observed to have an insignificant impact on the quantity of SOCs.

Keywords: soil carbon stocks, burnt lands, vegetation types, fallow lands, climate change, guinea savanna, ghana

1. Introduction

The dynamics of global terrestrial soil organic carbon (SOC) stocks may either alleviate or exacerbate climate change impact. SOC is important for regulating the function of natural ecosystem and has great impact on soil water-holding capacity, soil structure, soil cation exchange capacity, and the ability of soils to store nutrients and form complexes with metal ions (Van, 2001). Changes in soil organic carbon could have spectacular impacts on the concentration of greenhouse gases in the atmosphere. If carbon is released from soil to the atmosphere, climate change will be exacerbated. On the other hand, if more carbon is accumulated in soil and the emissions decrease, climate change will be retarded (Schils et al., 2003).

Most of the world burnt biomass matter (vegetation) is from the savannas, and because 2/3 of the earth savannas are in Africa, the continent is now recognized as “burnt centre” of the planet (Roy, 2003). Nutrients cycling in the ecosystems particularly are influenced by fire. Fires have been observed to substantially alter carbon cycling in the forest (Hatten and Zabowski, 2009) and grassland areas (Bremer and Ham, 2010; Oluwole et al., 2008). The complexity of several biogeochemical processes affects fire long-term impact on the ecosystem–atmosphere carbon exchange (Kaye et al., 2010; Houghton et al., 2009). The quantity of carbon losses varies from one ecosystem to the other and between surface and deep soils and is usually affected by the combine actions of vegetation and climate (Harden et al., 2004). The Savannas for example are usually associated with low soil organic matter content and low agricultural production resulting from lower rainfall and soil fertility (Scholes and Hall., 1996).

Organic matter is generally higher on grasslands of high root matter content and have slower decomposition rate and efficiently contribute to the formation of humus than forest leaf litter. The organic carbon is however noted to decrease less quickly with depth in grasslands than in forest lands, this is because of its fibrous roots system that stretches deep into the soil profile. Surface deposition and incorporation of residues accumulates organic matter unusually at the top layers of the soil. The subsurface horizons of the soils are generally lower in organic carbon contents than the surface layers (Brady and Weil, 1996). Soil organic matter is significantly higher beneath tree canopies of grasslands compared to between them (Scholes and Hall, 1996). Cooler climates tends to be higher in soil organic matter content (Brady and Weil, 1996) than warmer climates with high temperatures in savannas which are usually associated with high soil respiration losses, that accelerate mineralisation rapidly releases soil nutrients (Scholes and Hall 1996). Soil moisture also influence soil organic matter accumulation (Brady and Weil 1996). Continuous changes in the wet and dry conditions favors decomposition since soil respiration can continue at water potentials below the stage when production ceases (Scholes and Hall, 1996). SOM is lowest in areas where temperatures are high and rainfall is low (Brady and Weil 1996).

While SOM is affected by climate and vegetation over broad geographic areas, soil texture and drainage often affect it within a local area. Organic matter in soils widely ranges from a mere trace in sandy soils and desert soils, to as high as 20 or 30% forest or poorly drained A horizons. The amounts of organic residues in soil are generally higher in fine-textured soils, because of their greater nutrient and water-holding capacities. Soils aeration and organic matter oxidation are lower in fine-textured soils due to their smaller pores sizes (Brady and Weil, 1996). Direct fire combustion results in short-term loss of carbon. Soils ravaged by fires may be warmer and wetter with increasing decomposition rate than in those not burnt (Ågren et., 1996). Depending on intensity, fire annihilates aboveground vegetation and the nutrient content transferred to the soil as ash. The chemical and biological properties of the soil are altered due to the ash that is added after the burning. Increase in accessible nutrients occurs due to the ash that falls on the soil but are momentarily dropped, as nutrients are lost through erosion and leaching as well as taken up by vegetation (Schlesinger, 1997).

In Ghana, man-made savanna fires are not uncommon. These fires are mainly grass fires with lower intensity compared to forest fires (Bagamsah, 2005). In Ghana, especially the Northern region, the dry season has been characterised with annual bush fires which result in annual vegetation losses and exposes the rather fragile savanna soil in the area to extreme climatic conditions which reduces the productivity efficacy of lands in the Region. Each year, several hectares of lands are burnt without regard to its consequences on soil fertility and subsequent release of carbon and other trace and greenhouse gases emissions (Nyadzi et al., 2015).

The United Nations Framework Convention on Climate Change (UNFCCC) reports that, only a minute fraction of developing countries takes records of soil carbon data (Grieco, 2005). Decisive action therefore needs to be taken to limit soil carbon released via burning and subsequent involvement in emissions into the atmosphere. Also, estimates of soil organic carbon stocks are required to assess the fertility of soil. The effect of human generated fires on SOC stocks remains unclear as a result of diverse opinions that emanate from different studies carried out at different locations and ecological zone. This study hypothesized that there is a significant difference in SOCS between burnt and unburnt fallow lands, also vegetation type have significant impact on SOCS and therefore seek to quantify the vertical distribution of SOC stocks and compare the results under burnt and unburnt land and under different vegetation types

2. Method

2.1 Description of Study Area

This study was carried out in the in the Northern Region of Ghana found in the Guinea Savanna Agro-Ecological Zone (Figure 1). The region is located between the latitudes 8° 30'N and 10° 30'N and the longitudes 2° 30'W and 0° 00'W (GSS, 2010). The annual rainfall ranges between 1005mm and 1150 mm with a monthly average temperatures ranging from about 27ºC (August) to about 36ºC (March/April) . The rainy season is associated with high relative humidity of about 65-85% which drops in the dry season to about 20% (Cobbina et al., 2011). The soils in the study area are mixtures of yellow and brown to yellow and grey in colour. The soil texture is sandy loam or silty and coarse sandy loam depending on whether developed over the Voltaian shales or granites respectively (Benneh, and Dickson, 1988). According Bagamsah (2005) the top soils in the area are mostly sandy interspersed with gravels which increases with depth.

The area is characterised by mid-dry savannah cover with patches of dry savannah and wet savannah (Menz, and Bethke, 2000). The natural vegetation includes trees species, grasses (both annual and perennials) are classified

(Figure1) and described in details by Bagamsah, (2005). The inhabitants of the area practice subsistence agriculture which is an an integral part of their livelihood (Nyadzi, 2016), with compound farms at the immediate surrounding of their houses, and bush farms, just few meters after the compound farm or several kilometers away from the villages. The farmers mainly grows cereals (maize, millet), tubers (yam and cassava) and vegetables (pepper, tomatoes, okra and cowpea) (Bagamsah, 2005).

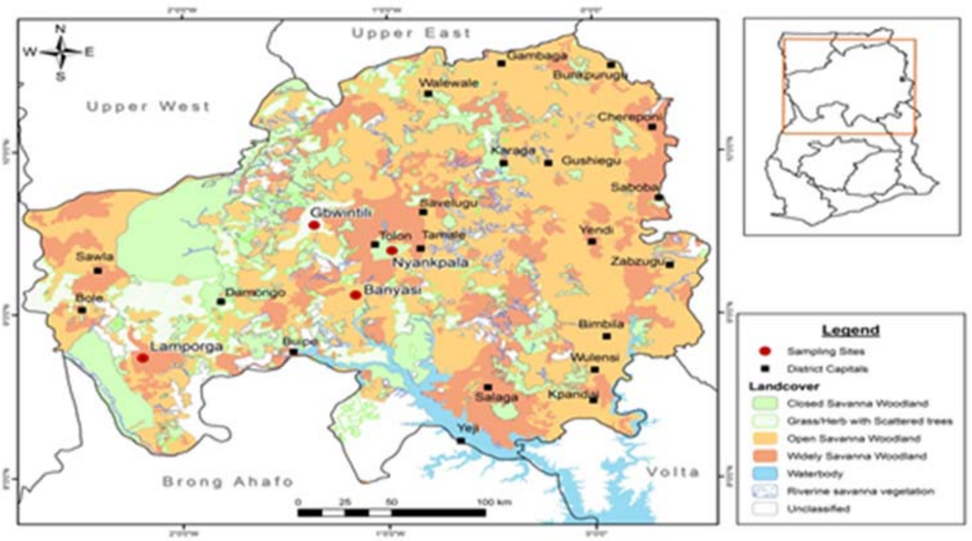

Figure 1. Map of the study area (also showing the location of Northern Region in Ghana) [69].

2.2 Site Selection and experimentation

Soil Samples were taken from four different vegetation types classified by (Nyadzi et al., 2015; Bagamsah, 2005). The method for the classification was based on the structural basis of the vegetation as described by Dansereau, (1951). These vegetation types (Figure 2) are: Widely open savanna woodland (WOSW), Grass/herb with scattered trees (GHST), Open savanna woodland (OSW), closed savanna woodland (CSW). With the help of a geographic positioning system (GPS), four communities showing dominance of each vegetation type were selected across the region.

Widely Open Savanna Woodland (WOSW)

Grass/Herbs Fallow with scattered Trees and Shrubs(GHST)

Open Savanna Woodland dominated by Shrubs(OSW)

Closed Savanna Woodland dominate by Shrubs (CSW)

Figure 2. The four vegetation types as classified by Bagamsah (2005).

Soil samples were randomly taken randomly from marked plots on chosen experimental sites within each vegetation type. Soils under WOSW were sampled in the Lamporga community; those on GHST were sampled in the Gbwintili community. While soils under OSW were sampled in the Banyasi community, soils under CSW were also sampled in the Nyankpala community (Figure 1).

In determining soil organic carbon stocks, three (3) experimental plots each of 2500m^2 area (50 m x 50 m) were randomly marked out under each vegetation type for both burnt and unburnt lands. For each of the demarcated plots, five (5) sampling points (Figure 3) were marked and soil samples collected at each point for three (3) different soil depths. Soil from each depth was composited, mixed thoroughly and replicated into three for the analysis of % C concentration. Undisturbed soil samples were also taken from the same plots at a three sampling points diagonally to determine the bulk density (Figure 3).

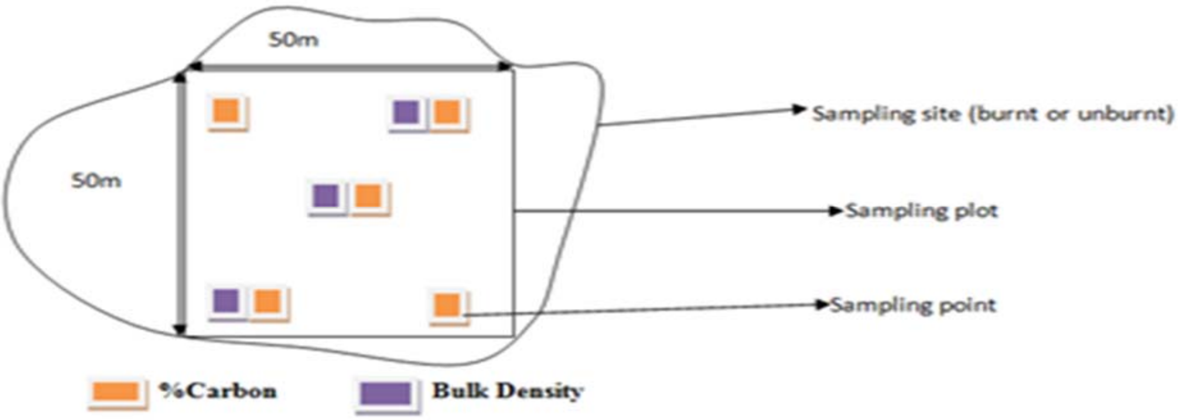

Figure 3. Experimental layout for sampling soil for %C and bulk density

2.3 Soil Sample and Sampling Procedures

Soil samples were collected from burnt and unburnt fallow lands within the four different vegetation types and at three different depths. Fallow and farmlands were differentiated from each other by help of an informal interview with the inhabitants close to the identified sites. Historical information about the area with regard to fallow periods, bushfires and land use were obtained through informal interview. All sampled lands had a fallow period of two years and the burning occurred in the same year as sampling was done. The sampling was however carried out twelve (12) weeks after the burning had occurred.

Three (3) different plots were marked out under each of the four (4) vegetation types identified across the study area, and soil sampled from both burnt land and unburnt lands. At every sampling point, the soil samples were taken at different depths of 0-10 cm, 10-20 cm and 20-30 cm on all the sampling plots for both burnt and unburnt. These depths were chosen because according to FAO (1988), average carbon stocks have been calculated for the top 0 – 30 cm soil layer with a larger part of organic soils and this layer is considered to be the most active part of soil in terms of greenhouse gases emissions.

A total of four hundred and thirty-two (432) soil samples were collected for the entire study. This consist of three hundred and sixty (360) soil samples (180 from burnt and 180 from unburnt fallow lands) for the analysis of % C concentration. Seventy-two (72) undisturbed soil samples (36 from burnt and 36 from unburnt fallow lands) were taken for bulk density determination. For the purpose of homogeneity and less effect of fire on the controlled unburnt plots, Burnt and unburnt plots were a minimum of approximately 100 m away from each other within each vegetation type.

2.4 Determination of Soil Organic Carbon Stocks (SOCS)

Soil organic carbon (SOCS) was calculated using the following formulae (Pearson et al., 2007):

$$\mathrm{SOCS} = \mathrm{P} \times \mathrm{V} \times \%\ \mathrm{C}$$

$$\mathrm{V} = \mathrm{d} \times \mathrm{A}$$

Where;

SOCS = soil organic carbon stock per unit area [t ha-1],

P= soil bulk density [t m^{-3}]

V= volume of soil sample [m^{-3}]

d = Soil depths (0-10cm, 10-20cm, 20-30cm depths) [m]

% C = carbon concentration [%]

A = area of land sampled [m^2]

The percentage %C and the bulk density were determined using Wakley Black and core methods respectively. The laboratory analysis was carried out at the faculty of Agriculture-University for Development Studies, Nyankpala Campus and Savanna Agriculture Research Institute (SARI) all in Northern Region of Ghana.

2.5 Statistical Analysis

GenStat was used to run analysis of variance (ANOVA) at a confidence level of 95% to determine the statistical significance within the data sets. Duncan multiple range test was used for separation of means. Pearson Correlation at 95% confidence level was also was used to determine the relationship between bulk density, carbon concentration and bulk density & SOCS.

3. Results and Discussion

3.1 Vertical distribution of SOCS, %C and bulk density

Results show that, on the average, SOCS and %C generally decrease at an increasing depth (Table 1). SOCS and %C were highest in 0-10cm followed by 10-20 cm and lowest in 20-30cm. Soil Bulk density on the other hand increased at an increasing depth with the lowest value recorded in 0-10 cm and highest in 20-30cm.This trend occurred under all the vegetation types and on both burnt and unburnt lands. There were however some few exceptional unexplained cases on some sampling plots and replicates where SOCS, %C and bulk density deviated from this pattern. This observation in vertical trends of SOC, %C and bulk density were consistent with other works of (Dahal and Kafle 2013; Post et al., 2000), Bulk density on the average (within the 30cm depth) ranged from 1.44g/cm3 in OSW to 1.61 g/cm3 in GHST on burnt land and 1.39g/cm3 in OSW to 1.55g/cm3 in GHST on unburnt lands (Table 2). Agyare (2004) reported bulk density within the range of 1.15g/cm3 to 1.89g/cm3 of the top soils (0-20cm depth) in the Tolon /Kumbungu district (Avornyo et al., 2014) also recorded comparable bulk density values within the range of 1.2g/cm3 in silt loam soils to 1.5g/cm3 in sandy loam soils around Golinga irrigation site. These woks were all carried out in the Northern Region of Ghana. Bagamsah (2005) also reported a range of 1.3g/cm3 to 1.7g/cm3at 0-10cm depth within the study area. Higher bulk density is however a strong indication of high sand content with low organic matter (C fertility). On burnt lands, %C on the average (30cm depth) ranged from 0.195% in GHST to 0.378 % in WOSW while unburnt lands recorded a range of 0.161% in GHST to 0.389% in OSW.SOCS also ranged from 3.14 t/ha in GHST to 6.48 t/ha in CSW on burnt lands and 2.50 t/ha in GHST to 5.57 t/ha in CSW on unburnt lands (Table 2). SOCS, %C and bulk density insignificant (p>0.05) varied across all the vegetation covers on both burnt and unburnt lands (Table 2), but differed significantly (P<0.05) across depth on all the vegetation types for burnt and unburnt lands. This implies that the four vegetation types did not affect SOCS, %C and bulk density statistically; however, the depth of a soil affected the measure of %C, SOCS and bulk density.

Table 1. Effect of Vegetation, Depth and fire on Bulk density, %C and SOCS

Treatments	Burnt lands			Unburnt lands			Burnt & Unburnt lands		
VEGETATION	BD (g/cm^3)	C (%)	SOCS (t/ha)	BD (g/cm^3)	C (%)	SOCS (t/ha)	BD (g/cm^3)	C (%)	SOCS (t/ha)
GHST	NS	NS	NS	NS	NS	NS	1.416b	0.4195a	5.925a
WOSW	NS	NS	NS	NS	NS	NS	1.458b	0.3519a	5.108b
OSW	NS	NS	NS	NS	NS	NS	1.527a	0.3959a	6.023a
CSW	NS	NS	NS	NS	NS	NS	1.584a	0.1782b	2.819c
Significance	_	_	_	_	_	_	*	*	*
LSD (at 5%)	_	_	_	_	_	_	0.04372	0.0264	0.391

DEPTHS									
0-10cm	1.477b	0.4616a	6.754a	1.445b	0.4008a	5.746a	1.461b	0.4312a	6.250a
10-20cm	1.521a	0.3546b	5.334b	1.468b	0.2973b	4.316b	1.494b	0.3259b	4.825b
20-30cm	1.553a	0.2694c	4.145c	1.513a	0.2345c	3.518c	1.533a	0.2520c	3.831c
significance	*	*	*	*	*	*	*	*	*
LSD (at 5%)	0.02164	0.0924	1.317	0.0157	0.0882	1.225	0.01237	0.05245	0.741
CV (%)	5.0	31.8	29.0	5.0	33.2	31.2	5.0	32.5	30.1

Note: All means with the same letter in a column are not significantly different at $p<0.05$ using Duncan's multiple range test. *= significant at $P< 0.05$; NS = not significant

Table 2. Descriptive statistics of %C, BD and SOCS on burnt and unburnt and under different vegetation types

Vegeta-tion	Burnt Lands						Unburnt Lands					
	C		BD		SOCS		C		BD		SOCS	
	M (%)	STDEV (S)	M (g/cm^3)	STDEV (S)	M (t/ha)	STDEV (S)	M (%)	STDEV(S)	M (g/cm^3)	STDEV (S)	Mean (t/ha)	STDEV (S)
GHST	0.195	0.003 (-1.45)	1.61	0.008 (-1.71)	3.14	0.105 (-1.69)	0.16	0.024 (-1.48)	1.55	0.005 (-1.71)	2.50	0.115 (-0.68)
WOSW	0.378	0.004 (2.24E-13)	1.48	0.034 (-0.23)	5.57	0.531 (-0.38)	0.33	0.010 (-0.94)	1.43	0.018 (1.16)	4.64	0.435 (0.94
OSW	0.450	0.036 (0.67)	1.44	0.052	6.45	0.775 (1.72)	0.39	0.017 (-1.61)	1.39	0.047 (-0.52)	5.40	1.185 (-0.69)
CSW	0.424	0.005 (0.41)	1.53	0.145 (1.36)	6.48	2.308 (1.32)	0.37	0.028 (-0.87)	1.52	0.033(-1.2)	5.57	0.974 (-1.73)

* Reference year 2014. (GHST= Grass/herbs with scattered trees and shrubs WOSW= Widely Open Savanna Woodland, OSW=Open Savanna Woodland dominated by Shrubs, CSW= Closed Savanna Woodland). M=Mean, STDEV= Standard deviation and S= Skewness Note: The variations in the values on the table 2 above were statistically insignificant as indicated in Table 1.

Adu (1995), stated that, soils of northern Ghana have been widely reported to be low in organic matter content. Table 1 shows that, at depth 0-10cm on both burnt and unburnt land; SOCS was highest in CSW followed by WOSW then OSW with GHTS recording the least. At 10-20cm; CSW had the highest SOCS, OSW followed then WOSW with GHST recording the least on burnt land while on unburnt land OSW had the highest SOCS, followed CSW then WOSW with GHST still recording the least. On burnt and unburnt land at 20-30cm; CSW recorded the highest stocks of SOCS followed by OSW then WOSW with GHST as the least stock of SOC. On the average, (0-10cm) of burnt lands, %C ranged from 0.23% in Gbwintili (GHST) to 0.56% in Banyasi (OSW) and 0.19% in Gbwintili (GHST) to 0.50% in Nyankpala (CSW) on unburnt lands. These values were comparatively lower than the results of Bagamsah, (2005) who reported an average of 0.26% in Nasuam and 1.07% in Kpandain within a 0-10cm depth. Abagale et al., (2012) also recorded a higher values ranging from 0.85% to 1.10 % on eroded and non-eroded top most soil layer in Dindo farmlands in the Northern region of Ghana. This implies that, organic carbon within the study area varies greatly among communities and within soil layers. This can be attributed to the texture of soil and history of management practices carried out in a particular area. The variations of SOCS and %C by depth and by vegetation type could be attributed to the varied vegetation types with different root systems, below and above ground biomass as well as the conditions prevailing on each site. This explanation is consistent with Esteban and Robert (2000) who reported that the amount of SOC may be eclipsed by the effects of plant allocation. Plant production and decompositions determine C inputs to the soil profile, and plant allocation above and below ground and between shallow and deep roots may leave distinct imprints on the relative distribution of soil carbon with depth. They further stated that in arid systems, the relatively deep root distributions of shrubs may lead to soil C profiles that are deeper than those in arid grasslands. Dahal and Kafle (2013) also stated that the variation of the total organic carbon stock can be attributed to the variation in the site conditions, vegetation maturity level, and land altitude.

3.2 Fire Effects on SOCS Under Different Vegetation Covers

Empirical results (figure 4) of this study reveal that, Soil organic carbon stocks was significantly ($P>0.05$) higher on burnt than unburnt lands. The sum of SOCS in 30cm depth on the average ranged from ~16.71 t/ha to ~19.43t/ha and ~7.49 t/ha to ~ 16.19 t/ha on burnt and unburnt sites respectively. CSW recorded ~16.7t/ha on unburnt sites and~19.43t/ha on burnt sites, WOSW was ~13.93t/ha on unburnt site and ~16.71 t/ha on burnt sites. OSW also had ~16.19 t/ha on unburnt sites and ~19.36 t/ha on its burnt sites, while GHST recorded ~7.49 t/ha and 19.42 ~t/ha on unburnt and burnt sites respectively. GHST recorded 20.49% forming the highest increase in SOCS after burning whilst WOSW had 16.64% increase and OSW and CSW also recorded 16.37 % and 14.05% increase respectively.

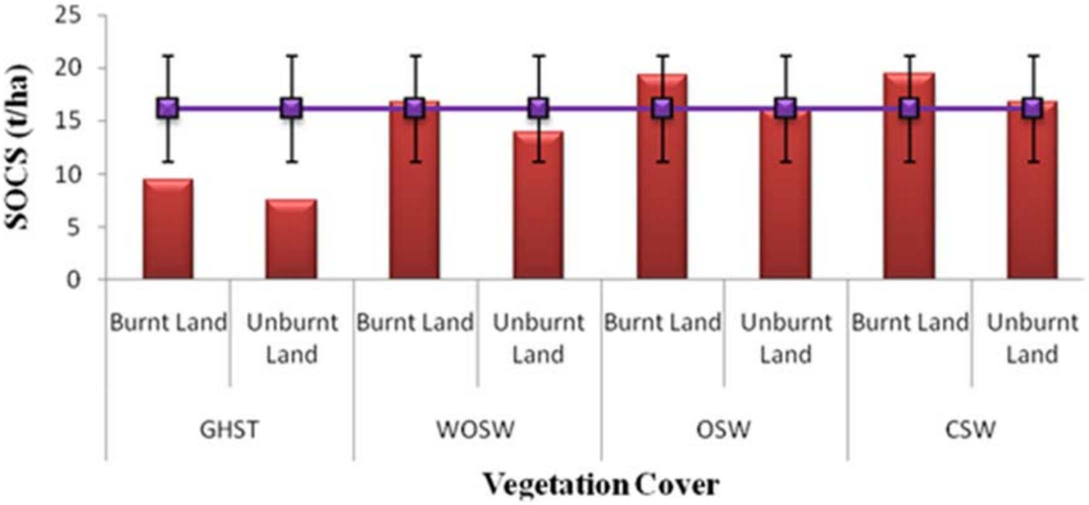

Figure 4. SOCS (30cm depth) on Burnt and Unburnt Lands under Different Vegetation covers

The significant increase in SOCS after burning is consistent with those reported by other studies (Zhao et al., 2012; Kara and Bolat, 2009; Pardini et al., 2004), but contrary to the results of Neff et al.,(2005) who observed that there were significantly lower stocks of Soil organic Carbon on the recently burned site compared to the unburned sites. The effect of fire on SOM is highly variable from total destruction of SOM to partially scorching depending on fire severity, dryness of the surface OM and fire type (Neary, 2004). The effect of fire on SOM is highly dependent on the type and intensity of the fire, among other factors, such as soil moisture, soil type, and nature of the burned materials. Therefore, the effect on soil processes and their intensity influenced by fire are highly variable and no generalised tendencies can be suggested for most of the fire-induced changes in humus composition (Kang and Sajjapongse 1980). Johnson, (1992) reported that low-intensity prescribed fire usually results in little increase in soil carbon, but intense prescribed fire or wildfire can result in a huge loss of soil carbon. Bagamsah (2005) indicated that the intensity of fires in Northern Ghana is lower comparably to those of the forest zones.

The difference in SOCS on burnt and unburnt lands may be due to low combustibility that left burnt plant residues and remains of macro and microorganisms that might be added to the soil in the form of ash after the burning. Savanna fire can therefore be referred to as a catalyst in enriching soil with organic carbon depending on its intensity and how the nutrient rich ash remaining on the land is managed. Gonza´lez-Pe´rezaet al., (2004) reported that increases in soil OM content and consequently soil organic carbon are due to an increased deposition of dry leaves and charred plant materials in fires. Low and moderate fire intensity is known to increase organic matter and Soil organic carbon whilst high intensity results in measurable reduction. (Gonza´lez-Pe´rezaet al., (2004) and Rashid (1987), observed an increase of C in soil after a moderate wildfire while a sharp organic C reduction occurred after a high intensity wildfire. Pyne, (2001) also stated that after a fire, there is an increase of available nutrients in soil, mainly in the form of water-soluble components of ash that became available to living organisms and therefore the ‘‘fertilizing’’ effect of fire is known since the beginning of agriculture and forestry.

Although direct burning can result in the loss of soil organic carbon as observed by other authors, this depends on many factors including the intensity of the fire and how the nutrient rich ash remaining on the land is managed. Even though works done on the same subject in the northern region of Ghana suggest bush fire as the cause for the observed decline in soil fertility (Agyemang ,2011; Abatania and Albert,1993),the reasons given by the authors are not direct burning effect rather the surface erosion of the nutrient-rich ash that remains after vegetation burning. These nutrients may be transported from the burned sites to other areas leached to lower horizons beyond plant root zones (Stark, 1977) or carried along by runoff and wind to different sites, resulting in a local loss of plant nutrients including soil organic carbon because of vegetation losses (Núñez-Delgado, 2011; Binkley and Christensen, 1992).

3.3 Correlation between % C, SOCS and Bulk Density.

Bulk density has been frequently related to SOC in soil storing large amounts of SOM (Howard et al., 1995; Arrouays and Pelissier, 1994). In this study, Pearson's statistical correlations of the mean values revealed a significantly strong negative correlation between BD & %C and BD & SOCS under all the vegetation types (Table 3). Similar results were found by other authors (Sakin et al., 2011; Mestdagh et al., 2006; Prevost, 2004). Jeffrey (1970) found that negative relationships between SOM (%C) and BD might be a universal opinion. However, a strong positively significant correlation existed between %C and SOCS (Table 3).

Table 3. Correlation Matrix and Significance of BD, % C and SOCS by depth

Variables	**R(P)-values**	
	Burnt	Unburnt
BD & %C	-0.811(0.001)	-0.710(0.010)
BD & SOCS	-0.771(0.003)	-0.636(0.026)
%C& SOCS	0.997(<0.001)	0.994(<0.001)

Note: R= correlation matrix with P= correlation significance in Parenthesis. All the correlation are significant at P<0.05 Using Pearson correlation.

The analysis of soils in the study sites as presented imply that, soils in the area are generally low in SOCS and in the face of a changing climate (increasing temperature and unreliable rainfall) soils of this kind can barely support plant growth. Consequently, increasing temperatures will accelerate the mineralisation of the rather small quantity of organic carbon (C) in the soil and also result in an increase of carbon release and CO2 into the atmosphere which largely contributes to global warming. Crops such as peanut, corn, sorghum and alfalfa which roots exceed 30cm depth will assessed little amount of soil carbon thus their growth and development is likely to be retarded.

4. Conclusion

This study clearly shows that SOCS and %C significantly decrease at an increasing depth while bulk density significantly increased at an increasing depth. Also, a significantly strong negative correlation exist between BD and %C and BD and SOCS under all the vegetation types and across depth. This implies that, soil fertility (Organic matter) might decrease across depth thus sand content of the soil might also increase as you moved down the soil layer. Vegetation types were observed to have an insignificant impact on the quantity of SOCS on unburnt lands. However, soils on CSW had highest stocks of organic carbon, while GHST recorded the lowest on both burnt and unburnt lands. Fire significantly increased SOCS on burnt lands due to the nutrient rich ash remaining on the soil after burning. However, aside vegetation cover as established in this work other environmental factors such as topography, parent materials land use contribute to SOC in a given location.

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