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SOIL ORGANIC CARBON AND NITROGEN STORAGE AND DISTRIBUTION IN THE AGRICULTURAL SOILS AS AFFECTED BY SOIL DEPTHS AND INUNDATION LAND TYPES

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Abstract

A study was initiated on soil organic carbon (SOC) and total nitrogen (TN) storage and their distribution as affected by soil depths and inundation land types selecting ideal two catena across eight soil profiles up to the depth of 120 cm in the Brahmaputra and the Ganges alluviums. Soil organic carbon and TN storage is higher in the surface soil depth than the other soil depths. The contents and distribution of SOC and TN in all the soil depths varies significantly. Moreover, inundation land types and soil depths exhibited a significant effect ($p<0.001$) on SOC and TN storage. Soil organic carbon and TN storage were higher in the lowland (LL) and medium lowland (MLL) sites than that in the highland (HL) and medium highland (MHL) sites across the alluviums, which indicates that the topographic variability as well as their water recession conditions which ultimately focuses on SOC loss or sequestration. The Brahmaputra alluvium possesses higher SOC and TN storage than the Ganges alluvium which may be due to the variability of their land use and local management practices. Proper emphasis should be given on sub soil depths and inundation levels in formulating any agricultural policy planning.

Keywords: Soil organic carbon and nitrogen, Storage and distribution, Soil depths and inundation land.

Introduction

The biogeochemical cycles of carbon (C) and nitrogen (N) in terrestrial ecosystems have received increasing attention worldwide over the past few decades because the emission of their oxides contributes greatly to global warming (Fu *et. al.,* 2010; Canadel *et al.,* 2021)). As soils contain significantly more carbon than is present as CO_2 in the atmosphere, the stability of this soil store, particularly under changing temperature and other climatic factors, is a major source of uncertainty in future climate change predictions (Knorrs *et. al.,* 2005; Davidson and Janssen, 2006). Soil is a major pool of carbon and nitrogen and plays an important role in their global cycles (Batjes, 1996). The loss of C and N via the emissions of greenhouse gases, (GHGs) (CO_2, CH_4 and N_2O)

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from soil to the atmosphere by natural or anthropogenic processes is a contributory factor to global warming. Consequently, sequestration of soil organic carbon (SOC) and conservation of total nitrogen (TN) are of increasingly scientific and political interests worldwide. Soil organic carbon and TN, often tightly coupled, are controlled by a number of natural and anthropogenic factors, including climate, vegetation, topography, parent material, intrinsic soil properties, land use and management practices (Homann *et. al.,* 1995; Ajami *et. al.,* 2016)). A better understanding of SOC and TN contents and their relationships with these controlling factors is critical to evaluate soil C and N pools as well as potentials for C sequestration and N conservation to offset anthropogenic greenhouse gas emissions. Soil organic carbon is one of the main factors affecting soil quality and agricultural productivity.

Being a source as well as storage of plant nutrients, SOC plays an important role in terrestrial C cycle (Freixo *et al.,* 2002; Elbasiouny *et al.,* 2022)). Land use has a significant effect on SOC storage, since it affects the amount and quality of litter input, litter decomposition rate, and stabilization of SOC (Bronson *et al.,* 2004). Information on global and regional SOC pool in topsoil is generally available for a variety of land use and climatic conditions (Batjes, 1996). However, study on SOC and TN storage in soils as affected by inundation land is very scanty, particularly in Bangladesh. It is widely accepted that SOC is largely concentrated in the top 30 cm of the soil, but there is a growing evidence that deeper soil horizons have the capacity to sequester high amounts of SOC (Jobbagy and Jackson, 2000; Swift, 2001) and that this should be considered for SOC emission-storage analysis. The importance of SOC sequestration in sub-soils mitigating the greenhouse effect is related to the fact that subsoil SOC occurs in fairly stable and highly recalcitrant forms to biodegradation (Batjes, 1996; Nierop and Verstraten, 2003; Lorenz and Lal, 2005). SOC surveys usually consider a fixed soil depth, typically 1 meter. Global surveys based on vegetation units (Post *et al.,* 1982) and soil taxonomic units (Eswaran *et al.,* 1993; Batjes, 1996) indicate that soil store 1500-1600 Pg C in the top one meter. However, soil carbon can be underestimated in its global budgets by fixing a lower boundary at 1m depending on the vertical distribution of SOC. Soil organic carbon content exhibits considerable variable regarding spatially, both horizontally according to land use and vertically within the soil profile (Dhakal *et al.,* 2010). The SOC diminishes with depth regardless of vegetation, soil texture, and clay size fraction (Trujilo *et al.,* 1997). Soils of the world are potentially viable sinks for atmospheric carbon and may significantly contribute to mitigate the global climate change (Lal *et al.,* 1998). However, the assessment of potential carbon sequestration in soil requires estimating carbon pools under existing land uses and its depth wise distribution in the soil profile. The objectives of this study were: (i) to estimate the SOC and TN distribution and storage across the study sites; and (ii) to assess the impact of land types and soil depths on SOC and TN distribution and storage.

Materials and Methods

Two ideal catena were selected across the two alluviums: the Brahmaputra and the Ganges, based on the land types for the current study. Forty eight soil samples from the eight profiles of the two catena at different soil depths (0-20, 20-40, 40-60, 60-80, 80-100 and 100-120 cm) were collected. Prior to analysis, the soil samples were air-dried and gently disaggregated. The soil samples were then gently ground using a mortar and pestle and passed through 2 mm sieve and mixed thoroughly. The samples were then preserved in sealed plastic containers for laboratory analysis. An outline of the site characteristics of the land types of the eight profiles is presented in Table 1.

The highland (HL) means the land which is above normal flood level. The medium highland (MHL) indicates the land which normally is flooded up to about 90 cm deep during the flood season. The medium lowland (MLL) denotes the land which normally is flooded up to between 90 cm and 180 cm deep during the flood season. Lowland (LL) states the land which normally is flooded up to between 180 cm and 300 cm deep during the flood season (FAO-UNDP, 1988).

Soil organic carbon was determined by following the method of Walkley and Black (Nelson and Sommers, 1982) and the Kjeldahl method (Bremner and Mulvaney, 1982) was used for total soil nitrogen (TSN) determination. The particle size analysis of soils was carried out by the hydrometer method as described by (Gee and Bauder, 1986). Soil bulk density was determined by using the core method as described by Blake and Hartge (1986). It may be noted that the bulk density and SOC concentration (%) are the two prerequisites for estimating SOC stock or storage. Thus, the SOC and TN storage were calculated using the following equations (Batjes, 1996; Chen *et al.,* 2007; Zhang *et al.,* 2013). Data is reported as mean± standard deviation. Two-way analysis of variance (ANOVA) was employed to assess the effects of land types and soil depths on SOC and TN storage or concentrations. One-way ANOVA was used to examine the effect of soil depths on SOC and TN storage. Regression analyses were used to test the relationships between SOC and TN storage at 0-20 cm depths, 0-60 cm depths, and 0-120 cm depths. All statistical analyses were conducted using SPSS, version 20.0.

Table 1. Information on the inundation land types of the eight profiles of the Brahmaputra and the Ganges alluvium.

Land types	Information/ Characteristics	Brahmaputra alluvium	Ganges alluvium
HL	Location	24˚08' N and 89˚ 58' E	23˚ 49' N and 89˚ 00' E
	Topographic position	Upper part of the ridges of a catena under the Brahmaputra alluvium	Upper part of the ridges of a catena under the Ganges alluvium
	Land use	Banana -Fallow	Banana/orchards-Fallow
	Soil series	Sonatala series (Aeric Endoaquepts)	Sara series (Aeric Endoaquepts
MHL	Location	24˚ 06' N and 89˚ 56' E	23˚ 51' N and 89˚ 01' E
	Topographic position	Middle part of the ridges	Middle part of the ridges
	Land use	Boro rice – Transplanted Aman rice	Boro rice –Tobacco/Transplanted Aman/Pulses
	Soil series	Silmandi series (Aeric Endoaquepts)	Ishurdi series (Aeric Endoaquepts)
MLL	Location	25˚00' N and 89˚ 45' E	23˚56' 88˚59'
	Topographic position	Moderately lower part of the ridges	Moderately gentle lower part of the ridges
	Land use	Boro rice- Fallow	Boro rice-Transplanted Aman/Fallow
	Soil series	Ghatail series (Typic Endoaquepts)	Gheor soil series (Typic Endoaquepts)
LL	Location	24˚08'89˚55'	23˚56' 88˚59'
	Topographic position	Lower part of the ridges of the Brahmaputra alluvium	Lower part of the ridges of the Ganges alluvium
	Land use	Boro- Fallow/Grazing grass	Transplanted Aman/ Rabi vegetables- Fallow
	Soil series	Balina series (Typic Endoaquepts)	Garuri series (Vertic Endoaquepts)

Results and Discussion

Soil organic carbon contents at different soil depths across the inundation land types: The highest SOC concentration was found in the topsoil (0-20 cm) across the eight land types of the two alluviums (Table 2). Soil organic carbon contents depend on the balance between organic carbon (OC) input and loss from soils (Zhuang *et al.,* 2007). Topsoil layer (0-20 cm) is tilled and receives greater residue inputs which are subsequently mineralized. Thus this layer possesses higher SOC than the other soil layers (20-120cm). Chaplot *et al.* (2010) reported that the topsoil layer may be able to sequester atmospheric CO_2 and thus mitigate climate change where more biophysical activities take place. Xiao-

Wei *et al.* (2012) noted that surface soils are rich in SOC due to being covered by highly productive vegetation or subject to long-term use of organic fertilizers or flooding conditions. Soil organic carbon in the top soil layer (0-20 cm) varies significantly ($P<0.001$) when tested using Tukey's Honestly Significant Difference (HSD). Besides, SOC concentration showed a decreasing trend from the top soil layer to the bottom layer for all land types of the Brahmaputra and the Ganges alluviums (Table 2).

The mean SOC concentration across the Brahmaputra alluvium (BA) varies from 0.41% (4.15 g/kg) to 1.15% (11.56 g/kg). Lowland sites of BA show the highest SOC concentration than the HL and MHL sites. The mean SOC concentration across the Ganges alluvium (GA) varies from 0.36% (3.61 g/kg) to 0.74% (7.48 g/kg) where low land sites show the highest SOC concentration than the HL and MHL sites (Table 2). Among the two alluviums, the Brahmaputra alluvium (BA) contains more SOC than the Ganges alluvium (GA). Low land (LL) sites contain a higher SOC concentration in both the alluviums than the other land types (HL and MHL). Thus, lowland (LL) and even medium lowland (MLL) types of the both alluviums contain higher SOC due to the nature of inundation depths. On the other hand, the HL and MHL types lose their SOC due to the increased decomposition being not inundated, erosion, and more intensive tillage (Ritchie *et al.,* 2007). Roose and Barthes (2001) noted that SOC is lost in the higher topography, through erosion, runoff and leaching where erosion and runoff contribute a large portion of carbon losses and these are highly accelerated in cultivated land as compared to undisturbed land.

Table 2. Soil organic carbon (SOC) distribution (%) at different soil depths across the eight land types of the alluviums.

Depths (cm)	Brahmaputra Floodplains				Ganges Floodplains			
	HL	MHL	MLL	LL	HL	MHL	MLL	LL
0-20	0.71	0.88	1.05	1.82	0.80	1.0	1.4	1.81
20-40	0.46	0.63	0.68	1.60	0.38	0.51	0.61	0.79
40-60	0.40	0.54	0.60	1.0	0.30	0.40	0.50	0.61
60-80	0.36	0.40	0.51	0.91	0.28	0.31	0.38	0.50
80-100	0.30	0.25	0.41	0.90	0.21	0.20	0.21	0.39
100-120	0.26	0.18	0.33	0.71	0.20	0.14	0.20	0.39
Mean± SD	0.41± 0.16	0.48± 0.25	0.59± 0.25	1.15± 0.44	0.36± 0.22	0.42± 0.31	0.55± 0.44	0.74± 0.54

TN contents at different soil depths across the inundation land types: The highest TN concentration was found in the topsoil (0-20 cm) across the eight land types like SOC. TN concentration across the four land types of Brahmaputra alluvium (BA) varied from 0.03 to 0.18% (0.30 to 1.8 g/kg) where the MLL/LL types contains the highest TN concentration and the HL and MHL contains the lowest TN concentration. TN concentration across the land types of the Ganges alluvium (GA) varied from 0.02 to 0.20% (0.22 g/kg to 2.0 g/kg) where MLL and LL sites contains highest TN concentration and the HL and MHL sites contains the lowest TN concentrations which are consistent with their SOC levels. MLL and LL types contain higher TN concentrations than the HL and MHL land types across the alluviums (Table 3). Among the two alluviums, BA contains more TN than the GA as reported for SOC. TN in the top layer varies significantly ($P<0.001$) when tested using Tukey's Honestly Significant Difference (HSD). TN concentration showed a decreasing trend downward from the top soil layer (0-20 cm) across the land types of the two alluviums.

Table 3. Total nitrogen (TN) distribution (%) at different soil depths across the eight land types of the alluviums.

Depths (cm)	Brahmaputra alluvium				Ganges alluvium			
	HL	MHL	MLL	LL	HL	MHL	MLL	LL
0-20	0.10	0.09	0.12	0.18	0.08	0.12	0.14	0.20
20-40	0.07	0.08	0.08	0.17	0.04	0.07	0.07	0.09
40-60	0.07	0.07	0.08	0.14	0.04	0.05	0.07	0.08
60-80	0.07	0.06	0.07	0.13	0.04	0.05	0.06	0.08
80-100	0.05	0.03	0.06	0.12	0.03	0.03	0.03	0.06
100-120	0.05	0.03	0.06	0.11	0.03	0.02	0.03	0.06
Mean± SD	0.07 ± 0.01	0.06 ± 0.02	0.07 ± 0.02	0.14 ± 0.02	0.04 ± 0.01	0.05 ± 0.03	0.06 ± 0.04	0.09 ± 0.05

The above result showed that the effect of land types and soil depths across the study sites on SOC is significant indicating both land types and soil depths are important factors influencing the SOC distribution across the inundation land types. A similar observation of the effect of topographic land condition and soil depths on SOC have been made by other authors (Chen *et al.,* 2007; Fang *et al.,* 2012; Fu *et al.,* 2010; Uddin *et al.,* 2019). Land types and soil depths exhibited a significant effect on SOC and TN concentration as tested by two-way ANOVA. The SOC and TN contents varied significantly ($P<0.001$) across the land types as well as soil depths. Land types and soil depths showed a significant effect on TN concentration (P<0.001) (Table 4), and the distribution of TN in soil was similar to SOC.

Table 4. Two-way ANOVA for the effect of land types and soil depths on SOC and TN.

Parameters	df	Soil Organic carbon (SOC)		Total nitrogen (TN)	
		F	P	F	P
Land types	7	34.949	<0.001	31.710	<0.001
Soil depths	5	18.865	<0.001	27.808	<0.001

The current study revealed that the highest SOC and TN concentration were found in the top soil layer (0-20 cm) in all the profiles across the alluviums. This layer is the most important part of the profile where maximum pedogenic activities take place. The high residue inputs in the surface soils may contribute to the increased SOC and TN distribution (Wu *et al.,* 2004; Liu *et al.,* 2005). SOC and TN is less variable in the deeper soil layers (60-120 cm) across the land types, than the 0-60 cm layer, which suggests that SOC and TN remained relatively stable in the soil depths between 60-120 cm. The study also showed that SOC and TN were found variable within 0-60 cm depths across the land types where most physical and chemical activities taken place. The SOC and TN contents across the land types decreased with increasing depths. On the other hand, the lowest SOC and TN were found in the HL and MHL sites and the highest SOC and TN were found in the LL sites across the two alluviums. A moderate level of SOC and TN was found in the MLL types (Tables 2 and 3).

The above results agreed with other findings (Chen *et al.,* 2007), indicating that both topographic nature and land use influence the SOC as well as TN contents. The lower SOC in the HL and MHL sites may be attributed to the reduced residue input in the soil and extensive soil erosion because of their higher elevation in the landscape and also due to intensive tillage, which is common in such land types. Guo and Gifford (2002) reported that plant roots also play an essential role in influencing SOC and TN distribution. Wei *et al.* (2009) revealed that distributions of fine roots are lower in higher topographic level than lower topographic level due to differences in vegetation. Similarly, LL and MLL types provide fine root system under anaerobic rice-rice cultivation with even residue decomposition which may also be responsible for higher SOC and TN contents in the MLL and LL types. The SOC and TN contents of the MLL and LL sites were higher than those of other land types, which may be attributed due to their inundation nature as well as their nature of farming. The topographic nature and anaerobic farming systems in the MLL and LL types may have greatly reduced the nutrients losses from reduced soil erosion. Erosion and leaching are more prevalent in the HL and MHL types because their drainage. SOC and TN losses are more prevalent in the HL and MHL sites due to the processes of erosion and runoff. Roose and Barthes (2001) noted that erosion and runoff contribute a large portion of C losses and these are highly accelerated in the cultivated land than the uncultivated soils.

Soil organic carbon and total nitrogen storage at different soil depths for different inundation land types: The average amounts of SOC storage varied from 1.70 kg/m^2 to 4.52 kg/m^2 in the 0-20 cm layer, 0.97 kg/m^2 to 2.52 kg/m^2 in the 20-60 cm layer and 0.33 kg/m^2 to 2.40 kg/m^2 in the 60-120 cm layer across the two alluviums of the eight profiles respectively. On the other hand, SOC storage across the inundation land types of the BA varied from 6.03 to 17.46 kg/m^2. SOC storage across the inundation land types of the GA varied from 5.20 to11.37 kg/m^2 (Table 5). Similar observations have been reported by several studies regarding the SOC storage. Tarnocai (1997) and Uddin *et al.* (2022) reported that average SOC content in the surface soils ranged from 4.9 to 18.7 kg/m^2. Sakin (2012) also reported that SOC content varies from 3.57 kg/m^2 to 6.47 kg/m^2 in the Harran plain soils in Southeastern Turkey. In the present study, compared with the HL and MHL sites, the SOC storage in the MLL and LL sites was higher across the two alluviums. The SOC storage decreases with increasing depths across the different land types.

Table 5. Soil organic carbon storage (kg/m^2) at different soil depths across the land types of the two alluviums.

Depths (cm)	Brahmaputra alluvium				Ganges alluvium			
	HL	MHL	MLL	LL	HL	MHL	MLL	LL
0-20	1.70	2.14	2.60	4.44	1.92	2.40	3.41	4.52
20-40	1.12	1.56	1.74	4.03	0.91	1.25	1.52	2.02
40-60	0.97	1.33	1.53	2.52	0.73	0.99	1.28	1.62
60-80	0.89	0.99	1.32	2.40	0.68	0.77	0.97	1.33
80-100	0.74	0.60	1.06	2.37	0.50	0.48	0.53	0.94
100-120	0.61	0.43	0.79	1.70	0.46	0.33	0.48	0.94
Total	6.03	7.05	9.04	17.46	5.20	6.22	8.19	11.37
Mean ± SD	1.00± 0.38	1.17± 0.63	1.50± 0.63	2.91± 1.07	0.86± 0.54	1.03± 0.74	1.36± 1.08	2.91± 1.07

TN storage in the soils was similar to SOC. The average amounts of TN storage varied from 0.20 to 0.50 kg/m^2 in the 0-20 cm layer, 0.10 to 0.42 kg/m^2 in the 20-60 cm layer and 0.07kg/m^2 to 0.34 kg/m^2 in the 60-120 cm layer across the alluviums of the eight profiles respectively. The TN storage across the inundation land types of the BA ranged from 0.85 to 2.12 kg/m^2. The TN storage across the inundation land types of the GA varied from 0.65 to1.44 kg/m^2 (Table 6). Similar observations have been reported by several studies. Carter *et al.* (1998) reported that TN in Canada farming soils ranged from 0.36 to 1.05 kg/m^2 and the TN storage in the MLL and LL sites were higher than those HL and MHL soils. They also noted that TN storage also varied with the increasing depths across different land types. Liu *et al.* (2012) also reported that the average densities of SOC and TN at a depth of 1m were about 7.72 and 0.93 kg/m^2, respectively, in the northeastern margin of the Qinghai-Tibetan Plateau. The above situation regarding SOC and TN contents are consistent with Bangladesh situation because plateau margin occupies alluvial characteristics similar to the alluvial soils of Bangladesh.

Table 6. Total nitrogen storage (kg/m^2) at different soil depths across the land types of the two alluviums.

Depths (cm)	Brahmaputra alluvium				Ganges alluvium			
	HL	MHL	MLL	LL	HL	MHL	MLL	LL
0-20	0.24	0.21	0.30	0.44	0.20	0.28	0.34	0.50
20-40	0.19	0.19	0.21	0.42	0.11	0.17	0.17	0.24
40-60	0.19	0.17	0.20	0.35	0.10	0.12	0.17	0.21
60-80	0.17	0.14	0.18	0.34	0.10	0.12	0.15	0.21
80-100	0.12	0.07	0.15	0.31	0.07	0.07	0.07	0.14
100-120	0.11	0.07	0.14	0.26	0.07	0.07	0.07	0.14
Total	1.02	0.85	1.18	2.12	0.65	0.83	0.97	1.44
Mean ± SD	0.17± 0.04	0.14± 0.06	0.19± 0.05	0.35± 0.06	0.10± 0.04	0.13± 0.07	0.16± 0.09	0.23± 0.13

The effect of soil depths on SOC and TN storage in soils are presented in Table 7. Soil depths had significant influence ($P<0.05$) on SOC and TN storage as assessed by a one-way ANOVA study.

Table 7. One-way ANOVA for the effect of soil depths on SOC and TN storage in soils.

Depths (cm)	df	Soil Organic carbon (SOC)		Total nitrogen (TN)	
		F	P	F	P
0-20	8	28.034	<0.05	17.308	<0.05
20-60	8	6.281	<0.05	6.179	<0.05
60-120	8	8.446	<0.05	8.560	<0.05

F and P values, from one-way ANOVA; df is degrees of freedom; All values show significant at P<0.05

The relationships between SOC and TN storage among the topsoil (0-20 cm) and deeper layers (0-60 cm), and (0-120 cm) are shown in Figs. 1-4. All the changes in SOC and TN storage with increasing depths were evaluated using regression equations. The relationships of SOC storage between the soil depths 0-20 cm and 0-60 cm (Fig. 1), and 0-20 cm and 0-120 cm (Fig. 2) show strong correlations (r = 0.92 and 0.85 respectively). Likewise, the relationship of TN storage between the soil 0-20 cm and 0-60 cm depths (Fig. 3) and 0-20 cm and 0-120 cm depths (Fig. 4) show strong correlations (r = 0.86 and 0.80 respectively). In this study, mean SOC and TN storage calculations also showed that SOC was higher in the surface soil (0-20 cm depth) than that in the deeper layers (Tables 1-2). This is consistent with the findings of Zhang *et al.,* (2011). On the other hand, SOC and TN storage was higher in the LL and MLL sites than that in the HL and MHL sites (Tables 1-2) across the alluviums, which indicates that the topographic variability as well as their water recession conditions are related to carbon loss or sequestration. Ritchie *et al.,* (2007) reported that topographic patterns and processes involved in SOC redistribution across agricultural landscapes are the key to understanding the potential for SOC dynamics. In the present study, SOC and TN storage was higher in the surface level (0-20 cm) than the deep layers (60-120 cm) across the study sites.

On the other hand, mean SOC and TN storage was higher in the Brahmaputra alluvium (BA) than the Ganges alluvium (GA). Soil organic carbon storage increases as it progresses from HL towards LL across the land types of BA and GA (Fig. 5); similarly, TN storage increases from HL to towards LL across the land types of BA and GA (Fig. 6). The low SOC in the soils of HL and MHL sites is linked to the removal of crop residues, deterioration of soil aggregation due to intensive tillage (Stoate *et al.,* 2001; Hamza and Anderson, 2005). The highest SOC densities were found in MLL and LL sites in each alluvium where these lands are utilized by irrigated paddy cultivation. Higher SOC densities in flooded paddy soils agrees well with previous studies (Jia-Guo *et al.,* 2010) and is explained by natural fertility of wetlands and other lowlands and by the long-term use of organic fertilizers and flooding, which provide a strong supply of organic carbon (OC) with lower decomposition rates (Wang *et al.,* 2003).

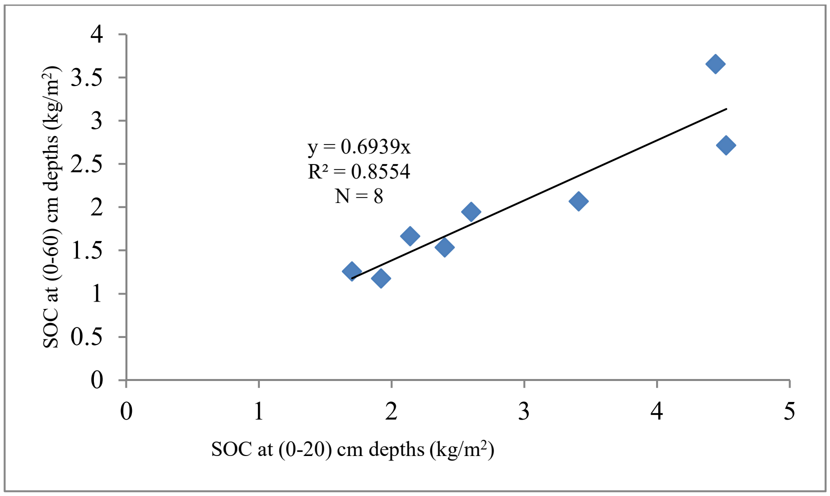

Fig. 1. Relationship of SOC storage between the soil depths 0-20 cm and 0-60 cm in the eight profiles of the two alluviums.

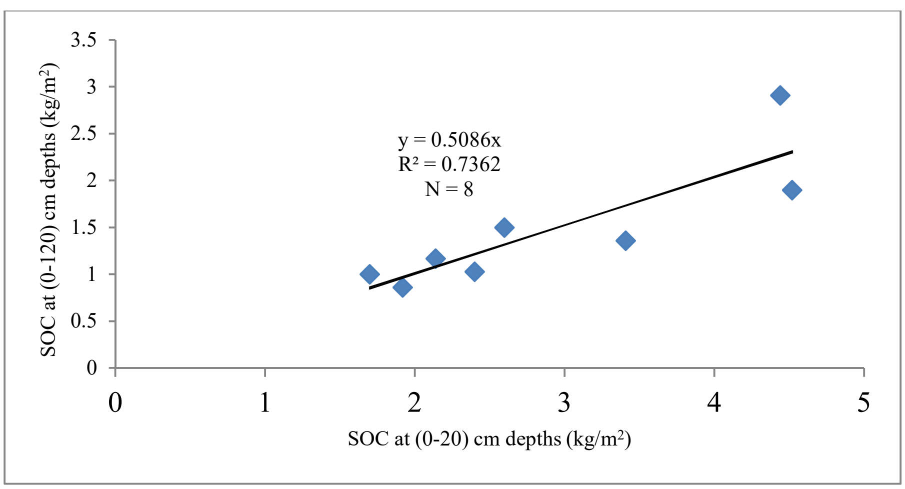

Fig. 2. Relationship of SOC storage between the soil depths 0-20 cm and 0-120 cm in the eight profiles of the two alluviums.

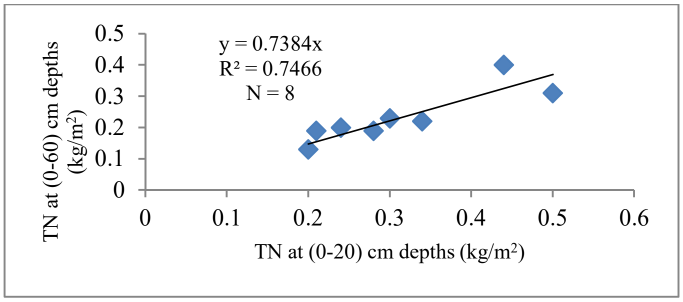

Fig. 3. Relationship of TN storage between the soil depths 0-20 cm and 0-60 cm in the eight profiles of the two alluviums.

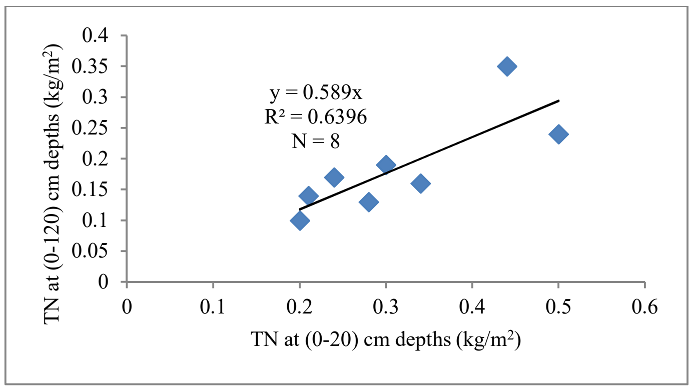

Fig. 4. Relationship of TN storage between the soil depths 0-20 cm and 0-120 cm in the eight profiles of the two alluviums.

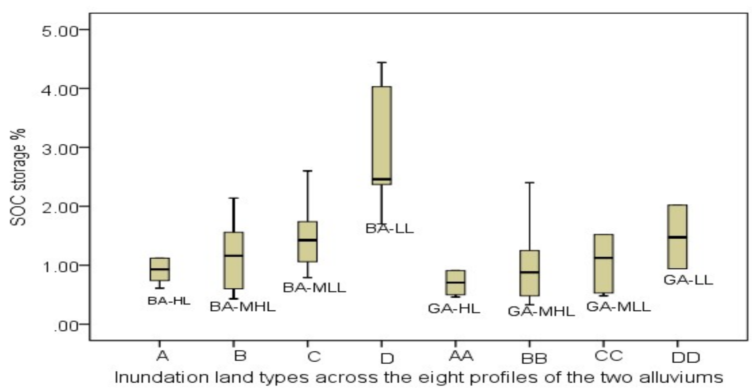

Fig. 5. Boxplots showing SOC storage (%) across the eight profiles of the two alluviums (A, B, C, and D: SOC storage (%) at HL, MHL, MHL and LL respectively across the Brahmaputra alluvium; AA, BB, CC, and DD: SOC storage (%) at HL, MHL, MLL and LL respectively across the Ganges alluvium).

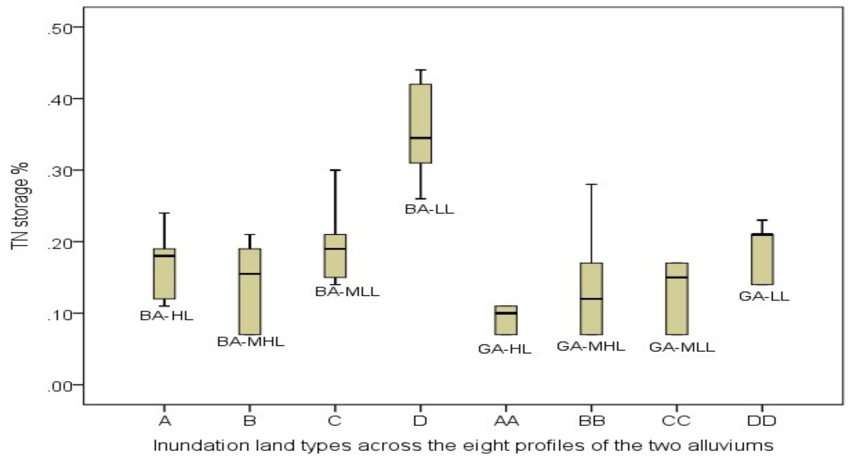

Fig. 6. Boxplots showing total nitrogen (TN) storage (%) across the eight profiles of the two alluviums (A, B, C, and D: TN storage (%) at HL, MHL, MLL and LL respectively across the Brahmaputra alluvium; AA, BB, CC, and DD: SOC storage (%) at HL, MHL, MLL and LL respectively across the Ganges alluvium).

Conclusion

The results showed that land types and soil depths significantly affect SOC and TN distribution, as well as their storages in soils. The SOC and TN contents in the surface layer are higher than those in the deeper layers due to the high residue inputs. Lower land elevation has higher SOC and TN than the higher land elevation across the Brahmaputra and the Ganges alluviums. The variation in SOC and TN distribution and storage is related to land variability and the inundation nature of the land across the study sites.

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