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Variation of bulk density and organic matter in soils of tea garden belt of undivided Darrang district, Assam

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Abstract

Quantitative measures to monitor soil physical properties like bulk density and organic matter are more developed now and are still being explored as to how these measures control the total pore space and pore size distribution in soil. The present study has been undertaken to study the variation of SOM and ρ_b in and around some selected tea gardens of Darrang district, Assam for strengthening regional soil quality database so that purpose-oriented soil assessments and predictions can be made in the area. Thirty soil samples were collected from the study area and analysed for SOM and ρ_b as per standard procedures. The study reveals SOM and ρ_b in the area exhibit an unsymmetrical distribution with a long tail either on the right or left side of the mean. It is, therefore, important that we value and conserve our soils so that they will continue to be useful in the future.

Key Words: Compaction, Bulk density, Soil organic matter, Soil quality.

Introduction

Assessment of soil quality requires the measurement of the present state of the soil and judgements about its suitability for use. Soil physical properties like bulk density and organic matter control the total pore space and pore size distribution in soil. Bulk density (ρ_b) is a measure of the mass of particles that are packed into a volume of soil. It is useful in estimating, evaluating, and calculating many physical soil properties. The measurement of ρ_b provides a relative value of the porosity and compaction of a soil. Thus, ρ_b is an important soil structure attribute. Saxton et al. estimated generalized bulk densities and soil-water characteristics from texture and developed a set of equations from which soil-water characteristic equations for a number of soil textural classes can be derived [1]. One of the dominating factors changing ρ_b is the soil's organic matter (SOM) concentration that alters the soil's compressibility [2]. The term SOM has been used in different ways to describe the organic constituents of soil. Baldock and Skjemstad defined the term as "all organic materials found in soils irrespective of origin or state of decomposition" [3]. Adams estimated the change in soil bulk density from change in soil organic matter and organic carbon content [4]. Loss of organic matter from soil is a cause for concern because organic matter contributes to soil quality in many ways. Because of the many useful effects on soil quality, retention of soil organic matter is a high priority in sustainable soil management. The benefits of increasing soil organic matter include carbon sequestration and an increase in the capacity of the soil to store water and nutrients. No previous work to explore the distribution pattern of ρ_b and SOM was found in Darrang district, Assam. Although various chemical parameters of soil quality in the tea garden belt of Lakhimpur, Darrang and Sonitpur district of Assam was reported [5, 6, 7, 8], there is no earlier statistics available for ρ_b and SOM. Thus, the present study has been undertaken to study the variation of SOM and ρ_b in and around some selected tea gardens of Darrang district, Assam in order to strengthen the national and local soil quality database so that purpose-oriented soil assessments and predictions can be made in the area.

Materials and Methods

The study area Darrang district is situated in the eastern parts of India on the northeast corner of Assam. Located on the bank of mighty river Brahmaputra, the district is largely plain. Geographically, the district lies between $26^0 25^/$ and $26^0 55^/$ northern latitude and $91^0 45^/$ and $91^0 20^/$ eastern longitude (approximately). The district covers an area of 3,465.30 km^2 and falls under sub-tropical climatic region, and enjoys monsoon type of climate. Thirty soil samples were collected in and around the six selected tea gardens by adopting simple random sampling technique by maintaining a distance of about 50 meters between two samples during January to June, 2008. Soil sampling locations are presented in Table 1.

Table 1: Soil sampling locations

Sl. No.	Name of the Teagarden	Sample No's (Inside)	Number of Samples	Sample No's (Outside)	Number of Samples
1	Tangoni	A1-A3	03	A11-A12	02
2	Paneri	B1-B3	03	B11-B12	02
3	Dimakusi	C1-C3	03	C11-C12	02
4	Corramore	D1-D3	03	D11-D12	02
5	Ghagrapara	E1-E3	03	E11-E12	02
6	Singrimari	F1-F3	03	F11-F12	02

Bulk density was measured by cylindrical core method [9]. Soil organic carbon content in % was measured by following the procedure of Nelson and Sommers [10]. % Soil organic matter was calculated by using the equation:

% soil organic matter = % organic Carbon x 1.724 [11]

Results and Discussion

To look into the trend and distribution patterns of ρ_b and SOM in the soils of tea garden belt of Darrang district, data were exposed to several statistical treatments. Experimental data and conventional descriptive statistics based on normal distribution have been presented in Table 2 and 3 respectively.

Table: 2 Experimental data of SOM and bulk density in the study area

Sample No	SOM (%)	ρ_b (g/cm^3)
A1	1.48	0.775
A2	2.02	0.791
A3	3.48	0.991
B1	4.19	1.033
B2	3.31	0.994
B3	1.49	0.876
C1	5.00	0.921
C2	3.05	0.689
C3	2.79	1.090
D1	6.07	1.300
D2	3.52	1.450
D3	2.63	1.110
E1	3.90	1.230
E2	3.24	1.360
E3	3.05	1.320
F1	3.31	1.020
F2	3.05	1.480
F3	2.81	1.320
A11	3.50	0.866
A12	3.31	0.956
B11	3.26	1.130
B12	4.12	1.240
C11	2.09	1.010
C12	1.69	0.891
D11	1.34	0.791
D12	4.12	0.871
E11	2.95	0.987
E12	2.00	0.998
F11	4.83	1.010
F12	2.03	1.580

Table: 3 Descriptive statistics of experimental data

Descriptive Statistics	SOM (%)		ρ_b (g/cm^3)	
	Inside tea gardens	Outside teagardens	Inside tea gardens	Outside teagardens
Mean	3.244	2.936	1.097	1.027
Standard error	0.263	0.319	0.056	0.061
95% Confidence Interval for Mean	[2.670-3.798]	[2.234-3.640]	[0.98- 1.22]	[0.893-0.162]
5% Trimmed mean	3.185	2.920	1.099	1.010
Median	3.145	3.105	1.062	0.993
Variance	1.242	1.224	0.057	0.045
Standard deviation	1.114	1.107	0.239	0.212
Minimum	1.480	1.340	0.689	0.790
Maximum	6.070	4.830	1.480	1.580
Range	4.590	3.490	0.791	0.790
Inter quartile range	0.865	1.958	0.410	0.224
Skewness	0.766	0.176	0.007	1.776
Kurtosis	1.603	-1.113	-1.071	3.780

The bulk density of soil is inversely related to the porosity of the same soil. High bulk density is an indicator of low soil porosity and soil compaction. At the same time, bulk density also increases with clay content. The soil texture in the study area is classified as clay. The mean bulk density of soil inside and outside the tea gardens of the study area was found to be 1.097gm/cm^3 and 1.027gm/cm^3 respectively. The soils of the study area, thus, have low permeability and the decrease in soil porosity means that plant roots are often physically impeded by compact subsoil layers. This also implies that the subsoil of the area cannot held sufficient amount of available nutrients and water. The soils in the area are likely to exhibit properties which are somewhat difficult to manage or overcome. For example, soils in the area are often too sticky when wet and too hard when dry to cultivate. Subsoil in most of the sampling stations is found to be never wet up properly and others can have high mechanical impedance or poor aeration resulting in poorly developed root systems. The skewness and kurtosis values for bulk density inside and outside the tea gardens indicate that its distribution in the study area is not uniform with a long right tail with respect to the mean. Wide data range and high standard deviation obtained for bulk density in both inside and outside the tea gardens also likely to bias the normal distribution statistic in the area.

Monitoring soil organic carbon levels provides a good measure of the fertility of the soil. Good soils are generally understood to be sandy loom soils high in organic matter (4-10%). The soil samples in and around the tea gardens of Darrang district, Assam are found to contain low organic matter and are, therefore, difficult for plant root penetration. Within the study area there is a wide variety of soils. Some are highly productive and extremely important for agriculture, while others are thin and infertile with low agricultural potential. It may be due to sewage containing toxic metals, precipitation of acidic and other airborne contaminants as well as persistent use of fertilizers and pesticides in the tea gardens. Typically soil organic carbon varies as a function of climate and land use. It generally follows continental rainfall and temperature patterns. The climate is also not conducive to production and retention of high levels of organic matter. The distribution of SOM in the study area is found to be highly unsymmetrical. Positive skew obtained for SOM indicates an asymmetric tail extending towards higher values. Positive kurtosis data inside the tea garden indicates a sharp distribution while negative kurtosis outside the tea gardens indicates a flat distribution pattern of SOM.

Conclusion

A comprehensive analytical and statistical analysis of distribution of soil bulk density and SOM in both inside and outside the tea gardens of Darrang district, Assam has been presented. Setting and monitoring physical properties of soil is important to ensure that soil function is maintained, not only for the current land use, but also for potential future uses. Statistical observations show bulk density and SOM exhibit an asymmetric distribution with a long tail either on the right or left side of the mean in the study area. Wide data range, high standard deviation, differences between mean and median, significant skewness and kurtosis value indicate that the distribution of the studied parameters in the study area is widely off normal. It is, therefore, important that we value and conserve our soils so that they will continue to be useful in the future.

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References

[1] KE Saxton; WL Rawls; JS Rosenberger; RI Papendick. *Soil Sci. Soc. Am. J.,* **1986,** *50,* 1031-1036.
[2] J Ruehlmann; M Körschens. *Soil Sci Soc Am J.,* **2009,** *73,* 876-885.
[3] JA Baldock; JO Skjemstad. Soil organic carbon/soil organic matter, In: K.I. Peverill et al. (ed.) Soil analysis: An interpretation manual, CSIRO Publishing, Melbourne, Australia, **1999,** pp. 159–170.
[4] WA Adams. *J. Soil Sci.,* **1973,** *24,* 10-17.

[5] B Bhuyan; HP Sarma. *Ecol. Env. & Cons.,* **2006,** *12(1),* 75-79.
[6] KK Borah; B Bhuyan; HP Sarma. *Int. J. Chem. Sci.,* **2009,** *7(3)*,1563-1574.
[7] J Dutta; B Bhuyan; AK Misra. *Int. J. Chem. Sci.,* **2008,** *6(2),* 1099-1105.
[8] J Dutta; B Bhuyan; AK Misra. *J. Pharm. Chem.* **2009,** *3(4),* 116-120.
[9] MA Arshad; B Lowery; B Grossman. Physical Tests for Monitoring Soil Quality. In: JW Doran; AJ Jones (ed.) Methods for assessing soil quality, Madison, WI, **1996,** pp.123-41.
[10] DW Nelson; LE. Sommers. Total carbon, organic carbon, and organic matter. In: AL Page; RH Miller; DR Keeney (ed.), Methods of Soil analysis, Part 2, Chemical and Microbiological Properties. American Society of Agronomy and Soil Science Society of America, Madison, Wisconsin, **1982,** pp. 539–579.
[11] LE Allison. Organic carbon, In CA Black (ed.). Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, Agronomy No. 9, Madison, WI: American Society of Agronomy, **1965,** pp. 1367-1378.