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Estimating Status of Soil Organic Carbon in Tropical Forests of Narmada Forest Division, Gujarat, India

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Abstract

Present study deals with the assessment of organic carbon content in the tropical forest soils of Narmada Forest Division (NFD). Soil samples were collected during summer season by stratified random sampling method. Soil samples were collected from two depth class 0-15cm and 15-30cm. In 0-15 cm layer of Dry Deciduous Forest (DDF) showed Organic carbon content (Percentage) is in the range of 1.3±0.1 to 1.8±0.5 while, in 15-30cm it is in the range of 0.9±0.2 to 1.5±0.5. In 0-15 cm layer of Moist Deciduous Forest (MDF) showed Organic carbon content percentage is in the range of 1.1±0.3 to 1.8±0.3 while in 15-30cm it is in the range of 0.7±0.5 to 1.9±0.3. In 0-15 cm layer of Riverine Forest (RF) showed Organic carbon content is in the range of 1.2±0.2 to 1.9±0.1 while in 15-30cm it is in the range of 1.0±0.7to 1.7±0.4. Topography analysis shows that slope of all forest type possess highest Organic Carbon (OC) 1.8 Percentage.

Keywords: TDF, DDF, riverine forest, organic carbon percentage, narmada forest, soil.

Introduction

Tropical forest soils are rich in nutrients and it has supported enormous floral diversity and it has been suggested to conserve this diversity through sustainable management practices[1]. The soil, water, climate, flora and fauna constitute the basic natural resources and the national treasure of any country. The soil basic source to produce food, fodder, fuel and fiber and other require necessities of the human being. The formation of these soils is mainly governed by the characteristic deposition of organic matter derived from forest growth. Forest soils are heterogeneous in nature and their character changes with parent rocks, ground-configuration and climate. Consequently, they differ greatly even if they occur in close proximity to one another[2]. Soil Organic Carbon (SOC) is fundamental to the maintenance of soil fertility and function. Soil is key indicator of soil quality and influence a wide range of soil physical, biological and chemical properties[3].

Soil organic carbon (SOC) has following two major functions; First, SOC is primary component of soil organic matter (SOM), which plays important role in increasing water holding capacity, retaining, and some nutrient by Cation exchange (Eg. Ca^{2+}, Mg^{2+}, K^{+}) releasing other nutrients as organic matter (Eg. N, P and S) and capturing potential toxic agents like Mercury.[4] All the SOC found in the soil is primarily plant-derived. The two main sources of SOC in the soil are: i. Accumulation of SOM due to the humification after plant death and ii. Root exudates and other root-borne organic substances released into the rhizosphere during plant growth as well as sloughing of root hairs and fine roots by root elongation[5]. Therefore, following are two major objectives will cover in present stusy i) to assess the status of soil organic carbon percentage in Tropical Forests of Narmada Forest Division (NFD). ii) Forest type and topography wise analysis of SOC Percentage in Dry Deciduous Forest (DDF), Moist Deciduous Forest (MDF) and Riverine Forest (RF) of the study area.

Study Areas: Narmada Forest Division is administratively charged by the Surat Forest Circle in Gujarat State. It lies between 72.4º to 73.15º East (Longitude) and 21.24º to 22º North (Latitude). The geographical area of the Narmada District is 2755 Sq. km. which constitutes of 540.6 Sq. km Reserve Forest area (Excluding Protected Forest Area) which is 19.6% of total Geographical area. The district shares its border with the State of Maharashtra and is bounded with Surat in the South, Vadodara in the North, and Bharuch in the West[6]. The district is categorized into four blocks (*Talukas*), which includes Nandod, Sagbara, Tilakwada and Dediapada (figure-1). Climate of our present study area is periodical with three well distinct season's: Winter (November to February), Dry Summer (March to July) and Monsoon (June to September). The temperature varies in the range between a minimum of 10°C (average) in the winter and maximum 43°C (average) in the peak of summer. Monsoon usually starts in June and last up to September. July month gains maximum rainfall during entire Monsoon with the average rainfall of 1000mm per annum. The shower continues up to the second weeks of October[7].

Material and Methods

Soil samples were collected by Stratified Random Sampling (SRS) method using traditional grab technique in Summer Season due to avoid the negative impact of variation of moisture content on the collected soil and maintain uniformity of period.

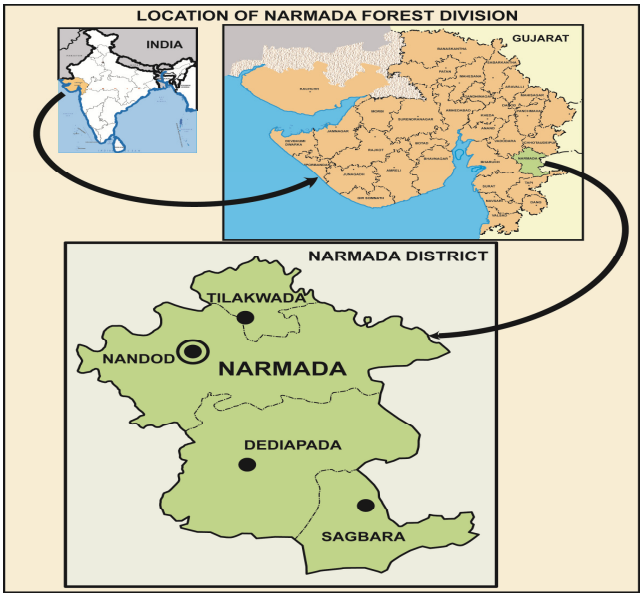

Figure-1
Location of Narmada Forest Division (Source: Author's developed from basic maps)

10 field days were spent in entire forest area of Narmada. Soil samples were very systemically collected by using suitable tools such as Hand hoe and were stored in properly coded zip lock polythene bags. Each soil sample was collected in two layers viz. 0-15 cm and 15-30 cm. The depth of layer was measured by using scale and tailor tap (30 cm). Soil samples were collected from distinct locations comprises of 10 Villages in coverage of 5 Forest Ranges and all 4 Blocks (*Talukas*) of entire Narmada Forest Division. Total 90 samples from 45 point locations were collected from entire forests of Narmada. Coordinates of the sample point location were marked by using GPS (Global Positioning System) and superimposed in following map (Figure- 2). Later on, collected soil samples were analysed using standard protocol Walkley and Black in the laboratory and Soil Organic Carbon percentage of all 90 samples were determined.

In Narmada Forest Division (NFD), soil samples were collected from both Forest and Non- Forest area based on the SRS method which has following five strata: Forest types (Three predominant forest types), Forest density classes (Three viz. Very Dense, Dense and Open), Topography (Hill tops, Hill slopes and Valley), Non Forest area- about 1000 meter away from the edge of the Forest and avoiding farmlands (Wasteland, Pasture etc.), Soil depth- two classes (0 to 15 cm top soil and 15-30 cm bottom soil), Total 90 soil samples were collected during study as per following Soil sample collection Model given in the table-1 and figure-2-3. After laboratory treatment, the Organic Carbon Values were calculated using standard equations proposed under Walkley and Black protocol. Later, the values were computed in MS-Excel Version-2007. The analysis was made between all selected above strata's. Mean ± SD was analyzed and Following Results were obtained, which are detailed further in table-2.

Result and Discussion

Findings of present study showed, Organic Carbon percentage (OC%) is high in 0-15 cm layer of inside Forest in all Forest types i.e Dry Deciduous Forest (DDF), Moist Deciduous Forest (MDF) and Riverine Forest (RF) except in outside forest back of Dry Deciduous Forest (DDF), Outside forest front of Moist Deciduous Forest (MDF) and Inside Forest hills, Outside forest front of Riverine Forest (RF), figure-4,5 and 6. Another study also showed that the organic carbon contents were lower than that of the surface. Organic carbon does not seem to translocate down through soil profile. The upper layers of soil generally have more favorable conditions for microbial activity in the process of organic matter decomposition[8].

Table-1
Soil sample collection strata's in present study

S. No.	Sample Location	Forest Type	Forest Density	Topo graphy	Depth Soil Layer	Total Collected Samples
1	Inside forest	3	3	3	2	54
2	Outside forest	3	3	2	2	36
Total Soil samples collected in Narmada Forest Division (NFD)						90

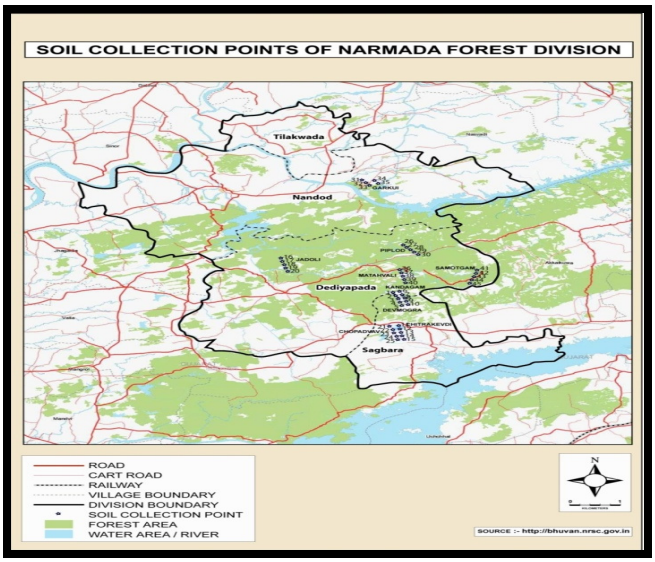

Figure-2
Point locations of collected soil samples from Narmada Forest Division (NFD)

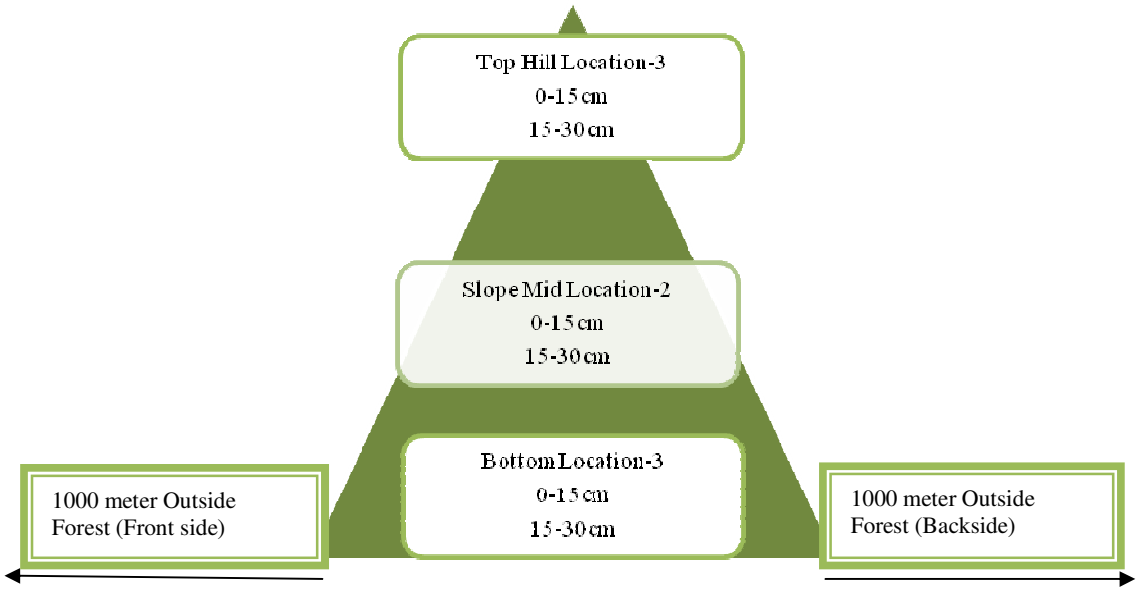

Figure-3
Soil Sample Collection Field Model in NFD, Gujarat

In the analysis of topography i.e. hills, slope and bottom the slope of all forest type i.e. Dry Deciduous Forest (DDF), Moist Deciduous Forest (MDF) and Riverine Forest (RF) are showing highest Organic Carbon (OC) contents i.e. 1.8±0.5 and 1.8±0.3. The data showed considerable difference of soil organic carbon in different type of forest. In Dry Deciduous Forest (DDF) and Moist deciduous Forest (MDF) showed highest organic carbon contents in inside forest of Slop, 1.8±0.5 while Riverine Forest (RF) showed highest contents in 0-15 cm layer of Outside back, 1.9±0.1 (table-2, figure-4,5 and 6). Organic Carbon (OC) contents in the present study is almost similar to the soils of Shoolpaneshwar sanctuary (1.52±0.53 to 1.6±0.47) done by Rathore and Jasrai[9].

In 0-15 cm layer of Dry Deciduous Forest (DDF) showed Organic carbon content is in the range of 1.3±0.1 to 1.8±0.5 while in 15-30cm it is in the range of 0.9±0.2 to 1.5±0.5. Almost similar organic carbon content i.e. 1.7 % was found in the soil of Jambughoda Wildlife Sanctuary, India[10]. In 0-15 cm layer of Moist Deciduous Forest (MDF) showed Organic carbon content is in the range of 1.1±0.3 to 1.8±0.3 while in 15-30cm it is in the range of 0.7±0.5 to 1.9±0.3[11]. According Mohanraj et al., in Moist Deciduous Forest (MDF) of Tamil Nadu total organic carbon ranged from 1.3to 1.7%. In 0-15 cm layer of Riverine Forest (RF) showed Organic carbon content is in the range of 1.2±0.2 to 1.9±0.1 while in 15-30cm it is in the range of 1.0±0.7to 1.7±0.4.

Table-2
Soil Organic Carbon (SOC%±SD) in forest areas of Narmada Forest Division (NFD), Gujarat

Locations	Topography	Soil Depth (in cm)					
		DDF		MDF		RF	
		(0 - 15 cm)	(15 - 30 cm)	(0-15 cm)	(15-30 cm)	(0 - 15 cm)	(15 - 30 cm)
Inside Forest	Hills	1.3±0.1	1.2±0.2	1.6±0.7	1.3±0.5	1.7±0.5	2.1±0.3
	Slope	1.8±0.5	0.9±0.2	1.8±0.3	1.6±0.4	1.8±0.5	1.7±0.4
	Bottom	1.5±0.5	1.4±0.6	1.2±0.8	1.0±0.1	1.2±0.2	1.1±0.8
Outside Forest	Front	1.3±0.5	1.1±0.3	1.6±0.5	1.9±0.3	1.1±0.7	1.2±0.3
	Back	1.4±0.4	1.5±0.5	1.1±0.3	0.7±0.5	1.9±0.1	1.0±0.7

Note: DDF= Dry Deciduous Forest, MDF= Moist Deciduous Forest, RF= Riverine Forest

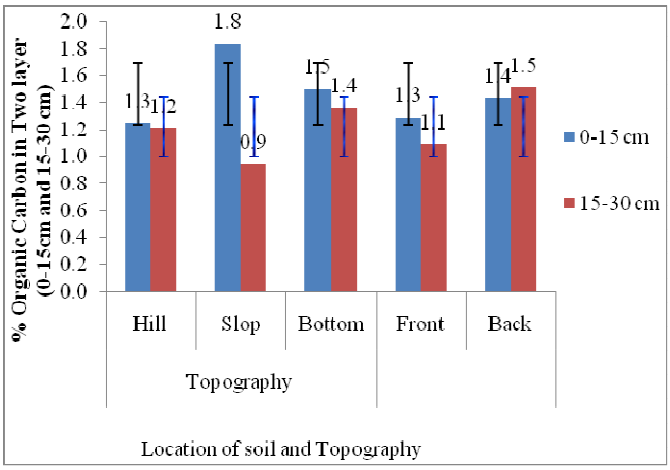

Figure-4
Dry Deciduous Forest (DDF)

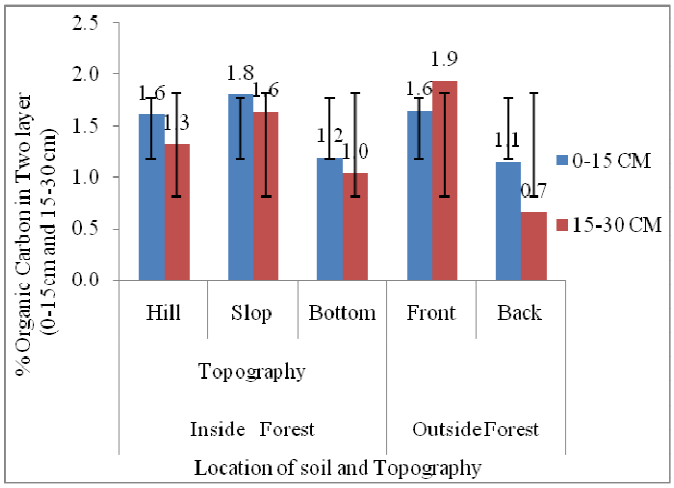

Figure-5
Moist Deciduous Forest (MDF)

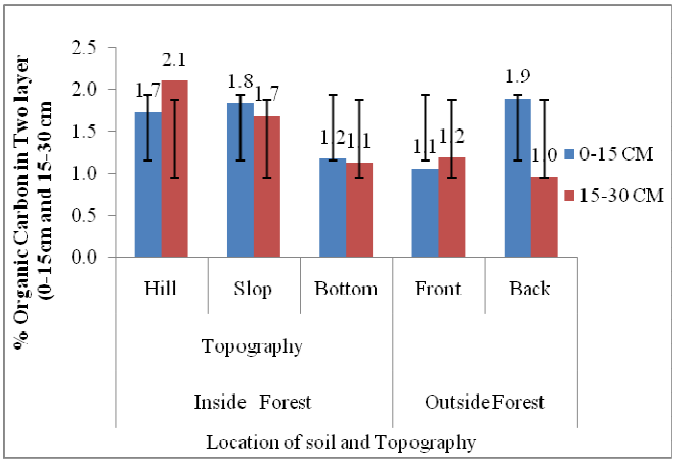

Figure-6
Riverine Forest (RF)

Conclusion

From above study, it can be concluded that soils of present study area are enriched with higher amount of SOC percentage in Tropical Forests of Narmada Forest Division. SOC% is high in 0-15 cm layer of inside Forest including all forest types which are Dry Deciduous Forest (DDF), Moist Deciduous Forest (MDF) and Riverine Forest (RF). The areas outside of the Forests were found to be less SOC% in soils due to lack of vegetation. The area with less SOC% are outside forest back of Dry Deciduous Forest (DDF), Outside forest front of Moist Deciduous Forest (MDF) and Inside Forest hills, Outside forest front of Riverine Forest (RF). The reason of higher SOC% in 0-15cm layer is due to higher deposition of litter and Forest floor inside the Forests soils. So from the surface (0-15 cm) while the subsurface of 15-30 cm layers has less amount of SOC%. Topography and Forest slopes possess maximum SOC% while outside Forest areas have relatively very less SOC% (figure-4,5 and 6). Therefore it can be concluded that SOC% varies widely with forest type and topography.

Acknowledgment

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