SOIL ORGANIC CARBON APPRAISAL IN A SEMI-EVERGREEN FOREST, EASTERN GHATS OF INDIA AS A RESULT OF DEGRADATION – A GEOSPATIAL STUDY

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ABSTRACT: Tropical forests have variety of biodiversity values, which provide invaluable services to the living being on earth. In the recent years, tropical forests are regarded as valuable global resources that act as sink for carbon dioxide in order to mitigate global climatic change. In many parts of the world, tropical forests are being rapidly cleared by various means. Soil organic carbon (SOC) is concentrated in the upper 12 inches of the soil. So it is readily depleted owing to the degradation activities. In the present study, it was aimed to assess the magnitude of disturbance in the availability of SOC in a semi- evergreen forest, situated in the Eastern Ghats of Tamil Nadu, India. The forest density of this region was mapped with QuickBird satellite data. Intensive field soil sampling and floristic study were conducted to estimate the SOC status in different density classes and to identify the species availability. The SOC density ranged from 274.06 t/ha to 147.84 t/ha in the very dense and degraded semi-evergreen forest respectively. The SOC content was also varied from 3.70 to 1.83 % in the very dense semi-evergreen and medium semi-evergreen forests respectively. The species composition in different density classes was also varied considerably. As a result of this study, it was identified that the disturbance to forests by various means not only affect the density of forests but also affect the below ground SOC status proportionately.

KEY WORDS: Soil organic carbon, Tropical forest, remote sensing, GIS

1. INTRODUCTION

Forests are considered to be one of the rich biological resources in the world. They serve the living beings on the earth in many ways. Tropical forests attain unique position among various forest types as they possess rich biodiversity. Apart from serving the mankind, forests acts as a global climatic balancer. It plays an important role in reducing the carbon dioxide concentration from the atmosphere (Lal 2001). When the forest is undisturbed, it acts as a sink and when it is disturbed, it acts as a source (Lal 2002).

In recent days, forests are disturbed by various means such as, deforestation, shifting cultivation, forest fire, illegal and selecting felling, grazing, etc (Lal 2001, UNEP 1992). As a result of these disturbances, the forests are getting depleted and degraded day by day (Balpande *et al.,* 1996, Lal 2003). At this juncture, it is our prime duty to conserve the forests by employing various management strategies. For effective management of forests, it is necessary to understand the present status of forests in terms of type, density and underground soil conditions. Soil plays a major role in the development and establishment of forests in any region (Turner *et al.,* 1995, Potter *et al.,* 1999). The various physico-chemical properties of soil determine the growth and development of any forest types (Richards and Stokes, 2004). Soil organic carbon (SOC) is one such property, which determines many characteristics of soil such as, nitrogen availability, water holding capacity, microbial activity, etc. Thus SOC can be used as an indicator to assess the status of soil in any region. In the present study, it was aimed to assess the SOC status in a Tropical semi-evergreen forests situated in the Eastern Ghats of Tamil Nadu, India.

2. STUDY AREA

The Semi-evergreen forest is situated in one of the hills of Eastern Ghats of Tamil Nadu, India above the river Cauvery. The total area belongs to the study area is about 3962.23 ha. Geographically it is situated between 11° 15' 11" - 11° 22' 15" N and 78° 19' 49" - 78° 25' 00" E (Figure 1).

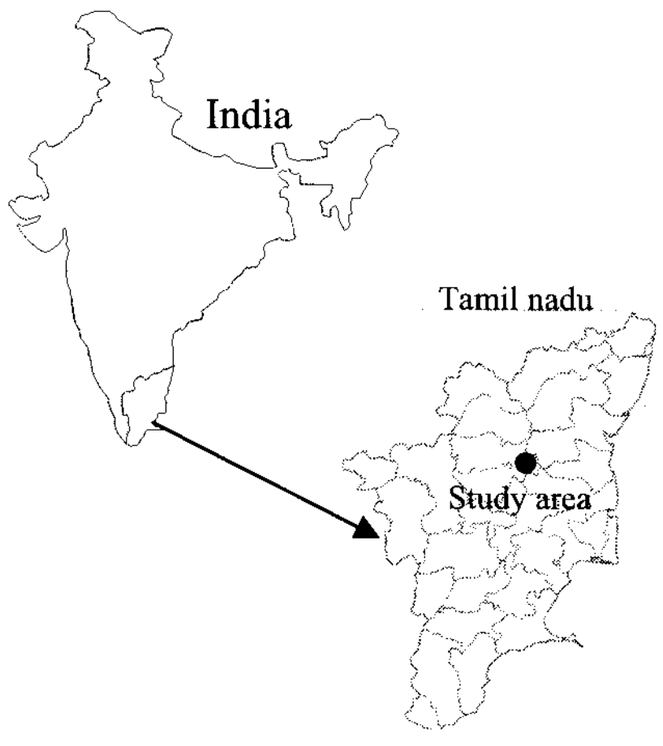

Figure 1. Location map of the study area

3. MATERIALS AND METHODS

In the present study, QuickBird satellite data acquired on 2005 September is used (Figure 2). The Survey of India (SOI) topographical maps on 1:50,000 scale, Leica GS 20 PDM Global positioning system (GPS), Erdas Imagine 9.1 Image processing and ArcGIS 9.1 GIS software were used.

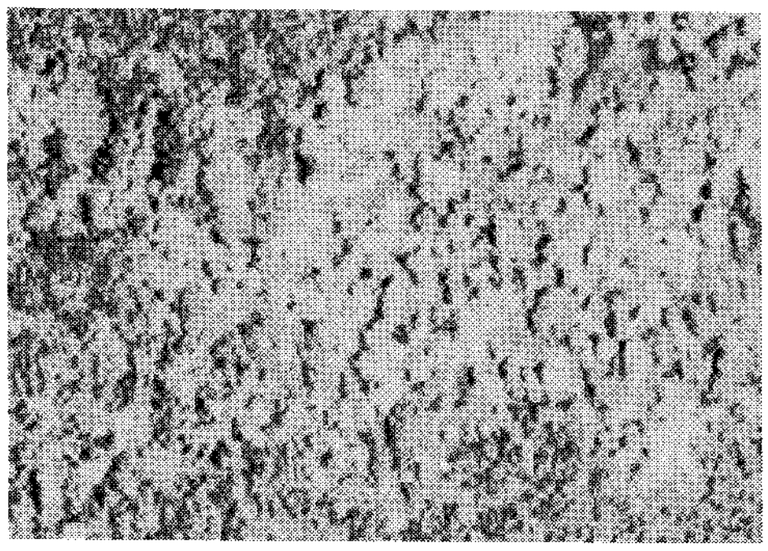

Figure 2. QucikBird satellite data of the study area, Bands 4,3,2 in RGB

3.1. Forest cover mapping

The QuickBird satellite data was used to classify the semi-evergreen forest from other forests types and its density. The forest was divided into four density classes viz., very density (>70%), dense (40 – 70%), open (10 – 40%) and degraded (<10%) according to canopy closure (FSI 2004). Expert classification technique (Ramachandran 2007) was used to classify the forest area.

3.2. Estimation of SOC

Soil samples were collected systematically in every two km intervals from the profile pits excavated to a dimension of 1x1x1 m. Samples were collected from 30, 60 and 90 cm depth separately. All the samples were shade dried in the laboratory and SOC status was estimated using Walkey and Black (1934). The percentage of coarse fraction (>2.0 mm size) was worked out for each layer. Bulk density was determined by Clad method and then corrected for percent coarse fractions. It was then used for the estimation of SOC density (Mg ha^{-1}) and SOC stock.

4. RESULTS AND DISCUSSION

The semi-evergreen forest area was divided into 4 density classes viz, very dense, dense, open and degraded. The very dense semi-evergreen forest occupied a maximum of 1984.23 ha followed by dense (978.42 ha), medium (851.74 ha) and degraded (147.84 ha).

The mean SOC content of surface, middle and bottom layer of very dense semi-evergreen forest were 3.7 ± 2.73, 2.21 ± 1.64 and 1.82 ± 1.68 respectively (Table 1), which is higher than all other density classes. The SOC distribution followed the order of surface > middle > bottom layers.

Table 1. Soil organic carbon content (%) of different forest types of Kolli hill

Forest type	Area (ha)	Soil Organic Carbon content (%)		
		Surface (0 to 30 cm)	Middle (30 to 60 cm)	Bottom (60 to 90 cm)
Very dense semi-evergreen	1984.23	3.70 (2.73)	2.21 (1.64)	1.82 (1.68)
Dense semi-evergreen	978.42	3.43 (2.91)	1.62 (1.49)	1.39 (1.45)
Medium semi-evergreen	851.74	1.83 (0.76)	1.13 (0.36)	0.76 (0.45)
Degraded semi-evergreen	147.84	2.40 (1.04)	1.10 (0.50)	0.91 (0.33)
Total semi - evergreen	**3962.23**	**2.90 (2.21)**	**1.58 (1.24)**	**1.27 (1.23)**

In the case of SOC density, the highest density was recorded in the very dense semi-evergreen forests (274.06 t/ha). The dense semi-evergreen forest had a SOC density of 233.65 t/ha. The open semi-evergreen forest had low SOC content (143.02 t/ha) than the degraded semi-evergreen forest (193.49 t/ha) (Table 2).

Table 2. Soil organic carbon density (t/ha) of different forest types in Kolli hill

Forest type	Area (ha)	Soil Organic Carbon density (t/ha) (0 to 90 cm)	
		Mean	SD
Very dense semi-evergreen	1984.23	274.06	175.57
Dense semi-evergreen	978.42	233.65	193.92
Medium semi-evergreen	851.74	143.02	54.85
Degraded semi-evergreen	147.84	193.49	80.62
Total semi -evergreen	**3962.23**	**184.00**	**123.13**

As per the present estimation, the SOC available in the very dense semi-evergreen forest was 5,43,798.07 t. Likewise in the total dense semi-evergreen forest the SOC content was 2,28,607.8 t. In the open and degraded semi-evergreen forests the SOC density were 1,21,815.8 t and 28,605.5 t. The total SOC density of present study area was estimated to be 9,22,827.17 t. The difference in the SOC availability between various density classes is mainly due to degradation of forests. As the very dense semi-evergreen forest is intact, the underground soil is also in an undisturbed state. So the soil and its physico-chemical properties are in perfect equilibrium. When the forest is disturbed by various means then this equilibrium of soil is also getting disturbed, which leads to many cascading negative effect; one such effect is the loss of SOC from the soil. Necessary measures should be taken to arrest the disturbance factors to forests, thereby the forests will be protected and also its underground soil environment.

5. CONCLUSIONS

In the present study, the SOC status was estimated in different density classes of a semi-evergreen forest. The QuickBird satellite data was found to be highly suitable for density classification of forests. The SOC estimation carried out in this study portrayed clearly the status of SOC in different density classes of forest. The difference in the SOC density between different forest density classes was mainly due to disturbance to the forests.

ACKNOWLEDGEMENTS

The first author of this article thanks the Department of Science and Technology, New Delhi for funding this work with DST- Fast Track Young Scientist program. We thank the Tamil Nadu Forest Department for their help and support.

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