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RESEARCH ARTICLE

INFLUENCE OF LAND USE LAND COVER CLASSES ON CARBON SEQUESTRATION IN SOILS OF SIRSI AND SIDDAPUR TALUKA OF UTTARA KANNADA DISTRICT, INDIA

***Koppad, A.G. and Pavan Tikhile**

Department of Agricultural Engineering, Agricultural College Bijapur -586101, Karnataka

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ABSTRACT

The study was conducted in Sirsi and Siddapur talukas (14^0 13' 0"N to 14^0 50' 0"N Latitude and 74^0 34' 0"E to 75^0 3' 30"E Longitude) of Uttar Kannada district to assess the influence of land use land cover on carbon sequestration in soil. The IRS P6 LISS-III imageries was used for land use land cover classes using ERDAS software with ground truth data. The land use classes viz., Dense forest, Sparse forest, Horticulture plantation, Agriculture and Barren-land were identified. The soil samples at one meter depth in all land use classes were collected and soil organic carbon (SOC) was estimated. The result indicated that the SOC in soils of different land use classes are significantly different. The total SOC in Sirsi taluka was 15.47 million tonne and that of Siddapur was 10.52 million tonne. The average SOC in Sirsi and Siddapur soil was 108.82 t/ha and 102.63 t/ha respectively. The Carbon mitigation potential in soils of dense forest was 2.78 times more in Sirsi and 2.86 times more in Siddapur taluka as compared to Agriculture soil followed by horticulture plantation in both taluka.

INTRODUCTION

Carbon (C) sinks can play an important role in meeting the challenge of climate change. More recently scientists have been analyzed soil organic carbon to measure the net exchange of C between soil and atmosphere (Janzen 2005). Soil can be considered as the largest pool of terrestrial organic carbon in the biosphere storing more CO_2 (2,200 Pg) than is contained in plants (Batjes, 1996), so small changes in the size of this flux can have a large effect on atmospheric CO_2 concentrations (Schlesinger and Andrews, 2000) and thus constitute a powerful positive feedback to the climate system. Carbon sequestration is the process of capture and long-term storage of atmospheric carbon dioxide (Roger and Brent, 2012, Watson *et al*., 2000) in soil, vegetation (especially forest), oceans and geologic formation. Through the process of photosynthesis, plants assimilate carbon and return to the soil as litter and stored as soil organic matter (Negi and Gupta, 2010). Soil store 2.5 to 3.0 times higher as that stored in the plants (Post *et al*., 1990) and two to three times more than the atmospheric as CO_2 (Davidson *et al*., 2000). Approximately 1500 Gt of organic carbon is stored in the world's soils to a depth of 1 m, with a further 900 Gt between 1-2 m (Kirschbaum, 2004). Forest and Forest soil play an important role in the global carbon balance (Kuldeep and Upasana, 2011; Jha *et al.*, 2003). The forest soils are one of the major carbon sink in earth because of higher content of organic carbon (Dey, 2005). Land use land cover changes directly affect the carbon sequestration rate in soil (Lal, 2004) and other factors including climate, vegetation type, anthropogenic activities and land use land management practices (Six and Jastrow, 2002; Baker, 2007). The practices of carbon sequestration in soil help to reduce concentration of atmospheric CO_2 and in turn helps plant growth as well as increasing crop yield (Shachi and Venkatramanan, 2009). The first estimate of the organic carbon pool in the Indian soil done in the year 1984 and it was 24.3 pg (1 Pg = 10^{15} g) based on 48 soil sample (Gupta *et al.,* 1984).

****Corresponding author:*** koppadag2007@rediffmail.com

The remote sensing technologies are being used for real time land use land cover (LULC) data analysis and area estimation under different land use practices. Geographical information system (GIS) technology useful for preparation of maps. The present study is an attempt to estimate the current status of carbon sequestration stock in soils of various land use in Sirsi and Siddapur taluka of Uttar Kannada district (Karnataka).

MATERIALS AND METHODS

The study was conducted in Sirsi and Siddapur talukas of Uttar Kannada district, Karnataka, India. This region lies between 14^0 13' 0"N to 14^0 50' 0"N Latitude and 74^0 34' 0"E to 75^0 3' 30"E Longitude covering a surface area of 2178.50 sq.km. with average elevation of 590 meters. The climate in Sirsi and Siddapur is strongly influenced by the south-west monsoon. The average temperature in the study area is 28°C-32°C during the summer and 17°C-22°C during the winter. The study area is shown in Fig 1.

The toposheets of the study area (48J/9, 48J/10, 48J/11, 48J/13, 48J/14, 8J/15, 48N/2, and 48N/3) with 1:50,000 scale were procured from SOI Bangalore. IRS-P6 LISS-3 satellite image path 097 row 063 dated 22 January 2010 with spatial resolutions of 23.5 x 23.5 meter was procured from NRSC Hyderabad. The toposheets are geo-referenced for demarcation of boundary line of the study area and area extraction in Arc-GIS. The image was processed using ERDAS IMAGINE 2011 and classify the land use land cover thematic map with the ground truth data collected from GPS.

Soil samples at one meter depth were collected from different land use land cover class area viz., Dense forest, sparse forest, plantation, agriculture and barren land. While taking the samples the land terrain was considered. In sloppy land the number samples were taken along the slope from top to bottom and in case of flat land grids at equidistance was followed and representative soil sample was

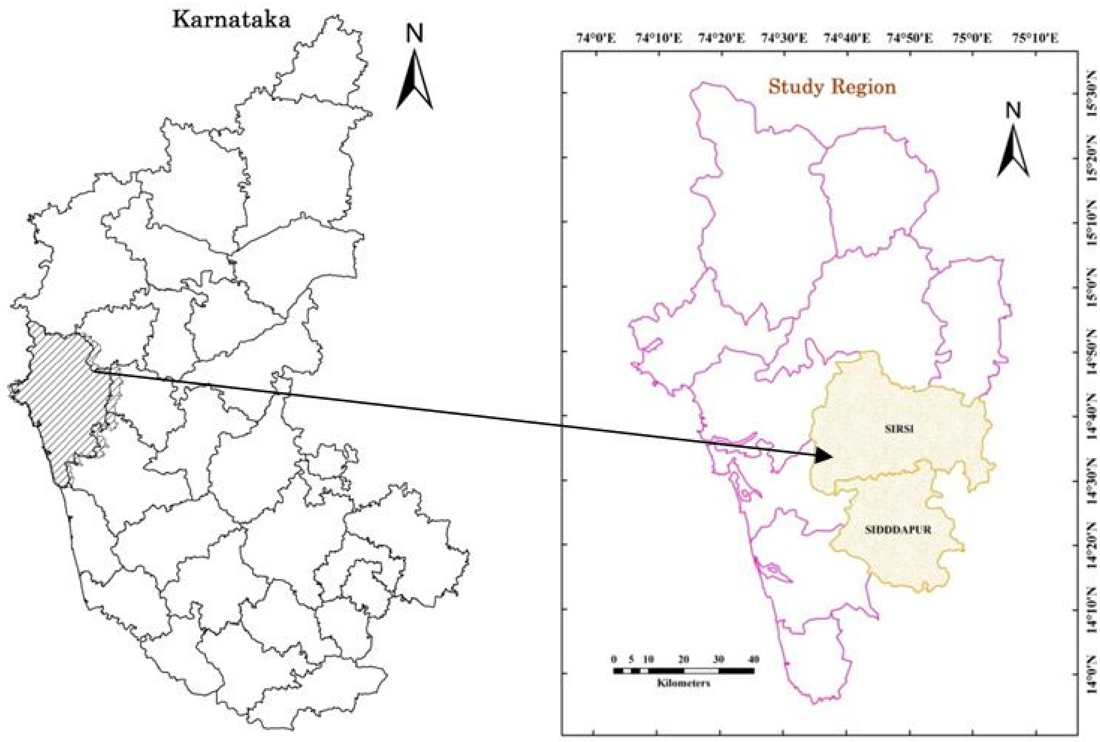

Fig. 1. Location of study area in Uttara Kannada District

collected. The soil sample spot latitude and longitude was recorded with GPS. The soil sample to the depth of one meter was collected using soil screw auger and core sampler was used to collect the soil core at different depth for estimating the bulk density. The soil sample was analyzed in laboratory for SOC estimation using Walkley and Black rapid titration method (Walkely and Black, 1934). The per cent of SOC value obtained from the WB method was multiplied by standard correction factor of 1.32 (De Vos *et al.,* 2007) to obtain the corrected SOC. The total SOC was estimated using the following formula.

SOC % = (BTV-STV) x 0.5N FASx0.003 x 100/wt. of soil Where, BTV= Blank titrated value, STV= Sample titrated value, FAS=Ferrous Ammonium Sulphate.

Total SOC (tonnes) + SOC % /100* BD (t/m^3)*area (m^2)*depth of soil (m) BD= Bulk density.

The map indicating SOC content and carbon stock in soils of different land use and land cover classes is prepared in Arc GIS. The flow chart for the methodology used is given in Fig.2.

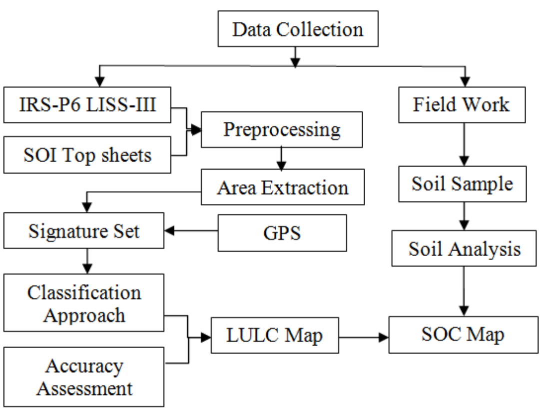

Fig. 2. Flow chart of methodology

RESULT

The land use land cover map of Sirsi and Siddapur taluka of Uttara Kannada District is shown in Figure 3. The land use and land cover classes and SOC pool is given in Table 1 and 2. The results indicated that about 48.37% (63763 ha) area in Sirsi and 51.28% (44106.9 ha) area in Siddapur taluka were occupied by dense forest followed by Spares forest covering 5112.39ha and 21925.7ha respectively. The Agriculture land covered in 21715.30 ha and 10153.7ha, Barren land in 34936.6 ha, and 5837.46 ha and horticulture plantation was in 4437.54 ha and 2811.46 ha in Sirsi and Siddapur respectively. The settlement and water body covers an area of 1279.95 ha and 586.02ha in Sirsi and 907.61ha and 276.31hectares in Siddapur respectively (Fig.3). The SOC content and carbon stock in soils of different land use and land cover area in both taluka is given in Figure 4. The maximum SOC is found in Dense forest of both talukas which was1.25% in Sirsi and 1.21% in Siddapur taluka followed by horticulture plantation (1.09% & 1.04% respectively) and very less percentage of SOC was found in agriculture soil (0.53% & 0.42% respectively). Soil organic carbon pool under different land uses in Sirsi and Siddapur taluka indicated that the dense forest having higher SOC pool in Sirsi (163.75 t/ha) and in Siddapur (156.09 t/ha) as compared to other land use classes (Table 1 and 2). The results showed that the mitigation potential for Dense forest was 2.78 times more than Agriculture land (1.00) in Sirsi and 2.86 time in Siddapur. Mitigation potential of dense forest is maximum followed by horticulture plantation, sparse forest and barren land in both taluka (Table 1 and 2). The statistical analysis showed that the SOC sequestration in dense forest is more significant when compare to other land use systems in both taluka. The SOC distributed in each land use classes over entire taluka was not significant but among the land uses it is significant at 5% level.

DISCUSSION

The dense forest recorded highest SOC followed by horticulture plantation in Sirsi and Siddapur taluka mainly due to addition of leaf litter and other organic matter resulted more microbial activities which in turn creates more soil organic carbon content (Conanat *et al.*, 2001, Lal, 2011). The agriculture soil shown less SOC due to expose of soil and more utilization of nutrients by the crop.

Table 1. SOC pool under different Land use land cover classes in Sirsi Taluka

Sl. No.	LULC classes	Areaha	Area%	SOC%	B.D.t/m^3	SOC Lakh tonnes	SOC t/ha	M.P.
1	Dense Forest	63763	48.37	1.25	1.31	104.41	163.75	2.78
2	Horticulture Plantation	4437.54	3.37	1.09	1.22	5.90	132.98	2.26
3	Spares forest	5112.39	3.88	0.95	1.21	5.88	114.95	1.95
4	Barren land	34936.6	26.50	0.64	1.15	25.71	73.60	1.25
5	Agriculture Land	21715.3	16.47	0.53	1.11	12.78	58.83	1
6	Settlement	1279.95	0.97	-	-	-	-	-
7	Water body	586.02	0.44	-	-	-	-	-
	Total	131831	100			154.68	Av.108.82	
	SEm - 0.04	CD@5% - 0.11						

Table 2. SOC pool under different Land use land cover classes in Siddapur Taluka

Sl. No.	LULC classes	Areaha	Area%	SOC%	B.D.t/m^3	SOC Lakh tonnes	SOCt/ha	M.P.
1	Dense Forest	44106.9	51.28	1.21	1.29	68.85	156.09	2. 86
2	Horticulture Plantation	2811.46	3.26	1.04	1.25	3.65	130.00	2.38
3	Spares Forest	21925.7	25.49	0.83	1.28	23.29	106.24	1.95
4	Barren Land	5837.46	6.79	0.48	1.38	3.87	66.24	1.21
5	Agriculture Land	10153.7	11.80	0.42	1.30	5.54	54.60	1
6	Settlement	907.611	1.06	-	-	-	-	-
7	Water body	276.31	0.32	-	-	-	-	-
	Total	86019.14	100			105.21	Av.102.63	
	SEm - 0.05	CD@5% - 0.15						

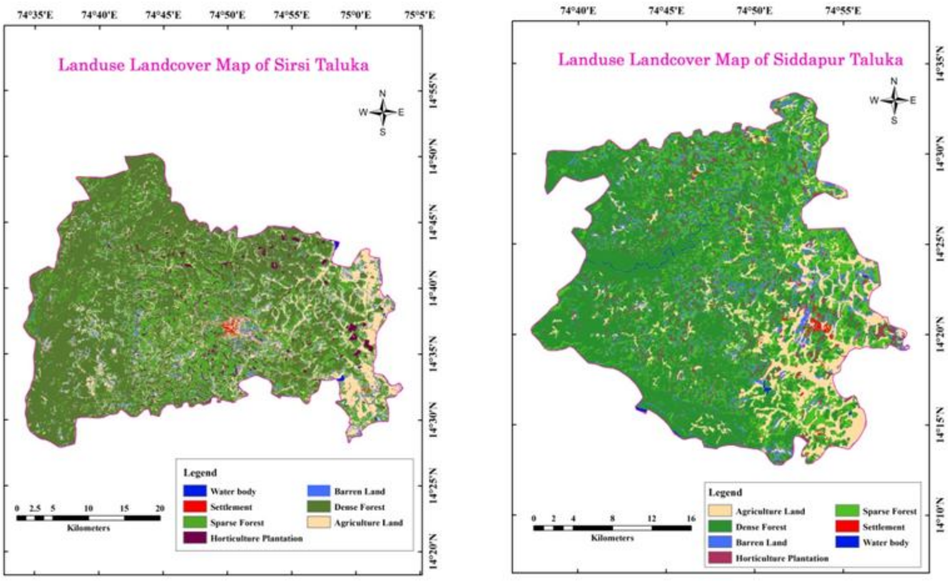

Fig. 3. Land use land cover map of Sirsi and Siddapur taluka of Uttara Kannada District

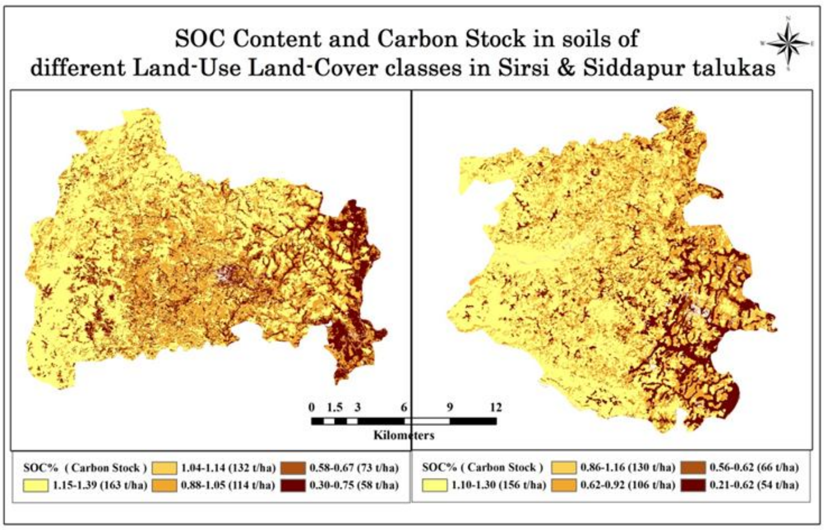

Fig. 4. SOC content and carbon stock in soils of Sirsi and Siddapur taluka

Conclusion

Forest soils acts as both carbon sources and sink, it has potential to form an important component to combat global climate change. Dense forest sequester more carbon in soils as compared to other land use systems. Deforestation partially or completely leads to soil carbon depletion. Dense forest maintains carbon stock in soils consistently. The remote sensing techniques are most suitable for acquiring current data about land use land cover. The results indicated that forest cover must be maintained to sequester more carbon in soils.

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