INFLUENCE OF FOREST TYPES ON SOIL CARBON SEQUESTRATION IN UTTARA KANNADA DISTRICT AS ASSESSED BY REMOTE SENSING AND GIS TECHNIQUE

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Abstract:

The study was taken up in haliyal and Joida taluka of UK districts during the year 2012-2014. The study area lies between 14^0 55' N to 15^0 30' N Latitude and 74^0 15' E to 74^0 55' E Longitude. The IRS P6 LISS-III imageries were used for estimating the area under different land use land cover classes using ERDAS software with ground truth data collected from GPS. The land use land cover classes viz., Dense forest, , Horticulture plantation, Sparse forest, forest plantation, open land and Agriculture land were identified in supervised classification. According to the land use systems, soil samples at one meter depth 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 and average SOC in Haliyal taluka was 11.257 million tonnes (in 81792 ha) and 123.55 t/ha respectively, similarly in Joida taluka was 20.69 million tone (in 177206 ha) and 83.59 t/ha, respectively. Among the different land use land cover classes, in haliyal taluka dense forest sequestered more SOC 184.08 t/ha, followed by horticulture plantaion (143.80 t/ha) where as in Joida taluka dense forest sequestered SOC of 120.36 t/ha followed by open land (73.80 t/ha). It is concluded that deciduous forest in Haliyal taluka sequestered more soil organic carbon compared to evergreen forest of Joida taluka due to more contribution from the leaf litter in deciduous forest hence forest types play an important role in sequestering atmospheric carbon in to the soil.

Key words:Forest, GPS, GIS, remote sensing, imageries, LULC, SOC.

Introduction

Soil carbon sequestration is one of the alternative ways to mitigate carbon dioxide (CO_2) concentration which in turn reduce green house gas in the atmosphere [1]. Soils can store large amounts of carbon up to 50-300 tonnes per hectare, which is equivalent to 180-1100 tonnes of carbon dioxide [2]. Forest ecosystems play a major role to reduce CO_2 concentration from atmosphere and store in soil [3]. The ultimate source of soil carbon is atmospheric CO_2 that is captured by plants in the process of photosynthesis and finally stored in soil as soil organic carbon (SOC). In most of the terrestrial ecosystems the amount of carbon in soil is usually greater than the amount in the above ground mass [4] and soil carbon pool is approximately 3.1 times higher than the atmospheric pool of 800 GT [5]. The quantity of carbon present in soil is controlled by a complex interaction of processes determined by carbon inputs and decomposition rates.

Currently, the only viable way to trap atmospheric carbon dioxide is via photosynthesis, where carbon dioxide is absorbed by plants and turned into carbon compounds and store in biomass as well as in soil [6]. Changes in trees productivity and species composition lead to changes in forest soils [7] which take lead on SOC variation. Land use land cover changes directly affect the carbon sequestration rate in soil [8] and other factors including climate, vegetation type, topography and anthropogenic activities [9]. Forest and Forest soil play an important role in the global carbon balance [10]. The sequestered carbon finally acts as a sink in the forest land [11]. The remote sensing technologies are being used for preparation of land use land cover (LULC) map and area estimation under different land use in different forests. Geographical information system (GIS) technology is useful for spatial analysis and preparation of SOC distribution map with the help of ground truth data collected from GPS. The present study is an attempt to estimate the carbon sequestration stock in forest soils of various land use land cover system in deciduous and evergreen forests of Uttara kannaa district of Karnataka.

Materials and Methods

The study area showing the Haliyal and Joida taluka place of UK district in Karnataka is shown in figure 1. The Toposheets covering the study area with scale 1:50,000 were procured from SOI Bangalore. IRSP6 satellite LISS-3 imageries path 097 row 063 dated 22

January 2010 spatial resolutions with 23.5 x 23.5 meter procured from NRSC Hyderabad. The images were processed using ERDAS IMAGINE 2011 and classify the land use land cover map and SOC stock in both Haliyal and Joida taluka was done using Arc GIS 10. The ground truth data was collected with GPS and the land use land cover was classified using supervised classification technique.

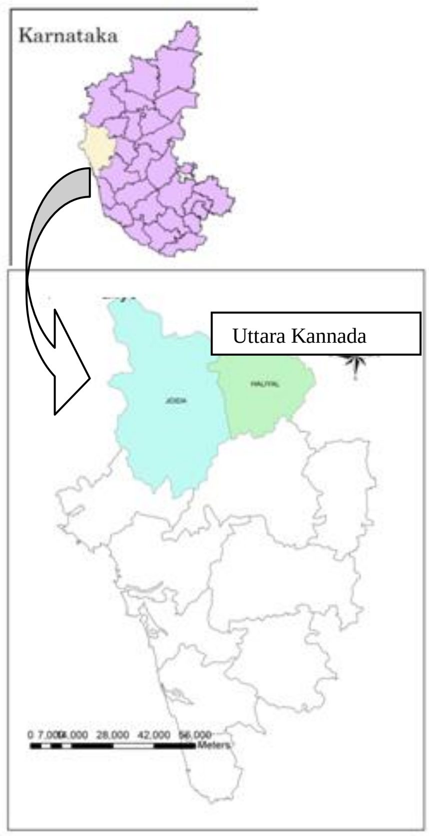

Fig.1 Study area showing Haliyal and Joida taluka of UK district

Soil samples were collected from different land use land cover class viz., Dense forest, horticulture plantation, sparse forest, open land and agriculture land. While taking the samples, the land terrain was considered. In sloppy land three number of samples was taken along the slope from top to bottom and in case of flat land grid at equidistance was followed and representative soil samples were collected. The latitude and longitude of soil sample spot was recorded with GPS. The soil sample to the depth of one meter depth was taken using soil screw auger and core sampler was used to collect the soil core at different depth for estimating the bulk density. SOC was determined using Walkley and Black rapid titration method [12]. The % of SOC value obtained from the WB method was multiplied by standard correction factor of 1.32[13] to obtain the corrected SOC.

SOC % = (BTV-STV) x 0.5N FASx0.003 x100 / wt. of soil

Total SOC (tones) = SOC % /100* BD (t/m^3)*area (m^2)*depth of soil (m)

BTV= Blank titre value, STV= Sample titre value, FAS=Ferrous Ammonium Sulphate

BD= Bulk density.

The detailed methodology followed for the preparation of land use land cove map and SOC pool map is given in fig 2.

Fig 2. Flow chart of methodology used.

Result and Discussions:

The data on total land area, SOC %, SOC pool and average SOC according to land use and land cover class is given in table 1. The results indicated that in Haliyal taluka, the land use land cover classes are dense forest, horticulture plantation, sparse forest and open land and Agricultural land where as in Joida taluka only three land use classes are found, dense forest, open land and Agricultural land. In dense forest SOC% and SOC (t/ha) higher in Haliyal taluka (1.18% and 184.06 t/ha respectively and 112 million tonnes in 81792 ha) where as it was less in Joida taluka (1.02% and 120.36 t/ha, respectively and 206 million tones in 177206 ha). The SOC was less even in open land and Agricultural land in Joida taluka as compared to Haliyal taluka. Joida taluka major area is covered with forest which is evergreen forest. But in Haliyal taluka many land use systems are present and in all the classes SOC % is higher. As per the GPS ground truth data land use land cover classes are prepared in ERDAS and Arc GIS software. The land use land cover class and average SOC pool in tonnes per hectare is given in figure 3 and 4 respectively for Haliyal taluka and in figure 5 and 6 for Joida taluka which are representing deciduous and evergreen forest respectively.

The results indicated that deciduous forest found to influence the carbon sequestration in soil significantly higher as compared to evergreen forest. This variation must be due to the higher leaf litter fall in deciduous forest compared to evergreen forest. In Joida taluka the topography is undulating which leads to more of runoff leads to soil erosion and there is more chances of leaf litter transport hence there is less chances of in-situ carbon sequestration in soil. In flat land found in Haliyal taluka runoff flow is less, hence there are chances of more litter decomposition and more of carbon sequestration into the soil.

The carbon mitigation potential of deciduous forest is higher mainly due to higher leaf litter fall and microbial activities which creates more organic carbon in soil [14].

Table 1.Area, SOC% SOC pool as per land use land cover classes in Haliyal and Joida taluks of UK district

LU/LC Classes	Haliyal				Joida			
	T. Area (ha)	Avg. SOC%	SOC Lakh tonne	SOC t/ha	T. Area (ha)	Avg. SOC %	SOC Lakh tonne	SOC t/ha
Dense Forest	40693.80	1.18	74.91	184.08	166244.00	1.02	200.09	120.36
Horticulture Plantation	1905.48	1.24	2.74	143.80	-	-	-	-
Spares Forest	14818.60	0.98	16.26	109.73	-	-	-	-
Open land	1876.22	0.84	1.99	106.06	3528.94	0.81	2.60	73.80
Agriculture land	22498.20	0.65	16.67	74.09	7433.40	0.51	4.21	56.61
Total/avg	81792.30	0.98	112.57	123.55	177206.34	0.78	206.9	83.59

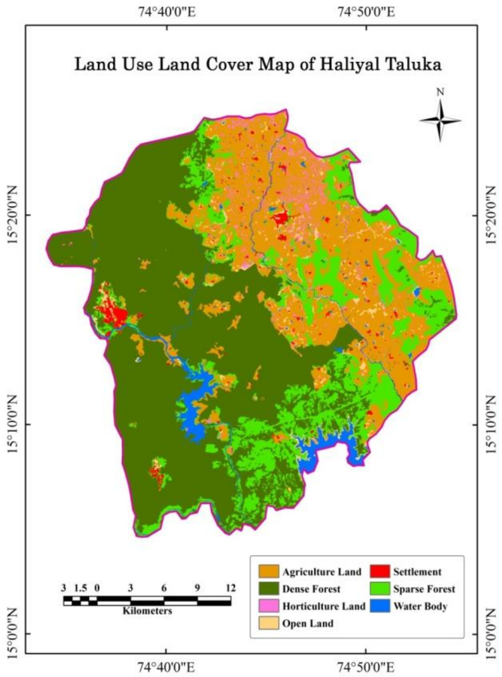

Fig.3. Land use land cover class of Haliyal taluka

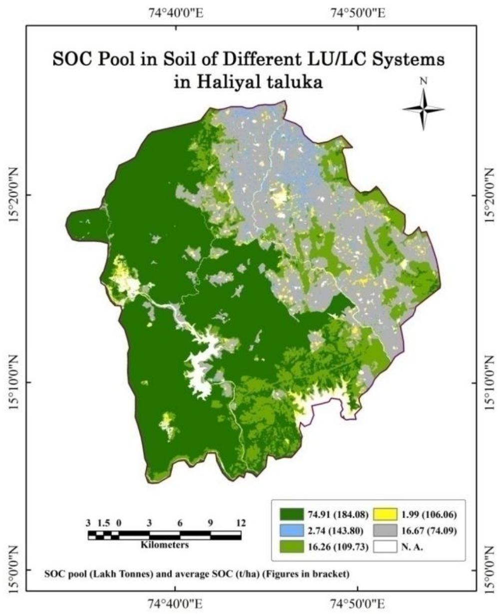

Fig.4. SOC Pool in different land use land cover class in Haliyal taluka.

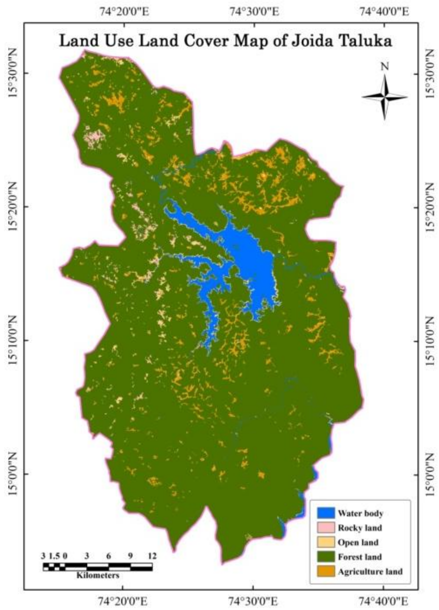

Fig.5. Land use land cover class of Joida taluka

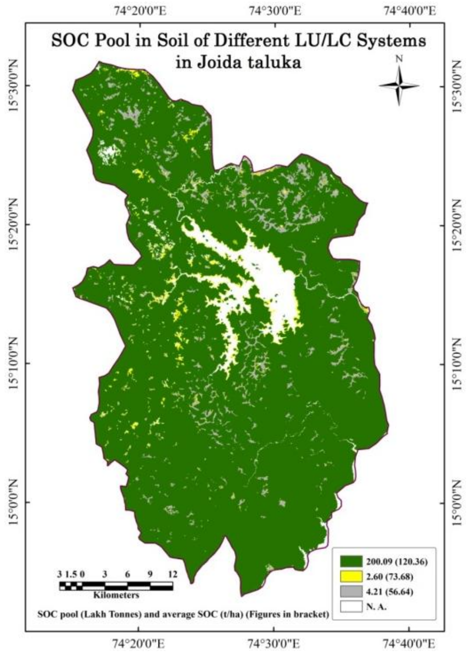

Fig.6. SOC Pool in different land use land cover class in Joida taluka.

Conclusion

The dense forest having deciduous in nature sequesters more carbon than dense forest of evergreen in nature. The carbon depletion in soil is more in spare forest and open land due to deforestation and degradation of forest. The remote sensing data of satellite imageries and GPS are most suitable for acquiring current data about land use land cover through ERDAS and GIS software. The forest cover must be maintained to sequester atmospheric carbon in to the soil. The study indicated that deciduous forest in Uttar

Kannada district of Karnataka found to sequester more atmospheric carbon in soil compared to evergreen forest.

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