Original Research Article

Distribution of carbon stocks under different land use systems of Somawarpettaluk, Kodagu District

Abstract:

A study was conducted in Somawarpet taluk of Kodagu district in Karnataka to know the distribution of carbon stocks under different land use systems namely natural forest, coffeebased agroforestry land use and paddy land use systems. Soil samples were collected at different depths like 0-20 cm, 20-40 cm, 40-60 cm and 60-80 cm with five replications under each land use systems. Natural Forest showed the highest mean value of soil organic carbon content of 18.06g kg^{-1}, followed by coffee land sue system with organic carbon content of 13.86 g kg^{-1} and the lowest mean valueof 8.23 g $kg^{-1}$was found in paddy land use system. Thehighest soil carbon stock mean value of 4140.23 t $ha^{-1}$was noticed in natural forest, followed by coffee land use system with carbon stock content of 3267.38 t ha^{-1} and lowest value of 2171.45 t ha^{-1} of carbon stock content was observed under paddy land use system.In all the land use systems soil organic carbon content and carbon stock content was decreasing with increasing soil depth. Bulk density of these land use systems also affected carbon stocks.

Key words: Carbon stock, Land use systems, Soil organic Carbon.

Introduction:

Global warming is one of the environmental problem which modern world is facing. Carbon emission is measured as the strongest causal factor.This advancement has resulted in high emission of carbon in the ecosystem. It is well known that vegetation play very important role in ecosystem dynamics. Therefore; there is a growing interest to manage our soil appropriately in order to offset the ever increasing rise in atmospheric CO_2 concentration. The

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global natural carbon sinks include the terrestrial systems and the atmosphere oceans, fossil fuel deposits. In the terrestrial systems, the carbon is sequestered in rocks and sediments, in swamps, wetlands and forests and in the soils and agriculture. Soil is a potential carbon sink and could offset rising atmospheric carbon dioxide. Atmospheric CO_2 can be recaptured in agricultural soils if soil organic carbon (SOC) decomposition rates are slowed, more crop biomass is annually returned to the soil.

Carbon sequestration is the net removal of atmospheric carbon dioxide and its storage in terrestrial system for a very long period of time as lived pools of carbon (may be thousands of years). The soil has significant role in carbon cycle. The soil organic carbon stock acts as a major part of the terrestrial carbon reservoir than the atmospheric carbon (Grace, 2004) with storage of about 1500Pg to 2000Pg C (1 Pg =1015 g or 1 Pg = 1 billion tonnes) in the top 100 cm depth layer in the world soils (Wang *et al*., 2012). The carbon pool in soil is twice the amount present in the atmosphere and changes in the soil carbon pool can affect the composition of the atmosphere significantly (Feller and Bernoux, 2008). Absorbing carbon dioxide from the atmosphere and moving into the physiological system and biomass of the plants and finally into the soil is the only way to remove large volume of the major greenhouse gas (CO2) from the atmosphere into the biological system (Ramachandran *et al*., 2007).

Soil carbon refers to the total carbon in soil which includes both inorganic and organic forms.Among the different ecosystem in India, forests can play a greater role in climate change through the sequestration or emission of carbon, an important greenhouse gas; through biological growth, which can increase forest stocks or through deforestation, which can increase carbon emissions. A huge amount of carbon is stored in forests (Salleh*et al*., 2001). According to FAO (2010) the total forest carbon stocks of the world is 652 Giga tonnes (161.8 t ha^{-1}). Carbon is captured in its vegetation, litter and soil.Coffee based agroforestry land use system emerged for potential carbon sequestration, which is compensating the deforestation with capturing requisitioning carbon and contributing to mitigate the climate change.Different land use systems variable with its nutrient status, which mainly depends on the type of vegetation, extent of biomass and nutrient management practices along with other conservation strategies. The large amount of biomass is produced and added to soil continuously from diverse tree species in natural forest, coffee agroforestry and Paddy land use in Somawarpet taluk of Kodagu District. This creates continuous cycle between above ground biomass and below ground root biomass by different tree species and contributing to

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soil organic carbon pool and its fertility status.The above mentioned land use systems has greater role in carbon sequestration to sustain the ecological safety.

Material and methods

The study area covered Somawarpet taluk of Kodagu district in Karnataka. The latitude and longitude coordinates of Somawarpet taluk, Kodagu district are $12^{0}59'$ N latitude and $75^{0}84'$ E longitudes.Location map of study area presented in Fig. 1.The climate of this region may be broadly termed as tropical except at the higher ranges of the hills where it is sub-tropical. The annual precipitation of Somawarpet taluk is 1569.8 to 2862.71 mm with a mean of 1944.40 mm.

A study was undertaken to know the distribution pattern of selected soil carbon stock in soils under three land use systems of the Somawarpet, Kodagu district as follows, Natural forest (*Hopeaponga, Ficusbenjamina, Terminaliapaniculata,Terminaliatsjeriam-cottam. syzygiumcumini etc.,*), Coffee based agroforestry- (predominantly Robusta coffee (*Coffee acanephora*) was grown under native tree species of *Acrocarpusfraxinifolius*, *Dalbergialatifolia*, *Lagerstroemia microcarpa*and *Syzygiumcumini*), and paddy land use system (Plate 1).The 60 representative soil samples were collected from 0 to 20 cm, 20 to40 cm, 40 to60 cm and 60 to80 cm depth from different land use systems with five replications. The analysis of soil samples for the organic carbon content and carbon stock content was done using standard procedures.

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Methods of soil analysis

Potassium Dichromate Oxidizable Carbon (PDOC)

Determination of Potassium Dichromate Oxidizable Carbon was carried out by wet oxidation method by (Walkley and Black, 1934).

Bulk Density (BD)

The bulk density of soil was estimated by laboratory method for disturbed soil as per the procedure described by Gupta (2007).

Weigh a large bottle of about 50 ml capacities without a stopper, fill it up with soil, flush to the brim tapping the bottle about 20 times and weigh. Remove the soil and now fill the bottle with water by means of burette and note the exact volume of water needed to fill the bottle.

The bulk or apparent density was obtained by dividing the weight of the soil and volume of the soil.

<u>*Soil Organic Carbon stock*</u>

Changes in Soil Organic Carbon (SOC) generally occur over many years and it is often difficult to identify small changes. The TOC contents stock in soil (t ha^{-1}) was calculated using equation (Manjunatha*et al.*, 2012).

$$\text{Carbon stock}\ (\text{t ha}^{-1}) = \frac{\text{Area}(\text{m}^2)\ \times \text{BD}\ (\text{Mg m}^{-3})\ \times \text{Depth (cm)} \times \text{OC}\ (\text{g kg}^{-1})}{1000}$$

Results and Discussion

Among different land use systems the PDOC value ranged from 11.43 to 23.10 g kg^{-1} in natural forest, 8.96 to 17.31 g kg^{-1} in coffee land use system and 3.95 to 11.11 g kg^{-1} in paddy land use system respectively (Table 1). Natural forestrecorded higher mean PDOC value of 18.06 g kg^{-1}, followed by coffee land use system with mean PDOC value of 13.86g kg^{-1} and the lowest mean value was found in paddy land use system (8.23 g kg^{-1}). In all the land use systems PDOC content was decreasing with increasing soil depth. Increase in organic carbon of forest soil due to continuous addition of bio mass through leaf and roots have been reported by Geo Jose (2006).Thelower mean organic carbon status (8.23 g kg^{-1}) content in paddy land might be attributed to lower vertical mixing of soils and alsodue to the inadequate organic substrate from the farming system. The highest potassium dichromate oxidizable organic carbon (PDOC) status is recorded in the natural forest was attributed to the long term addition of carbon over more than 25-50 years in these soils coupled with minimum physical disturbance to surface soil as compared to agriculture and horticulture land use systems. Similar results are also reported by (Brij*et al.*, 2012).Similar results have been reported by Yao *et al*. (2010).

The highest mean value of bulk density (BD) was found in paddy land use system (1.33 Mg m^{-3}) followed by coffee based agroforestry (1.19 Mg m^{-3}) and the lowest mean value was found in natural forest (1.16 Mg m^{-3}). In all the land use systems BD content increases with increasing soil depth (Table 1).

Influence of different land use systems on carbon stock in different land use systems were presented in (Fig. 2). Highest carbon stock potential was observed in Natural forest

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(4140.23t ha^{-1}) followed by coffee based agroforestry (3267.38t ha^{-1}) and lowest value of carbon stock potential was observed in paddy land (2171.45t ha^{-1}). In all the land use systems carbon stock content was decreasing with increasing soil depth.Among different land use systems the carbon stock value ranged from 2766.06to 5035.80 g kg^{-1} in natural forest, 2257.92 to 3912.96g kg^{-1} in coffee based agroforestry, and 1106.56 to 2822.96 g kg^{-1} in paddy land use system respectively. Indicating higher organic carbon turnover through decomposition of leaf litter and due to the quality and quantity of biomass turnover. The larger the biomass turn over higher would be the carbon stock.Roy *et al.* (2010) also found increase in organic carbon status with addition of organic matter through leaf litter in forest land use system. The larger carbon stock observed under natural forest might be due to dense vegetation and depositions of plant leaf litters with least disturbance of the natural forest such as forest fire, grazing and also anthropogenic pressure is totally restricted and less temperature fluctuations due to canopy cover. Hence the carbon stock will be more in natural forest. These results of present study are in agreement with findings of Tchienkoua and Zech (2004).

The lowest mean value of carbon stock was found in paddy land use system 2171.45t ha^{-1} of carbon due to lower soil organic carbon stock which is due to exposer of soil to light and more utilization of nutrients by the crops, a similar result was found in Lal and Puget (2005). These results are in agreement with the findings of Han *et al.* (2010).

Conclusion:

The present investigations have shown that, soil organic carbon content was highest in natural forest compared to other land use systems.Soil organic carbon significantly varies among different land use systems and increase in soil carbon storage may be possible through proper management of land use system.It is concluded that, the highest carbon sequestration potential was observed in natural forest followed by coffee land use system.

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BRIJ, L. L., MANISH, K. P., PRAMOD, J. AND BISWAS, A. K., 2012, Soil organic carbon pools and indices under different land use system in vertisols of central India. *J. Indian Soc. Soil Sci*., **60**(2): 125 -131.

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Natural Forest

Coffee Based Agroforestry

Paddy Land Use System

Plate 1: Different land use system in the study area

Table 1. List of variables in Cropping Systems

Cropping Systems	Depth (cm)	PDOC (g kg^{-1})	BD (Mg m^{-3})	Carbon stock (t ha^{-1})
	0-20	23.1	1.09	5035.80
	20-40	21.36	1.14	4869.17
	40-60	16.34	1.19	3889.87
NF	60-80	11.43	1.21	2766.06
	Range	**11.43-23.10**	**1.09-1.21**	**2766.06-5035.80**
	Mean	**18.06**	**1.16**	**4140.23**
	0-20	17.31	1.13	3912.96
	20-40	16.05	1.16	3723.6
	40-60	13.12	1.21	3175.04
CBA - I	60-80	8.96	1.26	2257.92
	Range	**8.96-17.31**	**1.13-1.26**	**2257.92-3912.96**
	Mean	**13.86**	**1.19**	**3267.38**
	0-20	11.11	1.27	2822.96
	20-40	10.06	1.31	2634.67
	40-60	7.8	1.36	2121.6
PL	60-80	3.95	1.4	1106.56
	Range	**3.95-11.11**	**1.27-1.40**	**1106.56-2822.96**
	Mean	**8.23**	**1.33**	**2171.45**

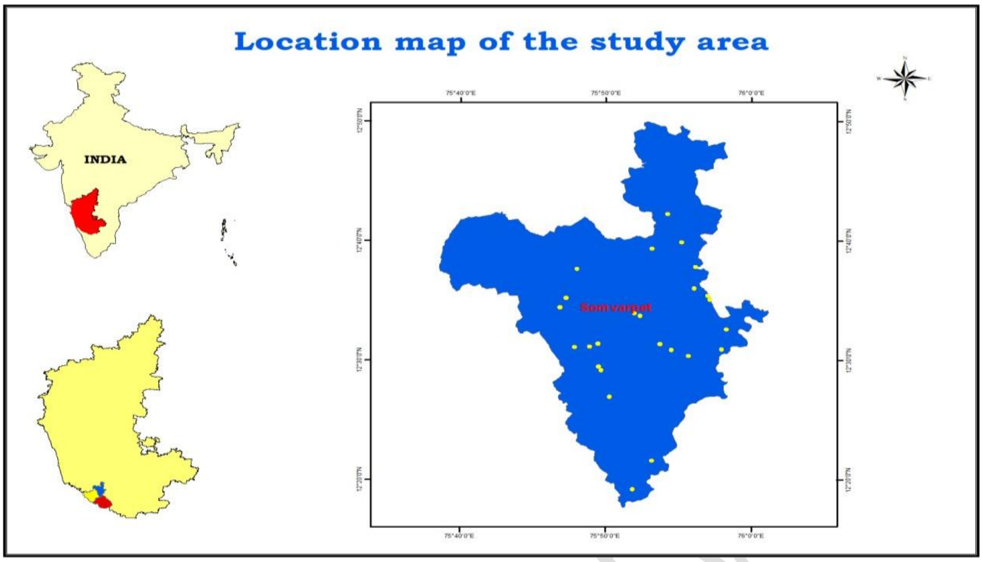

Fig.1: Location map of study area

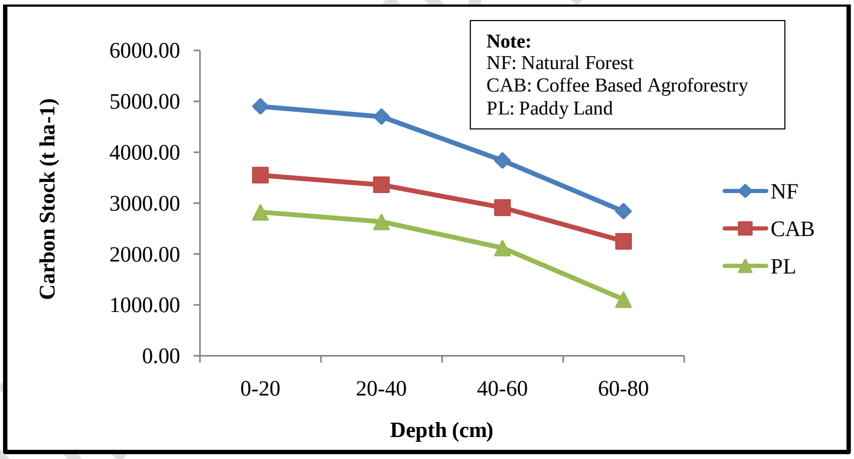

Fig.2: Soil carbon stock content under different land use systems