Estimation of c-stock in private forest of North Western Ghats, Maharashtra

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Abstract

Climate change and Global warming has raised the concerns over increasing proportion of greenhouse gases especially amount of CO_2 in the atmosphere. Trees are natural sinks of Carbon and store in different parts of trees via process of photosynthesis. Trees foliage, branches, stem and stump accounts for aboveground biomass of the tree and roots accounts for the below ground biomass of the tree. Above and below ground biomass together makes a tree's total biomass and half (50%) of its dry weight is store carbon of that particular tree. Tropical forests of the world are major source of carbon and cutting or burning those forests could increase the Co_2 emission in the atmosphere. India's forest and tree cover constituting 23.81% of the geographical area of the country and western Ghats remains one of the largest tropical forests of the world and fear to be deforested in the near future. Particularly district of Ratnagirialone in Northern Western Ghats holds large partof forest under the private ownership and could be sold out to the private loggers to get economic benefit. Carbon stock in one of the private forest of Ratnagiri district, in North Western Ghats, Maharashtra has been estimated using plot sampling based field inventory method todetermine stored carbon and how much store carbon could be halt converting into greenhouse gases. Total carbon stock both above and below ground has been calculated using biomass density and then converted into C-stock.Estimation of C-stock gives a better idea to know stored C in private forest and how much could be mitigate from the atmosphere through planting same amount of trees per ha by afforestation and reforestation activities.

INTRODUCTION

Anthropogenic activities are responsible for global environmental change and increased atmospheric Co_2 concentration caused by emissions of greenhouse gases. Researchers have estimated that the average global surface temperature is likely to rise by 1.4 to 5.8°C by the end of the 21st century(Ramchandran et al 2007).Land use change such as deforestation and forest degradation are the second largest source of the greenhouse gases emissions and contributes approximately 10% of GHGs emissions (Latham 2014).India experienced dramatic growth in fossil fuel Co2 emission per year and becoming the world's one of the largest fossil fuel Co2 emitting country (Boden et al 2011).In 2012, India has increased its emission by 7% compared to 2011 and stands at number four with 6% share in emission of Co2 worldwide (Jos et al 2013).Forests are capable of effective sequestration and storage of more carbon in above-ground and below-ground biomass of the tree by photosynthesis process than any other terrestrial ecosystem(Holly et al 2007);in addition it plays an important role to global environment. Estimation of Carbon stock in private forest is important in case of commercial exploitation of timber to the global carbon cycle (Basuki et al 2009).Forest Biomass provides estimates of the potential amount of stored carbon in forest vegetation that absorbed and assimilated by tree foliage and stored in tree boles, large roots, branches and fine roots as well as foliage, which can be added to the atmosphere as carbon dioxide (CO_2) when the forests are cleared or burned(Unwin and Kreidemann 2000).The account of dry forest biomass represents the potential amount of Carbon and can be converted to C content by taking half of the dry biomass weight (Brown et al 1989) is required as primary inventory data to Estimate C-stock in forest. Biomass density (the quantity of biomass per unit area, or Mg dry weight ha^{-1}) determines the amount of carbon emitted to the atmosphere (Houghtan et al 2009).

The United Nations Reducing emissions from deforestation and forest degradation (REDD) programme is a concept to help developing countries, communities and individuals through sustain the Carbon-stock in the forest by providing incentives to reduce greenhouse gas emissions from deforestation and degradation of forest land(Gibbs et al 2007, Angelsan et al 2008).India's current forest and tree cover is estimated to be 78.29 million ha, constituting 23.81% of the geographical area of the country(ISFR 2011).Large forest dependent population of the country affecting forest in the form of deforestation (Davider et al 2010). Western Ghats of the country is one of the largest tropical forests left in the world and is a Biodiversity hotspot. (Mayers1990).The district of Raigad, Ratnagiri and Sindhudurg in the Northern Western Ghats facing major threats of deforestation as most of the forest area comes under the private ownership (FSI 2011). Estimation of carbon stock in this private forest of North western Ghats is necessary to know the possible emission reduction by protecting private forest from deforestation and amount of carbon dioxide that can be stop converting it in Co2 in atmosphere. The most of the biomass of the forest can be found in trees, particularly on aboveground forest biomass whichaccounts for 70–90% of total forest biomass (Cairns et al 1997).

Materials and methods

Study Area:

This study presents estimation of total storage of C (above ground and below ground) in 538 acre private forestofkalambaste Village in North Western Ghats situated in Ratnagiri district of Maharashtra, India. Geographically it is situated between 17°10'55.64"N 73°36' 36.72" E and 17°09'46.89"N 73°36'31.67"E. Elevation ranges from 67m to 234m above mean sea level. Forest contains semi evergreen with moist and dry deciduous vegetation cover.

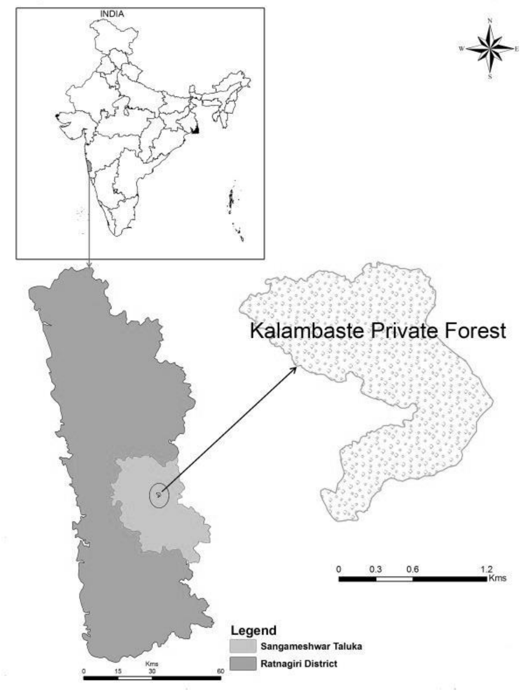

Fig.1: Study area of Private forest in North Western Ghats situated in Ratnagiri District, Maharashtra, India.

Data collection and analysis

Plot sampling technique was used to estimate the standing biomass of the trees in different sample plots. 10 temporary sample plots of 1 ha (100×100 m) were laid randomly on the satellite map of the forest area based on forest type.

In a region of mature or upland forest on the order of 100 km across where climate and elevation do not vary much, a sample of 25 1ha plots will produce an estimate of aboveground biomass with an error of 10%, or better (Condit R. 2008).Here, the area intended to survey is less than10 km across where climate and elevation do not very much, so, randomly a sample of 10 1ha plots decided to be taken for sample survey to estimate whole population area of 538 acre private forest. Twenty-five 20×20 m quadrates in each 1 ha Plot were laid and inside the each quadrat of 1 ha plot all trees with minimum diameter limit of 10 cm were measured at the breast height of 1.3 meter above ground. No measurements were made for dead wood, soil or fodder to estimate C-stock. Variables such as tree species name, DBH and tree heights were measured inside the 1 ha sample plots.

The method used to estimate above-ground biomass based on use of estimated Volume over bark per ha, VOB converted into Biomass (t/ha) (Brown et al. 1989, Brown and Iverson 1992, Brown and Lugo 1992, Gillespie et al. 1992).

Total Biomass=VOB×WD×BEF…………Eq.1

Timber volume over bark was calculated using followed equation (Pearson T et al 2007):

$$VOB = \frac{1}{3}\pi r^2 h \ldots\ldots\ldots\ldots\text{Eq.2}$$

Volume over bark measured of each tree inside the twenty five quadrats of 1 ha sample plot based on the Eq.2. Stem biomass of each measured tree was calculated by multiplying the volume over bark with the wood density of each species published byFAO 1997.However; few species wood density data were not available there. In these situations 0.57 arithmetic mean for most common wood density values for tropical tree species were taken (Reyes et al.1992).

Total above ground tree biomass was calculated using biomass expansion factor (the ratio of the total above-ground tree biomass to the biomass of the merchantable timber) (Brown and Lugo 1992)

BEF = Exp{3.213 - 0.506*Ln(BV)} for BV < 190 t/ha……………………………………………Eq.3

Where,

BV = biomass of inventoried volume in t/ha, calculated as the product of VOB/ha (m3/ha) and wood density (t/m3)

Finally, the total above ground biomass of each species present in 1 ha area was summed up and average of ten 1 ha sample pots were calculated.

The following regression model was used to estimate below ground biomass (Cairns et al. 1997)

BGB = exp (-1.0587 + 0.8836 x Ln AGB) ……………………………………………………Eq.4

Where,

AGB = above ground biomass (t/ha)

Total Biomass Density

Total biomass of the forest area was estimated by adding above ground biomass to the below ground biomass.

Total Forest Biomass=AGB+BGB……….Eq.5

Dry mass of biomass contains 50% of its weight carbon. So multiplying total biomass density with 50% can give the C-stock estimation in the forest vegetation (Brown et al. 1989) this can be expressed in formula as follows:

C-stock = Total biomass x50%.............Eq.6

RESULTS AND DISCUSSION

Most of the trees DBH inventoried in sample plots fall into 10 to 20 cm and height fall into 4 to 8 m.

Total biomass density (Above ground and below ground) of 9 sample plots varies between 73 t/ha to 136 t /ha with average of 106 t/ha. This average biomass density converted to the whole interested private area which gives the figure of 23128 ton biomass in 538 acre private forest.

Biomass converted into C-stock by conversion factor of 50%. It varies between 36 t C/ha to 68 t C/ha with average of 53 ton C/ha and 11564 ton C available in 538 acre of private forest.

In this result, trees height and DBH are the most important variable to estimate C-stock since, trees are natural absorber of Co_2 and through the process of photosynthesis it converted into potential amount of stored carbon in forest vegetation that absorbed and assimilated by tree foliage and stored as organic compounds rich in carbon such as Starch, lignin, cellulose and hemicelluloses, lipid and waxes, mostly in secondary woody tissues in tree boles and in large roots, as well as in foliage, branches and fine roots.

North Western Ghats store incredible amount of C in their Private forest. There will be a real challenge to conserve this C-stock and stop converting it into atmospheric Co2. While it is true that big portion of the private forest in North Western Ghats has been deforested to get commercial benefit.

In short, regulating the estimation of C-stock in Private Forest of North Western Ghats could give the estimate of stored Carbon and indicate the magnitude of changes in carbon pools.

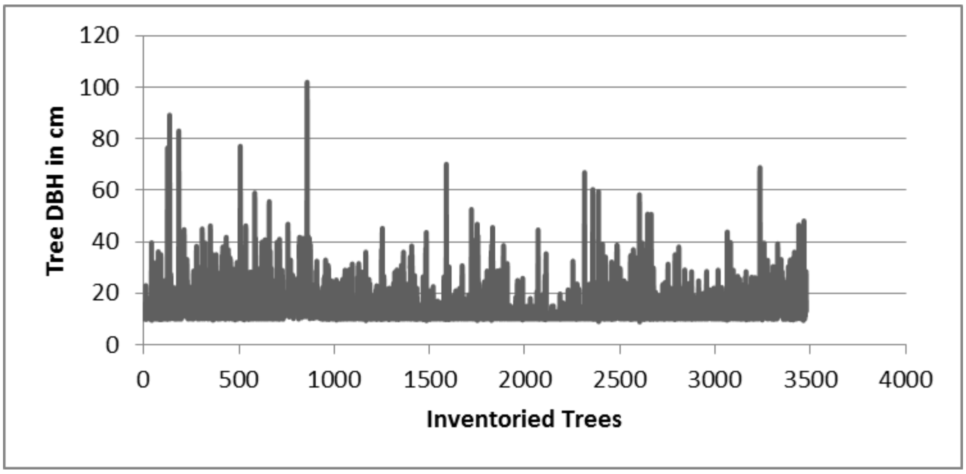

Figure 1.DBH (cm)of Inventoried trees inside the sample plots of 1 ha inaprivateforest of Ratnagiri District of North Western Ghats, Maharastra

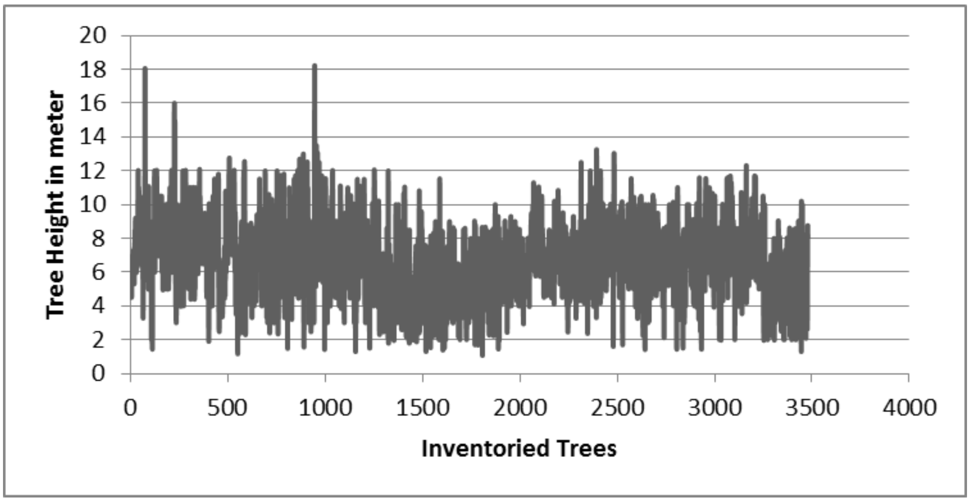

Figure 2. Height (meter) of Inventoried trees inside the sample plots of 1 ha in a private forest of Ratnagiri District of North Western Ghats, Maharashtra

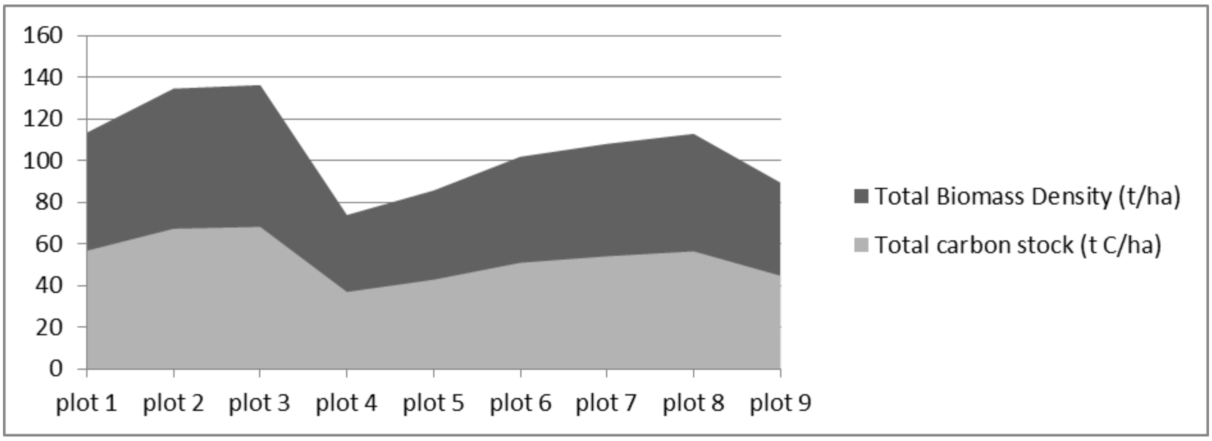

Figure 2. Sample plotwiseTotal Biomass density (t/ha) and Total Carbon stock (t C/ha) of Inventoried trees inside the sample plots of 1 ha in Private forest of Ratnagiri District of North Western Ghats, Maharashtra

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