Original Research Paper

Volume-9 | Issue-7 | July - 2019 | PRINT ISSN No. 2249 - 555X

Environmental Science

CARBON SEQUESTRATION POTENTIAL OF DIFFERENT FOREST ECOSYSTEMS OF MANIPUR, NORTHEAST INDIA

Amrabati Thokchom

Department of Life Sciences, Manipur University, Imphal-795003, India.

ABSTRACT Rate of carbon sequestration potential were assessed in tropical, sub-tropical and temperate forest ecosystems of Manipur, Northeast India. Carbon stock in the aboveground biomass was recorded to be highest in the sub-tropical forest (319.18 Mg ha-^{1}) followed by temperate (54.45 Mg ha-^{1}) and tropical forest (38.35 Mg ha-^{1}) The rates of carbon sequestration was in the order of the tropical>temperate> sub- tropical forest thus tropical forest being young sequestered more carbon than the other two old forests. Thus our study indicates that the young forests have a huge potential in the reduction of carbon dioxide levels in the atmosphere and could be used as C-sinks in the Northeast India depending upon the level of protection.

KEYWORDS : carbon sequestration, carbon stock,.

INTRODUCTION

Forests play an important role in reducing atmospheric CO_2 which contribute to global warming of earth surface. Human activities result in the emission of certain greenhouse gases predominantly CO_2 into atmosphere and that affect the global climate. The forests play a vital role to mitigate the climate changes in reducing the carbon dioxide which is being utilised through process of photosynthesis. Therefore forests are significant reservoir of carbon which is stored in living, dead biomass and soil. The loss of forests on global scale is a significant contributing factor in climate change .The United Nation Framework Convention on Climate Change (UNFCCC) and Clean Development Mechanism (CDM) have considered a new initiatives to reduce emissions from deforestation and degradation in developing countries (REDD). These activities are involved in new plantations and protection of young forests but the old-growth forests are not protected because it is generally thought that they cease to accumulate carbon.

Enhancing C sequestration by increasing forested land area is an effective measured to mitigate the climate change and contribute toward the prevention of global warming (Watson 2000). Thus assessment of carbon stock in vegetation in different forest ecosystems is basic step in evaluating the carbon sequestration potential of an ecosystem. In Manipur three major forest types i.e. tropical, sub-tropical and warm temperate occur along the altitudinal ranges in valley and hills. The present study envisages to estimate carbon stock and rate of carbon sequestration in the in three different forest ecosystems of Manipur to ascertain its role as potential C sink and to meet the challenges in mitigation of CO_2 increase in the atmosphere in the light of international agreement on climate change. Thus the study will fill the gap on the current state of knowledge on carbon budget of forest ecosystems of Manipur, Northeast India and to enhance the understanding of the role of forests in mitigation of climate change.

The major objectives of the present study were to estimate (i) to quantify the carbon stock in the vegetation and (ii) to determine the rate of carbon sequestration of different forest ecosystems

MATERIAL AND METHODS

Study site

The present study was conducted in tropical, subtropical and temperate forest of Manipur, Northeast India. Tropical forest site is located at 23^{0}13′N and 94^{0}17′ E at an altitude of 261 -360 m above mean sea level along the Myanmar border in the Chandel district of Manipur which is about 112 km from Imphal, the capital of Manipur. It is dominated by *Dipterocarpus tuberculatus* and co-dominated by *Melannorrhoe ausitata* and is young secondary forest and subjected to biotic disturbances of selective logging and annual fires. Sub-tropical forest site is located at Langol hills(24^{0}45′ N : 93^{0}55′ E) at an altitude of 780-910 m above mean sea level which is about 7 km from Imphal city and dominated by *Quercus serrata* and co-dominated by *Rhus succidanae.* Temperate forest is located at 25^{0}13′N latitude and 94^{0}24′E longitude at an altitude of 1800 to 1970 m above mean sea level in Shiroy hill, Ukhrul district which is about 105 km from Imphal and dominated by *Alnus nepalensis* and co-dominated by *Rhododendron arboreum* subjected to moderate disturbances.

The climate of the area is monsoonal with a warm moist summer followed by a monsoon rainy season and a cool dry winter. Mean monthly maximum temperature varied from 22.3 (December) to 30.3 °C (May) and the mean minimum temperature from 4.8 (January) to 22.3 °C (July). Average annual rainfall is 1,408 mm mostly received in the rainy season (June–October).

Soil sampling and analysis of soil

Five soil samples were collected randomly from the study site at monthly intervals from November 2016 to November 2017 for the analysis of physico-chemical characteristics. Soil moisture, soil temperature, soil organic carbon, total soil nitrogen and total soil phosphorus were determined on monthly basis in all the forest sites. The soil organic carbon was estimated by Walkley and Black method, soil moisture content by Gravimetric method (oven dry at 105°C for 24 hrs). Total soil nitrogen was measured by 2100 Kjeltec system and available soil phosphorus was determined following the method given by Bray and Kurtz (1945).

Data analysis

Ten replicates plot of 10 X 10m size will be earmarked in the study areas of each of the forest types. In each plot all trees individuals with circumference at breast height (1.37m) greater than 10cm were measured. The aboveground biomass (AGB) of tree species was estimated in tropical forest, sub-tropical forest and temperate forest ecosystems of Manipur by using regression equation developed by Brown (1997).The regression model used for the calculation of aboveground biomass is given as $Y= 21.297-6.953 (D) + 0.740 (D^2)$ Where, Y is the aboveground biomass (AGB) and D is the diameter of the tree (cm).

To convert aboveground biomass to carbon stock we assumed that 50% of the dry matter was carbon (Ngo *et al.*2013) and the carbon sequestration was calculated as the annual increase in the carbon density per ha at each site by species.

RESULT AND DISCUSSION

Physico-chemical properties of soil

Soil texture is sandy loam, loam and clay loam in tropical forest, subtropical forest and temperate forest respectively. Soil is acidic with pH ranging from 3.90 to 6.74 across the forest study sites. The soil temperature was found to be lowest in temperate forest and highest in the tropical forest where it was reverse trend in the case of soil moisture. Soil organic and total nitrogen were highest in temperate forest and lowest in the tropical forest (Table.1) owing to the slow rate of litter decomposition coinciding with low temperature at higher altitude (Table.1).

Table 1: Physico-chemical properties of soil in tropical, subtropical and temperate forests of Manipur, Northeast India

Parameters	Tropical	Sub -tropical	Temperate
Soil texture	Sandy loam	Loam	Sandy loam
Sand (%)	71.30	60.00	72.78
Silt (%)	16.81	20.15	22.67
Clay (%)	11.13	19.85	4.55

Soil pH	4.15-6.74	4.21-5.98	3.90-4.51
Soil temperature(°C)	19.68-31.98	16.02-24.87	9.20-20.70
Soil Moisture (%)	8.23-17.67	18.48-35.22	18.80-59.20
Bulk Density(g cm^{-3})	1.38-1.56	1.37-1.67	0.74-1.10
Organic carbon (%)	0.95-1.62	0.90-2.70	1.05-3.78
Total Nitrogen (%)	0.28-0.70	0.40-1.22	0.41-1.80
Total soil phosphorous (%)	0.11-0.22	0.14-0.19	0.21-0.56

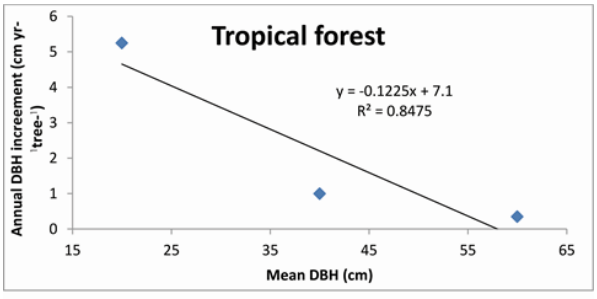
Forest structure, vegetation carbon density and rate of carbon sequestration

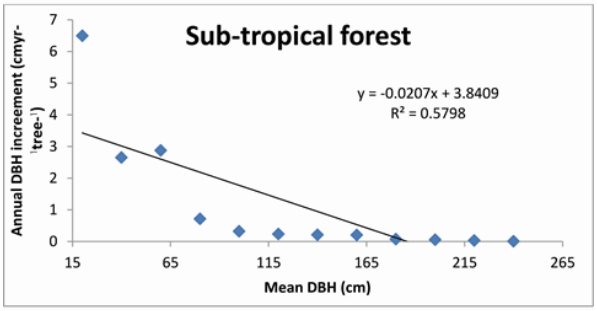
Across the three sites a total of 47 plant species were recorded and among all the forest sites subtropical forest exhibited a maximum number of species. Highest stand density was recorded in the tropical forest (2170 trees ha^{-1}) followed by subtropical forest (1630 trees ha^{-1}) and temperate forest (1230 trees ha^{-1}). Analysis of variation shows a significant variation in the density distribution across the forest types ($F_{2,19}$=6.47; p<0.005). The density of tree species decreased steadily with the increase of the DBH class .In tropical and temperate forest 52% and 60% of stand density where recorded in the low DBH class (0-30cm) whereas in subtropical forest 50% of stand density where found in the 0-30 and 30-50 cm DBH class.

The aboveground carbon density was 38.35 $Mgha^{-1}$ in the tropical forest, 319.18 $Mgha^{-1}$in subtropical forest and 54.45 Mg ha^{-1} in the temperate forest. Analysis of variation shows a significant difference in the carbon density distribution across the forest types ($F_{2,33}$=24.05; p<0.001). In our study we find that there was a wide variation in the aboveground carbon density among the forest sites. The carbon density in the subtropical forest was eight times more than the tropical forest and six times the temperate forest. It is obvious as subtropical forest site being a sacred grove was well protected by local people and consists of matured, fully stocked and old growth forest. The low value of carbon density in tropical forest which is being young secondary forest at early succession stage and also subjected to mild biotic disturbances. Similar finding was also reported for the tropical forest of Singapore (Ngo *et al.* 2013). The present tropical forests lies in the lower altitude and moderately disturbed, large trees more than 70 cm DBH were not available in this forest while temperate forest having high altitude is subjected to less disturbance. Thus it is important to note that altitude and level of disturbance also play a very important role in the storage of carbon in the vegetation as similar studies were also reported by Sharma et al.2010 .

Rate of carbon sequestration

Annual rate of carbon sequestration was estimated to be highest in tropical forest (11.41Mg C ha^{-1}) followed by temperate (10.34 Mg C ha^{-1}) and sub-tropical (9.84 Mg C ha^{-1}) forests which is just a reverse with the carbon stock being lowest in tropical and highest in sub-tropical forest. Thus large carbon stock does not necessary for high carbon sequestration potential and similar result was also reported by Yadav et al. 2017 in the mid hill of Indian Himalayas.





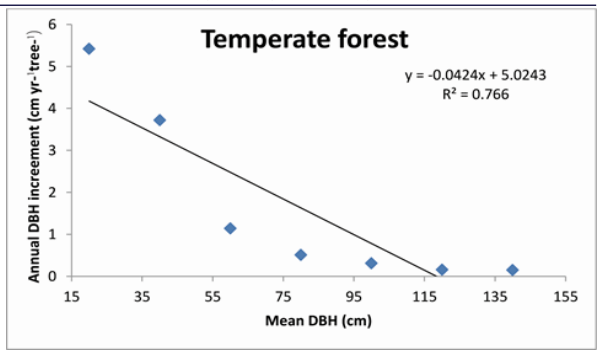


Fig.1.Relationship between DBH increment (cm $yr^{-1}tree^{-1}$) and mean DBH (cm) in temperate, subtropical and tropical forest.

Relationship between annual DBH increment and mean DBH class for the different forests shows an exponential decline model for all the species indicating highest increments for trees in the lowest DBH class (Fig1). Thus it shows that the rate of carbon sequestration was high in the young forest rather than the mature forest as there will be net addition to standing biomass to carbon storage. Thus the young forest needs to be protected and conserved for mitigating the climate change has also reported in dry tropical forest of India (Chaturvedi *et al.*2011)

CONCLUSIONS

We studied the carbon density and rate of carbon sequestration in the vegetation in the tropical, subtropical and temperate forests of Manipur, North-East India. Our study showed that most of the vegetation carbon resides more in the old-growth (high DBH) trees in well protected forests than the young secondary forests having low DBH. But the rate of carbon sequestration was high in the young tropical forest while comparing with the mature forest of the sub-tropical . Therefore to mitigate the increasing atmospheric CO_2 efforts are also needed to protect the young forest from lodging and fire and reforestation and afforestation programme could be recommended to enrich the forest stock.

REFERENCES

1. Chaturvedi, R.K., A.S. Raghubanshi & J.S. Singh. 2011. Carbon density and sequestration in woody species of tropical dry forest in India. Forest Ecology Management 262:1576-1588.
2. Ngo, K.M., B.L.Turner, H.C. Muller- Landau, S.J. Devies, M. Larjavaara, N.F.M. Hassan & S. Lum .2013. Carbon stocks in primary and secondary tropical forests in Singapore. Forest Ecology Management 296: 81-89.
3. Sharma, C.M., N.P. Baduni, S. Gairola, S.K. Ghildiyal & S. Suyal .2010. Tree diversity and carbon stocks of some major forests of Garhwal Himalaya, India. Forest Ecology Management 260: 2170-2179.
4. Watson, R.T. 2002. Land use, land-use change, and forestry: A special report of the IPCC (Cambridge: Cambridge University Press) pp.377.
5. Yadav, R.P., J.K.Bisht & J.C.Bhatt.2017.Biomass, carbon stock under different production systems in the mid hills of Indian Himalaya. Tropical Ecology 58:15-21.