COMPARATIVE STUDY OF ABOVE GROUND BIOMASS AND CARBON STOCK IN CHAKRATA FOREST DIVISION

ABSTRACT

Forests plays important role in ecosystem. Forest shows a variety of ecosystem services, one of the most important ones being absorbing carbon dioxide from the atmosphere and converting it into biomass. Biomass refers to the mass of the living organism within a tree.Forests play a major role in sequestering carbon and regulating the global carbon and energy cycles. Accurately estimating forest biomass is crucial for understanding carbon stock and sequestration, forest degradation, and climate change mitigation. The primary objective of this research paper is to find out above ground biomass as well as carbon stock of coniferous species of Chakrata forest divisionalso known as "Jaunsar Bawar" located in the state Uttarakhand.Sample plots are selected on random basis in 22 compartments from where data is collected. Techniques used for assessment of biomass are traditional field measurement. Biomass has measured through collection of information on DBH, Number of tree species, tree height etc within sample plots. The present study demonstrates that Chakrata forest division is one of most floristic diverse forest area. Chakrata forest division is very diverse consisting of 5 major forest types from sub-tropical to alpine forest. Under Chakrata forest division Kanasar forest range is acclaimed in Asia for Deodar tree growth. Present study also illustrates the well growth of *Deodar*, *Kail*,Silver fir and Spruce.

Keywords:-Above Ground Biomass, Stem density, Carbon stock, Carbon Pool, Carbon Sequestration

INTRODUCTION

India is the 10th largest forested country in the world (FAO, 2010) but in context of the forest area of various continents and countries of the world, it is still reasonable. According to the State of Worlds Forest Report (2010) published by FAO forest cover of India is higher than the total percentage of forest cover of South Asia (19%) and some of its neighboring countries like Maldives (3%), Bangladesh (11%) and Pakistan (2%) but less than World's (31%), Europe's (45%), Nepal's (25%) and Srilanka's (29%).Woody biomass is the accumulated mass, above and below ground, of the roots, wood, barks, and leaves of living and dead woody shrubs and trees. Biomass generally includes all live and dead material in all forms of vegetation (trees, shrubs, vines, etc.),or the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment[1].Forest ecosystem constitute huge amount of biomass and thus it play a major role in carbon sequestration and global climate regulation [2]. Forest AGB serves as a quantitative description of the ecosystem's vegetation layer, typically measured in terms of mass per unit area. It is worth nothing that AGB is

expressed in dry weight, which eliminates the influence of water content in organisms and more accurately reflects the actual material content [3].There are different methods of forest biomass estimation. Forest Biomass estimation through field measurement ismost accurate but it is time consuming as well as more man power are uses. It is also hard to collect data in large area. TheAbove-ground biomass of the tree is mainly the largest carbon pool and it is directly affected by deforestation and forest degradation [4].

MATERIALS AND METHODS

Accumulated biomass estimation in the forest ecosystem is important for evaluating the productivity and sustainability of the forest. It also gives us an idea of the amount of carbon that can be emitted in the form of carbon dioxide when forests are being cleared or burned. Biomass estimation of the forest ecosystem enables us to estimate the amount of carbon dioxide that can be sequestered from the atmosphere by the forest. The accurate assessment of biomass estimates of a forest is important for many applications like timber extraction, tracking changes in the carbon stocks of forest and global carbon cycle. Forest biomass can be estimated through field measurement and remote sensing and GIS methods. This research paper is mainly based on field measurement [5, 6].

Two methods of field measurement are available. The first one is the destructive method of tree biomass estimation. Among all the available biomass estimation method, the destructive method, also known as the harvest method, is the most direct method for estimation of above-ground biomass and the carbon stocks stored in the forest ecosystems [7]. This method involves cutting of all the trees in the known area and measuring the weight of the different components of the harvested tree like the tree trunk, leaves and branches [5, 8, and 9] and measuring the weight of these components after oven dried. This method of biomass estimation is limited to a confined area or less tree sample sizes. This method determines the biomass accurately for a particular area, it is time and resource consuming, strenuous, destructive and expensive, and it is not feasible for a large-scale. This method is also not applicable for degraded forests containing threatened species [10]. Usually, this method is used for developing biomass equation to be applied for assessing biomass on a larger-scale [11, 12].

The second method of tree biomass estimation is the non-destructive method. This method estimates the biomass of a tree without felling. The non-destructive method of biomass estimation is applicable for those ecosystems with rare or protected tree species where harvesting of such species is not very practical or feasible. Monte's et al.developed a non- destructive method for the above-ground biomass estimation of thuriferous juniper (*Juniperus thurifera L.*) woodlands in the High Central Atlas, South of Morocco [10]. In this method, the biomass of the single tree was estimated by taking into account the tree shape (by taking two photographs of the tree at orthogonal angles), physical samples of different components of the trees like branches and leaves and dendrometric measurements, volume and bulk density of the different components. Although it is a non-destructive method, to validate the estimated biomass, the trees

had to be harvested and weighted. Another way of estimating the above-ground forest biomass by non-destructive method is by climbing the tree to measure the various parts [13] or by simply measuring the diameter at breast height, height of the tree, volume of the tree and wood density [5] and calculate the biomass using allometric equations [13,14]. Since these methods do not involve felling of tree species, it is not easy to validate the reliability of this method. These methods can also involve a lot of labour and time and climbing can be troublesome.

Methodology

The methodology used in present study has been presented below-

(1) Bole Biomass

For the purpose, only trees with Diameter at Breast Height more than 10 cm were taken into account. The Diameter and Height of trees were recorded from field. Volume of the tree was calculated using volume equations used by FSI which was multiplied by its specific gravity to obtain biomass.

Bole Biomass = Volume of the Tree x Specific Gravity.

Values of Specific Gravity were same as used by Forest Survey of India.

(2) **Above-Ground Biomass**

Aboveground biomass was calculated by multiplying the Bole Biomass with Biomass Expansion Factor (BEF).

Aboveground biomass = Bole Biomass x BEF.

Where, BEF was taken from IPCC Good Practice Guidance for LULUCF.

(3) **Carbon Stock**

For calculating the Carbon Stock, equations from the IPCC Good Practice Guidance for LULUCF were used. Formulae used for Carbon Stock Calculation as per IPCC is given below:

$C = \{V \times D \times BEF^2\} \times \{1 + R\} \times 0.5$

Where,

C: Total Carbon calculated in Biomass (ton/ha)

V: Merchantable Volume (m3 /ha),

D: Specific gravity

BEF: Biomass expansion factor for conversion of merchantable volume to aboveground tree biomass dimensionless,

R: Root-to-shoot ratio, dimensionless.

RESULTS AND DISCUSSIONS

The major findings of present study has been presented in table1 and graphically illustrated in figure1. In this study highest average AGB 107.41 tonnes/ha is recorded in case of *Cedrus deodara* species with Average carbon stock of 226.7 tonnes/ha as compared to Fir and spruce which are 53.51 tones/ha and 113.29 tonnes/ha. In case of species *Pinus wallichiana* Average

above ground biomass is 38.3 ton/ha and average carbon stock is 81.08 ton/ha. Total AGB is maximum in case of *Cedrus deodara* followed by Fir & spruce and *Pinus wallichiana* which are respectively 1933.45 ton, 963.3 ton & 689.42 ton. Total carbon stock is maximum in case of *Cedrus deodara* followed by fir &spruce and lastly *Pinus wallichiana* which are respectively 4080.65, 2039.2 and 1459.48. Where as in study of Sharma et al., (2010) most of the conifer dominated forest types had higher carbon storage than broad leaf dominated forest types. Protecting conifer dominated stands especially those dominated by *Abies pindrow* and *Cedrus deodara*, would have the largest impact, per unit area, on reducing carbon emissions from deforestation. Also in study of Sharma et al.,(2008) forest biomass in the Indian Himalayan state of Himachal Pradesh discovered that the highest AGB density of 1158 tonnes/ha was recorded for the reserved forest followed by 728, 13,11,8,5, and 3 tonnes/ha in the protected forest, fallow land cultivated – unirrigated land, grassland, orchard land and cultivated- irrigated land respectively.

Table 1:Comparison of AGB and Carbon Stock between Deodar, Kail , Fir and Spruce

Comparison between Deodar, Kail , Fir and Spruce			
Name of species	***Cedrus deodara***	***Pinus wallichiana***	***Fir and Spruce***
Average AGB (ton/ha)	107.41	38.30	53.51
Total AGB(ton)	1933.45	689.42	963.30
Average carbon stock(ton/ha)	226.70	81.80	113.29
Total carbon stock(ton)	4080.65	1459.48	2039.20

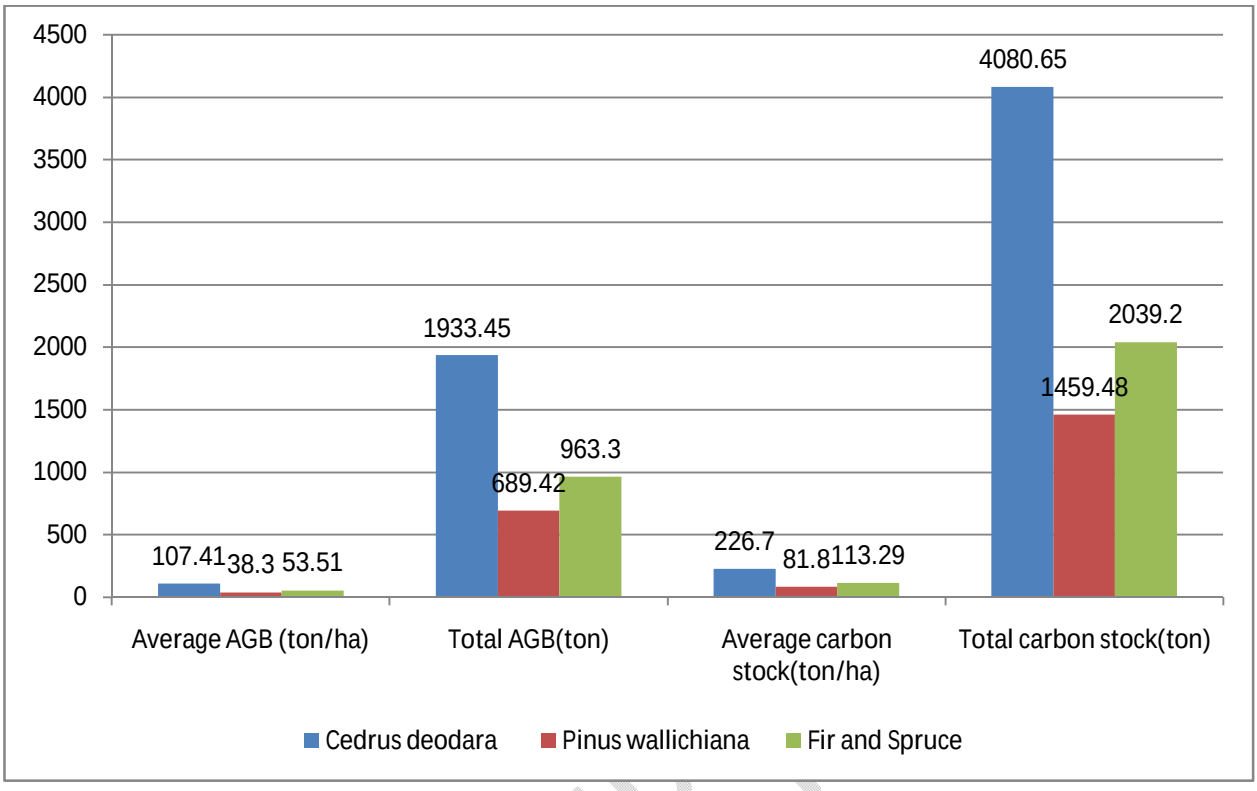

Fig. 1 Comparative Analysis of AGB and Carbon Stock

Conclusion

Forests play an important role in global carbon cycling, since they are large pools of carbon as well as potential carbon sinks and sources to carbon in the atmosphere. Accurate estimation of forest biomass is required for greenhouse gas inventories and terrestrial carbon accounting. Thus, it has a potential to form a chief component in the mitigation of global warming and adaptation to climate change. Estimation of the forest carbon stocks enable us to assess the amount of carbon loss during deforestation or the amount of carbon that a forest can store when such forests are regenerated. The principal element for the estimation of forest carbon stocks is the estimation of forest biomass. Chakrata forest division under Uttarakhand state is one of most floristic diverse forest area. Under Chakrata forest division Kanasar forest range is well known in Asia for Deodar tree growth. Above study also depict the well growth of *Cedrus deodara* tree, *Pinus wallichiana* tree as well as silver fir and Spruce. But now a day's trees deforestation as well as people's recreation purpose in Kanasar forest range disturbed the Growth of *Cedrus deodara*. Consequently the lush and green beauty Deodar forest of Kanasar range is decreasing day by day. Chakrata forest division is very diverse consisting of 5 major forest types from sub-tropical to alpine forest. Deodar being dominant species in Conifer is important species for ecosystem productivity and local people's dependency. Many people come to visit the natural beauty of Deodar in Kanasar forest range which is main source of income of nearby villages. *Abies pindrow* is the desired species for house construction. As altitude increases trees size decreases

and less diversified tree are found as compared to lower altitude, therefore biomass also decreases which directly relates to less carbon sequestration among higher altitude species. Carbon stock is an indicator of carbon credit. Higher the carbon stock more will be the carbon credit in terms of stake which if provided with proper awareness and techniques will help in upliftment of poverty and the socio economic status of local people. Thus it will encourage people to practice afforestation in and around the vicinity of their society and property as well as forest ultimately gaining all the tangible and intangible benefits from the forest. Forest plays a major role in amelioration of climate in different ways. The total amount of carbon a healthy forest sequesters is of enormous importance in terms of major environmental changes such as climate change and global warming. The effects of such catastrophic events can be minimized if not reversed by possible involvement of local community in different forestry activities which not only increase people's awareness but also helps to minimize the menace of such global events in the long run.

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