Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com
Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(6): 760-767

Received: 11-09-2016
Accepted: 12-10-2016

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Carbon stock Assesment of moist temperate forest Yakhtangay district Shangla and its effect on insect infestations

Adnan Iqbal and Ahmad Hussain

Abstract
The amassing of carbon dioxide (CO_2) in the climate is growing because of different human activities. Forest act as a carbon sink. It was accompanied by a recent study in Shangla district located in Khyber-Pakhtunkhwa province at 34^0-31′ to 33^0-08′ North latitude and 72^0-33′ to 73^0-01′ East longitude. Yakhtangay is placed 28 km away from the top Shangla at an elevation of 6000 feet above sea level. Various analytical and statistical methods were utilized to find carbon stock, biomass and soil organic carbon. The result and outcomes were further analyzed by Statistical indicators such as means, co-efficient of variance (%CV), and standard deviation (SD) was used for determination of existence biomass in high and beneath growing stock at every plot stage. Statistical software such as Sigma Plot version 10 will be utilized for arrangement of consequences by graphs and figures. The results showed that *Pinus wallichiana* mean trunk density was 404 ± 4.7 trees ha^{-1}. The stem density moderation for *Abies pindrow* 160 ± 4.32 trees ha^{-1}. *Pinus wallichiana* mean basal area was 1.493497 ± 0.28 m^2ha^{-1}. *Abies pindrow* in basal area extends to 1.680068-0.50672 m^2ha^{-1} with the basal area mean of 1.5140 ± 0.39 m^2ha^{-1}. The *Pinus wallichiana* mean height tree 24.76471 ± 2.48 m. The stem volume of *Pinus wallichiana* was found maximum 154.16 ± 0.512 m^3ha^{-1} while was determined in the basal area of 18.17 m^2ha^{-1} stem minimum in *Abies pindrow* 0.6822 ± size 0.04 m^3ha^{-1} at basal area 0.30672 m^2ha^{-1}. In *Pinus wallichiana* the average stem biomass 78.51912 ± 2.03 (t ha^{-1}) in the basal area of 18.17 ± 0.8. The average total biomass in the most extreme *Pinus wallichiana* 159.26 ± 1.78 t ha^{-1} and was less biomass 0.76 ± 0.86 tons per hectares in *Abies pindrow*. The carbon stocks in forests account as considered, TCS (t ha^{-1}) = (AGB+BGB+UVB) ×0.5 Total organic matter (%), and bulk density of the soil and the depth of the horizon g / cm^3. The research investigations were carried out on major forest species such as *Pinus wallichiana* and *Abies pindrow*. The objectives were determine to estimate biomass, carbon stocks of the study area. The data revealed that increasing stock of carbon has negative effect on controlling infestation and vice versa.

Keywords: Carbon stock, Assesment, moist temperate forest, insect infestations

1. Introduction
The amassing of carbon dioxide (CO_2) in the climate is growing because of different human activities. Forest act as a carbon sink. Clearing of forest causes an increase in the percentage of carbon dioxide, as well as crush important sink of carbon. The real issue of global importance today is the increased level of CO_2 from 315 ppm in 1959 to 399.89 ppm in 2013 (NOAA, 2013) [1]. Biomass of plants establish a serious carbon stock in numerous environments. In *Pinus wallichiana* and *Abies pindrow* biomass is shown above ground & subterranean portions of yearly and perpetual trees. Connected biomass through yearly & enduring herbaceous plants is generally fleeting, that is. When they rot and recover every year before at regular intervals. Trees and woody plants, both amass a lot of carbon (C) up to many t ha^{-1} (IPPC, 2006) [2].
Forests are the characteristic stockpiling plants with carbon and the evaluation of C existing in the forest biomass is the vital segment to focus the commitment of forest area to worldwide carbon cycle. (Gairola *et al.,* 2011) [3]. Between animal and plant community plants have the biggest capacity to mitigate worldwide environmental variation due to carbon because of its wooden nature (Sharma *et al*., 2011; Danquah *et al.,* 2012) [3, 5]. Forest can possibly absorb 20-50 times extra C as compare to infertile grounds (Houghton 1995) [6]. One way to deal with a record for GHG emanations is to access forest carbon stocks under distinctive forest situations crosswise over forest matures. The measure of carbon put away and hence discharged to the environment differs extraordinarily relying upon forest conditions (Gibbs *et al*, 2007) [7].
The anthropogenic arrival of carbon dioxide into the climate from the fossil burning powers

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speaks to a developing danger into the worldwide atmosphere. Despite the fact that a permanent answer for this issue can just get through the advancement of innovations that don't rely on beforehand put away C; in minimum period, counterbalancing emanations of greenhouse gasses collected through other carbon dioxide decrease strategies might give about relief at 750 Pg. (IGBP, 1998) [8] the atmospheric carbon pool is extensively lighter than the amount of C put away inside soil (2200 Pg in upper 1 m) of which about 1500 Pg is natural C (Batjes, 1996) [9]. Carbon is promptly traded among these 2 pools and is influenced through anthropological action, especially farming practices. The impacts of insects and pests on forest carbon sequestration include direct effects of increased tree mortality and decreased productivity as well as indirectly effects that ramify through the ecosystem due to altered natural cycling, plant phenology and species composition. (Brockerhoff *et al*., 2006) [10].

The objectives of the present study were:
To estimate the biomass of the study area.
To determine the present carbon stocks of the study area.
To access available carbon sink and finding out a possible way for enhancing carbon sinks.

2. Materials and Methods

2.1 Study Area

It was accompanied by a recent study in Shangla district located in KP Province at 34^0-31′ to 33^0-08′ North latitude and 72^0-33′ to 73^0-01′ East longitude. Yakhtangay is placed 28 km away from the top Shangla at an elevation of 6000 feet above Sea level. The area is located in the moist temperate region and therefore obtain monsoon in summer (July, August) and snowfall in the winter. Usually the beginning of the fall of snow in mid-November and lasts until mid-April, sometimes also observed early snowfall. Average height of Shangla district is 2125 meters above sea level.
Average rainfall ranges from 1500-2000 mm/Year (Forest management plan 2000-2010). The dominant species of the area are *Pinus wallichiana, Abies pindrow.* Found a number of medicinal plants in the region that are Unab (*Zizyphus sativa*), Althea (*Althaca aromatic*), Banafsha (*Viola odorata*), Mushki Bala (*Valeriana species*)
Study related information, for example, verifiable accounts & maps of region remained gathered from the workplace of Divisional forest office Shangla. Appraisal of C stock of obliges data on tree height, size, diameter, density, and structure element. It has been gathered this data through the sample plots in the whole area of concern.

2.2 Methods

2.2.1 Plot Selection

The geo-relevant forest, sheets and topographic maps, history log cabin, and subtle earth elements and other data relevant to unite the forest Division of KP forest management department. It was created twenty pieces of 0.1 hectares in the whole study area. The plots fit round as there is a circle with a radius of 17.84 meters. The plots have to make illustrative area for a full study. Sub-plot of four square meters of bushes and one square meter of herbs and grasses were taken. To test the soil, and pits of size 0-30 cm in each plot of the study area.

2.2.2 Data collection in plot

The accumulation of field data, was calculated diameter at chest level for each tree of a way to dia tape, and calipers in each sample area. Haga altimeter and Abney's level to estimate the height of the tree. 4 m^2 was harvested plants and bushes 1 m^2 for herbs and grasses and weight late been resolved (kgm^2). The sample of one kilogram place in the labeled luggage to estimate the oven dry weight in the research center.

2.2.3 Estimation of biomass

Been confirmed biomass originates from the wood density of the important and volume of trees. Biomass of stem was recorded as follows:
Biomass (kg) = basic wood density (kg) × Volume (m^3)
It was rated leaves, branches, twigs and roots commitment in general biomass by utilizing advantage of the extension of biomass factor was sourced. And the types of trees to expand biomass factor in particular of literature can be reached, if the BEF study of the trees cannot be reached then communicates almost considered the species to estimate (Haripriya, 2000) [11]. It uses respect BEF trees and a wide stock of India's 1.59, which was the practice in India to detect from biomass types of securities and wide by Haripriya, 2000 [11]. For estimate the total carbon stock in the top of the vegetation cover story, each of biomass on 2 divided into 50% of the plant biomass carbon equivalent (Kehzo *et al*., 2010).

2.4 Calculation of Soil Carbon

2.4.1 Soil Sampling

Soil tests were collected from focus designed to test the soil. Three samples of soil and one collection from every piece of 0.1 hectares at a depth of 0-15 cm and 16-30 cm of the way to auger soil and soil cores from recognized from 198.24 size cm^3 (diameter = 5.9 cm and height = 7.25 cm). In a block field (g) of each sample of the soil was measured and placed in a bag labeled and was transferred to a laboratory for further study.

2.4.2. Soil carbon Determination

The calculation of carbon in the soil in the gm^{-1} way to a prescription product (Persion *et al*., 2008) Carbon soil in t ha^{-1} was rigid. Soil carbon t ha^{-1} soil bulk density (g / cm^3) × SOC% content × thickness of the soil layer in cm × 100.

2.5 Total Carbon Stocks Computation

The plants have emerged whole forests and carbon stocks animals (t ha^{-1}), which includes full carbon stocks (t ha^{-1}) of the plants underneath, all of the carbon stock (t ha^{-1}) of the highest vegetation cover story and carbon in the soil (t ha^{-1}). And recorded a total carbon stocks (t ha^{-1}) by including carbon stocks of each frame (Beneath ground biomass, and soil C, above ground biomass t ha^{-1}).

2.6 Statistical Analysis

Statistical pointer, for example, used the media, and participated in the master of the difference (% CV), standard deviation (SD) to determine the biomass in the presence of high and under the stock status in every stage of the plot. Statistical programming, for example, was used Sigma plot shaped 10 outputs game plan according to charts and numbers. Was produced regression models to audit the virtual density stem (ha^{-1}) with stem diameter (cm) and height (m), and basal area (m^2ha^{-1}) with volume of stem (m^3ha^{-1}) and biomass stems (t ha^{-1}).

3. Results and Discussion
3.1 Results
3.1.1 Density
Pinus wallichiana mean trunk density was 404 ± 4.7 trees ha^{-1}. Most of the greatest density solution & a lowest of 470 plants and 370 in each plot. And it recorded the intensity of the trunk of the trees 191 ha^{-1}. Between 16 cm and 42 cm in diameter and 46 plants ha^{-1} in more than 42 cm diameter measuring. Subjugated by blue pine in the study area.
The stem density moderation for *Abies pindrow* 160 ± 4.32 trees ha^{-1}. It was observed intensity of practice in *Abies pindrow* 230 ha^{-1} tree. The minimum density of 30 while in each plot. Stem thickness was 28-36 cm diameter 83 trees ha^{-1}.

3.1.2 Basal area
Pinus wallichiana mean basal area was 1.493497 ± 0.28 m^2ha^{-1}. The most basal maximum area was 1.512 whereas the minimum is 0.374 m^2ha^{-1}. *Abies pindrow* in basal area extends to 1.680068-0.50672 m^2ha^{-1} with the basal area mean of 1.5140 ± 0.39 m^2ha^{-1}.

3.1.3 Tree Height
The *Pinus wallichiana* mean height tree 24.76471 ± 2.48m. Blue pines varies from 33 meters to 12 meters in height 18-50 cm in diameter consistently. Stem height (m), diameter (cm) the settlement of the relationship between the polynomial (Table 4.4; Figure 4.4).
Due to the tallness diameter of trees generally rise. The relationship between tree heights (m) and stem diameter (cm) regression models has to produce of a diverse classes of the study area to be studied.

3.1.4 Tree Volume
It was dissolved stem size in the m^3ha^{-1} for all the species. There was a touch on the immediate size of the stem (m^3ha^{-1}) and basal area (m^2ha^{-1}). Stem increase with the increase in the volume of the basal area (Annex I, II). The stem volume of *Pinus wallichiana* was found maximum 154.16 ± 0.512 m^3ha^{-1} while was determined in the basal area of 18.17 m^2ha^{-1} stem minimum in *Abies pindrow* 0.6822 ± size 0.04 m^3ha^{-1} 1at basal area 0.30672 m^2ha^{-1}.The connection in all species was polynomial, and linear. The outcomes of the learn zone demonstrate that the blue pine volume (m^3ha^{-1}) was most astounding as a contrast with *Abies pindrow.*

3.1.5 Stem biomass determination
The solution stems thickness in both types of basic wood density (kgm^3) and volume (kgm^3). Basic wood density estimates have been strained each species in force and one of the understanding as of Sheikh (1992) [12] the In Pakistan specifics of the various tree densities. As the size of decided (m^3ha^{-1}) of whole forest types and the amount of basic wood density of the biomass deferential tree trunk was intended through the formula attached.
Stem biomass = Basic wood density (Kgm^3) × volume (m^3ha^{-1}).
The regression models were created to examine the relationship of basal area (m^2ha^{-1}) & stem biomass (kg m^3). Table 4 Figure 4.4). In both types the connection is linear and polynomial. Explanation of reactionary models of regression that (m^2ha^{-1}) relates basal area specifically by the stem biomass of the stem (kgm^3). In *Pinus wallichiana* stem biomass average is 78.51912 ± 2.03 (t 1 hectare) in the basal area of 18.17 ± 0.8.

3.1.6 Total tree Biomass determination
He dominated the entire biomass of tree in the timberland, including the stem, leaves, and roots, branches and twigs biomass. The biomass of the tree have been resolved basic wood density estimates (kgm^3) & estimates of the size of intended (m^3ha^{-1}). The thickness of the timber came from completely kinds of trees out of the writing can be accessed Sheikh (1993) [13]. There is a need biomass expansion of the species actually concerned to total tree biomass concentration, but shockingly not found the will of the recent data on a real commitment to each of the trees. However, the biomass expansion factor of 1.59 for all practical focus for all types of biomass. This breakage was connected by Harapriya (2000) [11] to detect the expansion of the biomass of tree leaves the forest needle in India component. On aggregate stems and biomass tons hectares 1 with1. 59 War total biomass factor has been resolved t ha^{-1}.
The average total biomass in the most extreme *Pinus wallichiana* 159.26 ± 1.78 t ha^{-1} and were less biomass 0.76 ± 0.86 tons hectares per in *Abies pindrow.*

3.1.7 Biomass determination in understory vegetation (Shrubs and grasses)
The biomass aggregate figures in the bushes 67.12 t ha^{-1}. Shrubs the average biomass 3.35 ± 1.92 t ha^{-1}. The most extreme biomass 6.37 tons hectares 1 in plot No. 20 while the less biomass 0.90 t ha^{-1} plot no 0.5. And was fined a total biomass in grasses 31.70 t ha^{-1}. The mean total biomass in herbs 1.58 ± 0.78 tons hectares 1. The biomass maximum 2.70 in no. 13 plot while he was at least 0.22 t ha^{-1} in a conspiracy no. 17.

3.1.8 Carbon stock determination in forest
It was necessary in carbon stocks in forest biomass on the upper ground t ha^{-1} below plant biomass story and biomass under the ground. The ratio was 0.5 to change the use of the overall biomass t ha^{-1} in whole carbon stock. The carbon stocks in forests account as considered

$$TCS\ (t\ ha^{-1}) = (AGB+BGB+UVB) \times 0.5$$

Where
TCS=overall carbon stock
AGB=on top ground biomass
BGB=beneath ground biomass
UVB=under story vegetation biomass
0.5=conversion factor

The calculation of the entire carbon stock (t ha^{-1}) by the formula above.

3.1.9 Determination of soil carbon
The carbon in the soil to determine means of the relationship of the total organic matter (%), and bulk density of the soil and the depth of the horizon g/cm^3. Total carbon was calculated at 535.73 tons of soil t ha^{-1}. Determine the average carbon stock in the soil 28.17 ± 10.12 t ha^{-1} in the study area. The stock of carbon extreme 52.18 in Plot no. 2, where this was the lowest 13.17 t ha^{-1} in No. 7 plot.

3.1.10 Determination of total carbon
Aggregate carbon controlled through calculating the amount of carbon in a specific tool. Hypothesis carbon present in a specific component. The premise of carbon in forests, and carbon stock under what the whole story vegetation t ha^{-1} and the entire stock of carbon in the soil t ha^{-1} in the ecosystem individual forest was all the carbon stock as a focus

TCF (t ha^{-1}) =TC+UC+SC

Where
TFC= total carbon in forest
TC=total carbon in forest (trees)
UC= whole carbon in under vegetation (shrub and grasses)
SC=soil carbon

In *Pinus wallichiana* and *Abies pindrow* the total carbon stock in forests mean 79.63 ± 2.32, 1.56 ± 13.039 respectively. Equally, in the soil, shrubs, grasses and in the study area the average carbon stock of 32.17 ± 9.10 and 2.53 respectively. As a result of this study clearly that vegetation upstairs in the (trees) have an average carbon stock of 171.49 t ha^{-1} while the soil has a 32.17 t ha^{-1}. Exposed soil in the study area to overflow and loss due to melting of usual snow and also Agriculture.

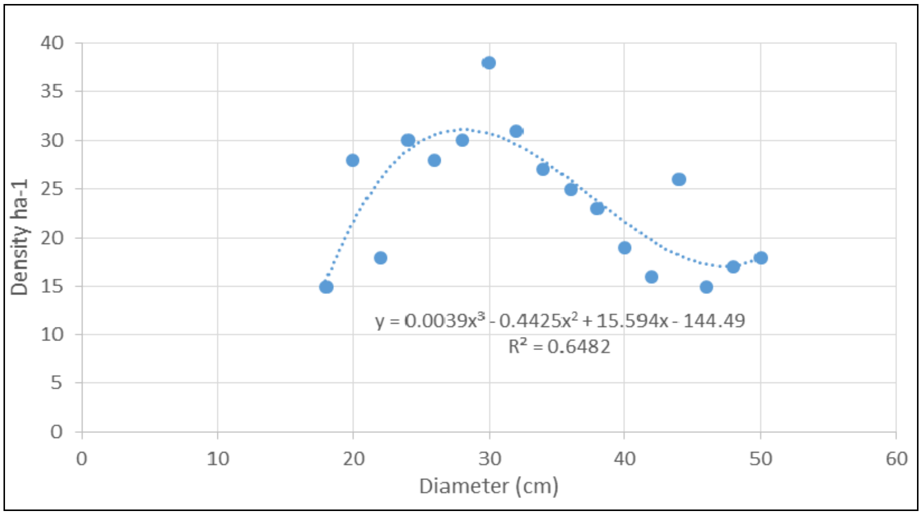

Fig 3.1: Relationship between Diameter and density in *Pinus wallichiana*

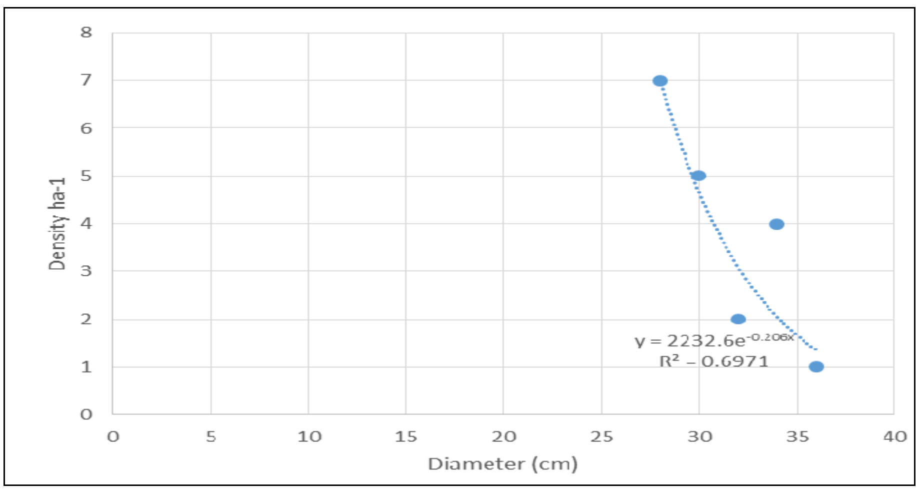

Fig 3.2: Relation between Diameter and density in *Abies pindrow*

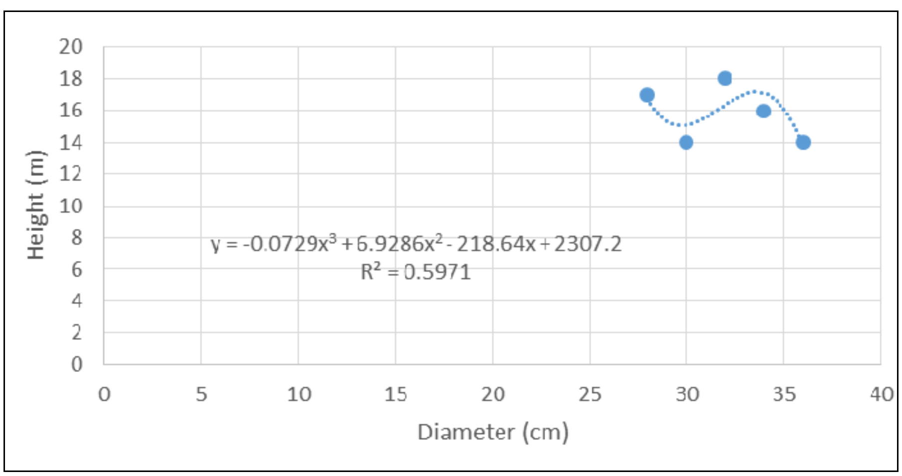

Fig 3.3: Relationship between diameter and tree height in *Pinus wallichiana*

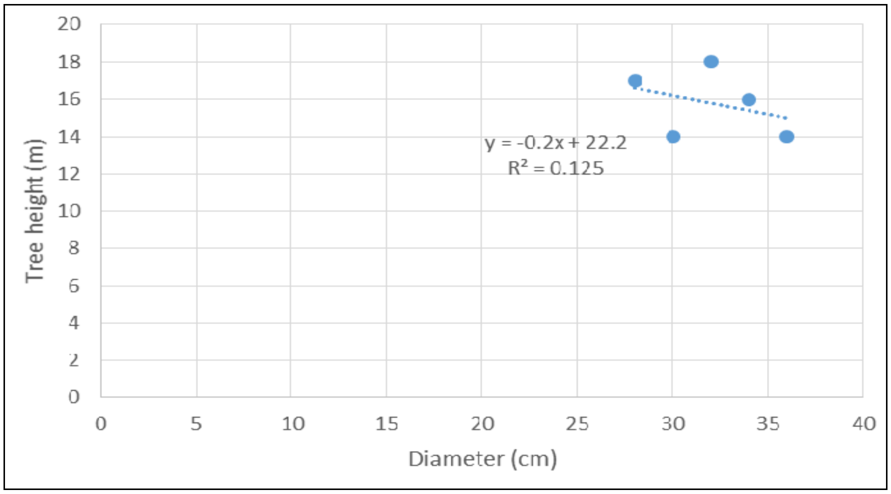

Fig 3.4: Relationship between diameter and tree height in *Abies pindrow*

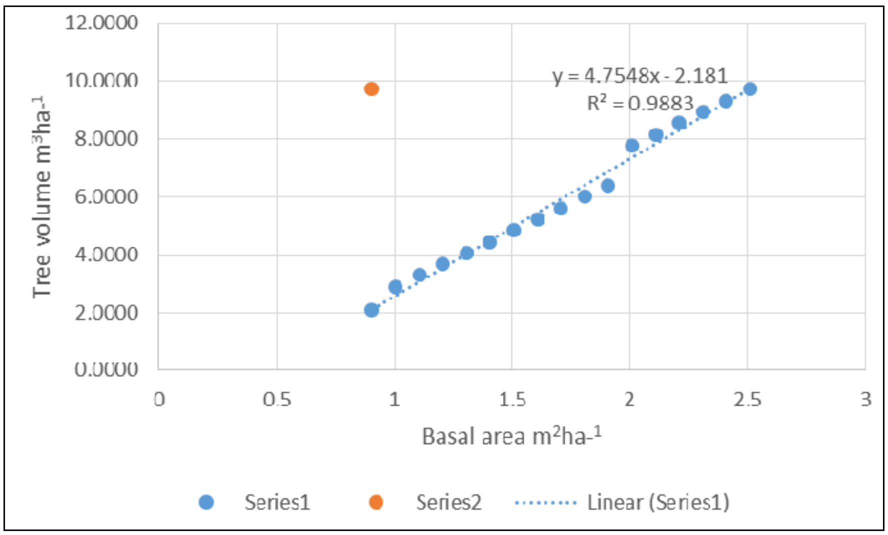

Fig 3.5: relationship between tree volume and basal area in *Pinus wallichiana*

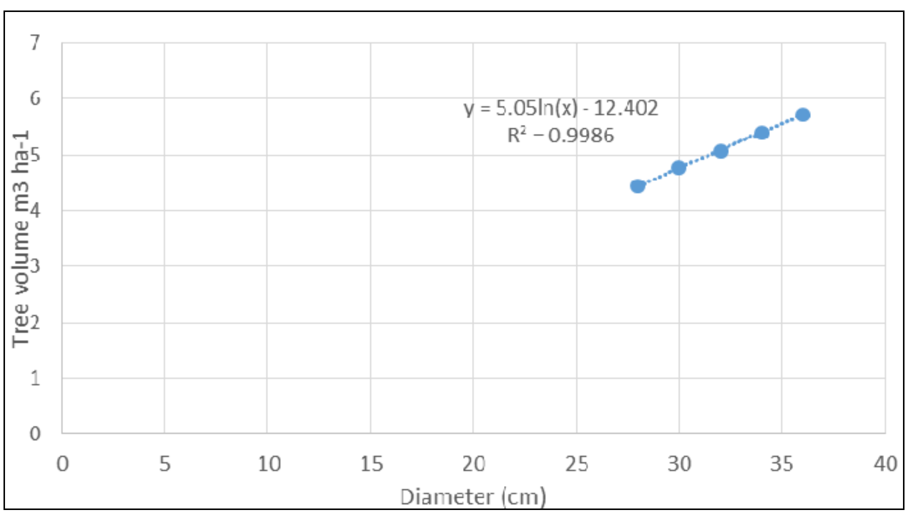

Fig 3.6: relationship between tree volume and basal area in *Abies pindrow*

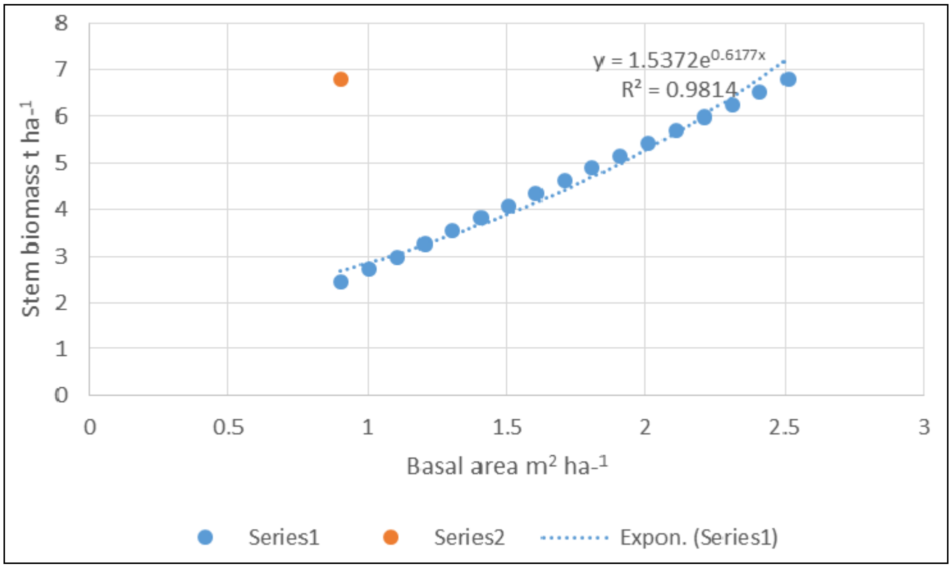

Fig 3.7: Relationship between stem biomass and basal area in *Pinus wallichiana*

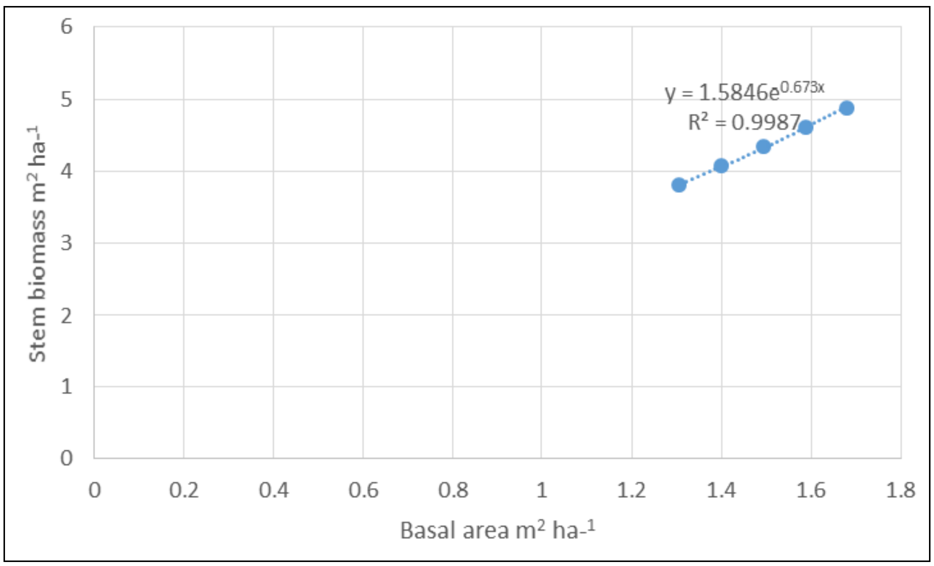

Fig 3.8: Relationship between stem biomass and basal area in *Abies pindrow*

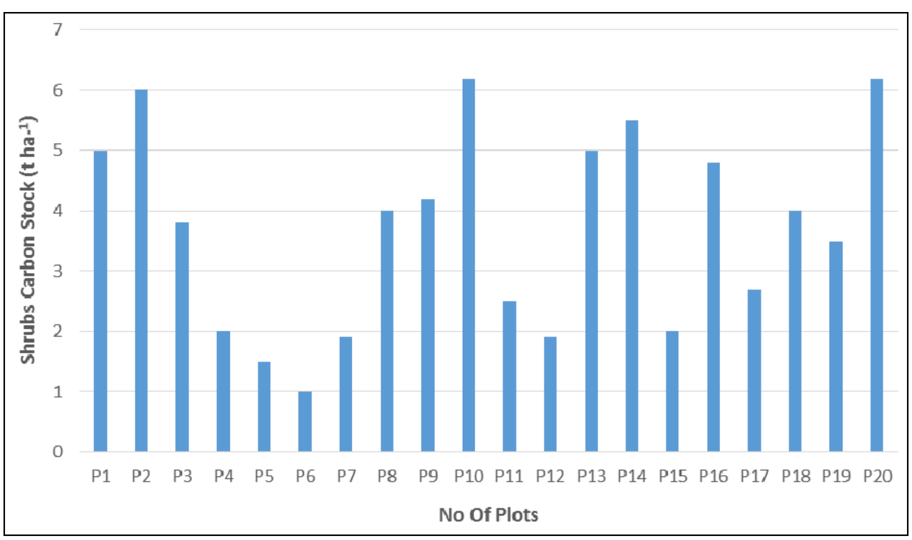

Fig 3.9: Plot wise shrub carbon stock

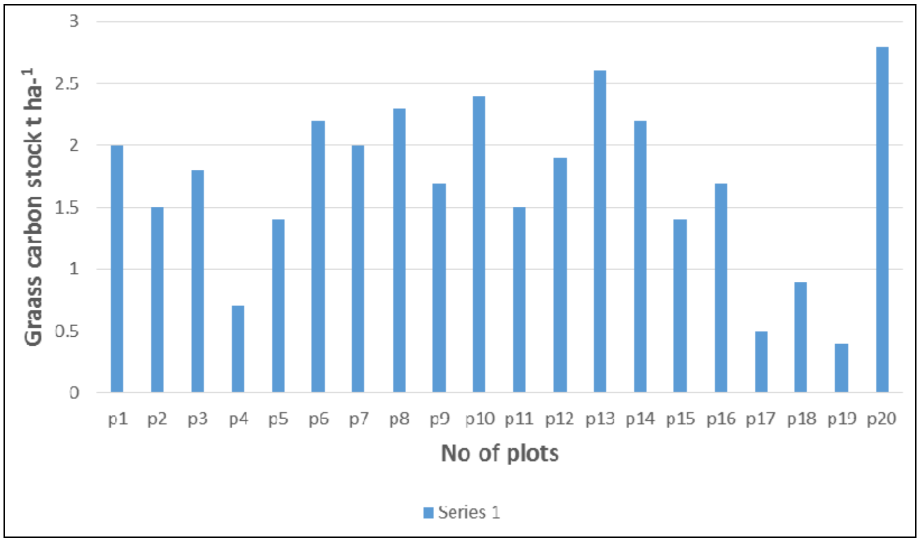

Fig 3.10: plot wise grass carbon stock

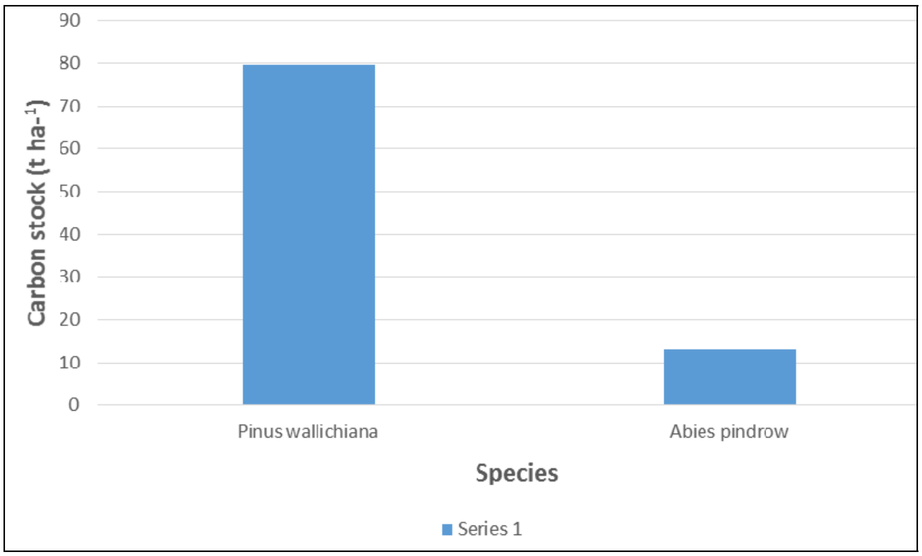

Fig 3.11: Species wise carbon stock

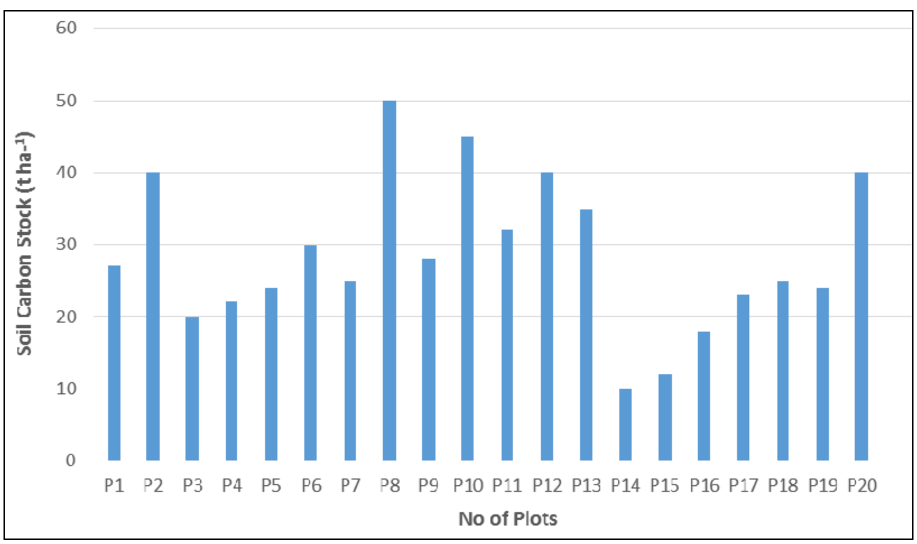

Fig 3.12: Plot wise soil carbon stock

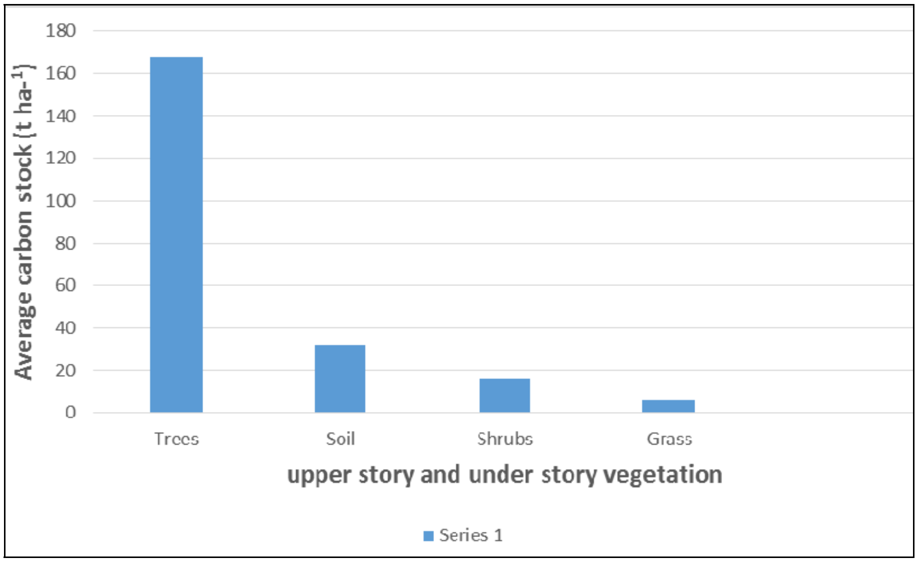

Fig 3.13: Mean under story and upper story vegetation carbon stock

4. Conclusion

The study area demonstrated that forest put away most astounding measure of carbon when contrasted with soil, shrubs and grass. The study affirmed that soil has minimum carbon stock 32.17±9.10 t ha^{-1} and its primary reason was the constant episode of snow in the study area. The snow wash out the top soil layer when it melts in summer, as a result the natural matter misfortunes and result in low soil carbon. In the study area, a significant forest area has become under agriculture. And also due to timber mafia and lack of supervision, sliding of land is also major cause because constructing roads and easy access for timber mafia, which was once under forest area. As an outcome forest area is decreasing day by day. When carbon is stored in trees, herbs, shrubs and soil there will be less chance of infestation but when it is exposed then it was difficult to control infestation. Proper supervision of forest area, reforestation of pillaged area, afforestation, control of deforestation and treatment of raided area territory can prepare the region as a sink of carbon.

5. Recommendations

The following general recommendations were put forwarded on the basis of the results of the present study Moist temperate forest of the study area have the maximum of above ground mass, but proper scientific forest management practices should be enhanced to conserve the above ground biomass because it is the main source of carbon sink.

Soil erosion should be mitigated in the study area to improve natural regeneration of the moist temperate forest of the study area to enhance the watershed value of the forest.

Reforestation practices are needed on current basis to improve the cover in the blank areas of the forest and increase carbon sequestration.

The enforcement of the forest law and policy are needed to monitor forest degradation and shifting cultivation in the study area.

Present study provide a base for further study in future regarding estimation of forest biomass and assessment of carbon stock in the moist temperate forest.

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