Carbon Stocks of Pure Cedrus Deodara Forest in Kumrat Valley, Dir Upper, KPK, Pakistan

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Abstract: The study The Present study was carried out in pure *Cedrus Deodara* forest of Kumrat Valley Dir Kohistan. The study was aimed to calculate biomass (t ha^{-1}) and carbon stock (t ha^{-1}) in the above and below ground biomass. Overall, 32 sample plots were laid out. The size of each plot was 0.1 ha. In each sample plot stem density(t ha^{-1}) tree diameter(cm),tree height (m),stem volume(m^3ha^{-1}),stem biomass(t ha^{-1}),total tree biomass(t ha^{-1}) and total carbon stock (t ha^{-1}) was calculated. The result of the present study showed that average tree density was 238 trees ha^{-1}. Average stem volume was measured as 1839.41 (m^3ha^{-1}).The mean stem biomass was 857.40 (t ha^{-1}).The mean total tree biomass was estimated 1281.26 (t ha^{-1}).The calculated carbon in above and below ground biomass of *Cedrus Deodara* forest was 640.63 (t ha^{-1}).

Key words: *Cedrus Deodara*, Kumrat Valley, Climate Change, Biomass and Carbon Stock

1. INTRODUCTION

Carbon dioxide (CO_2) is the most important greenhouses gas. Different human activities accelerating the rate of carbon dioxide those causing global warming and climate change. Global climate change (CC) is the burning and hot issue among scientific community because of increasing carbon dioxide concentration in atmosphere day by day due to various manmade activities. According to intergovernmental panel on climate change (IPCCC) that earth average temperature increased 0.6 ^{0}C over last century and considered likely or probable happen to increased from 1.4 to 5.8 ^{0}F by the end of current century (LEAD, 2008).

Kyoto protocol recognized forest is one of the important carbon sinks. According to the Kyoto protocol, forests are defined as ecosystem that can attain at least 5 m height with 30% canopy cover and should cover at least 1 hectare area with width greater than 30 m. In a forest Five carbon should be reported from five pools which includes(1) carbon present in above-ground living biomass; (2) carbon in below-ground living biomass; (3) carbon in dead wood; (4) carbon present in fine litter and (5) soil organic carbon (Kyoto, 1997; Nizami, 2012: Adnan and Nizmai ,2014).

Pakistan is member to the Kyoto protocol. Being a member to the protocol each member country must figure out their stored carbon in the forest ecosystem. In Pakistan the measurement of stored carbon in forest are in initial steps. The present study was conducted in pure deodar forest of Kumrat valley Dir Kohistan Khyber Pukhtoonkhwa. The study was aimed to find out carbon stocks in pure deodar forest of Kumrat valley in above ground biomass and below ground biomass. The objective of the study was to measure the carbon stock in above and below ground biomass in pure deodar forest of the study area.

2. MATERIALS AND METHODS

STUDY AREA

The Study was conducted in Kumrat valley which is located in District Dir upper, Provinces Khyber Pukhtoonkhwa, Pakistan. The latitude and longitude of Kumrat valley is 35º 32'11.44'' N 72º 13'45.01'' E. The elevations from sea level range from 2439-3048 m. The average precipitation in study area ranges from 700-1500 mm. Temperature ranges from 0.7-30ºC. Soil of study area is mostly loam and rich in humus with abundance of organic matter.

METHODOLOGY

Research design

For the present study stratified random sampling was used. The Pure *Cedrus deodara* forest (PCDF) was divided into four study sites. In each study site 8 samples plots were taken. The size of each sample plot was 0.1 ha. Over all 32 sample plots were taken in the PCDF. Stratification was based on forest cover and stem density.

Plot selection and plot size

The area maps, topographic sheets, data about growing stocks were taken from respective forest department. The sample plots were selected randomly within different strata of pure *Cedrus deodara* forest. Overall total 32 plots were taken from the forest. The size of each plot was taken 0.1ha. The shape of sample plot was square (Dimension 33×33 m^2). Coordinates and elevation (m) of each plot was determined by GPS.

Measurement of Volume

For the estimation of stem volume (m^3 ha^{-1}), height of tree (m) and tree diameter (cm) at DBH was measured. The height of tree was calculated by Abneys level. The diameter (cm) of tree was measured by Caliper. The following formula was used to find out stem volume (m^3 ha^{-1}) (Adnan *et al*., 2014).

V (m^3 ha^{-1}) = AH×FF where

- V= stem Volume(m^3 ha^{-1}),
- H= Height of tree in meter
- A= Cross-sectional area at BH point. And
- FF= form factor

Measurement of Stem biomass

The stem biomass (t ha^{-1}) was calculated from the relationship of stem volume (m^3 ha^{-1}), and basic wood density (kg m^{-3}). . The value of Basic wood density (BWD) was sourced from available literature (Haripriya, 2000; Adnan *et al*., 2014). The following formula was used to estimate stem biomass (t ha^{-1}).

- Stem biomass (t ha^{-1}) = Stem volume (m^3 ha^{-1}) × Basic wood density (kg m^{-3})/ 1000

Measurement of Total biomass

The total tree biomass (t ha^{-1}) was obtained from the relationship of stem biomass (t ha^{-1}) and biomass expansion factor. The Biomass expansion factor (BEF) was taken 1.51. That has been used by various authors (Haripriya, 2000; Adnan et al. 2014 and Adnan and Nizami, 2014) for total tree biomass calculation. Total tree biomass was calculated using below formula.

Total tree biomass (t ha^{-1}) = Stem biomass (t ha^{-1}) × Biomass expansion factor (BEF).

Determiniation of Carbon stocks

The total carbon stock was calculated by using conversion factor of 0.5. This conversion factor was multiplied with total biomass (t ha^{-1}) and total carbon stocks (t ha^{-1}) were estimated. This conversion factor has been used globally by. (Roy *et al*., 2001; Brown and Lugo, 1982; Malhi *et al*., 2004 and Nizami, 2012; Adnan *et al*., 2014). The following formula was used to calculate TCS (t ha^{-1}).

- Total carbon stock (t ha^{-1}) = Total biomass (t ha^{-1}) × Conversion factor (CF).

Statistical analysis

Statistical software's like Past, Sigma plot version 10 and Ms Exile was used for statistical analysis.

3. RESULTS AND DISCUSSION

Stem Density

Stem density is the number of trees per hectare. . In present study the average stem density of pure *Cedrus deodara* forest was recorded 238 trees ha^{-1}. The maximum density of pure *Cedrus deodara* forest was 370 trees ha^{-1}. Details of stem density ha^{-1} are given in figure no 1.

Figure No 1: Plot wise stem density ha^{-1}

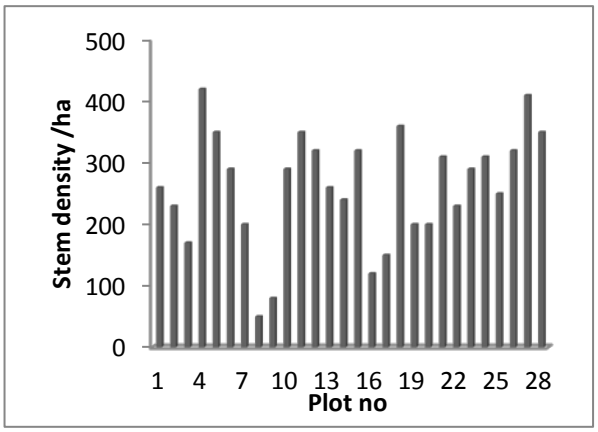
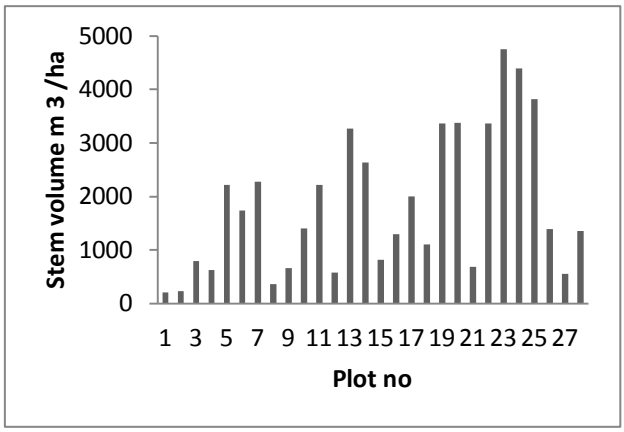


Figure No 2: Plot wise stem volume m^3 ha^{-1}



Total tree Biomass

Total tree biomass was measured from stem biomass and BEF. In present study the mean stem volume was 1839.41 m^3 ha^{-1}. A detail of stem volume is given in figure no 2. Stem biomass was measured from the value of calculated stem volume and Basic wood density. The mean stem biomass was 857.40 t ha^{-1}. Plot wise details of stem biomass t ha^{-1} are given in figure no 3

Figure No 3: Plot wise stem biomass t ha^{-1}

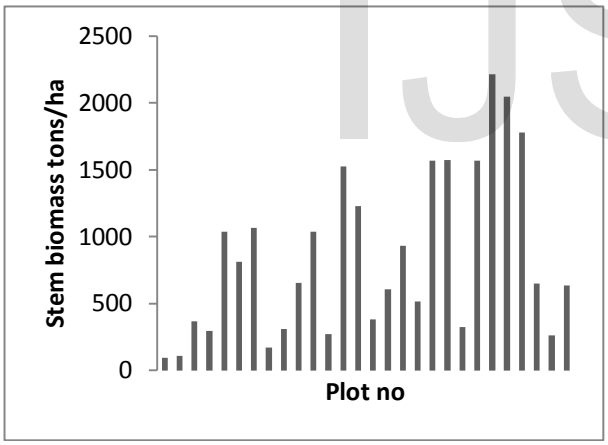
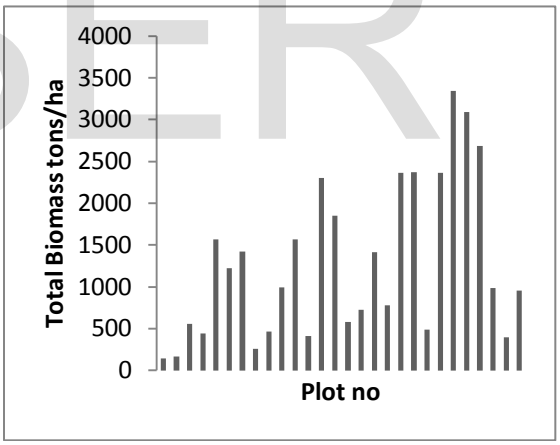


Figure No 4: Plot wise total tree biomass t ha^{-1}



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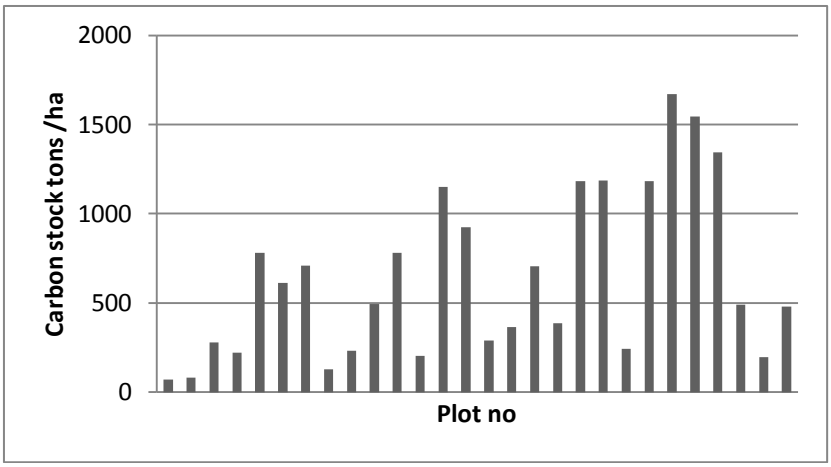
The average total tree biomass in pure *Cedrus deodara* forest was 1281.26 t ha^{-1}.The maximum total tree biomass was 3344.03 (t ha^{-1}) while minimum total tree biomass was 143.04 (t ha^{-1}) respectively. Details of Plot wise total tree biomass (t ha^{-1}) in figure no.4

Carbon stocks

The total carbon is determined from total biomass multiply with conversion factor 0.5. This conversion factor have been globally used for the estimation of carbon stock from the biomass (Adnan *et al*., 2014; Nizami, 2012). Details of carbon stock (t ha^{-1}) are given in figure no 5. The details showed that the mean carbon stock in the Pure *Cedrus deodara* forest is 640.63 t C ha^{-1}. In study area the Pure *Cedrus deodara* forest comprise of old and large diameter trees. Most of the tree in study site consist of mature and over mature. This result a high value of carbon stock.

Figure No 5: Carbon stock t ha^{-1} in upper storey vegetation



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