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Assessment of Carbon Sequestration Potential by Tree Species in Attarsumba Range

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Abstract

Increasing level of greenhouse gases in atmosphere is common concern of the world today. Greenhouse gases are responsible for increase of global temperature. Due to human activities, industrialization, and burning of fossil fuels, the amount of greenhouse gases in atmosphere is increasing. Carbon dioxide (CO_2) is the main reason for global warming and the climate change. Trees are major carbon sink of the world. Carbon sequestration is the process of removal of excess carbon dioxide from the atmosphere. This study was carried out in Attarsumba range, comes under Gandhinagar forest Division. According to the revised classification of forest types by Champion and Seth (1968), part of this forest falls under group 5-A Tropical Dry Deciduous Forests. The Range is occurred within the geo position between 23005' Latitude and 72097'Longitude.The total area of villages is 1,365.35 hectares, which covers about 12.12 % of total Gandhinagar Forest Division. Total number of species present in the range is 76. The maximum number of major trees species present in girth class 0-30 cm. The range is dominated by Acaciatortilis (Forsk) Hyne (86250).

Keywords: Carbon sequestration, Attarsumba Range, Dominant tree species, Global temperature

Introduction

Carbon sequestration is the long term capture and storage of atmospheric carbon in different carbon sinks including vegetation and soils (*Gibbs et al., 2007*). Forest ecosystem is one of the most important carbon sinks of the terrestrial ecosystem. It uptakes the carbon dioxide by the process of photosynthesis and stores the carbon in the plant tissues, forest litter and soils. Thus, forest ecosystem plays important role in the global carbon cycle by sequestering a substantial amount of carbon dioxide from the atmosphere (*Vashum and Jay Kumar, 2012).* Forests play important roles in reducing the greenhouse effect by storing atmospheric CO2.Biomass is an important carbon pool in forest ecosystems (*Fahey et al., 2010),* especially tree biomass, including the trunk, branches, foliage, and roots. Most of the total carbon in plantations is stored in aboveground biomass (trunk, branches, foliage) *(Sharma et al.,2010).*

Carbon sequestration in growing forests is known to be a cost-effective option for mitigation of global warming and global climatic change. Estimates of carbon stocks and stock changes in tree biomass (above and belowground) are necessary to study climate change under United Nations Framework Convention on Climate Change *(Green et al., 2007*). The increasing carbon emission is of major concern for entire world as addressed in Kyoto protocol (*Chavan and Rasal 2010; Ravindranath et al., 1997).* Terrestrial vegetation and soil represents important sources and sinks of atmospheric carbon (*Watson et al., 2000).* The Intergovernmental Panel on Climate Change, in its 2007 report, predicts that temperatures will rise by 2.74.3°C over India by the 2080s. The panel also predicated an increase in rainfall over the Indian sub-continent by 6-8 percent and that the sea level would rise by 88 centimetres by 2100. An annual mean surface temperature rise by the end of this century, ranging from 3°C to 5°C (under A2 IPCC scenario) and 2.5°C to 4°C (under B2 IPCC scenario), with the warming more pronounced in the northern parts of India.

Materials and Methods

Principle:

Carbon stock assessment of total tree species, including above ground biomass, below ground biomass. To develop model to determine standing woody biomass from Girth at Breast Height (GBH) for carbon stock calculation of total tree species of Attarsumba range. Establish a method to estimate carbon sequestration of total tree species by non-destructive method.

A) Study Area:

This study was carried out in Attarsumba range, comes under Gandhinagar forest Division. According to the revised classification of forest type by Champion and Seth (1968), part of this forest falls under group 5-A Tropical Dry Deciduous Forests. The Range is occurred within the geoposition between 23005' Latitude and 72097'Longitude.The total area of villages is 1,365.35 hectare, which covers about 12.12 % of total Gandhinagar Forest Division. The climate of the tract is characterized by hot summer, cool winter, and general dryness except in the south - west monsoon months. The cold season from December to February is followed by the hot season from March to May. The period from June to September is the monsoon season followed by the post-monsoon period of October – November (*Patel Y.B. et al., 2014)*

B) Methodology

For the estimation of carbon stock of major tree species, non-destructive method was used. The biomass of trees was estimated on the basis of GBH (Girth at Breast Height) and tree height

1) Above Ground Biomass (AGB):

The AGB of trees includes the whole shoot, branches, leaves, flowers, and fruits. To estimate biomass of different trees, non-destructive method was used. The biomass of tree was estimated on the basis of GBH and height. To prevent accidently counting tree species twice marking each tree with colour brush. Each tree recorded individually in above given format with their scientific name if identification is possible. Height and DBH (Diameter at breast height) are the basic measurement of standard for trees. This measurement is recorded for all trees. DBH can be determined by measuring tree GBH (Girth at Breast Height), approximately 1.3 meter from the ground. The GBHs of trees having diameter greater than 10 cm were measured directly by measuring tape and height of the trees were measured by using Haga's altimeter (Hangarge*et al.,* 2012; Kumar Phani *et al.,* 2009).

Allometric equations for biomass usually include information on trunk Diameter at breast height *DBH* (in m), total tree height *H* (in m), and wood density (in Kg/m^3). The unit of the AGB estimated from the allometric equation is the kilogram (Kg). AGB is calculated using the following formula:

$$\text{AGB (Kg/tree)} = \text{Volume of tree } (m^3) \times \text{Wood density } (Kg/m^3)$$

$$= \pi r^2 H\ (m^3) \times \text{Wood density } (Kg/m^3)$$

$$= \frac{(GBH)^2}{4\pi} \times H \times \text{Wood density } (Kg/m^3)$$

Where, r = radius of the tree (in m) = GBH/2

H = Height of the tree (in m)

Radius of the tree is calculated from GBH of tree. The wood densities were obtained from the website – www.worldagroforestrycentre.org/sea/products/AFDbases/WD/ (Hangarge*et al.,* 2012). Wherever the wood density of tree species was unavailable, the standard average value 0.6 gm/cm^3 were taken (Warran *et al.,* 2001)

2) Below Ground Biomass (BGB):

The Below Ground Biomass (BGB) includes all biomass of live roots excluding fine roots having < 2 mm diameter. The BGB has been calculated by multiplying AGB by 0.26 factors as the root: shoot ratio. BGB is calculated by given following formula BGB (Kg/tree) or (ton/tree) = AGB (Kg/tree) or (ton/tree) x 0.26 (MacDicken, 1997).

3) Total Biomass:

Total biomass of trees was calculated by sum of AGB and BGB of trees. The Total Biomass of trees was calculated by following method (Hangarge*et al.,* 2012).

Total Biomass (Kg/tree) or (ton/tree) = AGB + BGB.

Result and Disscusion

The range is dominated by Acacia tortilis (Forsk) Hyne (86,250). Acacia Senegal Willd (65,120), Azadirachtaindica A Juss (26,560), Holopteliaintegrifolia (Roxb) P (21,700) etc, are the other leading species in Attarsumba range. In higher girth class (above 150cm) are Acacia nilotica (L) Dell (120), Holopteliaintegrifolia L (40). The maximum number of major trees species present in girth class 0-30 cm and followed by girth class 31-60 cm , girth class 61-90 cm , girth class 91-120 cm, girth class 121-150 cm and girth class above 150 cm (Table-1).

Sr. No.	Scientific Name	Girth (in cm)						Total Carbon Stock (in ton)
		0-30	31-60	61-90	91-120	121-150	Above 150	
		H	H	H	H	H	H	H
1.	*Acacia nilotica* (L) Dell	5570	5660	3750	1900	360	120	17360
2.	*Acacia Senegal* Willd	38680	22670	3690	80	---	---	65120
3.	*Acacia tortilis*(Forsk) Hyne	32660	28440	21630	3420	100	---	86250
4.	*Azadirachtaindica* A Juss	20210	5270	950	120	10	---	26560
5.	*Holopteliaintegrifolia* (Roxb) P	14940	4130	1880	600	110	40	21700
	Total	**112060**	**66170**	**31900**	**6120**	**580**	**160**	**216990**

Table-1: Girth Class wise total number of major trees species of Attarsumba range

Sr. No.	Scientific Name	Girth (in cm)						Total Carbon Stock (in ton)
		0-30	31-60	61-90	91-120	121-150	Above 150	
		H	H	H	H	H	H	H
1.	*Acacia nilotica* (L) Dell	1437.86	5870.55	14502.54	17717.86	5591.54	4453.64	49573.99
2.	*Acacia Senegal* Willd	4662.67	18602.65	10736.36	911.27	---	---	34912.95
3.	*Acacia tortilis*(Forsk) Hyne	3586.25	22590.11	63629.98	28024.43	1328.72	---	119159.49
4.	*Azadirachtaindica* A Juss	3293.84	4932.5	2687.24	867.11	145.30	---	11925.99
5.	*Holopteliaintegrifolia* (Roxb) P	1353.84	3071.62	4540.14	3407.75	1053.16	1056.83	14483.34
	Total	**14334.46**	**55067.43**	**96096.26**	**50928.42**	**8118.72**	**5510.47**	**230055.76**

Table-2: Girth Class wise total carbon stock of major trees species of Attarsumba range

Conclusion

The carbon stock determined for major tree species in Attarsumba range shows that Acacia tortilis (Forsk) Hyne and Acacia nilotica (L) Dell have the maximum carbon sequestration potential. While on the basis of the girth class, the capacity to absorb carbon is the highest in the girth class 61-90 cm. On the basis of this study we can calculate carbon stock for tree species by non-destructive method. To rescue the world from global warming and climate change, the sustainable management of forest with the objectives of carbon sequestration is mandatory. Before applying the approach of forest carbon stock management, qualification of organic carbon in the different strata of forest is necessary and to quantify organic carbon sequestration potential of a forest accurate, easy and fast scientific method is required. The present study will unbolt a new arena in this aspect of forest management.

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