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CARBON STORAGE BY TREES IN KHRUNTI MODEL PLANTATION SITE OF TATA STEEL AT KALINGANAGAR, ODISHA (INDIA)

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ABSTRACT

Carbon storage by dominant tree species in Khrunti Model Plantation site of TATA Steel at KPO near Duburi was quantified to assess the magnitude and role of plantation in combating the rise of carbon dioxide in the ambient air. The Above Ground Biomass (AGB) and Above Ground Carbon (AGC) of each species were assessed to evaluate the carbon dioxide equivalent of each species. The AGB ranged from 2.85 tonnes/ha (in *Sweitenia mahogani*) to 54.33 tonnes/ha (in *Lagerstroemia indica*) during premonsoon while the minimum and maximum values of AGB were 3.57 tonnes/ha (in *Sweitenia mahogani*) and 61.71 tonnes/ha (in *Lagerstroemia indica*) respectively during monsoon. The AGC ranged from 1.33 tonnes/ha (in *Sweitenia mahogani*) to 24.94 tonnes/ha (in *Lagerstroemia indica*) during premonsoon while in monsoon season the minimum and maximum values of AGC were 1.60 tonnes/ha (in *Tabebuia sp.*) and 26.66 tonnes/ha (in *Lagerstroemia indica*) respectively. Few trees of Bakul (*Mimusops elengi*) were not being considered in the study because of their stunted growth and DBH < 20 cm. The highly acidic soil may be one of the reasons behind the low AGB and subsequent AGC of the species in the plantation site.

KEY WORDS: Khrunti Model Plantation Site, Above Ground Biomass (AGB), Above Ground Carbon (AGC), Carbon dioxide- equivalent.

INTRODUCTION

The ecosystem service of trees in terms of carbon sequestration and carbon dioxide recycling is poorly documented[1] although considerable storage and sequestration of carbon dioxide occurs by trees during their normal process of growth. The storage of carbon by trees varies spatially and temporally based on abundance of the species, growth rate of the species and site conditions. Net annual carbon sequestration is positive for growing forest with considerable AGB of the species. The net sequestration, however, becomes negative during periods of forest decline and/or loss when carbon emissions from dead trees occurs through decomposition or forest fire that exceeds the carbon uptake by live trees. The edaphic factors have significant influence on the carbon sequestration by tree species.

The present study was undertaken in the Khrunti Model Plantation site of TATA STEEL during 2015 with the aim to assess the AGB and AGC of the planted species. The values were finally converted to carbon dioxide-equivalent.

MATERIALS AND METHODS

Study Area: The present study was conducted in the Khrunti Model Plantation site of TATA STEEL (20º58′27.6″N/85°21′51.6″E). The plant site is located in the Jajpur district of Odisha, at around 20º 45′ N latitude and 85º 50′ E longitude. The site is located north-west of the city of Bhubaneswar, about 110 km by road. We selected 15 tree species in the area based on the relative abundance of the trees.

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The study was undertaken during two seasons (premonsoon and monsoon) in 2015.

Above Ground Biomass (AGB) Estimation: The biomass of above ground structures (stems, branches and leaves) was estimated as per the standard procedure[1].

Above Ground Carbon (AGC) Estimation: The fresh samples of stem, branch and leaf were collected for each species and oven dried at 70°C. Direct estimation of percent carbon for each species were carried out by *Vario MACRO elementar* make CHN analyzer, after grinding and random mixing the oven dried stems, branches and leaves separately[1].

RESULT

A total of 15 trees species were documented from the study site (Table 1).

Above Ground Biomass (AGB)

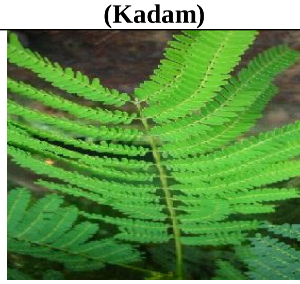
The present study shows the AGB is more in monsoon compared to premonsoon season. The relatively more value of AGB in the monsoon may be the growth of the tree in course of time or profuse availbility of fresh water during rainy season that often increases the pH of the ambient soil. The AGB ranged from 2.85 tonnes/ha (in *Sweitenia mahogani*) to 54.33 tonnes/ha (in *Lagerstroemia indica*) during premonsoon while the minimum and maximum values of AGB were 3.57 tonnes/ha (in *Sweitenia mahogani*) and 61.71 tonnes/ha (in *Lagerstroemia indica*) respectively during monsoon in the study site (Table 1). Few trees of *Mimusops elengi* (common name: Bakul) were not being considered in the study because of their stunted growth and girth at breast height < 20 cm. The highly acidic soil may be one of the reasons behind the low AGB of the species in the plantation site.

Above Ground Carbon (AGC)

The stored carbon in the tree is found to increase with the growth of species (documented in the present study in terms of biomass). The AGC ranged from 1.33 tonnes/ha (in *Sweitenia mahogani*) to 24.94 tonnes/ha (in *Lagerstroemia indica*) during premonsoon while the minimum and maximum values of AGC were 1.60 tonnes/ha (in *Tabebuia sp.*) and 26.66 tonnes/ha (in *Lagerstroemia indica*) respectively during monsoon. The AGC of all the species except *Terminalia arjuna* (Arjun) was higher in monsoon compared to the premonsoon season. The percentage of carbon in the selected species ranged from 43.8% (in *Spathodea campanulata*) to 49.1% (in *Millettia pinnata*) during premonsoon while it encompassed from 41.1% (in *Spathodea campanulata*) to 47.8% (in *Millettia pinnata*) in the monsoon season (Table 1).

Table 1. Seasonal variations of AGB and AGC in the dominant trees species in the Khrunti Model plantation study site.

S. No	Species	AGB		AGC	
		Premonsoon	Monsoon	Premonsoon	Monsoon
1.	 ***Albizia saman* (Sirish)**	**4.14**	**4.36**	**1.92 (46.3%)**	**1.95 (44.8%)**
2.	 ***Tabebuia* sp.**	**3.19**	**3.63**	**1.50 (47.1%)**	**1.60 (44.2%)**
3.	 ***Spathodea campanulata* (Spathodea)**	**4.16**	**4.29**	**1.82 (43.8%)**	**1.76 (41.1%)**

4.	 ***Alstonia scholaris*** **(Chatim)**	**3.84**	**4.02**	**1.69 (44.0%)**	**1.70 (42.3%)**
5.	 ***Terminalia arjuna*** **(Arjun)**	**3.66**	**3.84**	**1.71 (46.7%)**	**1.68 (43.8%)**
6.	 ***Mimusops elengi*** **(Bakul)**	**-**	**-**	**-**	**-**
7.	 ***Anthocephalus chinensis*** **(Kadam)**	**4.14**	**5.22**	**1.90 (45.8%)**	**2.24 (42.9%)**
8.	 ***Delonix regia*** **(Gulmohar)**	**23.12**	**29.66**	**10.84 (46.9%)**	**12.40 (41.8%)**
9.	 ***Millettia pinnata*** **(Karanj)**	**31.61**	**34.55**	**15.52 (49.1%)**	**16.51 (47.8%)**

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10.	 ***Azadirachta indica*** **(Neem)**	**14.69**	**17.84**	**6.61 (45.0%)**	**8.01 (44.9%)**
11.	 ***Cassia siamea*** **(Chakunda)**	**23.84**	**29.47**	**11.04 (46.3%)**	**13.11 (44.55)**
12.	 ***Dalbergia sissoo*** **(Sisam)**	**19.88**	**21.54**	**9.40 (47.3%)**	**9.69 (45.0%)**
13.	 ***Sweitenia mahagoni*** **(Mahogany)**	**2.85**	**3.57**	**1.33 (46.8%)**	**1.65 (46.1%)**
14.	 ***Lagerstroemia indica*** **(Jarul)**	**54.33**	**61.71**	**24.94 (45.9%)**	**26.66 (43.2%)**
15.	 ***Samanea saman*** **(Rain tree)**	**39.44**	**43.22**	**18.02 (45.7%)**	**19.10 (44.2%)**

‘ - ’ Means not quantified due to stunted growth and girth < 20 cm.

Figure 1. CO_2 analyzer monitoring atmospheric carbon dioxide in the Khrunti Model Plantation site.

DISCUSSION

The accumulation of anthropic carbon dioxide in the atmosphere with all its adverse impact is both a reality and a challenge in the present century. It has been documented by several researchers that the carbon dioxide level generated by human activities raises up to 20 Gt/yr, which encompasses activities like industrialization, urbanization, habitat modification etc [2]. At the beginning of the industrial *era*, the carbon dioxide concentration in the air was around 275 ppm; in the first years of the current century the level was considerably higher ~367 ppm and as per the latest survey in and around the present study area the level of carbon dioxide has touched 399 ppm **(Fig. 1)**. The safe level of carbon dioxide concentration in atmosphere is 350 ppm [3,4]. The values greater than this create complaints of drowsiness, headache, sleepiness, nausea and increased heart rate. A level greater than 40,000 ppm results in permanent brain damage, coma and even death [5,6]. Considering this serious adverse situation, the present work was undertaken to monitor the capacity of Khrunti Model Plantation site of Kalinganagar Project at Duburi, Jajpur to store and sequester carbon. The plantation site exhibited a very poor figure in terms of carbon storage and subsequent carbon dioxide – equivalent. The total carbon dioxide equivalents in premonsoon and monsoon season are 397.26 tonnes/ha and 433.35 tonnes/ha, which is much less when compared with similar species monitored in the heart of the Bhubaneshwar city of Odisha [3]. The edaphic factors particularly the nature of the soil is crucial in this context as the soil pH in the study area ranges around 3.0, which hinders the availability of nutrients to the plants leading to poor growth. Excessive use of chemical fertilizer on long term basis may also be another reason behind the poor quality of the soil in the Khrunti Model Plantation site. Thus the present study may serve as pathfinder to select tree species with ability to capture maximum amount of carbon in terms of CO_2 –equivalent and at the same time adopt policies for soil management for better growth of the selected species.

CONCLUSION

Carbon now being a priced environmental commodity in the global marketplace, the present research may serve as a milestone towards future carbon sequestration ventures by government, business, researchers or individuals alike; thus helping to offset atmospheric storage of CO_2 by increasing the forest belt cover, simultaneously aiding in climate change mitigation.

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CONFLICT OF INTEREST: NIL

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