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Date: 17th August 2018

Certificate

This is to certify that the Carbon Sequestration Report prepared by Bio-Geo Consultancy with due cooperation of the principal and staff of Rayat Shikshan Sanstha's R. B. Narayanrao Borawake College, Shrirampur, Tal.-Shrirampur, District- Ahmednagar – 413719, India, is prepared by following appropriate procedures, methods, knowledge and expertise in the field of Environmental Sciences.

I was actively associated with the process of collecting data and documentation of trees, bushes, grass cover and soils causing carbon sequestration. I have also conducted workshops of students and teachers on methods of quantification of biomass and carbon sequestration.

I wish a great future to the college and expect that the students and staff would be enthused to reduce carbon footprint by adopting methods of conservation of soil, water, plants and energy within the college campus and in society as well.

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A REPORT ON

CARBON SEQUESTRATION

R. B. NARAYANRAO BORAWAKE COLLEGE, SHRIRAMPUR,

DIST. AHMEDNAGAR, MAHARASHTRA

2017-2018

ACKNOWLEDGEMENT

We take this opportunity to express our gratitude towards the founder president of the Institute Hon'ble Shri Sharadchandraji Pawar, and his colleagues in the management council. We also express sense of gratitude towards Honorable Sau. Meenatai Jagadhane, Chairman, Rayat Educational campus Shrirampur and Local Management Committee of the college for their valuable guidance, continuous encouragement, generous gift of time with constructive criticism and suggestion during the composition of work of entire 'Green Audit Report' 2017-18.

We express our deep sense of gratitude to Principal **Dr. K. H. Shinde** who inspired and encouraged us throughout the work. We gratefully acknowledge the help provided by them on several occasions. The assistance provided by Dr. S. P. Cholke, Dr. P.V. Badadhe, Dr. K.W. Pawar, Prof. D. B. Bankar, Prof. S. B. Sasane and students proved to be valuable to make the report in proper shape.

Place: Shrirampur.

Date: 12/04/2018

Dr. Jyotiram C. More **Dr. Ravindra Ranpise**

Dr. Praveen Saptarshi

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INTRODUCTION:

Climate change is the hottest issue all over the globe. The four major green house gases (NO2, CH4, CFC and CO2) are responsible for capturing heat energy in the atmosphere and in turn increase in global temperature. The contribution of carbon dioxide in this process is as high as 60%. Therefore carbon sequestration has been considered to be the best possible solution for avoiding the disaster due to climate change. This kind of externalities has been internalize wisely by continuous efforts done by R.B.N. Borawake college, Shrirampur. The college has very good carbon pool in the form of luxuriant growth of forest in a dedicated area of 42.17 acres, along with presence of tall trees within the campus. In addition to this the soil layer covered with grasses and bushes is also far more than the areas covered by roads, buildings and platforms. Thus qualitatively best practices in the college offer extraordinary scope for carbon sequestration. This report attempts to quantify the amount of carbon emission due to consumption of electricity and fossil fuels. This is compared with the carbon pool observed in the college. This report also highlights the measures taken by the college and its importance in the context of externalities of climate change. Hopefully college management would appreciate the competitive work and continue to document related activities in future so that success stories can be built which can be followed by other educational institutes.

CARBON FOOTPRINT:

The term “carbon footprint” refers to a person or organization’s carbon consumption, or the CO_2 or GHG emitted directly or indirectly during the life cycle of an activity or a product [*TERI*, 2008]. Therefore, carbon footprint can be used to evaluate an object’s (including a region, an organization, or a product) impact on environment. According to the original footprint calculations, energy consumption of human activities is generally converted to bio-productive area so as to evaluate the sustainability of consumption from an ecological point of view.

Carbon Sequestration:

The term "carbon sequestration" is used to describe both natural and deliberate processes through which CO_2 is either removed from the atmosphere or diverted from emission sources and stored in the ocean, terrestrial environments (vegetation, soils, and sediment), and geologic formations. This carbon is stored stable solid form by direct and indirect fixation of atmospheric CO_2. Direct soil carbon sequestration occurs by inorganic chemical reactions that convert CO_2 into soil inorganic carbon compounds such as calcium and magnesium carbonates. Direct plant carbon sequestration occurs as plants photosynthesize atmospheric CO_2 into plant biomass. Subsequently, some of this plant biomass is indirectly sequestered as soil organic carbon (SOC) during decomposition processes. The amount of carbon sequestered at a site reflects the long-term balance between carbon uptake and release mechanisms. Many agronomic, forestry, and conservation practices, including best management practices, leads to a beneficial net gain in fixation of carbon in soil.

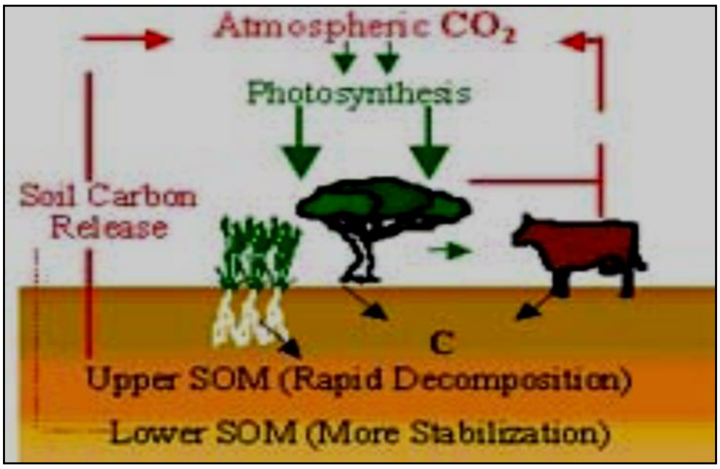

Figure 1 : Carbon Sequestration Process

Unlike many plants and most crops, which have short lives or release much of their carbon at the end of each season, forest biomass accumulates carbon over decades and centuries. Furthermore, carbon accumulation potential in forests is large enough that forests offer the possibility of sequestering significant amounts of additional carbon in relatively short periods – decades. Terrestrially, carbon is stored in vegetation and in the soil. Plants store carbon for as long as they live, in terms of live biomass. Once they die, the biomass becomes a part of the food chain and eventually enters the soil as soil carbon. If the biomass is incinerated, the carbon is reemitted into the atmosphere and is free to move in the carbon cycle.

TYPES OF SEQUESTRATION:

There are number of technologies under investigation for sequestering carbon from the atmosphere. These can be discussed under three main categories:

- **Ocean Sequestration:** Carbon stored in oceans through direct injection or fertilization.
- **Geologic Sequestration:** Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage.
- **Terrestrial Sequestration:** A large amount of carbon is stored in soils and vegetation, which is natural carbon sinks. Increasing carbon fixation through photosynthesis, slowing down or reducing decomposition of organic matter, and changing land use practices can enhance carbon uptake in these natural sinks.

Benefits of Soil Carbon Sequestration:

Removing CO_2 from the atmosphere is only one significant benefit of enhanced carbon storage in soils. Improved soil and water quality, decreased nutrient loss, reduced soil erosion, increased water conservation, and greater crop production may result from increasing the amount of carbon stored in agricultural soils.

Important clauses of Kyoto Protocol related to carbon sequestration:

The Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC, 1997) has provided a vehicle for considering the effects of carbon sinks and sources, as well as addressing issues related to fossil fuels emissions.

Soil Carbon Sequestration:

Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately remitted. This transfer or “sequestering” of carbon helps off-set emissions from fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity.

AIM:

This study is aimed at measuring carbon footprint and carbon sequestration in the campus area and to compare both the processes in the context of capacity building by the R. B. N. Borawake College, Shrirampur, Dist. Ahmednagar Maharashtra.

MAJOR OBJECTIVES OF STUDY CARBON EMISSION AND SEQUESTRATION:

1. To measure carbon emission from power (electrical) consumption
2. To measure carbon emitted from transportation and other activities
3. To estimate Soil organic matter
4. To estimate organic biomass of trees
5. Analyzing results for determination of carbon footprint analysis and carbon sequestration

Scope:

Removing CO_2 from atmosphere is significant benefit of enhanced carbon storage in soil. High level of fossil fuel combustion and deforestation have transformed large pools of fossil carbon (coal and oil) into atmospheric CO_2, strategies for reducing CO_2 in atmosphere include soil carbon sequestration, tree planting etc.

Scientists are doing work to understand impact of land use and land management on soil sequestration and ways to increase storage time of carbon in soil. Underline mechanisms controlling soil structure and storage of carbon these include various chemicals, physical, biological, mineralogical and ecological process. They are also doing work to find out relationship between biodiversity, atmospheric CO_2 level, and increase nitrogen deposition in carbon storage.

Location Map

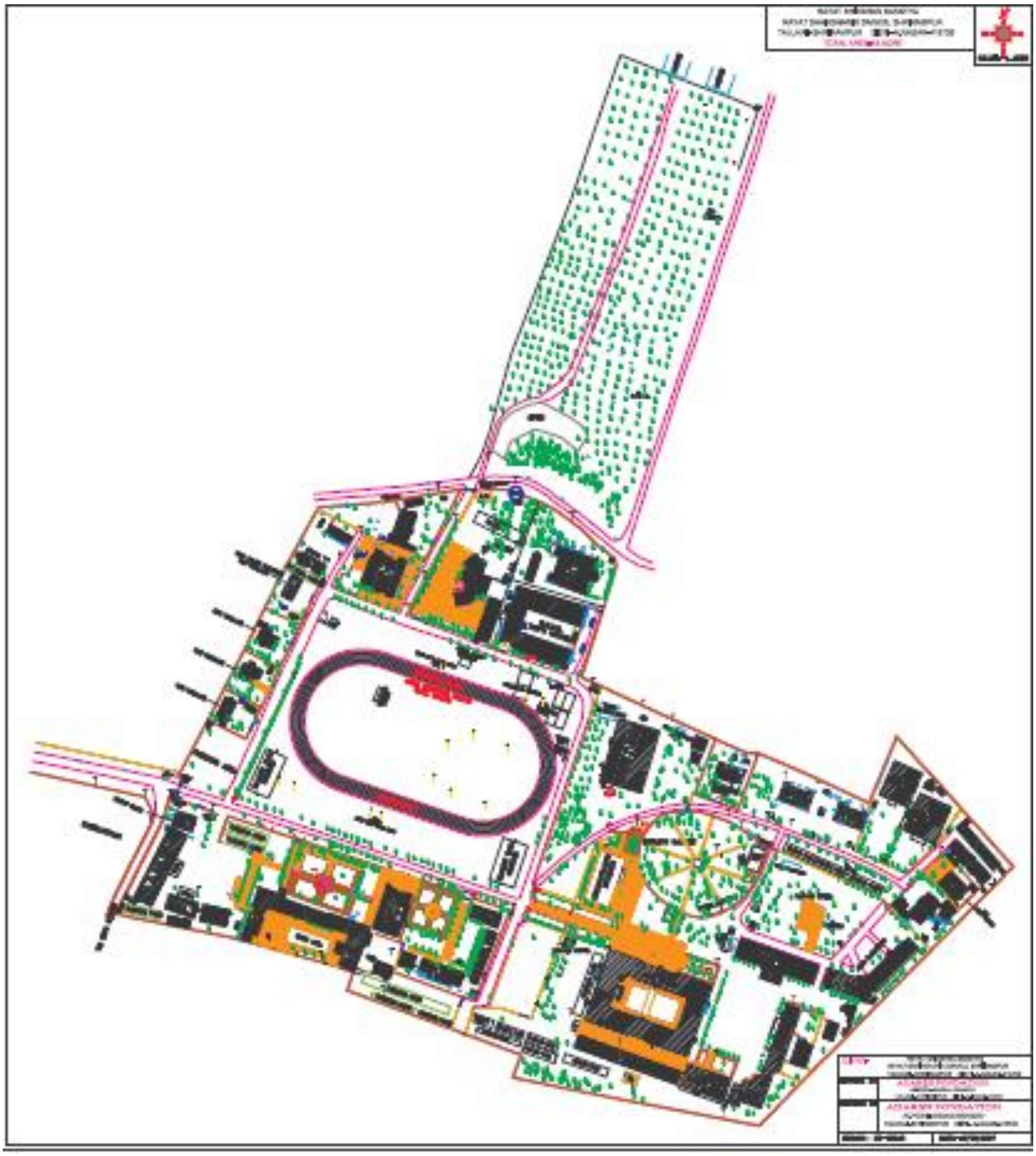

Figure 2 : Location map showing college campus area, green color dots in map shows trees in college campus, the north area has teak garden

POSSIBLE OUTCOME OF THIS STUDY:

It may be used for following purpose.

- Develop a quantitative analysis to understand carbon emission potential
- Estimation of carbon sequestration in college campus

- Formulation of strategies for plantation and other means for carbon sequestration
- Creation of awareness in the stakeholder regarding carbon emission and its capturing

METHODS FOR ASSESSMENT OF CARBON EMISSION AND CARBON SEQUESTRATION:

1. Carbon Emission

A. Power Consumption activity

The power consumption of individual has been studied by using secondary data of energy audit report done for college campus in 2016. Along with the same average electrical consumption per month was taken from last six months reading from college electricity bill. The energy/power generated through coal or diesel emits certain amount of carbon into atmosphere considering the fact carbon emission is calculated for present study.

The energy consumption at college is particularly for running light, fans and other instruments. Hence to measure the carbon emission from electrical consumption C= βE, where C is carbon dioxide emission, β is emission factor which is 0.81 ton/MWh and E is electrical consumption (Bajpai 2012).

B. Consumption of fossil fuels

For the assessment of carbon emission the primary data was collected by survey in the college campus. Firstly for accounting of vehicular emission the no. of vehicles (two wheelers, four wheelers) measured which were visited to college campus every day. An average of six working days had been considered for the same. Parking areas and campus area had monitored from morning 7 am to evening 7 pm also number of students coming from ST buses are counted to determine indirect emission hence to calculate per capita emission.

Emission factor Bus 0.023 kg CO2 per passenger per Km

Two wheeler 0.054 kg CO2 per vehicle per Km

Four wheeler 0.175 kg CO2 per vehicle per Km

Auto 0.13 kg CO2 per passenger per Km

(The emission factor is based on the percentage of carbon present in the fuel used for the vehicle whereas the present values given above are suitable at India Ref. Cerana Foundation)

2. Carbon Sequestration

C. Estimation of carbon sequestration from Soil Organic matter

- Selection of land use category or project activity strata, sampling method and location of sampling plots.
- Collection of soil samples at two depths (0 to 15 cm and 15 to 30 cm) from each stratum.
- Estimation of bulk density.
- Estimation of organic matter or carbon content in the soil sample in the laboratory using the Walkley and Black methods.
- Calculation of carbon stock in tonnes of carbon per hectare using organic matter content, bulk density and depth of soil.

D. Above ground biomass and carbon estimation of the trees

The biomass from the surrounding areas of college campus was estimated from the Diameter at Breast Height (DBH) and from the total height of the tree. A constant for wood density of about 690 kg/m^3 is taken in consideration for measuring total biomass of the tree. Hence the volume of dry and green biomass (calculated) from the constant values has been considered in estimating the carbon sequestration by the trees.

ESTIMATION OF CARBON EMISSION:

A. Carbon emission through power consumption activity

Carbon emission was estimated from the power consumption in college campus. Hence the total power consumption was taken on the basis of power consumed throughout the month in different block of college campus. An electricity consumption bills for a year i.e. April 2017 to March 2018 is considered as an authentic source through which the total unit of electrical consumption was calculated. It can be seen that the vast campus area having more than 13 Block with different sub-block areas in it. The total power consumption for last one year is 162991 units, whereas the average monthly consumption calculated is 13582.5 units.

Based on this we can calculate carbon emission from the campus by using following equation

$$C = \beta E$$

Total units of electricity 13582.5 units i.e. in KWH is converted into MWH become 13.58

Therefore,

$$C=0.81*13.58$$

Carbon emission per month from electricity consumption is 10.99 tons per month. Here carbon emission factor for electricity has been assumed to be 0.81 per MWh. This is based on electricity generation through thermal power station. However, Shrirampur may be receiving electricity partly through thermal power and partly through hydro-electric power at Koyana. This means that the factor 0.81 may be less at Shrirampur and total carbon emission due to electricity consumption may further be reduced. However, the exact data for Shrirampur feeder could not be available and hence we have assumed the factor on higher side.

If we calculate it per person it comes to about 2.13 Kg/capita of carbon emission per month this is far less than average per capita consumption of electricity in urban sector.

Table 1 : Block wise electricity consumption at college campus

Month	**College**	**Block A Porch**				**Block**				**Block J**					**Block O**			**Block P**		**Total Units**
		1	**2**	**3**	**27**	**B Off.**	**F Chem.**	**H**	**I**	**L. Hos1**	**L. Hos 2**	**3**	**4**	**L. Host**	**Host**	**Bore-well**	**Well**	**Bank**	**Pol. Cons.**	
Apr-17	70	179	61	70	1134	909	1188	193	89	661	239	204	206	350	1906	2803	1393	350	66	12071
May-17	70	179	61	70	1134	1000	1188	193	114	661	191	144	196	350	2641	2436	1393	350	66	12437
Jun-17	48	201	78	66	1134	1203	1188	224	211	661	953	866	976	350	2874	4048	1393	350	66	16890
July-17	42	337	105	56	1134	1173	2313	355	214	661	886	758	912	350	2544	2629	1393	350	66	16278
Aug-17	29	94	80	80	1134	861	824	80	153	661	734	730	754	350	2504	2844	1393	388	66	13759
Sept-17	22	126	52	26	1134	1584	1253	49	284	661	649	665	659	350	2022	1767	1393	392	66	13154
Oct-17	20	83	34	16	1134	857	799	40	94	661	435	435	441	350	1423	1832	1393	270	66	10383
Nov-17	21	73	34	18	1134	749	420	19	73	661	436	410	433	350	1320	362	1393	283	66	8255
Dec-17	25	92	46	18	1134	1103	341	20	138	661	482	431	487	350	1102	1239	1393	409	66	9537
Jan-18	48	348	134	32	1134	1276	1139	79	130	5953	1307	1253	1343	350	3412	1864	1393	668	66	21929
Feb-18	37	255	110	38	2267	1191	1094	57	74	672	822	827	829	292	2810	1864	1161	2100	55	16555
Mar-18	35	207	83	64	1136	1260	690	40	53	672	677	577	684	292	1856	1836	1161	365	55	11743
																Total Yearly consumption				162991
																Average monthly consumption				13582.58

B. Carbon emission from transport activity

Number of vehicles visiting everyday to college campus along with the mode of transport used by students, teacher, staff and visitors has been surveyed to understand this activity through which carbon is emitted into atmosphere. As per the weekly survey there are average 580 two wheelers and 11 four wheelers coming in college premises every day. About 2000 student/staff/teacher are coming to college by using state transport bus service.

Hence for calculating the carbon emission we have considered average 5 Km of distance travelled by each of the person. The emission factor suitable for India terrain had been used in computing the carbon emission.

a. Emission from 2000 no. of individual

   2000*0.023*5 = **230 Kg of CO2 per day**

b. Emission from two wheelers

   580*0.054*5 = **156.6 Kg of CO2 per day**

c. Emission from four wheelers

   11*0.175*11= **9.625 Kg of CO2 per day**

   a +b + c = 230+156.6+9.625 **= 396.225**

Therefore total carbon dioxide emitted from transport activity within and outside college premises is **396.225 Kg of CO2 per day or 11.87 tons/month**

Overall carbon emission from the college campus is A+B, it means both the activities from which carbon emitted in the surrounding of college campus.

Therefore total carbon emission =

Carbon Emission = 10.99 + 11.87 = 22.86 tons/month = 274.32 tons/year

ESTIMATION OF CARBON SEQUESTRATION

A. Carbon Sequestration by soil organic matter

The soil organic carbon is the major of soil organic matter present in the soil layer at the depth of 10 to 30 cm from ground level. The Soil Organic Matter (SOM) concentration differs among climate, soil type and land uses. Depletion of SOM, a widespread problem on croplands and grazing lands is exacerbated by soil degradation. Most soils have extremely low levels of soil organic carbon (SOC) contents, ranging from 8 to 10 g/kg. Depletion of SOC pool is caused by fertility-exploitative practices and soil degradation processes. Low external input of chemical fertilizers and organic amendment causes depletion of SOC pool because nutrients harvested in agricultural products are not replaced, and are made available through mineralization of SOM.

'Every tonne of carbon lost from soil adds 3.67 tonnes of carbon dioxide (CO_2) gas to the atmosphere. Conversely, every one tonne increase in soil organic carbon represents 3.67 tonnes of CO_2 sequestered from the atmosphere and removed from the greenhouse equation.'

'For example, a 1% increase in organic carbon in the top 20 cm of soil with a bulk density of 1.2 g/cm3 represents a 24 t/ha increase in soil OC which equates to 88 t/ha of CO_2 sequestered."

Many factors affect soil organic matter levels:

- Soil depth – the organic matter content generally decreases as you dig deeper
- Soil type – sandy soils generally have lower soil organic matter than heavier soils such as loams
- Management practices – excessive cultivation reduces organic matter levels
- Temperature – organic matter breaks down quicker in hot climates compared with cool climates
- Soil water content – organic matter breaks down quicker in moist soil (though not permanently saturated) compared with dry soil

Carbon is a key ingredient in soil organic matter. Lands produce organic compounds by using sunlight energy and combining carbon dioxide from the atmosphere with water from the soil.

Well decomposed organic matter forms humus, a dark brown, porous, spongy material that provides a carbon source in soil. Plants assimilate carbon by the process of photosynthesis some of the carbon remains in plant tissue that is either consumed by animals or remain in soil as a litter. When plants die and decompose.

Table 2 : Carbon Sequestration in college campus

Serial No.	Place of Observation	Result	Carbon in Tons/Ha
1.	Botanical Garden	0.70	**14**
2.	Teak Forest	0.75	**15**
	Average carbon sequestered in college campus		**14.5 ton/ha**
	Total area 42.17 acres = 17.06 Ha **Therefore, total 247.37 ton CO_2 sequestered in college campus**		

Since the total area of college campus is about 42.17 acres i.e. 17.06 hectares of land we must require the average carbon sequestered per hectare so that we can estimate the total carbon sequestered in college campus. Therefore the total carbon sequestered is equal to **247.37 ton in college campus**.

The soil samples for measuring organic matter have been collected from the botanical garden and teak forest area of college campus. It was showing 0.70 % and 0.75 % of organic carbon respectively. The carbon equivalent for this is equal to 14 ton/ha in botanical garden and 15 tons per hectare at teak forest. Thus the atmospheric carbon sequestered in college campus is equivalent to 51.38 and 55.05 ton/hectare CO_2**.**

Further if we treat total **247.37 ton/ha CO_2** then 3.67 times of atmospheric CO_2 is accounted to be 742.11tons of carbon sequestration.

B. Above ground biomass and carbon estimation from trees

Estimation of above-ground biomass (AGB) is an essential aspect of carbon stocks. Estimated C pools in different forest types can be used to in making decisions about C management within forests. Generally in estimation of biomass from tree the allometric equations are used. Allometric equations describe the relationship of one part of a plant to another part of a plant. Usually some parts of the plat are easier to measure than other parts. Usually it is easy to measure and predict the hard parts i.e. tree trunk or girth and height (eg. Use diameter to predict tree height for a given species). In present study we had first measured the aboveground biomass for trees. It was calculated using the tree girth at breast height and total height of the tree, similarly the constant variables based on tree species is taken into account for estimating total biomass. This is further used for measuring carbon C stored in the tree species.

Tree survey conducted in college campus was showing more than 2000 nos. of trees present in college premises. We had taken 1646 nos. of trees from which total biomass had been estimated. As per the protocol the trees selected in present assessment need to have tree girth more than 15cm.

Table 3 : Estimation of carbon sequestered from tree biomass

Sr. No.	Scientific Name of Plant	Number of Plant/s	Carbon as Biomass
1	Hyophorbe lagenicaulis	71	698.62
2	Alstonia scholaris	12	37.30
3	Azadirechta indica	42	182.14
4	Ficus bengalensis	17	433.20
5	Delonix regia	15	173.20
6	Ficus religiosa	8	445.78
7	Tamarindus india	42	242.16
8	Mangifera india	2	8.13
9	Podocarpous sp.	2	16.11
10	Sterculia foetida	3	27.61
11	Dypsis lutescens	9	73.39
12	Dalbergia melanoxylon	2	18.20
13	Annona reticulata	2	9.18
14	Gmelina arborea	2	15.02

15	Calistemon lanceolatus	1	7.95
16	Helictrus sp.	1	9.82
17	Holoptelia sp.	1	6.57
18	Bombax ceiba	1	5.25
19	Pterospermum acerifolium	1	8.74
20	Mimusops elengi	1	5.04
21	Coccus nucifera	38	288.29
22	Grevillea robusta	1	14.08
23	Erythrina india	1	15.26
24	Peltoforum sp.	12	321.78
25	Tectona grandis	1250	2499.13
26	Spathodia campinulata	15	49.73
27	Pongamia pinnata	10	55.35
28	Casurina tree	20	166.58
29	Cassia fistala	10	121.49
30	Artocarpus heterophyllus	2	15.22
31	Samanea saman	3	77.26
32	Cassia Siamea	10	48.15
33	Arucaria sp.	6	11.47
34	Polyalthia longifolia	20	91.81
35	Cordia dichotona	3	16.31
36	Eugenia jambulana	10	160.30
	Total	**1646**	**6375.62**

There are total 1646 number of tree from this the *Tectona grandis* species having highest number of plants (1250) and the other species are more than 10 in numbers like *Hyophorbe lagenicaulis, Azadirechta indica, Ficus bengalensis, Tamarindus india, Delonix regia, Alstonia scholars, Coccus nucifera, Polyalthia longifolia, Casurina tree, and Spathodia campinulata.*

Total carbon estimated as biomass from the tree species in present study is **6375.62 tons of carbon**

The carbon sequestered can be calculated as soil organic matter plus the carbon estimated from tree biomass i.e. **C + D**

Carbon Sequestered in college campus is equal to

Carbon sequestered = C+ D = 742.11 + 6375.62 =7117.73 tons of CO_2

Table 4 : The carbon emission and sequestration balance as per study

Total Carbon emission from all measured activity in college campus	Total carbon sequestered from soil organic matter and tree biomass
274.32 tons per year	**7117.73 tons of CO_2**

EVALUATION OF FINDINGS:

The results based on our observations carried out during the survey clearly show that the college campus has much more capacity of carbon pool compared to yearly carbon footprint. In other words it may be stated that carbon sequestration capacity of the campus is so much so that the present rate of carbon emission persists for about **25.9 years** to come. Thus, the college has proactively equipped itself by putting efforts continuously for a long period so as to build its capacity for carbon sequestration.

RECOMMENDATIONS:

- There should be more number of indigenous plant species in the campus and teak forest as well. There is much scope to fill in the gaps in teak forest. The plantation of indigenous shrubs may be useful to develop additional tier of biomass. Some indigenous tree species can also be grown in the gaps.
- The water consumption requires more electricity as compared to other uses, hence a solar electric pump is recommended. However, care should be taken to find out appropriate technology for given levels of groundwater and required elevation of storage tanks.
- There must be large number of awareness activities towards environment
- A minimum concretization in open spaces/ground of the college campus can increase carbon pool

PHOTO GALLERY

Figure 4 Information of instrument

Figure 3 Trainings to the student

Figure 6 Trainings to the student

Figure 5 Observations in teak forest

Figure 7 Two wheelers in parking

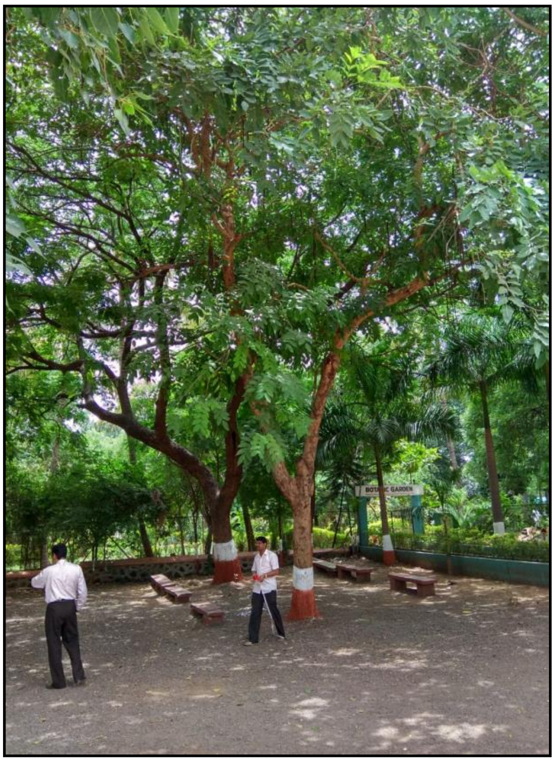

Figure 8 Measuring tree height

Figure 7 Teak forest

REFERENCES:

- Vishnu Bajpai, Gouri Kulkarni, Sun Sheng Han Ramachandra T. V,(2012), Carbon emission due to electricity consumption in the residential sector; *LAKE 2012: National Conference on Conservation and Management of Wetland Ecosystems*
- David J. Nowak*, Daniel E. Crane (2002); Carbon storage and sequestration by urban trees in the USA, *Environmental Pollution*, 381–389, *Elsesevier*
- Energy Audit Report, (2016); R. B. N. Borawake College Shrirampur, Dist., Ahmednagar, Audited by Aditi Engineering Service, Nashik
- R. Ostadhashemi, T. Rostami Shahraji, H. Roehle, S. Mohammadi Limaei, (2014), Estimation of biomass and carbon storage of tree plantations in northern Iran; *Journal Of Forest Science*, *60, 2014 (9): 363–371*
- Meta Francis Justine, Wanqin Yang , Fuzhong Wu , Bo Tan , Muhammad Naeem Khan and Yeyi Zhao (2015); Biomass Stock and Carbon Sequestration in a Chronosequence of *Pinus massoniana* Plantations in the Upper Reaches of the Yangtze River, *Forests* ISSN 1999-4907
- Varade Ashwini (2010); Carbon Sequestration through soil organic carbon in Pune University Campus, *unpublished thesis.*

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