Carbon storage and sequestration by trees in VIT University campus

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Carbon storage and sequestration by trees in VIT University campus

A Mary Saral, S SteffySelcia and Keerthana Devi
Department of Chemistry, School of Advanced Sciences, VIT University, Vellore-632014, Tamil Nadu, India

E-mail : amarysaral@vit.ac.in

Abstract. The present study addresses carbon storage and sequestration by trees grown in VIT University campus, Vellore. Approximately twenty trees were selected from Woodstockarea. The aboveground biomass and belowground biomass were calculated. The above ground biomass includes non-destructive anddestructive sampling. The Non-destructive method includes the measurement of height of thetree and diameter of the tree. The height of the tree is calculated usingTotal Station instrument and diameter is calculated using measuring tape. In the destructive method the weight of samples (leaves) and sub-samples (fruits, flowers) of the tree were considered. To calculate the belowground biomass soil samples are taken and analyzed. The results obtained were used to predict the carbon storage.It was found that out of twenty tree samples *Millingtonia hortensis* which is commonly known as Cork tree possess maximum carbon storage(14.342kg/tree) and carbon sequestration(52.583kg/tree) respectively.

1. Introduction

Carbon is found in all living organisms and is the vital building block for life. Carbon found in various forms; mostly occur as plant biomass and organic matter in soil [1]. Trees capture CO_2 by fixing carbon during photosynthesis process and accumulating extra carbon as biomass. Plant grows through the natural process of photosynthesis, in which carbon dioxide is captured and stored in cells of plant.

One of the most burning issues in the modern era is the problem of change in climatic conditions and harmful role of greenhouse gases,which plays an important role in the changing temperatures at the international level. Trees act as a sink for CO_2 by fixing carbon during photosynthesis and storing excess carbon as biomass [2]. The possible sinks include plants, soils, carbonate minerals, geological formation and ocean.It is well known that Greenhouse effect and Global warming can be reduced by planting more trees that sequestrates more carbon.

Animal respiration and decay of biomass are the nonhuman sources of atmospheric CO_2[3]. The increase in CO_2 should be avoided as it leads to Global warming. Planting trees whichsequestrates carbon in large amount will reduce the atmospheric carbon. By calculating carbon storage in a tree helps us to plant more number of trees which store carbon more. Hence it is necessary to concentrate on increase carbon in sinks as well as reduce carbon emissions [3] in the environment where we live.

Forests in wet life zones have the fastest rate of aboveground biomass accumulation with reforestation[4]. In this paper we calculated the carbon storage and carbon sequestration in an area named Woodstock inside the campus of Vellore Institute of Technology, Vellore. VIT University has

bagged the Campus challenge award in 2013. This award was given to the University in recognition of the extensive and pioneering work carried out to promote sustainability and green campus strategies.

2. Methodology

2.1 Location

The study area comprises of eight acres of area and has 42 different species. Woodstock is a place located inside the VIT campus which is chosen as a study area. In the present study, the amount of biomass and CO_2 in standing woody biomass of selective five tree species from wood stock area was calculated.

2.2 Measurement of tree height and diameter at breast height (DBH):

To estimate biomass of different trees, non-destructive method was used. The biomass of tree was estimated on the basis of DBH and tree height. DBH can be determined by measuring tree Girth at Breast Height (GBH), approximately 1.3 meter above the ground. The GBH of trees having diameter greater than 10 cm were measured directly by measuring tape.

2.3 Above Ground Biomass (AGB) Of Tree

The above ground biomass of tree includes the whole shoot, branches, leaves, flowers and fruits. It is calculated using the following formula:

AGB kg = Volume of tree (m3) X wood density kg/m3.V $=\pi r^2 H$

Where V = volume of the cylindrical shaped tree in m3

R = Radius of the tree in meters

H = Height of the tree in meter

Radius of the tree is calculated from GBH of tree wood density is used from Global density database. The standard average density is 0.6 gm/cm.

2.4Estimation Of Below Ground Biomass (BGB)

The below ground biomass (BGB) includes all biomass of live roots excluding fine roots. The BGB has been calculated by multiplying AGB X 0.26 factors as the root: shoot ratio, BGB is calculated by following BGB (kg/tree) = AGB (kg/tree) X 0.26.

2.5Estimation of Total Biomass

Total biomass is the sum of the above and below ground biomass.

TB = AGB + BGB (kg/tree).

2.6Estimation of Carbon

Generally, for any plant species 50% of its biomass is considered as carbon.

Biomass X 50 %

2.7Determination of the Weight of Carbon dioxide Sequestered in The Tree

The weight of CO_2 is C + 2 X O = 43.99915.

Hence the ratio of CO_2 to C iscalculated as: 43.99915/12.001118 = 3.6663.

Therefore, in order to determine the weight of carbon dioxide sequestered in the tree, the weight of carbon in the tree is multiplied by 3.6663.

2.8Soil Sampling and analysis of metals

In order to study the nature and quality of soil sample available in our campus, the soil analysis was carried out. The samples were collected as per the standard procedure from the study area and brought to the laboratory. The sample was washed with ethanol and extracted with water and the extract thus obtained was stored for further use. About 0.2497g of $CaCO_3$, 0.1917g of KCl and NaCl of 0.254 was dissolved and made up to 100ml using distilled water to obtain 1000ppm of respective metal ion solution. Further it was used to prepare 20, 40, 60, 80, 100 ppm of respective metal ion solution. The Calcium, Potassium, Sodium in the sample are measured by Flame Photometry and Magnesium metal is measured by Atomic Absorption Spectroscopy.The instrument used for flame photometry is Flame photometer-128 which is a micro-controller based instrument. For AAS the instrument used was Perkin elmer

3. Results

3.1Result for Carbon storage and sequestration

Table 1.CO_2 sequestrated by single tree of different species in Woodstock, VIT University, Vellore.

Name of the tree	**Avg DBH (m)**	**Avg Height (m)**	**Volume (m^3)**	**Above ground biomass (kg/tree)**	**Below ground biomass(kg/tree)**	**Total biomass(kg/tree)**	**Carbon(kg/tree)**	**CO_2 Sequestrated(kg/tree**
Kigeliapinnata (sausage tree)	1.45	15.60	25.747	15.448	4.0165	19.464	9.7324	35.681
Agardirachtaindica(Neem tree)	0.80	12.50	6.2831	3.7698	0.9801	4.7500	2.3750	8.7074
Millingtoniahortensis(Cork tree)	1.72	16.33	37.943	22.765	5.9191	28.684	14.342	52.583
Cyatheadealbata(Silvertree fern)	1.23	15.60	18.536	11.116	2.8901	14.006	7.0031	25.675
Peltophorumferrogenium (Yellow flame)	1.20	15.26	17.249	10.349	2.6909	13.040	6.5204	23.905

Table 2.CO_2 sequestrated by all trees of different species in Woodstock, VIT University, Vellore

Name of the Tree	**Carbon Sequestrated (kg/tree)**	**Tree counts**	**Carbon Sequestrated by trees in kg**
Kigelia pinnata (Sausage tree)	35.681	9	321.129
Agardirachta indica (Neem tree)	8.7074	26	226.3924
Millingtonia hortensis (Cork tree)	52.583	21	1104.243
Cyathea dealbata (Silver tree fern)	25.675	17	436.475
Peltophorum ferrogenium (Yellow flame)	23.905	67	1601.635

The table 1 shows the amount of carbon stored and sequestrated by the single tree of five different species from Woodstock of VIT University. Table 2 shows the total amount of carbon stored by the entire trees present in the whole area. From table 1 it is clearly known that *Millingtonia hortensis* is the species which sequestrates carbon in large amount. But in the whole Woodstock area, *Peltophorum ferrogenium* sequestrates carbon more due to more number of species.

3.2 Result for soil sampling

By flame photometry soil analysis is done for Na, K, and Ca metals and Mg is analyzed by AAS and the results are shown in Table 3.

The table 3 shows the amount of calcium, potassium, sodium and magnesium present in the soil taken near the selected trees. The soil sampling has 58% of organic carbon. The soil where the tree is planted also plays a major role for carbon sequestration. By analyzing the soil near the different species, we came to a result that the soil near the tree *Millingtoniahortensis*has more number of metal ions.

Table 3. Amount of Calcium, Potassium, Sodium and Magnesiumin the soil sample taken near the trees estimated by flame photometry and AAS.

Name of the tree	**calcium (ppm)**	**Potassium(ppm)**	**sodium(ppm)**	**magnesium(ppm)**
Agardirachta indica (Neem tree)	1.16	1.34	4.32	0.0111
Millingtonia hortensis (Cork tree)	3.34	2.69	6.05	0.0067
Kigelia pinnata (Sausage tree)	1.27	0.49	5.32	0.0004
Peltophorum ferrogenium (Yellow flame)	1.00	0.90	5.23	0.0006
Cyathea dealbata (Silver tree fern)	1.20	0.79	4.73	0.0014

4. Conclusion

Trees play a major role in the reduction of atmospheric carbon dioxide levels. Though no single option is perfect, carbon sequestration has potential for great societal benefits. Continuing research is sure to bring about further breakthroughs particularly in the field of carbon capture. *Millingtonia hortensis* is sequestrating carbon in more amounts. Thus the university is requested to plant more number of *Millingtonia hortensis* tree.

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