REPORT OF TREE DIVERSITY AUDIT AND CARBON SEQUESTRATION ANALYSIS 2020-21

ALPHONSA COLLEGE PALA

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INTRODUCTION

Trees are one of the most important components of each and every terrestrial ecosystem and are a part of nature's precious gift. They provide a wide range of ecological, economic and aesthetic benefits that improve the quality of our life. Knowledge about the tree diversity in a community will enable the inhabitants to promote the diversity and to sustainably manage the trees.

Academic environment should be promoted for sustainable development and biodiversity conservation. Trees are an important part of college students' daily lives. Therefore, trees in the campus deserve special attention. Understanding the environmental, economic and social or community benefits of nature, in particular trees and forests, can lead to better vegetation management and designs to optimize environmental quality and human health for current and future generations.

In response to growing concern on global climate change, carbon management in vegetation is inevitable in order to offset the carbon emission in the atmosphere. Trees acts as a sink for the carbon dioxide to mitigate the global climate change. Carbon sequestration is a mechanism for the removal of carbon from the atmosphere by storing it in the biosphere. Through carbon sequestration, the effects of global warming and the attendant climate change can be reduced (IPCC, 2007b). The trees that sequester the most carbon dioxide from the atmosphere are those that grow the most rapidly. Calculating carbon storage in trees helps us to identify trees with comparatively high carbon storage potentiality. Hence increasing the carbon sinks as well as reducing carbon emissions in the environment we live is of prime concern.

This audit was mainly focussed to identify the trees in the campus of Alphonsa College, Pala along with a study on their economic, environmental and aesthetic benefits and to analyse the efficiency of campus trees in sequestering carbon. It is envisaged that the present study will generate information that can assist in building tree database for the campus, as well as in determining appropriate local management and conservation strategies from the perceptions of the people on campus.

OBJECTIVES

The main objectives of the audit were

- To identify, and document the diversity of trees in Alphonsa College Campus.
- To understand the economic, environmental and aesthetic benefits of trees in the campus.
- To calculate the carbon storage and sequestration by trees.

METHODOLOGY

Study Area

The study area, Alphonsa College Campus is located at Pala, Kottayam District, Kerala, India. The campus has a total area of 9.5 acres. Pala lies 35m above the sea level. The climate is tropical in Pala. The average annual temperature is 27.5^0C. Average precipitation is 3257mm. The geographical location of Pala is 9.708380 latitude and 76.684914 longitudes. The study area has laterite soil. Our study extended from August 2019 to January 2020. We identified 315 trees belonging to 47 species in the campus. In the present study, the amount of biomass and CO_2 in standing woody biomass of selected tree species from wood stock area was calculated.

Field Survey of Trees in the Campus

The present project is an attempt to identify the tree diversity along with its benefits in Alphonsa College Campus and to analyse their efficacy in sequestering carbon. Trees were identified with the help of standard flora (Hooker, 1872; Gamble, 1915; Manilal and Sivarajan, 1982). Each of the trees found in the campus was identified up to species level with their scientific name, local name and family. The trees were enumerated by direct counting using census method. Frequent visits were done to identify the flowering and fruiting seasons. Photographs were taken. The economical, ecological and aesthetic benefits of trees in the campus were studied.

Measurement of Tree Height and Diameter at Breast Height (DBH)

To estimate the biomass of different trees, non-destructive method was used. The biomass of trees was estimated on the basis of their DBH. 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.

Estimation of Above Ground Biomass (AGB)

The Above Ground Biomass of tree includes the whole shoot, branches, leaves, flowers and fruits. It was calculated using the allometric equation developed by Udayakumar et al., (2016) for the tropical dry forests.

AGB dry = exp (2.2014 LN (DBH) - 1.0615)

Where, AGB dry = Above ground dry biomass of tree (kg);

DBH = Diameter at breast height (cm);

2.2014 and 1.0615 are constants.

Estimation of Below Ground Biomass (BGB)

The Below Ground Biomass (BGB) includes all biomass of live roots excluding fine roots. Below Ground Biomass (BGB) was calculated using the following formula (Macdicken 1997, Hangarge et al., 2012):

BGB (kg/tree) = AGB (kg/tree) x 0.26.

Estimation of Total Biomass (TB)

Total biomass (TB) is the sum of the above and below ground biomass (Sheikh et al., 2011):

TB = AGB + BGB (kg/tree).

Estimation of Carbon Storage

Generally, for any plant species 50% of its biomass is considered as carbon (Pearson et al., 2005). Therefore, the weight of carbon in the tree was estimated by multiplying the biomass of the tree by 50% (Birdsey 1992).

Carbon storage = Biomass x 50 % (kg/tree).

Determination 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 is calculated as: 43.99915/12.001118 = 3.6663.

Therefore, to determine the weight of CO_2 sequestered in the tree, multiply the weight of carbon in the tree by 3.6663 (Vishnu and Patil 2016).

Report

Field Survey of Campus Trees

We identified 315 trees belonging to 22 families, 44 genus and 47 species in the campus (Table 1).

Table 1: Common name, Scientific name, Family and Frequency of tree species in Alphonsa College Campus

Sl. No.	Scientific Name	Malayalam Name / Common Name	Family	No. of trees
1	*Tectona grandis*	Thekku	Verbenaceae	107
2	*Swietenia mahagoni*	Mahogany	Meliaceae	88
3	*Artocarpus hirsutus*	Anjili	Moraceae	13
4	*Cocos nucifera*	Thengu	Arecaceae	11
5	*Carica papaya*	Kappalanga	Caricaceae	9
6	*Macaranga peltata*	Vatta	Euphorbiaceae	7
7	*Artocarpus heterophyllus*	Plavu	Moraceae	6
8	*Garcinia mangostana*	Mangosta	Clusiaceae	6
9	*Psidium guajava*	Pera	Myrtaceae	6
10	*Ravenala madagascariensis*	Traveler's Palm	Strelitziaceae	5
11	*Wodyetia bifurcata*	Foxtail Palm	Arecaceae	5
12	*Bauhinia variegata*	Mandaram	Fabaceae	4

13	*Manilkara zapota*	Sappota	Sapotaceae	3
14	*Syzygium malaccense*	Pananeer jamba	Myrtaceae	3
15	*Terminalia paniculata*	Maruthu	Combretaceae	3
16	*Blighia sapida*	Akee	Sapindaceae	2
17	*Crescentia cujete*	Thiruvattakkai	Bignoniaceae	2
18	*Lagerstroemia speciosa*	Poomaruthu	Lythraceae	2
19	*Mangifera indica*	Mavu	Anacardiaceae	2
20	*Morinda citrifolia*	Cherumanjanathi	Rubiaceae	2
21	*Nephelium lappaceum*	Rambutan	Sapindaceae	2
22	*Plumeria rubra*	Ezhachampakam	Apocynaceae	2
23	*Acacia leucophloea*	Chenkaringali	Fabaceae	1
24	*Albizia saman*	Mazhamaram	Fabaceae	1
25	*Aporosa cardiosperma*	Vetti	Euphorbiaceae	1
26	*Araucaria araucana*	Monkey Puzzle	Araucariaceae	1
27	*Azadirachta indica*	Ariyaveppu	Meliaceae	1
28	*Briedelia retusa*	Mulluvenga	Euphorbiaceae	1
29	*Callistemon citrinus*	Bottle Brush	Myrtaceae	1
30	*Cassia fistula*	Kanikonna	Fabaceae	1
31	*Citharexylum spinosum*	Parijatham	Verbenaceae	1
32	*Corypha umbraculifera*	Kodappana	Arecaceae	1

33	*Delonix regia*	Poomaram	Fabaceae	1
34	*Euphorbia antiquorum*	Chathurakalli	Euphorbiaceae	1
35	*Ficus exasperata*	Therakam	Moraceae	1
36	*Ficus racemosa*	Atthi	Moraceae	1
37	*Gmelina arborea*	Kumbil	Verbenaceae	1
38	*Magnolia champaca*	Champakam	Magnoliaceae	1
39	*Mimusops elengi*	Elangi	Sapotaceae	1
40	*Peltophorum pterocarpum*	Charakonna	Fabaceae	1
41	*Phyllanthus emblica*	Nelli	Euphorbiaceae	1
42	*Podocarpus sp.*	Brown or Black Pine	Podocarpaceae	1
43	*Pterocarpus marsupium*	Venga	Fabaceae	1
44	*Saraca asoca*	Ashokam	Fabaceae	1
45	*Syzygium jambos*	Champa	Myrtaceae	1
46	*Tamarindus indica*	Valampuli	Fabaceae	1
47	*Thespesia populnea*	Poovarasu	Malvaceae	1

Carbon Sequestration Analysis

The amount of carbon dioxide sequestered by selected trees in the campus was calculated (Table 2). *Albizia saman and Delonix regia* sequestered 52372.11 kg of CO_2 in their standing biomass followed by *Podocarpus* species (35339.53 kg). Other trees such as *Bridelia retusa* (32045.27 kg), *Pterocarpus marsupium* (32045.27 kg), *Artocarpus heterophyllus* (30463.79 kg), *Magnolia champaca* (24571.60 kg), *Swietenia mahagoni* (23206.11 kg), *Tamarindus indica* (19853.71 kg), *Macaranga peltata* (14199.23 kg), *Tectona grandis* (14199.23 kg), *Bauhinia variegata* (13791.16 kg), *Syzygium malaccense* (13791.16 kg) and *Peltophorum pterocarpum* (11847.86 kg) are found to have the CO_2 sequestration rate above 10000 kg. The remaining tree species' CO_2 sequestration rate is below 10000 kg. *Nephelium lappaceum* with the CO_2 sequestering potential of 129.59 kg is having the lowest among those values and is followed by *Manilkara zapota* with CO_2 sequestering of 181.92 kg.

Table 2: Amount of CO_2 sequestered by selected tree species in Alphonsa College Campus

Scientific Name	DBH (cm)	AGB (kg)	BGB (kg)	Total Biomass (kg)	Carbon Storage (kg)	CO_2 Sequestered (kg)
Albizia saman	275	22651.32	5889.34	28540.66	14270.33	52372.11
Delonix regia	275	22651.32	5889.34	28540.66	14270.33	52372.11
Podocarpus sp.	230	15284.6	3974.00	19258.60	9629.30	35339.53
Briedelia retusa	220	13859.77	3603.54	17463.31	8731.66	32045.19
Pterocarpus marsupium	220	13859.77	3603.54	17463.31	8731.66	32045.19
Artocarpus heterophyllus	215	13175.8	3425.71	16601.51	8300.76	30463.79
Magnolia champaca	195	10627.4	2763.12	13390.52	6695.26	24571.60

Swietenia mahagoni	190	10036.8	2609.57	12646.37	6323.19	23206.11
Tamarindus indica	177	8586.87	2232.59	10819.46	5409.73	19853.71
Macaranga peltata	152	6141.26	1596.73	7737.99	3869.00	14199.23
Tectona grandis	152	6141.26	1596.73	7737.99	3869.00	14199.23
Bauhinia variegate	150	5964.77	1550.84	7515.61	3757.81	13791.16
Syzygium malaccense	150	5964.77	1550.84	7515.61	3757.81	13791.16
Peltophorum pterocarpum	140	5124.28	1332.31	6456.59	3228.30	11847.86
Phyllanthus emblica	125	3992.86	1038.14	5031.00	2515.50	9231.89
Artocarpus hirsutus	119.5	3616.3	940.24	4556.54	2278.27	8361.25
Cassia fistula	118	3517.12	914.45	4431.57	2215.79	8131.95
Citharexylum spinosum	110	3013.48	783.50	3796.98	1898.49	6967.46
Terminalia paniculata	108	2894.18	752.49	3646.67	1823.34	6691.66
Gmelina arborea	105	2720.15	707.24	3427.39	1713.70	6289.28
Blighia sapida	93	2082.4	541.42	2623.82	1311.91	4814.71
Plumeria rubra	91	1985.09	516.12	2501.21	1250.61	4589.74
Azadirachta indica	90	1937.39	503.72	2441.11	1220.56	4479.46
Crescentia cujete	86	1752.88	455.75	2208.63	1104.32	4052.85
Euphorbia antiquorum	80	1494.89	388.67	1883.56	941.78	3456.33

Wodyetia bifurcata	73	1221.98	317.71	1539.69	769.85	2825.35
Ficus racemosa	72	1185.44	308.21	1493.65	746.83	2740.87
Mangifera indica	69	1079.42	280.65	1360.07	680.04	2495.75
Cocos nucifera	66	978.79	254.49	1233.28	616.64	2263.07
Ravenala madagascariensis	66	978.79	254.49	1233.28	616.64	2263.07
Ficus exasperata	65	946.44	246.07	1192.51	596.26	2188.27
Saraca asoca	52	579.1	150.57	729.67	364.84	1338.96
Callistemon citrinus	49	508.09	132.10	640.19	320.10	1174.77
Araucaria araucana	45	421.24	109.52	530.76	265.38	973.94
Morinda citrifolia	44.5	411	106.86	517.86	258.93	950.27
Acacia leucophloea	42	361.88	94.09	455.97	227.99	836.72
Lagerstroemia speciosa	42	361.88	94.09	455.97	227.99	836.72
Corypha umbraculifera	40	325.03	84.51	409.54	204.77	751.51
Psidium guajava	39	307.41	79.93	387.34	193.67	710.77
Carica papaya	33	212.82	55.33	268.15	134.08	492.07
Mimusops elengi	33	212.82	55.33	268.15	134.08	492.07
Aporosa cardiosperma	28	148.23	38.54	186.77	93.39	342.74
Thespesia populnea	26	125.91	32.74	158.65	79.33	291.14

Syzygium jambos	23	96.13	24.99	121.12	60.56	222.26
Garcinia mangostana	22	87.17	22.66	109.83	54.92	201.56
Manilkara zapota	21	78.68	20.46	99.14	49.57	181.92
Nephelium lappaceum	18	56.04	14.57	70.61	35.31	129.59

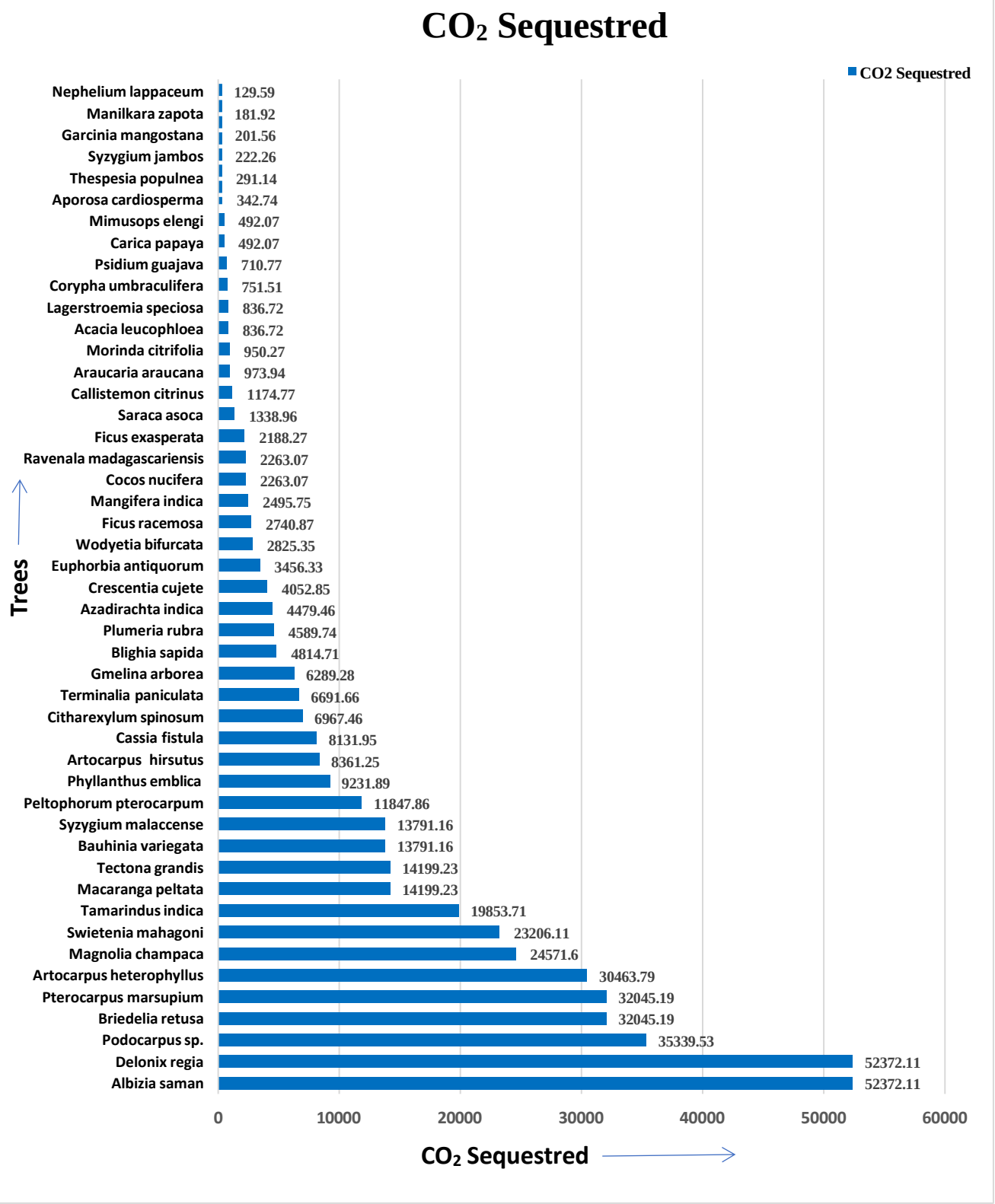

Figure 1. Amount of Carbon Dioxide sequestered by selected trees in the college campus.

SUMMARY

Trees play a vital role in the reduction of atmospheric CO_2 levels. They are carbon reservoirs on Earth. In the campus, *Albizia saman* and *Delonix regia* are found to have the highest carbon sequestration value whereas *Nephelium lappaceum* is found to have the lowest carbon sequestration value. The trees with higher biomass have more sequestration potential and the rate of CO_2 sequestration was high in *Albizia saman* and *Delonix regia* which had the highest average DBH, AGB and total biomass. The woody plants have more carbon sequestration potential than others as they store more carbon in their woody biomass. There was a significant positive relation between the tree DBH and CO_2 sequestration.

The carbon sequestration capacity of a tree species depends upon its age, height, girth size, biomass accumulation capacity, canopy diameter and most important wood specific density. So, the trees to be chosen for sequestering maximum amount of carbon in the present scenario of climate change, should be chosen with the following properties such as highest specific density, fast growth, increasing biomass at a fast rate, should have a huge canopy and also better climate adaptability, richer litter productivity, shorter rotation and should be disease resistant.

This study gives insights about the average total biomass, carbon stock and the amount of carbon sequestered by trees, which could be included in the afforestation programmes and carbon trading schemes. To rescue the world from global warming and climate change, the sustainable management of forest with the objectives of carbon sequestration is mandatory. By understanding and accounting for the ecosystem services provided by trees, better planning, design and economic decisions can be made toward utilizing trees as a means to improve environmental quality and human health and well-being. The results of this study may facilitate further planning and decision-making regarding plantation in the campus, because there is a need for better management and conservation of biodiversity in that area. There is a need to go for natural carbon sequestration by conserving existing diversity and promoting reforestation.