INTERNATIONAL ASSOCIATION OF BIOLOGICALS AND COMPUTATIONAL DIGEST
International & Peer-Reviewed Journal
E-ISSN: 2583-3995

BIOMASS AND CARBON SEQUESTRATION ESTIMATION OF TREE SPECIES IN PUNIT VAN, GANDHINAGAR

Anusha Maitreya*, Aanal Maitreya, Archana Mankad, Nainesh Modi

E-mail id: anushamaitreya.1809@gmail.com
aanalmaitreya@gujaratuniversity.ac.in
aumankad@gujaratunivesity.ac.in
nanineshmodi@gujaratuniversity.ac.in

Department of Botany, Bioinformatics, Climate Change & Impacts Management , School of Sciences, Gujarat University, Ahmedabad – 380009.

ABSTRACT

The most significant greenhouse gas on earth is carbon dioxide, which both absorbs and radiates heat. Earth's temperature is increasing because of greenhouse gases and other human activities. The process of removing and storing carbon dioxide from the atmosphere is known as carbon sequestration. It is the only way to lessen atmospheric carbon dioxide in an effort to slow down the rate of climate change. The chosen study area for the research work is PUNIT VAN, located in Gandhinagar, Gujarat, India. Gandhinagar city is also known as Green city, because of the diversity in vegetation and rich biodiversity. The study was conducted with quadrate random sampling method. There were 20 quadrates taken of 10× 10 m^2. Total area of Punit van is 14.70 hectare. In the research, 27 species, including 317 individuals have been recorded in Punit Van. The field data of the trees analyzed using the random sampling of quadrate method, which shows that the dominant tree species in each quadrate is Azardirachta indica as total of 68 tree species in 13 quadrates. While the least dominant species found in only 1 quadrate were Ailanthus excelsa Roxb., Dalbergia latifolia, Ficus benghalensis, Holopteria integrifolia, Madhuca longifolia, Mangifera indica, Milletia peguensis, Peltophorum pterocarpum, Saraca asoca, Strychnos nux-vomica with the total number of species 1, 1, 4, 5, 7, 6, 3, 6, 13, 7 respectively. Total 41.5 tones carbon sequestered in a hectare.

Key words: Carbon dioxide, carbon sequestration, greenhouse gas, quadrate sampling method

1. INTRODUCTION :

The earth's most vital element is carbon. The main ozone depleting substance on earth is carbon dioxide, which cause global warming. Earth's temperature is rising as a result of human activities and greenhouse gas on earth because it both reflects and absorbs heat. Greenhouse gases, in contrast to oxygen and nitrogen, which together make up the majority of earth's atmosphere, absorbs heat that is released from the surface of the earth and then re-emit it in every direction, including back toward the surface. Without carbon dioxide the natural greenhouse effect that keeps the earth's atmosphere above freezing would be insufficient. A major global crisis is climate change and global warming. Climate change affects the earth's temperature, humidity, wind, rainfall, and air pressure over an extended period of time. The primary contributing component to climate change that rises the temperature of the world is global warming.

The act of diverting carbon dioxide away from emission source and storing it in the ocean, terrestrial settings (vegetation, soils and sediments) and geologic formations is referred to as carbon sequestration. This process can be either natural or intentional. In simple words, The process of removing and storing carbon dioxide from the atmosphere is known as carbon

https://iabcd.org.in/

sequestration. It is the only way to lessen atmospheric carbon dioxide in an effort to slow down the rate of climate change. There are two types of carbon sequestration, biological and geological. In geological carbon sequestration, for an extended length of time, carbon dioxide that is released by industries, power plants and the processing of natural gas is pumped into porous rocks. In biological carbon sequestration carbon store in soil, forest and in the ocean. Plant store carbon in their stems, roots and soil. Plant use a process known as photosynthesis to convert carbon dioxide into oxygen. These carbons are used by plants for growth. In ocean carbon sequestration carbon gets stored in the ocean. The biggest potential sink for carbon dioxide produced by human-induced activities is the forest.

Study area :

The study area is located in Gandhinagar city of Gujarat, India. Gandhinagar city is the capital of the state of Gujarat in India. It is also known as the green capital of India. Gandhinagar city in which the importance of political, social and government offices and their residence is considered more important as compared to other cities. Many projects and urban development are taking place under Smart City. The facility of metro railway is also built in this city. In this city, small and large gardens have been built in many sectors. In addition to this, various types of forests have also been developed by the forest department. In Gandhinagar city opposite to sector 19 gymkhana, Punit van has been developed. The study area 'Punit Van' (Punit means holy and Van means forest) is a botanical. It covers 14.70 hectare area. It was developed in 2005 by the forest department of the Government of Gujarat. The planted trees are associated with planets, stars and zodiac signs. They have astrological significance with Hindu mythology. There were almost 3500 trees planted when it was developed. Punit van is home of Rashi-van, Nakshatra-van and Navagraha-van and many medicinal as well as ornamental plants including trees, shrubs, herbs and climbers etc. Joggers Park has also been created in the midst of the greenery of many trees. The purpose of this research is to study the carbon sequestration according to the surrounding

atmosphere and many trees. During this study many species of plants found in the area, their number and their density in Punit van have been studied and this study has been done for climatic value. Gandhinagar comprises the dry deciduous forest that lies in the western region. The vegetation of Gandhinagar is dense and has more than 400 species of trees.

MATERIALS & METHODOLOGY:

Materials:

Important materials that have been used to complete this study are given below.

GPS Application on smart phone, A DSLR Camera, Rope or Thread (50 meter for quadrate), Scissor, Measuring tape, A stick, Datasheet, Field notebook, Pen/Pencil

Methodology:

Sampling :

Random sampling method is used for this current research. When a quadrate involves the placing of quadrats at random coordinates, is called as random sampling. A random sampling is used for whether investigating the number of individual species, the diversity of species or the percentage cover in different areas, you would use random sampling. Quadrate method is used for finding out plant density and diversity. The quadrates were 10×10 m^2. Total study area is 14.70 hectares.

For the purpose of determining the aboveground biomass pool, the following parameters were measured. The subsequent factors were measured for the above ground biomass pool's estimation.

This research study was done by non-destructive method, in this method, it is not advisable to cut specific tree species in order to determine their biomass. Tree height is measured with stick method. Girth is measured at breast height with measure tape. By measuring the girth at DBH (Diameter at Breast Height), mathematical models can calculate the biomass. DBH is taken in account together with girth.

Estimation of Tree volume

The volume of tree was estimated by the following formula.

$V = \pi r^2 h$

Where, (V = Volume, r^2= Radius, h = Height) in cubic meter (cm^3).

Calculation of Above Ground Biomass (AGB)

The above ground biomass refers to all living biomass that is located above the soil. The predicted aboveground biomass based on diameter and height, the volume was estimated by dividing the biomass volume by wood density.

The estimate of the species' wood density from the web (www.fao.org).

AGB (kg/tree) = Volume of tree (m^3) × Wood density (g/m^3)

Note : if the wood density is not available, then the Standard average value 0.6 gm/cm^3 is considered for calculation

The Below Ground Biomass (BGB)

The below ground biomass includes the entire biomass of live roots excluding fine roots having < 2 mm diameter. The below ground biomass was calculated by multiplying Above

https://iabcd.org.in/

ground biomass by 0.26 factors as the root : shoot ratio was given by Ravindranath and Ostwald (2008) in their method.

BGB (kg/tree) or (ton/tree) = AGB (kg/tree) or (ton/tree) × 0.26

Where, 0.26 = Root to Shoot ratio

Total Biomass

The total biomass is the addition of the above and below ground biomass as described by Sheikh, et al.(2011), According to him Total Biomass is

Total Biomass (kg/tree) = AGB + BGB

Total Carbon

TC = TB/2 or TB×50%

Determination of the weight of carbon dioxide sequestered in the tree

Carbon dioxide is formulated by three molecules which include one molecule of carbon and two molecules of oxygen. Oxygen and carbon have atomic weights of 16 and 12 respectively. The weight of carbon dioxide is 44.

CO_2 = 1C + 2O = 1(12) + 2(16) = 44

The ratio of CO_2 to carbon is 44/12 = 3.667

RESULT & DISCUSSION:

The field data of the trees analyzed using the random sampling of quadrate method are presented in table 1, which shows that the dominant tree species in each quadrate is Azardirachta indica as total of 68 tree species were found in 13 quadrates.

While the least dominant species found in only 1 quadrate were Ailanthus excelsa Roxb., Dalbergia latifolia, Ficus benghalenalis, Holopteria integrifolia, Madhuca longifolia, Mangifera indica, Milletia peguensis, Peltophorum pterocarpum, Saraca asoca, Strychnos nux-vomica with the total number of species 1, 1, 4, 5, 7, 6, 3, 6, 13, 7 respectively.

The wood densities of different tree species are represented in table 2. The highest wood density is recorded in Acacia catechu 0.88 & the lowest wood density is recorded in Bombax ceiba L. 0.33.

Tree field data from the study region were compiled in table 1. It demonstrates that 27 species, including 317 individuals have been recorded in Punit Van. It also represents the average GBH in cm and average tree heights in meters. The average above ground biomass (AGB) per tree (ton/tree), average below ground biomass (BGB) per tree (ton/tree), the total organic carbon of each species in tones and the total organic carbon sequestered in 317 species have been concluded.

The estimated biomass (organic carbon) has been compared with allometric model. The most dominating species of the study area is Azardirachta indica having 68 trees, sequestrated 0.469 tons of carbon.

Scientific name of the tree species, total no of trees, average GBH, average height, average AGB, average BGB, average TB & total carbon sequestration in tones is shown in table 3.

The major carbon sequestrating species were Ficus benghalenalis (2.41 tons), Emblica officinalis (0.748 tons), Ficus racemose (0.695 tons), Peltophorum pterocarpum (0.477 tons). Total 41.5 tones carbon sequestered in a hectare.

https://iabcd.org.in/

Carbon sequestration potential of every tree species found in different quadrates of the study area is displayed in figure 1.

Table 1: No. of trees found in quadrate study in Punit Van

SRNO	SCIENTIFIC NAME	QUADRATE																			TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	Acacia catechu										3	6										9
2	Acacia		2				2	1					4	1					6		3	19
3	Aegle marmelos									43	2											45
4	Ailanthus excelsa Roxb.			1																		1
5	Azardirachta indica	2			9	6	4	6	2		3		10	10		5			4	3	4	68
6	Bombax ceiba										2							3				5
7	Butea monosperma										1	8										9
8	Cassia fistula			3	3	2	1				2			1				5		1		18
9	Cassia javanica		6																1		4	11
10	Cassia siamia	4							7													11
11	Dalbergia latifolia																1					1
12	Emblica officinalis										1				3							4
13	Ficus benghalenalis														4							4
14	Ficus racemose											6					6					12
15	Ficus religiosa										2	8			2							12
16	Holoptelia integrifolia																				5	5
17	Madhuca longifolia															7						7

18	Mangifera indica														6					6
19	Milletia peguensis					3														3
20	Mimusops elengi											1					3		4	8
21	Peltophorum pterocarpum			6																6
22	Pongamia pinnata						1		1											2
23	Prosopis cineraria									4	4									8
24	Saraca asoca													13						13
25	Strychnos nux-vomica														7					7
26	Syzygium cumini									1						7		1	2	11
27	Terminalia arjuna									5							7			12

Table 2: Wood densities of plant species of study area

Sr No	Scientific Name	Vernacular Name	Family	Wood Density (GM/CM³ or T/M³
1	Acacia catechu	Kher	Mimosaceae	0.88
2	Acacia sp.	Baval	Fabaceae	0.6
3	Aegle marmelos (L.) Corr.	Bili	Rutaceae	0.75
4	Ailanthus excelsa Roxb.	Arduso	Simaroubaceae	0.5
5	Azardirachta indica A. Juss.	Neem	Meliaceae	0.69
6	Bombax ceiba L.	Shimlo	Bombaceae	0.33
7	Butea monosperma (Lam.) Taub.	Khakhra	Fabaceae	0.48
8	Cassia fistula L.	Garmalo	Fabaceae	0.71
9	Cassia javanica L.	Pink cassia	Fabaceae	0.69
10	Cassia siamia	Kasod	Fabaceae	0.62
11	Dalbergia latifolia	Sisum	Leguminosae	0.75
12	Emblica officinalis Gaertn.	Aambala	Phyllanthanceae	0.80
13	Ficus benghalenalis L.	Vad	Moraceae	0.39
14	Ficus racemosa L.	Umro	Moraceae	0.6
15	Ficus religiosa L.	Piplo	Moraceae	0.6
16	Holopteria integrifolia (Roxb.) Planch	Kanajo	Ulmaceae	0.6
17	Madhuca longifolia var. latifolia (Roxb.) A. Chev.	Mahudo	Sapotaceae	0.74
18	Mangifera indica L.	Mango	Anacardiaceae	0.59
19	Milletia peguensis Ali	Moulmein rosewood	Fabaceae	0.6

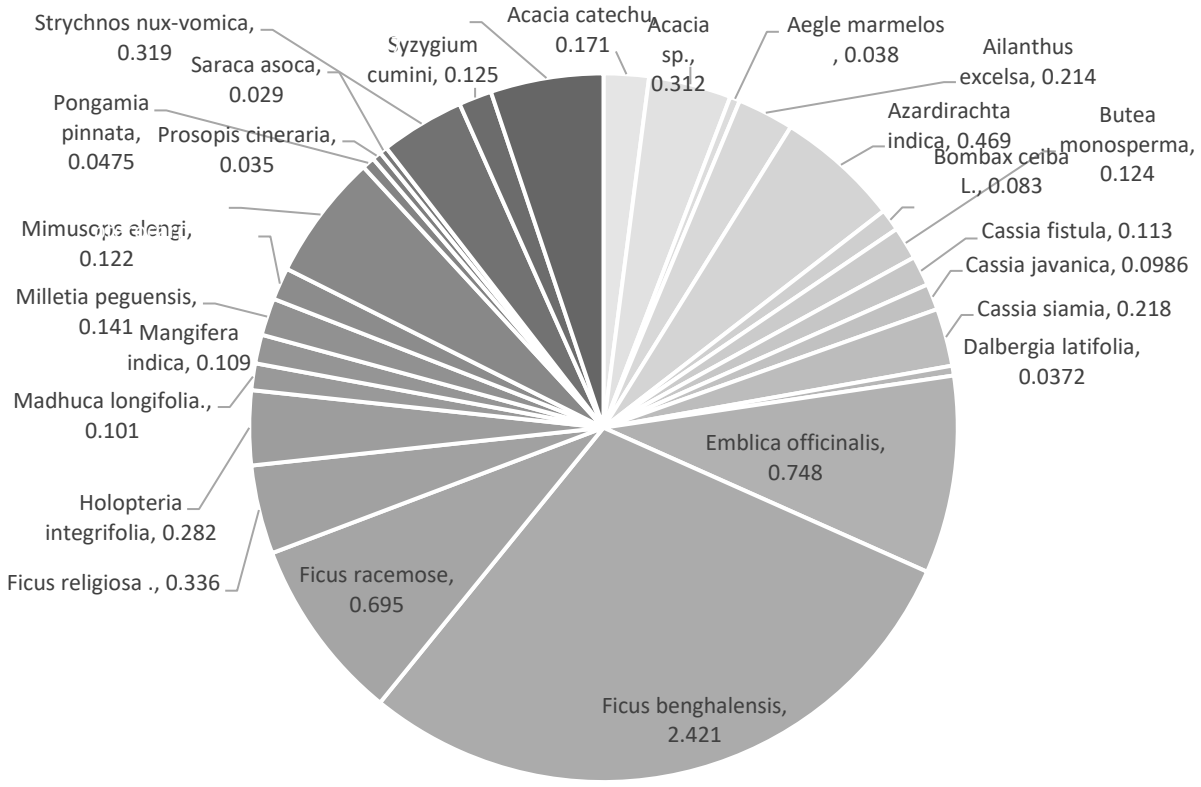
20	Mimusops elengi L.	Borsali	Sapotaceae	0.72
21	Peltophorum pterocarpum (DC) Baker ex DC	Tamraparni	Caesalpiniaceae	0.62
22	Pongamia pinnata (L.) Pierre	Karanj	Fabaceae	0.6
23	Prosopis cineraria (L.) Druce	Khijado	Mimosaceae	0.6
24	Saraca asoca (Roxb.) Wild	Ashoka	Caesalpiniaceae	0.6
25	Strychnos nux-vomica L.	Zer kochlu	Longaniaceae	0.6
26	Syzygium cumini L. Skeels	Jamun	Myteraceae	0.70
27	Terminalia arjuna (Roxb.) W. & A.	Arjun sadad	Combretaceae	0.68

Table 3 : A list of plant species of study area & physiological details

SR NO.	SCIENTIFIC NAME	NO. OF TREES	AVERAGE GBH(CM)	AVERAGE HEIGHT(M)	AVERAGE ORGANIC CARBON			CARBON SEQUESTRATION (TONNES)
					AGB	BGB	TB	
1	Acacia catechu	9	58	12.55	73.98	19.23	93.21	0.171
2	Acacia sp.	19	87.63	14.73	135.15	35.13	170.29	0.312
3	Aegle marmelos	45	33.24	10.08	16.64	4.32	20.97	0.038
4	Ailanthus excelsa	1	74	17	92.64	24.08	116.73	0.214
5	Azardirachta indica	68	101.26	14.40	202.86	52.74	255.60	0.469
6	Bombax ceiba L.	5	62.8	14	36.26	9.42	45.69	0.083
7	Butea monosperma	9	67.11	12.55	54.02	14.04	68.07	0.124
8	Cassia fistula	18	55.88	11.11	49.04	12.75	61.79	0.113
9	Cassia javanica	11	51.27	11.81	42.67	11.09	53.76	0.0986
10	Cassia siamia	11	77.27	12.81	94.45	24.55	119.01	0.218
11	Dalbergia latifolia	1	30	12	16.12	4.19	20.31	0.0372
12	Emblica officinalis	4	127.5	12.5	323.57	84.12	407.70	0.748
13	Ficus benghalensis	4	313.25	13.75	1047.36	272.31	1319.68	2.421
14	Ficus racemose	12	129.54	15	300.63	78.16	378.79	0.695
15	Ficus religiosa .	12	89.58	15.16	145.36	37.79	183.15	0.336
16	Holopteria integrifolia	5	82	15.2	122.05	31.73	153.79	0.282
17	Madhuca longifolia.	7	48.71	13.42	43.76	11.37	55.14	0.101
18	Mangifera indica	6	59.16	11.5	47.27	12.29	59.56	0.109
19	Milletia peguensis	3	62	13.33	61.21	15.91	77.12	0.141

20	Mimusops elengi	8	60.125	10.25	53.10	13.80	66.90	0.122
21	Peltophorum pterocarpum	6	111.33	13.5	206.50	53.69	260.19	0.477
22	Pongamia pinnata	2	45	8.5	20.55	5.34	25.90	0.0475
23	Prosopis cineraria	8	36.375	9.62	15.20	3.95	19.16	0.035
24	Saraca asoca	13	34.92	8.61	12.54	3.26	15.81	0.029
25	Strychnos nux-vomica	7	85	16	138.05	35.89	173.95	0.319
26	Syzygium cumini	11	56.81	12.09	54.38	14.14	68.52	0.125
27	Terminalia arjuna	12	93.16	15.75	185.03	48.10	233.14	0.427
Total trees		317	**Total carbon sequestrated**					8.30

Figure 1: pie chart of tree species and their carbon sequestration potential



CONCLUSION:

Trees are an important and significant source of storing carbon. They work wonder as carbon sinks. From the current research we can conclude that planting different tree species in variety have a significance impact on human kind, environment, biodiversity and climate

change. Certain plant species like Ficus benghalensis have larger girth area, so that it can capture more carbon dioxide from the atmosphere. Other tree species like Ailanthus excelsa, Azardirachta indica, Acacia catechu, Ficus racemosa, Ficus religiosa, Mangifera indica, Peltophorum pterocarpum have larger girth, height and tree canopy. They can be planted in larger numbers in residential areas, public parks, botanical gardens, artificial forests, educational campuses & roadside as well.

REFERENCES

1) Potadara Vishnu , Satish S Patil , (2016) IJIRSET, 5 pp 5459-5468.
2) David J Nowak , Daniel E Crane, (2002) Environment pollution, 116, pp 381-389.
3) Skog, Kenneth E Nicholson, Geraldine A(1998). Forest Products Journal, C,48 pp 75-83
4) Hangarge LM, Kulkarni DK, Gaikwad VB, Mahajan DM, Chaudhary N, 2012, Annals of Biological Research, 3(7):3426-9.
5) https://lnct.ac.in/wp-content/uploads/2020/03/UNIT-4B.pdf
6) https://grazingland.cssm.iastate.edu/measuring-tree-height-using-clinometer
7) carbon sequestration potential of tree species in the environment of north Maharastra university campus, Jalgaon, India .Suryavanshi M N , A R Patel ,T S Kale, P R Patil; Bioscience discovery pp 175-179, July 2014.
8) https://www.fao.org/3/w4095e/w4095e0c.htm
9) Pearson TRH Brown S and Ravindranath NH, 2005. Integrating carbon benefits estimates into GEF Projects: 1-56.
10) Chavan BL and Rasal GB, 2010. Sequestered standing carbon stock in selective tree species grown in university campus at Aurangabad, (MS). Science Research Reporter, 2(1):51-55.
11) Chavan BL and Rasal GB,2011. Sequestered carbon Potential and Status of Eucalyptus Tree. International Journal of Applied Engineering and Technology., 1(1):41-47
12) Chavan BL and Rasal GB, 2012, Carbon Sequestration potential of young Annona reticulate and Annona squamosa from University campus of Aurangabad. International Journal of Physical and Social Sciences,2(3):193-196.
13) Sheikh MA, Kumar M Bussman and Wand TNP,2011. Carbon Balance and Management doi.:1186-1750.
14) https://www.usgs.gov/faqs/what-carbon-sequestration#:~:text=Carbon%20sequestration%20is%20the%20process,carbon%20sequestration%3A%20geologic%20and%20biologic.