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Evaluation of biomass and carbon stock potential of avenue plantations under Haritha Haram: A case study of Telangana, India

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Abstract
The study was carried out to investigate the biomass and carbon stock of avenue plantations under Haritha haram programme in Telangana state. Enumeration was done to estimate the biomass, carbon stock of trees in National highway-65, State highway-01 and rural roads. Total biomass under National highway-65 was recorded maximum in *Azadirachta indica* (2121.07 tonnes), State highway-01 was highest in *Azadirachta indica* (532.62 tonnes), in Rural roads *Peltophorum pterocarpum* (166.12 tonnes). Total carbon stock in National highway-65 showed highest in *Azadirachta indica* (1060.53 tonnes), while State highway-01 showed in *Azadirachta indica* (266.31 tonnes) and in Rural roads *Peltophorum pterocarpum* (83.06 tonnes).

Keywords: Avenue plantation, biomass, carbon stock

1. Introduction
Global warming, climate change and biodiversity loss are the important currently debated issues among the world's scientists and policy makers [1]. The main cause is the fossil fuel burning and deforestation during the last few decades [2]. The last century finished with an increase in global temperature by 0.74 °C and the atmospheric CO_2 concentration of 379 ppm. Further, atmospheric carbon dioxide would be doubled by 2050 if the current rate of increase of CO_2 continues and it will lead to the global temperature rise of up to 2–4 °C [3]. A projection by [3] revealed that by the end of 21st century the global sea level will rise by 28–98 cm due to melting of polar ice, which would badly alter low-lying coastal countries (e.g. Bangladesh, Maldives and Netherlands) existence and livelihood patterns. Forests retention coupled with various reforestation and afforestation programmes in particular tropical regions can play an important role in mitigating global climate change through sequestering atmospheric carbon [4, 5, 6, 7].

Carbon sequestration is the process of absorption of carbon dioxide (CO_2) from the atmosphere and the carbon stock refers to the amount of carbon stored in trees in the form of biomass. Plants take up carbon dioxide from the atmosphere and incorporate it in the form of fixed biomass through photosynthesis during their growth processes, thereby acting as carbon sink. Some of this carbon is emitted back to the atmosphere but what is left-the live and the dead plant parts, above- and below ground, make up organic carbon reservoir [8]. Avenue plantation plays a pivotal role in reducing the pollution caused by vehicular movement [9] and also reduces concentration of CO_2 in atmosphere in the form of biomass [10]. India has the world's second largest road network after USA, out of 46.80 lakh km long road networks, National highway account for about 1 lakh km stretch which passes through urban, rural and forest areas of the country. They carry about 65% of freight and 85% of passenger traffic in India. National highways account for only 2% of the paved roads but still carries 40% of the automobile traffic signifies its importance in Indian economy. The incessant movement of vehicles on the highways emitting harmful gaseous and particulate matter is a major source of air pollution poses an imminent health threat for the people. Planting of trees along the national highway-65, state highway-01, rural roads provides variety of services *viz*., carbon sequestration, biodiversity conservation, oxygen supply, ecological balance, microclimate regulation, soil stabilization, groundwater recharge, shade *etc*. [11]. Avenue trees are adjacent to the roads where vehicle is moving and emitting pollution because of their proximity to generation of vehicle emissions, trees are important in reducing pollution [9]. Carbon storage, as estimated based on tree biomass production, is an efficient method for reducing the amount

of greenhouse gases in the atmosphere [12, 13].

Telangana state government has initiated, a flagship programme called 'Telangana ku Haritha Haram", in order to increase the forest cover from 24 percent to 33 percent as per National forest policy 1988. Under this programme many avenue plantations were taken up in different National, State highways and rural roads. However, there are meagre studies examining the carbon sequestration potential of avenue plantations under Haritha haram in Telangana state. In view of this context present study was undertaken to examine the biomass and carbon stock potential of avenue plantations under Haritha haram in Telangana state.

2. Materials and Methods

Study was conducted in Telangana state which lies at an elevation of 500m, located between latitude 15^0 46^1 and 19^0 47^1 N and longitude 77^0 10^1 and 81^0 43^1East. It has hot and dry climate with 900-1500mm rainfall in Northern Telangana and 700-900mm in southern Telangana. The study was carried out in three different kinds of roads *viz.*, National highway-65, State highway-01 and Rural roads.

Total national highway-65 in Telangana is 276.80 km which covers districts of Sangareddy, Rangareddy, Hyderabad, Yadadri, Nalgonda and Suryapet. Among these districts the study area was covered from Hyderabad to Choutuppal that covers around 49 km. Number of plots laid was 30 and each plot size was 120 m length and width of 10 m on both the sides of road. In state highway-01in Telangana state covers 237 km and the districts were Hyderabad, Medchal, Siddipet, Karimnagar, Peddapally and Mancherial. Experimental area was covered from Shamerpet to Gajwel. Number of plots laid along State highway-01 was 24 and each plot size was 100m length and 5m width on both the sides of road.

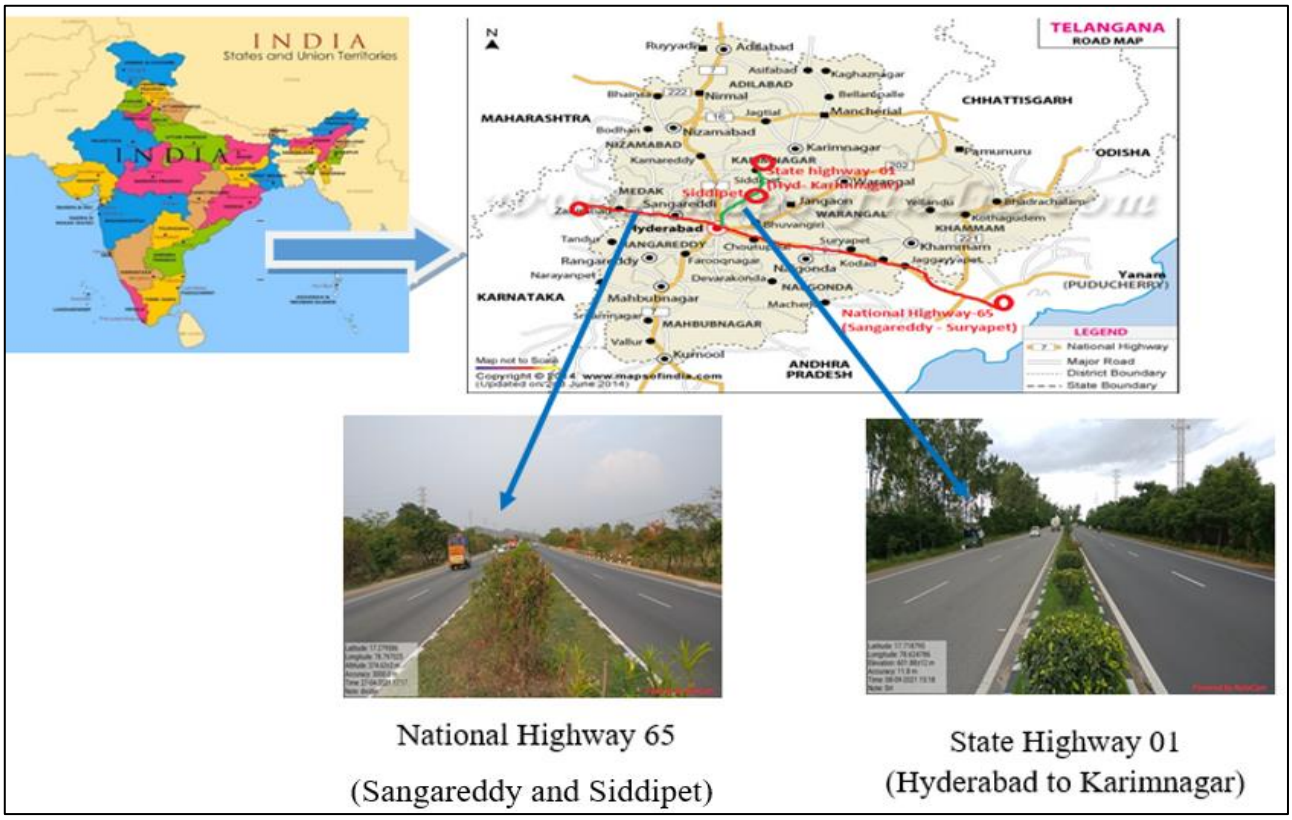


Fig 1: Study area of National highway-65 and State highway-01 of Telangana, India

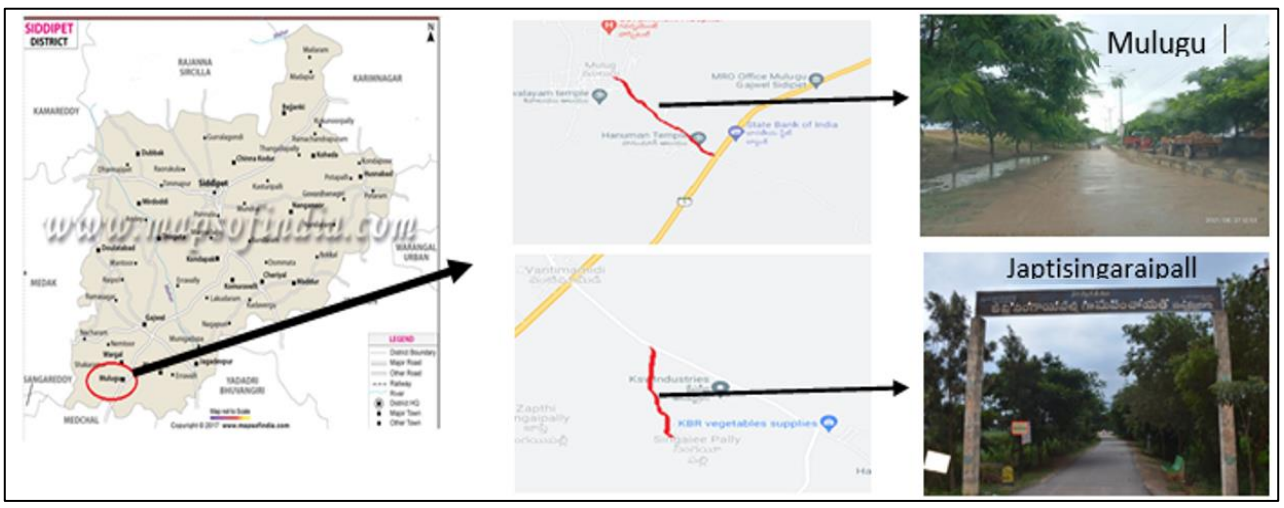


Fig 2: Study area of Mulugu village rural road and Japtisingaraipalli of Siddipet district, Telangana, India

In rural roads study was conducted from Mulugu village to Wargal village and Vantimamidi The study area of rural roads was from Mulugu village to Japtisingaraipally in Siddipet district. Plot size followed was 100m length and 3m width. Total number of plots laid was 20. Total area covered was 13km on both sides of the rural road. Various parameters were recorded during study *viz.*, name of the species, family, total height of tree (m), girth of trees (m) number of trees etc. Biomass and Carbon stock was calculated based on standard procedure given by [14]. During the survey total number of trees and species in each zone was numerically counted and recorded. Biological yield was calculated by considering the harvestable biomass of each functional unit of the system type. The estimation of above ground tree biomass was done by non destructive method using local volume equation developed by [15]. For the biomass and carbon stock study, the tree falling in the plot (50×10 m^2) was enumerated. The diameter at breast height (dbh) was measured with the help of tree calliper and height was measured with Ravi's multimeter [16].

2.1 Bio Mass Production

Biological yield was calculated by considering the harvestable biomass of each functional unit of the system type.

2.2 Above ground tree biomass

2.2.1 Biomass estimation

The estimation of above ground tree biomass was done by non-destructive method using local volume equation developed by [15]. For the biomass and carbon stock study, the tree falling in the plot (50×10 m^2) was enumerated. The diameter at breast height (dbh) was measured with the help of tree calliper and height was measured with Ravi's multimeter [16]. The above ground biomass was calculated by multiplying stem wood volume with wood density and biomass expansion factor (BEF).

2.2.2 Above ground biomass of trees

Total above ground biomass of trees were calculated by using the formula given by [17].

Total above ground biomass = Stem wood volume × Wood density × BEF

2.2.2.1 Stem volume estimation: Local volume equation developed for specific tree species was given below.

Local volume equation developed for specific tree species was given below

Tree species	Volume equation*	Wood density (g cm^{-3})**
Acacia leucophloea (Roxb.) Willd.	sqrt $V = -0.00142 + 2.61911D - 0.54703 \times$ sqrt D	0.9
A. modesta Wall.	sqrt $V = -0.00142 + 2.61911D - 0.54703 \times$ sqrt D	0.9
A. nilotica (L.) Delile	sqrt $V = -0.00142 + 2.61911D - 0.54703 \times$ sqrt D	0.9
Albizia lebbeck (L.) Bent.	$V = 0.00471 + 1.79326D^2$	0.53
Azadirachta indica Juss.	$V = 0.00471 + 1.79326D^2$	0.7
Bauhinia purpurea L.	$V = 0.00471 + 1.79326D^2$	0.67
Butea monosperma (Lam.) Taub.	$V = 0.00471 + 1.79326D^2$	0.48
Cassia fistula L.	$V = 0.066 + 0.287D^2$	0.64
Cordia dichotoma G. Forst.	$V = 0.00471 + 1.79326D^2$	0.53
Crateva religiosa Forst.f.	$V = 0.00471 + 1.79326D^2$	0.53
Ficus drupacea Thunb.	sqrt $V = 0.03629 + 3.95389 \times D - 0.84421$sqrt D	0.39
F. racemosa L.	sqrt V = 0.03629 + 3.95389 × D − 0.84421sqrt D	0.39
Holoptelea integrifolia Planch.	$V = 0.00471 + 1.79326D^2$	0.64
Pithecellobium dulce (Roxb.) Benth.	$V = 0.00471 + 1.79326D^2$	0.5
Pongamia pinnata (L.) Pierre	$V = 0.00471 + 1.79326D^2$	0.82
Prosopis juliflora (Sw.) DC	$V = 0.00471 + 1.79326D^2$	0.73
Salvadora oleoides Decne.	$V = 0.00471 + 1.79326D^2$	0.59
Syzygium cumini (L.) Skeels.	$V = 0.00471 + 1.79326D^2$	0.69

*(FSI 1996)

2.2.2.2. Biomass expansion factor (BEF)

It is the value taken into account the biomass of the other aboveground components of trees (leaves, twigs and branches etc.) using a biomass expansion factor. BEF defined as "the ratio of aboveground oven-dry biomass of trees to oven dry biomass of inventoried volume". Some expansion factors developed for various tree species was followed.

Tree biomass was estimated using 1×1m plots. All the crop plants within the border of quadrates were cut at ground level and collected samples were weighed, sub sampled and oven dried at 65 $\pm$ 5 ºC to a constant weight.

2.3 Below ground biomass

Below ground biomass of trees was calculated by using the simple default value of 25% (for hard wood species) to the total above ground biomass recommended by [18].

Below ground biomass = Above ground biomass × 0.25

2.4 Carbon stock

Biomass was converted into carbon by multiplying with a factor of 0.45 [19].

Carbon Stock = Total Biomass (Above ground + below ground biomass) × 0.45

3. Results and Discussion

The present investigation on avenue plantations under National highway-65 was recorded 21 tree species in 09 families with a total number of 3552 plants found in the sample plot of 30 (Table 1). Among the various families, maximum number of species recorded in Fabaceae family (10 species), while lowest number of species were noticed in the Apocynaceae (01 species), Malvaceae (01 species), Moraceae (01 species), Rubiaceae (01 species) and Myrtaceae (01 species). The emphasis on Fabaceae family was given, because of easy establishment, high adaptability, nitrogen fixing and high aesthetic value of trees etc. [20], similar results were also noticed by [21, 22, 23].

The study on relative frequency of plants was noticed maximum in *Alstonia scholaris* (25.19) followed by *Dalbergia sissoo* (12.86), while lowest relative frequency was recorded in *Ficus benghalensis* (0.61). Higher frequency in *Alstonia scholaris* was attributed to evergreen nature of tree, attractive leaves, flowers that are fragrant in nature and tree is small to medium size, hence it is preferred as first row plants in the national highway-65 [24]. The study on volume of trees was noticed maximum in *Alstonia scholaris* (3470.29 m^3) followed by *Azadirachta indica* (2439.69 m^3), on the other hand lowest volume of trees was noticed in *Melia azaderach* (51.63 m^3). The maximum volume of *Alstonia scholaris* and *Azadirachta indica* mainly attributed to higher number trees, higher diameter and height of tree that is contributed to higher volume [24]. These trees were used as second and third row of planting along with other tree species. The above ground biomass of avenue plantation under national highway-65 was reported highest in *Azadirachta indica* (1683.39 tonnes) followed by *Alstonia scholaris* (1249.30 tonnes), while lowest biomass was recorded in *Ceiba pentandra* (15.11 tonnes). Maximum volume in *Azadirachta indica* was due to higher specific gravity and larger sized trees. The data showed higher volume in compare to Bilaspur (129.34m^3) national highway-65 study [25]. Below ground biomass studies noticed maximum quantity of biomass in *Azadirachta indica* (437.68 tonnes), while lowest below ground biomass was recorded in *Ceiba pentandra* (3.93 tonnes). Below ground biomass is mainly attributed to above ground biomass [9;26]Total biomass of plant (above and below ground biomass) was recorded highest in *Azadirachta indica* (2121.07 tonnes) followed by *Alstonia scholaris* (1574.12 tonnes), on the other hand lowest total quantity of plant biomass was recorded in *Ceiba pentandra* (19.04 tonnes). Total biomass is the result of above and below grounds biomass. Data indicated that higher amount of biomass is due to the larger sized tree, higher specific gravity and better management practices etc., [25]. The experiment on total carbon stock of avenue plantation under national highway-65 65 was recorded highest in *Azadirachta indica* (1060.53 tonnes) followed by *Alstonia scholaris* (787.06 tonnes), while lowest total carbon stock was recorded in *Ceiba pentandra* (9.52 tonnes). Higher carbon stock was the results of higher biomass, and it will lower the pollution. [9, 26]. Overall total carbon stock under national highway-65 65 was noticed 4833.10 tonnes. These results revealed that higher amount of carbon stock in national highway-65 [27] in compare to 48.06 recorded by [25]. It was a good sign for combating climate change and global warming at local level and state as whole in Telangana state. It indicated that sate is also giving higher importance for planting of tree through Haritha Haram programme.

The study on avenue plantation under state highway-01was recorded 20 plant species in 09 families (Table 2). A total number of 1376 of plants found in 24 sample plots. The maximum number of plant species was noticed from Fabaceae family (08 species), while lowest number of plant species recorded from Meliaceae (01 species), Myrtaceae (01 species), Rubiaceae (01 species), Sapindaceae (01 species) and Bignoniaceae (01 species). The number of species as compared national highway-65 was low in the study area similar results were also recorded in the arid environments (28, 29 &30). The relative frequency of plants was noticed maximum in *Azadirachta indica* (11.48) followed by *Sterculia foetida* (8.57), while lowest relative frequency was recorded in *Ceiba pentandra (*1.16). The study on volume of plant was noticed maximum in *Azadirachta indica* (612.63 m^3) followed by *Sterculia foetida* (343.20 m^3), on the other hand lowest volume was noticed in *Neolamarckia cadamba* (42.95 m^3), followed by *Terminalia arjuna* (44.51m^3). In above ground biomass of avenue plantation under state highway-01-01 was reported highest in *Azadirachta indica* (422.72 tonnes) followed by *Terminalia catappa* (233.48 tonnes), while lowest above biomass was recorded in *Ceiba pentandra* (14.59 tonnes) and *Delonix regia* (21.42 tonnes). In the below ground biomass studies noticed highest quantity of below biomass was in *Azadirachta indica* (109.91 tonnes) followed by *Terminalia catappa* (60.71 tonnes), while lowest below ground biomass was recorded in *Ceiba pentandra* (3.79 tonnes) and *Delonix regia* (5.57 tonnes). The maximum quantity of total biomass (above and below ground) was recorded in *Azadirachta indica* (532.62 tonnes) followed by *Terminalia catappa* (294.19 tonnes), on the other hand lowest total quantity of plant biomass was recorded in *Ceiba pentandra* (18.38 tonnes) and *Delonix regia* (26.99 tonnes). Maximum biomass in *Azadirachta indica* was the result of higher number of trees, its height and diameter [31]. The experiment on total carbon stock under state highway-01 was recorded maximum in *Azadirachta indica* (266.31 tonnes) followed by *Terminalia catappa* (147.10 tonnes), while lowest total carbon stock was recorded in *Ceiba pentandra* (9.19 tonnes) and *Delonix regia* (13.50 tonnes). Higher carbon was the result of its biomass and density. Road side trees capture more quantity of large sized particulate matter than far ones [32] and in close proximity reducing point source pollution [33, 34]. Overall carbon sequestration of state highway-01 was noticed 1248.58 tonnes.

The study on avenue plantation under rural roads were recorded 09 species in 05 families (Table 3). A total number of 657 plants found in the sample plot of 20. The maximum of species was noticed from Bignoniaceae (03 species), on the other hand lowest families were recorded in Moraceae (01 species) and Malvaceae (01 species) similar results were also noticed by [35]. The relative frequency of plants was noticed maximum in *Peltophorum pterocarpum* (20.24) followed by *Delonix regia* (14.00), while lowest relative frequency was recorded in *Tecoma stans (*5.32). The study on volume of plants was noticed maximum in *Peltophorum pterocarpum* (212.65 m^3) followed by *Tabeubia rosea* (150.00 m^3), on the other hand lowest volume of plant species was noticed in *Chukresia tabularis (*28.03 m^3), followed by *Ficus religiosa* (30.64 m^3). In above ground biomass of avenue plantation under rural roads was reported highest in *Peltophorum pterocarpum* (131.84 tonnes) followed by *Tabeubia rosea* (105.00 tonnes), while lowest biomass was recorded in *Chukresia tabularis* (15.98 tonnes) and *Ficus religiosa* (16.24 tonnes). While below ground biomass was noticed highest in

Peltophorum pterocarpum (34.28 tonnes) followed by *Tabeubia rosea* (27.30 tonnes), on the other hand lowest below ground biomass was recorded in *Chukresia tabularis* (4.15 tonnes) and *Ficus religiosa* (4.22 tonnes). The results were in agree with the findings of [35]. The maximum quantity of total plant biomass (above and below ground) was recorded in *Peltophorum pterocarpum* (166.12 tonnes) followed by *Tabeubia rosea* (132.30 tonnes), on the other hand lowest total quantity of plant biomass was recorded in *Chukresia tabularis* (20.13 tonnes) and *Ficus religiosa* (20.46 tonnes). Total carbon stock results revealed that maximu carbon stock in *Peltophorum pterocarpum* (83.06 tonnes) followed by *Tabeubia rosea* (66.15 tonnes), while lowest total carbon stock was recorded in *Chukresia tabularis* (10.06 tonnes) and *Ficus religiosa* (10.23 tonnes). Higher carbon and biomass also reported by [36, 20, 37]. Overall total carbon sequestration in rural roads was found 293.21 tonnes.

Table 1: Biomass and carbon stock of Avenue plantation under National highway-65 (Hyderabad to Choutuppal)

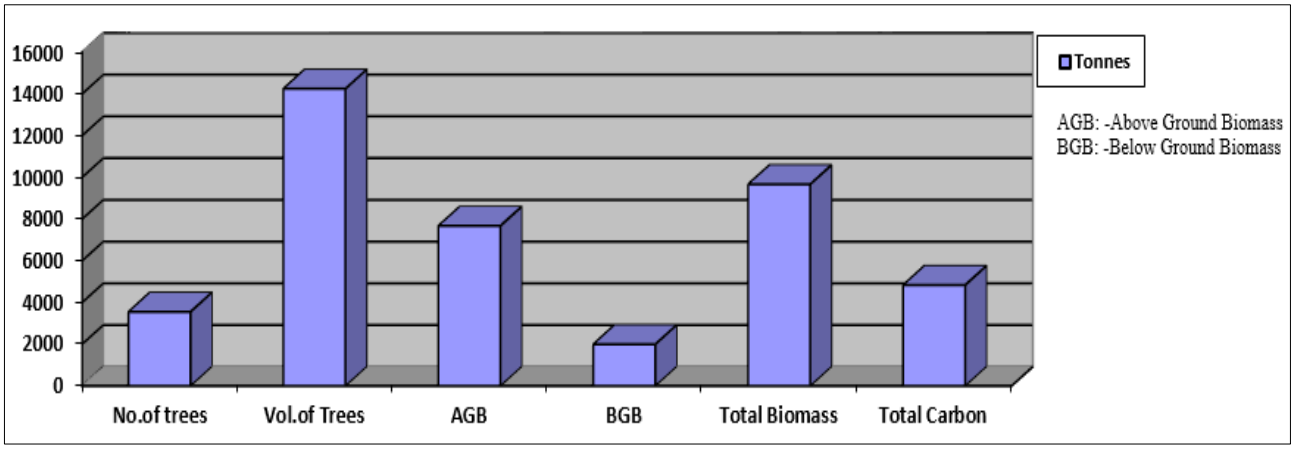
Sl. No	Species	Family	No. of trees	Relative Frequency	Vol of Trees (m^3)	Above Ground Biomass (t)	Below Ground Biomass (t)	Total Biomass (t)	Total Carbon stock (t)
1	*Albizia lebbeck*	Fabaceae	87	2.44	528.097	290.45	75.52	365.97	182.99
2	*Alstonia scholaris*	Apocynaceae	895	25.19	3470.290	1249.30	324.82	1574.12	787.06
3	*Azadirachta indica*	Meliaceae	397	11.17	2439.693	1683.39	437.68	2121.07	1060.53
4	*Bauhinia purpurea*	Fabaceae	154	4.33	395.877	265.24	68.96	334.20	167.10
5	*Cassia fistula*	Fabaceae	23	0.64	68.196	48.42	12.59	61.01	30.50
6	*Ceiba pentandra*	Malvaceae	31	0.87	65.690	15.11	3.93	19.04	9.52
7	*Conocarpus erectus*	Combretaceae	43	1.21	86.986	55.67	14.47	70.15	35.07
8	*Dalbergia sissoo*	Fabaceae	457	12.86	690.614	517.96	134.67	652.63	326.31
9	*Delonix regia*	Fabaceae	26	0.73	165.896	49.77	12.94	62.71	31.35
10	*Ficus benghalensis*	Moraceae	22	0.61	54.846	21.39	5.56	26.95	13.48
11	*Gliricidia sepium*	Fabaceae	41	1.15	228.564	93.71	24.36	118.08	59.04
12	*Melia azaderach*	Meliaceae	35	0.98	51.630	20.65	5.37	26.02	13.01
13	*Neolomarckia cadamba*	Rubiaceae	39	1.09	155.335	77.67	20.19	97.86	48.93
14	*Peltophorum pterocarpum*	Fabaceae	312	8.78	1610.502	998.51	259.61	1258.12	629.06
15	*Pongamia pinnata*	Fabaceae	269	7.57	763.614	633.80	164.79	798.59	399.29
16	*Samanea saman*	Fabaceae	356	10.02	2133.560	960.10	249.63	1209.73	604.86
17	*Spathodea companulata*	Bignoniaceae	58	1.63	121.770	30.44	7.92	38.36	19.18
18	*Syzygium cumini*	Myrtaceae	46	1.29	94.232	65.96	17.15	83.11	41.56
19	*Tabeubia aurea*	Bignoniaceae	55	1.54	159.515	84.54	21.98	106.52	53.26
20	*Terminalia arjuna*	Combretaceae	52	1.46	159.062	108.16	28.12	136.28	68.14
21	*Cassia auriculata*	Fabaceae	154	4.33	802.657	401.33	104.35	505.67	252.84
	Total		3552	99.89	14246.627	7671.58	1994.61	9666.20	4833.10

Table 2: Biomass and Carbon stock of Avenue plantation under State highway-01 (Hyderabad to Karimnagar) road

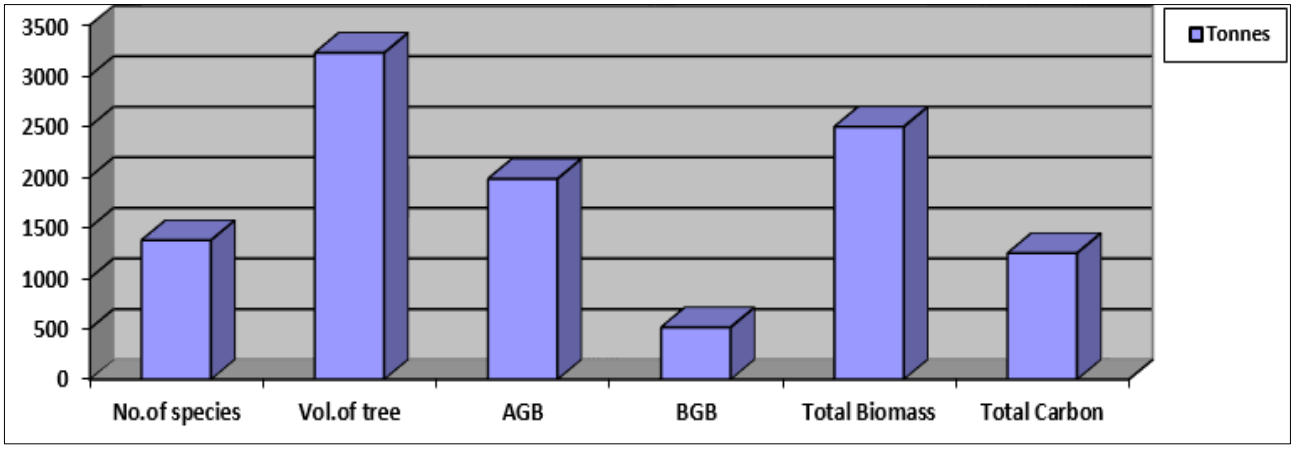
Sl. No	Species	Family	No. of trees	Relative Frequency	Vol of Trees (m^3)	Above ground biomass (t)	Below ground biomass (t)	Total biomass (t)	Total carbon stock (t)
1	*Albezia lebbeck*	Fabaceae	89	6.46	134.71	74.09	19.26	93.35	46.68
2	*Azadirachta indica*	Meliaceae	158	11.48	612.63	422.72	109.91	532.62	266.31
3	*Bauhinia purpurea*	Fabaceae	84	6.10	188.78	126.49	32.89	159.37	79.69
4	*Cassia siamea*	Fabaceae	65	4.72	82.02	53.31	13.86	67.17	33.59
5	*Ceiba pentandra*	Malvaceae	16	1.16	63.44	14.59	3.79	18.38	9.19
6	*Conocarpus erectus*	Combretaceae	65	4.72	138.07	88.37	22.98	111.34	55.67
7	*Dalbergia sissoo*	Fabaceae	57	4.14	47.46	35.60	9.26	44.85	22.43
8	*Delonix regia*	Fabaceae	54	3.92	71.40	21.42	5.57	26.99	13.50
9	*Eucalyptus tereticornis*	Myrtaceae	37	2.68	74.85	37.42	9.73	47.15	23.58
10	*Ficus benghalensis*	Moraceae	73	5.30	287.70	112.20	29.17	141.37	70.69
11	*Ficus religiosa*	Moraceae	54	3.92	70.68	37.46	9.74	47.20	23.60
12	*Neolomarckia cadamba*	Rubiaceae	72	5.23	42.95	21.47	5.58	27.06	13.53
13	*Peltophorum pterocarpum*	Fabaceae	104	7.55	155.09	96.15	25.00	121.15	60.58
14	*Pongamia pinnata*	Fabaceae	42	3.05	158.48	131.54	34.20	165.74	82.87
15	*Samanea saman*	Fabaceae	25	1.81	86.67	39.00	10.14	49.14	24.57
16	*Sapindus trifoliatus*	Sapindaceae	59	4.28	270.71	221.98	57.72	279.70	139.85
17	*Spathodea companulata*	Bignoniaceae	77	5.59	92.01	23.00	5.98	28.98	14.49
18	*Stercullia foetida*	Malvaceae	118	8.57	343.20	161.31	41.94	203.25	101.62
19	*Terminalia arjuna*	Combretaceae	51	3.70	44.51	30.27	7.87	38.14	19.07
20	*Terminalia catappa*	Combretaceae	76	5.52	262.34	233.48	60.71	294.19	147.10
	Total		1376	99.90	3227.71	1981.88	515.29	2497.16	1248.58

Table 3: Biomass and carbon stock of Avenue plantation under rural roads (Mulugu mandal Village roads)

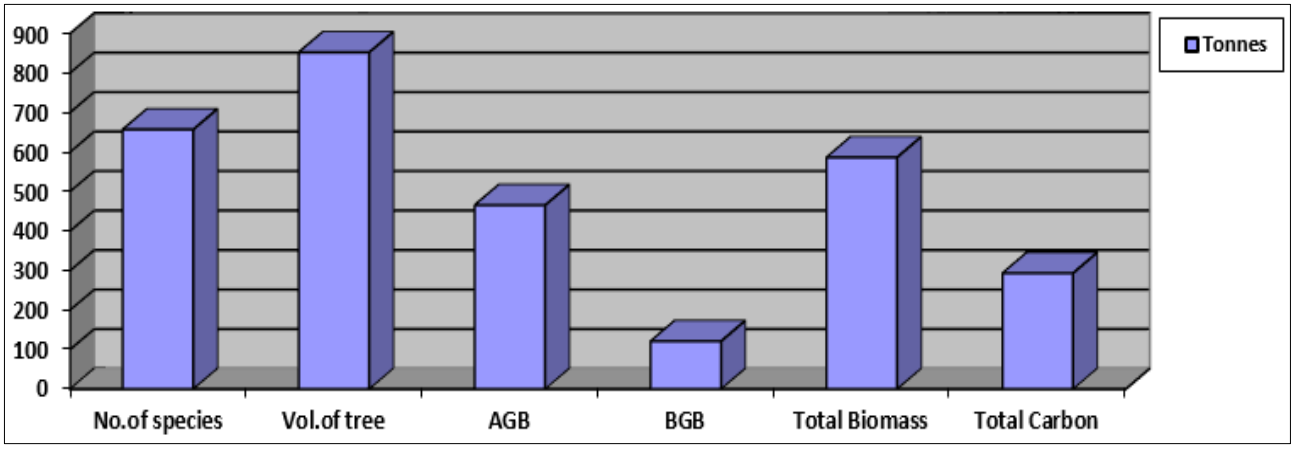
Sl. No	Species	Family	No. of trees	Relative Frequency	Vol of Trees (m^3)	Above ground biomass (t)	Below ground biomass (t)	Total biomass (t)	Total carbon stock (t)
1	*Azadirachta indica*	Meliaceae	44	6.69	49.07	33.86	8.80	42.66	21.33
2	*Chukrasia tabularis*	Meliaceae	49	7.45	28.03	15.98	4.15	20.13	10.06
3	*Delonix regia*	Fabaceae	92	14.00	104.23	31.27	8.13	39.40	19.70
4	*Ficus religiosa*	Moraceae	86	13.08	30.64	16.24	4.22	20.46	10.23
5	*Peltophorum pterocarpum*	Fabaceae	133	20.24	212.65	131.84	34.28	166.12	83.06
6	*Spathodea campanulata*	Bignoniaceae	87	13.24	79.07	19.77	5.14	24.91	12.45
7	*Sterculia foetida*	Malvaceae	70	10.65	131.49	61.80	16.07	77.87	38.94
8	*Tabebuia rosea*	Bignoniaceae	61	9.28	150.00	105.00	27.30	132.30	66.15
9	*Tecoma stans*	Bignoniaceae	35	5.32	67.10	49.65	12.91	62.56	31.28
	Total		657	99.95	852.29	465.42	121.01	586.42	293.21



Graph 1: Study of biomass and carbon stock of avenue plantation under National highway-65 65 in Telangana state



Graph 2: Evaluation of biomass and Carbon stock of Avenue plantation under State Highway 01 in Telangana state



Graph 3: Estimation of biomass and Carbon stock potential of Avenue plantation under Rural roads in Telangana state

4. Conclusions

It was observed that maximum amount of carbon stored in National highway-65-65 was in *Azadirachta indica* 1060.53 tonnes, while state highway-01 also recorded in *Azadirachta indica* 266.31 tonnes which is compared to national highway-65. On the other hand, in rural roads found maximum carbon stock in *Peltophorum pterocarpum* 83.06 tonnes. Overall carbon storage among all the species observed for National highway-65 was 4833.10 tonnes while state highway-01 noticed 1248.58 tonnes and in rural roads 293.21 tonnes. It is clearly indicated that there is huge potential to store atmospheric carbon in National, state and rural roads so as to mitigate climate change and Global warming.

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6. Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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