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CARBON SEQUESTRATION POTENTIAL OF ROAD SIDE STANDING TREES IN KAMAREDDY MUNICIPALITY, TELANGANA, INDIA

***Anil Ragula, Shyam Mukandam and Suryakiran Banoth**
Department of Botany and Forestry
Government Arts & Science Degree College, Kamareddy, Telangana
*Corresponding author Email: anilragula003@gmail.com

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ABSTRACT

In our study of Kamareddy Municipality area, we laid out a 27 sample plots linearly along the road side. 27 sample plots covered about 2.7 ha of land that means each plot size is 0.1 ha. We enumerated 229 number of tree individuals in sampled area. In the 27 sample plots, we calculated 53.5 M^3 0f tree volume, mean volume per plot is 1.98 M^3. Total biomass (AGB+BGB) is about 44.7 tones; mean biomass per plot is around 1.65 tones. Total carbon calculated 1.3 tons, mean carbon is 0.78 tones per plot. The total Carbon sequestration potential is 77.9 tones, mean carbon sequestration potential per plot is about 2.88 tones. By the calculations we assumed per hectare volume is 19.81 M^3, biomass is 16.5 tones, carbon stock is 7.88 tones and carbon sequestration potential is 28.85 tons per hectare.

Keywords : Kamareddy, Carbon sequestration potential, Above Ground Biomass and Below Ground Biomass.

INTRODUCTION

Anthropogenic climate change impacts humans, as well as ecosystems. The rising accumulation of greenhouse gases in the atmosphere is a major cause of global warming. Over the last century, increasing CO_2 levels from 300 ppm to 400 ppm caused an increase in ambient temperature of 0.5°C (IPCC. Climate change 2014). In the next 100years the temperature is predicted to rise by another 0.5–0.6o C. Recently, the World Bank reported that the United States' per capita CO_2 emissions have reached 17.5 t, whereas China and India's are 7.5 and 1.64 t, respectively. China does, however, have the highest overall CO_2 emissions, led by the US and India (World Bank Report. 2018). Forests play an important role in the global carbon cycle and, in particular, tropical forests account for 50 per cent of global biomass in sequestrating total Earth's carbon (Chapin *et al.,* 2002). Nevertheless, forests, which serve as sinks and as a source of energy, are rapidly degraded due to both natural and manmade calamities (Haripriya 2002 & Hooijer *et al.,* 2010).

India has the world's second-largest road network after the US (BRSI.2015-16). Recent reports have revealed that India has a road network of 5.5 million km that is used by 90 % of total passenger traffic and is increasing by 26.93 km per day (IBEF 2009 & Solanki *et al.,* 2006 As a result, road networks across Indian cities are increasingly growing, and existing roads within cities are expanding to boost economic development, jobs, and education services. Road accessibility is a significant determinant of human health and urban quality of life. (Solanki *et al*., 2006). This will cause traffic congestion, pollution and transport problems, with adverse health effects for urban residents (WHO 2002). Urban inhabitants are exposed to carcinogenic poly-aromatic hydrocarbons (Rahman *et al*., 2003) and air pollutants, and thus are at higher risk of developing atopic eczema, nasal discharge, blocked nose, sneezing and asthma (Kramer *et al*., 2019 & Montnemery *et al*., 2003).

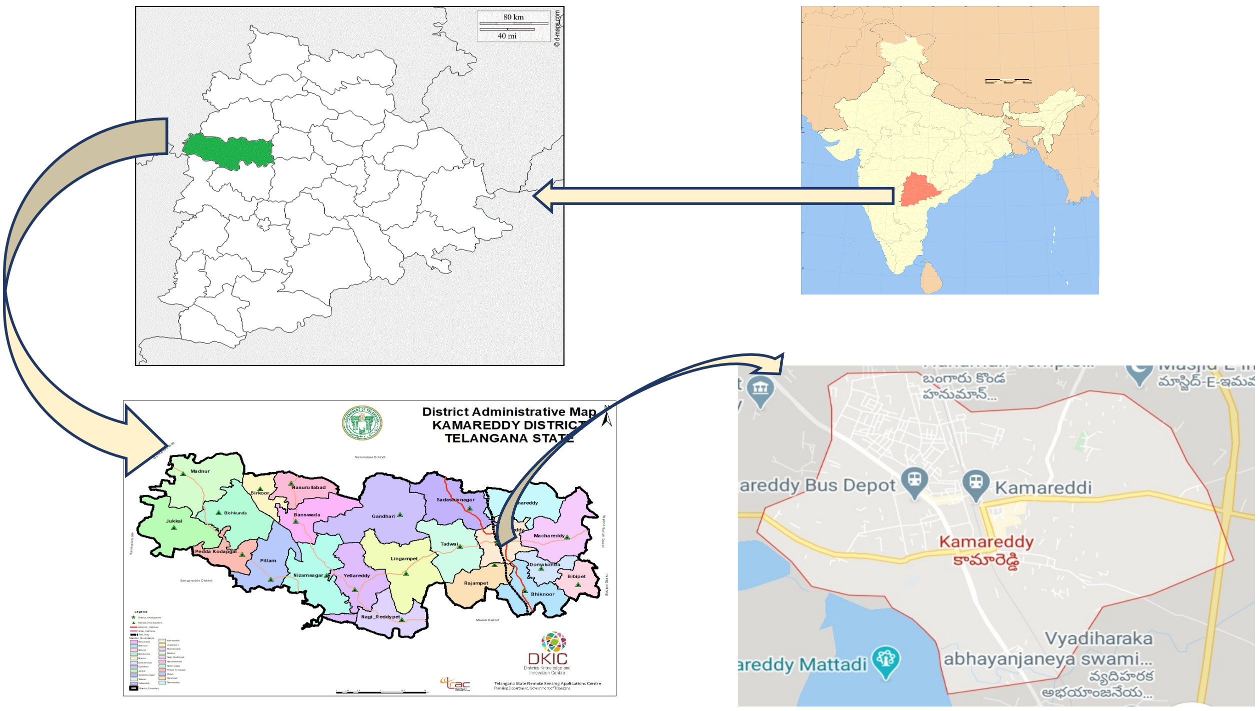
Even if they can escape to the upper atmosphere, trap heat and lead to global warming, Trees consume main emissions, such as CO_2, generated by vehicles and industry. Absorbed CO_2 is absorbed by photosynthesis, and trees are known as effective natural sinks of carbon. So planting trees is a step towards mitigating climate change (Seo and Mendelsohn, 2008). While there are 422 trees per person on Earth, the ratio in India has shrunk to 28:1 (Money, 2015). In India, tree cutting has increased vigorously in recent years for road widening, roads, and drainage. Urban authorities are planting exotic and fast-growing trees with small canopies, such as Backer Ex. K. Heyne , *Peltophorum pterocarpum* (DC.),*Senna siamea* (Lam.) H.S. Irwin & Barneby and *Delonix regia* (Boj. ex. Hook) Raf., *Samanea saman* (Jacq.) Merr., on roadsides instead of large-canopy, indigenous trees, such as *Azadirachta indica* A. Juss. (Neem), *Tamarindus indica* L. (Tamarind), Ficus spp. (Fig trees), *Terminalia arjuna* and *Mangifera indica* L. (Mango). Throughout the early 1980's, indigenous and long-lived tree species were used to provide shade and preserve long-term biodiversity for roadside plantations. The spacing of roadside plantations differed in terms of species selection, since broad tree spacing is optimal for large-crown species, whereas small-crowned, fast-growing tree species gain from narrower spacing (Akhtar *et al.*, 2008 & Zahabu *et al.,* 2015). The survival and growth of street trees depends heavily on traffic load, environmental stress and the level of care and protection, particularly during droughts and water logging (Referowska-Chodak, 2019).

Therefore, the production of roadside plantations in India is a challenging task, since a large number of trees are planted each year, but their survival rate is often low due to strong biotic pressures such as overpopulation, vandal destruction, parked vehicles, road hawkers, animal grazing and fire (Anil Ragula and Krishna, 2020). Successful urban plantations help to create clean air, shade the pedestrians and CO_2 sequestration. When properly handled, urban plantations can store more carbon than natural forests can achieve (Hutyra *et al*., 2011 &Tang *et al*., 2016). Tree plants with the highest CO_2 offset are therefore to be recommended for urban areas. Therefore, carbon estimates can help to better understand the role of trees in the global carbon cycle, and climate change mitigation strategies (Khanal *et al.,* 1970). This study therefore estimated the volume, biomass, and carbon and CO_2 stocks of various tree species along the roads of the municipality of Kamareddy, Telangana, India.

MATERIALS AND METHODS

Study area

Kamareddy is located at 18.3167 °N, 78.3500 °E (falling rain genomics Kamareddy). It covers an area of 14.11 km ^{2} is 110 km northwards from the state capital Hyderabad and 55 km south from the district headquarters of Nizamabad. After formation of Telangana state in 2014, Kamareddy became district headquarters. According to 2011 census and the statistical information by the Government of Telangana, the population of the town stood at 80378 (Basic information Kamareddy municipality).



(Source: Google Earth)

Present study focused on roadside standing trees that established linearly. A systematic sampling approach was used for tree sampling. 27 sample plots were selected along a stretch of road were laid out across different areas in Kamareddy municipality region. Each plot size 100×10m (length × width; 0.1 ha) covering total 2.7 ha for the survey. The tree species were enumerated with help of the measuring tape, girth and height were recorded.

The collected data were used for the estimation of the Volume of the individual tree. The volume was calculated by volumetric equations developed by Forest survey of India (FSI 1996).

Above Ground Biomass (AGB) was calculated by using the formula (Rajput et al., 1996 and Limaye & Sen (1956).)

$$AGB = volume\ (m^3) \times Specific\ Gravity\ (kg\ m^3)$$

Specific gravity of tree species taken from Reyes et al 1992 & Mani and Parthsarathy 2007.

Below Ground Biomass (BGB) calculated by multiplying the AGB by 26% (IPCC 2006)

$$BGB = AGB \times 0.26$$

The total biomass was calculated by sum of tree's AGB and BGB. Carbon stocks were determined by multiplying the total dry biomass by the default carbon fraction (0.475), which is the mean carbon content of the biomass

$$Carbon\ (t) = Biomass\ (t) \times 0.475$$

In the roadside plantations, the carbon storage in individual tree species was calculated by adding the carbon stock values of various trees to all study plots. The estimated carbon stock was converted into CO_2 stock by multiplying the carbon stock by 3.666 to determine tree-biomass CO_2

assimilation (Chandra and Bhardwaj, 2018; Kanime *et at*., 2013).

RESULTS AND DISCUSSION

In our study of Kamareddy municipality area, we laid out a 27 sample plots linearly along the road side. 27 sample plots covered about 2.7 ha of land that means each plot size is 0.1 ha. We enumerated 229 number of tree individuals in sampled area. The total sampled area was home for 49 no. of species belongs to the 20 families. The dominant family was Fabaceae followed by Bignoniaceae and Moraceae (Table1).

Table 1 : Tree Species enumerated in 27 sample plots in Kamareddy Municipality

S. No	Scientific name	Family	No. of individuals
1.	*Aegle marmelos* (L.) Correa	Rutaceae	1
2.	*Albizia amara* (Roxb.) Boiv.	Fabaceae	1
3.	*Albizia lebbeck* (L.) Benth.	Fabaceae	6
4.	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	1
5.	*Annona reticulata* L.	Annonaceae	1
6.	*Artocarpus integrifolia* Linn. f.	Moraceae	1
7.	*Azadirachta indica* A. Juss.	Meliaceae	31
8.	*Butea monosperma* (Lam.) Taub.	Fabaceae	1
9.	*Casuarina equisetifolia* L.	Casuarinaceae	4
10.	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	3
11.	*Cocos nucifera* L.	Arecaceae	3
12.	*Dalbergia latifolia* Roxb.	Fabaceae	1
13.	*Dalbergia paniculata* Roxb.	Fabaceae	2
14.	*Dalbergia sissoo* Roxb.	Fabaceae	15
15.	*Delonix regia* (Boj. ex Hook.) Raf.	Fabaceae	13
16.	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	5
17.	*Ficus benghalensis* L.	Moraceae	1
18.	*Ficus racemose* L.	Moraceae	1
19.	*Ficus religiosa* L.	Moraceae	4
20.	*Grevillea robusta* A.Cunn. ex R.Br.	Proteaceae	1
21.	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	2
22.	*Jacaranda mimosifolia* D.Don	Bignoniaceae	3
23.	*Lagerstroemia parviflora* Roxb.	Lythraceae	1
24.	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	1
25.	*Leucaena leucocephala* (Lam.) de Wit	Fabaceae	9
26.	*Mangifera indica* L	Anacardiaceae	2
27.	*Melia azedarach* L	Meliaceae	2
28.	*Millettia pinnata* (L.) Panigrahi	Fabaceae	7
29.	*Millingtonia hortensis* L.f.	Bignoniaceae	8
30.	*Monoon longifolium* Sonn. B.Xue & R.M.K. Saunders	Annonaceae	8
31.	*Moringa oleifera* Lam.	Moringaceae	1
32.	*Murraya koenigii* (L.) Sprenge	Rutaceae	1
33.	*Nyctanthes arbor-tristisL.*	Oleaceae	1
34.	*Peltophorum pterocarpum* (DC.) K.Heyne	Fabaceae	10
35.	*Phoenix sylvestris* (L.) Roxb., 1832	Arecaceae	4
36.	*Phyllanthus emblica* L.	Phyllanthaceae	2
37.	*Pithecellobium dulce* (Roxb.) Benth.	Fabaceae	5
38.	*Prosopis juliflora* (Sw.) DC.	Fabaceae	4
39.	*Samanea saman* (Jacq.) Merr.	Fabaceae	11
40.	*Senna siamea* (Lam.) Irwin et Barneby	Fabaceae	14
41.	*Spathodea campanulata* P.Beauv.	Bignoniaceae	8
42.	*Sterculia foetida* L.	Malvaceae	4
43.	*Syzygium cumini* (L.) Skeels.	Myrtaceae	3
44.	*Tabebuia rosea* DC.	Bignoniaceae	1
45.	*Tamarindus indica* L.	Fabaceae	1
46.	*Tectona grandis* L.f.	Lamiaceae	3
47.	*Terminalia catappa* L.	Combretaceae	5
48.	*Thespesia populnea* (L.) Sol. ex Correa	Malvaceae	3
49.	*Vachellia nilotica* (L.) P.J.H. Hurter & Mabb.	Fabaceae	9

In the 27 sample plots, we calculated 53.5 M^3 0f tree volume, mean volume per plot is 1.98 M^3. Total biomass (AGB+BGB) is about 44.7 tones; mean biomass per plot is around 1.65 tones. Total carbon calculated 21.3 tons, mean carbon is 0.78 tones per plot. The total Carbon sequestration potential is 77.9 tones, mean carbon sequestration potential per plot is about 2.88 tones. By the calculations we assumed per hectare volume is 19.81 M^3, biomass is 16.5 tones, carbon stock is 7.88 tones and carbon sequestration potential is 28.85 tons per hectare. Sample plot-8 having highest volume, biomass, carbon and CO_2 sequestration potential capacity. Sample plot no-15 holding the lowest volume, biomass, carbon and CO_2 sequestration potential capacity (Table no.2).

Table 2 : Plot wise volume, biomass, carbon and CO_2 sequestration potential

Sample plot no.	Location	Volume (m^3)	AGB (tons)	BGB (tons)	Total biomass (tons)	Carbon (tons)	CO_2 (tons)
1	Siricillaroad	1.897	1.237	0.322	1.559	0.741	2.715
2	Yellamma Temple	2.277	1.337	0.348	1.685	0.800	2.934
3	Near Kanyakaparameshwari Temple	0.942	0.632	0.164	0.796	0.378	1.387
4	Ramareddy Road	0.441	0.274	0.071	0.345	0.164	0.601
5	Driver’s colony	1.004	0.631	0.164	0.795	0.378	1.385
6	Shabdhipur Road	1.387	0.899	0.234	1.133	0.538	1.972
7	Naaj Complex	0.515	0.312	0.081	0.393	0.187	0.684
8	Old Bustand	21.032	14.576	3.790	18.365	8.723	31.980
9	PMH Temple Road	0.705	0.477	0.124	0.601	0.286	1.047
10	Railway Gate	0.605	0.352	0.092	0.444	0.211	0.772
11	Vadloor Road green homes	0.699	0.435	0.113	0.548	0.260	0.954
12	Vasavi School	0.579	0.375	0.097	0.472	0.224	0.822
13	Snehapuri Colony	0.347	0.209	0.054	0.263	0.125	0.458
14	Ashoknagar Colony	0.317	0.205	0.053	0.258	0.123	0.449
15	Near Vijaya Bank	0.235	0.141	0.037	0.178	0.085	0.310
16	CSI Church	0.431	0.254	0.066	0.321	0.152	0.558
17	Tekrial Road	0.980	0.643	0.167	0.810	0.385	1.410
18	NGO's Colony	0.519	0.355	0.092	0.448	0.213	0.780
19	Sai Baba Temple	1.646	1.066	0.277	1.343	0.638	2.338
20	Municipal Office	10.208	6.861	1.784	8.645	4.106	15.054
21	Court Road	0.974	0.628	0.163	0.791	0.376	1.378
22	Jeevadhan Hospital	1.128	0.740	0.192	0.933	0.443	1.624
23	Union Bank of India	0.909	0.567	0.147	0.714	0.339	1.243
24	Housing Board colony	1.184	0.729	0.190	0.919	0.436	1.600
25	Vasavinagar	0.572	0.342	0.089	0.431	0.205	0.751
26	GodamRoad	1.250	0.786	0.204	0.990	0.470	1.725
27	IslampurColony	0.696	0.452	0.117	0.569	0.270	0.991
	Total	**53.5**	**35.5**	**9.2**	**44.7**	**21.3**	**77.9**

In the entire sampled area of 2.7 ha, dominant species is *Azadirachta indica* A.Juss.enumerated 31 tree individuals and followed by *Dalbergia latifolia* Roxb15 tree individuals, *Senna siamea* (Lam.) Irwin et Barneby 13 tree individuals, *Samanea saman*(Jacq.) Merr. 11 and *Peltophorum Pterocarpacum* (DC.) K.Heyne 10 tree individuals (Table 1). *Azadirchta indica*A. Juss. species having highest Volume, Biomass, Carbon and CO_2 sequestration potential and followed by *Eucalyptus camaldulensis* Dehnh., *Dalbergia sissoo* Roxb. and *Terminalia catappa* L. (Table 3) (Fig. 1).

Table 3 : Species wise total volume, biomass, AGB, BGB, carbon and CO_2 in all Sampled Plots (list is in Decreasing Order)

S.No	Name of the species	Volume (m^3)	AGB (tons)	BGB (tons)	Total biomass (tons)	Total carbon (tons)	CO_2 (tons)
1	*Azadirachta indica* A.Juss.	25.74	17.838	4.638	22.475	10.676	39.138
2	*Eucalyptus camaldulensis* Dehnh.	9.247	6.251	1.625	7.876	3.741	13.716
3	*Dalbergia sissoo* Roxb.	3.053	2.055	0.534	2.589	1.23	4.509
4	*Terminalia catappa* L.	1.788	1.099	0.286	1.385	0.658	2.412
5	*Ficus benghalensis* L.	1.2	0.738	0.192	0.93	0.442	1.619
6	*Delonix regia* (Boj. ex Hook.) Raf.	1.008	0.622	0.162	0.784	0.373	1.366
7	*Samanea saman* (Jacq.) Merr.	0.969	0.596	0.155	0.751	0.357	1.308
8	*Senna siamea* (Lam.) Irwin et Barneby	0.927	0.57	0.148	0.719	0.341	1.251
9	*Albizia lebbeck* (L.) Benth.	0.949	0.507	0.132	0.639	0.303	1.112
10	*Murraya koenigii* (L.) Sprenge	0.755	0.465	0.121	0.585	0.278	1.019
11	*Ficus religiosa* L.	0.63	0.388	0.101	0.488	0.232	0.851
12	*Syzygium cumini* (L.) Skeels.	0.566	0.366	0.095	0.462	0.219	0.804
13	*Leucaena leucocephala* (Lam.) de Wit	0.524	0.315	0.082	0.397	0.189	0.691
14	*Phyllanthus emblica* L.	0.503	0.309	0.08	0.389	0.185	0.678

15	*Melia azedarach* L.	0.466	0.298	0.078	0.376	0.179	0.655
16	*Spathodea campanulata* P.Beauv.	0.466	0.298	0.078	0.376	0.178	0.654
17	*Millettia pinnata* (L.) Panigrahi	0.467	0.271	0.071	0.342	0.162	0.596
18	*Pithecellobium dulce* (Roxb.) Benth.	0.381	0.235	0.061	0.296	0.14	0.515
19	*Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.	0.288	0.193	0.05	0.243	0.116	0.424
20	*Dalbergia paniculata* Roxb.	0.288	0.179	0.046	0.225	0.107	0.392
21	*Prosopis juliflora* (Sw.) DC.	0.233	0.163	0.042	0.205	0.098	0.358
22	*Nyctanthes arbor-tristis* L.	0.235	0.144	0.038	0.182	0.086	0.317
23	*Casuarina equisetifolia* L.	0.224	0.137	0.036	0.173	0.082	0.302
24	*Cocos nucifera* L.	0.175	0.119	0.031	0.15	0.071	0.261
25	*Sterculia foetida* L.	0.233	0.119	0.031	0.15	0.071	0.261
26	*Phoenix sylvestris (L.)* Roxb.	0.19	0.117	0.03	0.148	0.07	0.257
27	*Tectona grandis* L.f.	0.175	0.111	0.029	0.14	0.067	0.244
28	*Peltophorum pterocarpum* (DC.) K.Heyne	0.116	0.093	0.024	0.117	0.056	0.204
29	*Jacaranda mimosifolia* D.Don	0.175	0.083	0.021	0.104	0.049	0.181
30	*Thespesia populnea* (L.) Sol. ex Correa	0.133	0.082	0.021	0.103	0.049	0.18
31	*Moringa oleifera* Lam.	0.126	0.078	0.02	0.098	0.047	0.171
32	*Dalbergia latifolia* Roxb.	0.106	0.068	0.018	0.086	0.041	0.15
33	*Mangifera indica* L	0.116	0.065	0.017	0.082	0.039	0.143
34	*Lagerstroemia parviflora* Roxb.	0.1	0.062	0.016	0.078	0.037	0.137
35	*Holoptelea integrifolia* (Roxb.) Planch.	0.116	0.058	0.015	0.073	0.035	0.128
36	*Aegle marmelos* (L.) Correa	0.058	0.051	0.013	0.065	0.031	0.112
37	*Ceiba pentandra* (L.) Gaertn.	0.175	0.049	0.013	0.062	0.029	0.107
38	*Annona reticulata* L.	0.058	0.043	0.011	0.054	0.025	0.093
39	*Albizia amara* (Roxb.) Boiv.	0.058	0.042	0.011	0.053	0.025	0.092
40	*Monoon longifolium* Sonn. B.Xue & R.M.K.Saunders	0.058	0.04	0.01	0.05	0.024	0.087
41	*Ficus racemose* L.	0.061	0.038	0.01	0.048	0.023	0.083
42	*Grevillea robusta* A.Cunn. ex R.Br.	0.058	0.037	0.01	0.047	0.022	0.082
43	*Millingtonia hortensis* L.f.	0.058	0.036	0.009	0.045	0.021	0.079
44	*Tabebuia rosea* DC.	0.058	0.034	0.009	0.043	0.02	0.074
45	*Artocarpus integrifolia* Linn. f.	0.058	0.032	0.008	0.04	0.019	0.07
46	*Alstonia scholaris* (L.) R.Br.	0.081	0.029	0.008	0.037	0.017	0.064
47	*Butea monosperma* (Lam.) Taub.	0.056	0.026	0.007	0.033	0.016	0.057
48	*Lannea coromandelica* (Houtt.) Merr.	0.077	0.026	0.007	0.033	0.016	0.057
49	*Tamarindus indica* L.	0.024	0.018	0.005	0.023	0.011	0.039

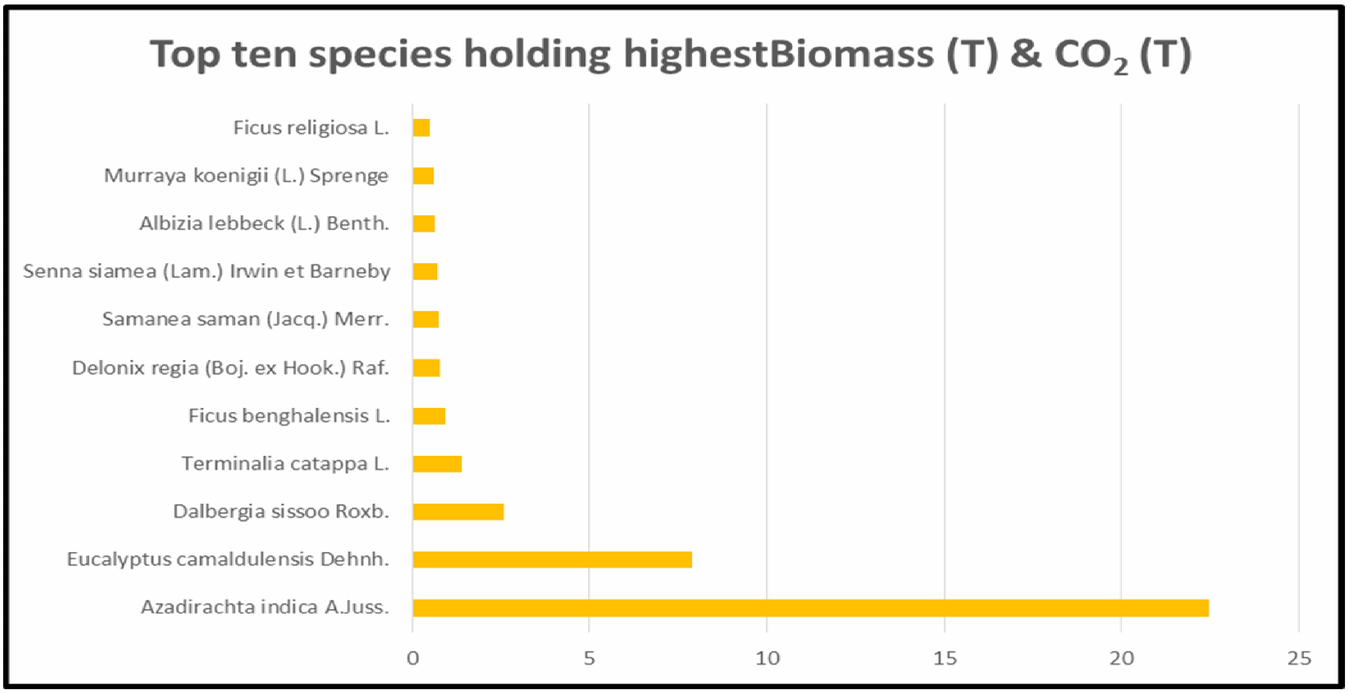


Fig. 1 : Top ten species holding highest biomass (tons) AND CO_2 potential.

CONCLUSION

The Kamareddy municipality area road side standing trees are holding less carbon stocks and CO_2 sequestration potential. In the study area the highest carbon stock and CO_2 were holding the *Azadirachta indica*A.Juss. That means Kamareddy area is suitable for Neem tree. Tree species belongs to the Fabaceae family also abundant, so we recommend the tree species holding highest volume, biomass, carbon and CO_2 sequestration potential they are *Azadirachta indica* A.Juss., *Delonix regia* (Boj. ex Hook.) Raf., *Eucalyptus camaldulensis* Dehnh., *Dalbergia sissoo* Roxb., *Terminalia catappa* L., *Ficus benghalensis* L., *Senna siamea*(Lam.) Irwin et Barneby, *Albezia lebbek* (L.) Benth., *Samanea saman*(Jacq.) Merr., *Peltophorum pterocarpacum* (DC.) K. Heyne*and Ficus religiosa* L.

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