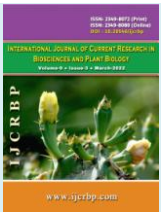
International Journal of Current Research in
Biosciences and Plant Biology

Volume **9** • Number **3** (March-2022) • ISSN: 2349-8080 (Online)

Journal homepage: www.ijcrbp.com



Original Research Article **doi:** https://doi.org/10.20546/ijcrbp.2022.903.002

Carbon stocks of scattered category of trees outside forest in Prakasam District, Andhra Pradesh, India

Dabbara Ramanjaneyulu[1], Ananthaneni Sreenath[1], Miryala Ramesh[2], Boyina Ravi Prasad Rao[1]*

[1]Department of Botany, Biodiversity Conservation Division, Sri Krishnadevaraya University, Ananthapuramu 515 003, Andhra Pradesh, India
[2]Department of Botany, P.S.C. & K.V.S.C. Govt. Degree College, Nandyal-518502, Andhra Pradesh, India

*Corresponding author; e-mail: biodiversityravi@gmail.com

Article Info

Keywords:
Carbon pool
Carbon sequestration
Trees outside forests
Plant biomass

Abstract

In the present study, carbon stocks of scattered structures of Trees outside Forest (TOF) in Prakasam district was estimated through sampling of 116 plots of size, 1 ha. Total number of individuals recorded in the sampled plots are 5014 with a mean stem density, 43.22 in a range of 18-92 per ha plot. The total biomass accounts for 3685.6 Mg. The mean carbon pool density of the sampled plots is 15.09 Mg ha^{-1} ranges between 2.18 and 73.90 Mg ha^{-1} and the total carbon pool for the sampled area is 1750.44 Mg.

• *Received: 10 January 2022* • *Revised: 24 February 2022* • *Accepted: 27 February 2022* • *Published Online: 6 March 2022*

Introduction

Climate change is the most important global environmental challenges affecting all-natural ecosystems consequently leading to species extinctions. Unabated burning of fossil fuels over the past one century has increased the concentration of greenhouse gases especially carbon-di-oxide in the atmosphere consequently resulting in enhanced greenhouse effect, the global warming. (IPCC, 2014). The main natural carbon sinks are plants, the ocean and soil. The uptake of carbon dioxide (CO_2), during photosynthesis is the major pathway by which carbon is removed from the atmosphere and this 'capturing and securing of atmospheric carbon in the form photosynthesis and subsequently to dead organic matter is called as 'carbon sequestration'. Vegetation in the form of forests and trees growing outside forests play a pivotal role in sequestration and trees are the largest component of aboveground biomass in terrestrial ecosystems.

Trees Outside Forests (TOF) are the trees found on neither lands that are not categorized as 'forest' nor 'other wooded land' irrespective of their patch size (FAO, 2010) and include agricultural land (including meadows and pastures), built-on land (including settlements and infrastructure) and barren land (including sand dunes and rocky outcroppings), orchards and plantations. TOF are classified into linear, scattered and block categories. Agricultural fields (field bunds), wastelands, settlements (towns/villages) are categorized under scattered category. Obligations from

international conventions has also made it necessary for conduct TOF assessment particularly the United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention on Biological Diversity (UN-CBD) have urged on keeping up-to- date information on tree resources within and outside forests (Beckschafer et al., 2017). Such assessments especially at district level hold immense significance. The present study is oriented with this background to estimate the carbon stocks of scattered category of TOF of Prakasam district, Andhra Pradesh.

Study area

Prakasam (formerly Ongole) District is located in the South-Central Portion of the Coastal districts of Andhra Pradesh and lie approximately between 15 30' to 16 00' NL and 79 0' to 80 0' EL (Fig. 1). The district comprises three revenue divisions namely Ongole, Kandukur and Markapur and 56 Mandals, besides one corporation and three municipalities. As many as 1002 Inhabited Revenue villages are existing in the district constituted into 1043 Gram Panchayats. In Prakasam district, round the year the climate is characterised by humidity and mean annual rainfall is about 900 mm. The mean maximum temperatures from April to June (35.7 C to 37.5 C) and mean maximum temperature is in the month of January (12.40 C). From July to November, the mean maximum temperature generally varies from 39.5 C to 29.5 C.

The district is drained by the rivers, Gundlakamma, Manneru, Musi and Paleru Rivers besides small rivers like Thammileru, Sagileru and Gudisileru and streams like Ogeru vagu, Nallavagu and Vedimangala vagu.

Total forest area of the district is 18.74% (FSI, 2019). In the coastal areas, there is abundant growth of Casurinas and cashew plantations. The important hill ranges in the district are the Nallamalais and the Veligondas which separate the district from Kurnool and Kadapa Districts.

Materials and methods

Sampling

In the present study, a non-destructive approach of Above-Ground Biomass (AGB) estimation was followed to study the carbon stocks of scattered category. A comprehensive format design of Vegetation Carbon pool Assessment (VCP) of Indian Institute of Remote Sensing (IIRS) (Singh and Dadhwal, 2008) was adopted for ground data collection. Sampling sites were identified and located with the help of Google earth software. The geographical co-ordinates for each plot were identified with the help of Global Positioning System (GPS). Plots were selected based on different density classes. All the tree taxa in the sampled plots were inventoried and identified following regional and local floras. A total of 116 sample plots with 100 × 100 m (i.e., 1 ha) dimensions were laid all over the district (covering 56 mandals) in agriculture fields and settlements including towns and villages.

Biomass estimation

Basal area- of each tree was calculated by using following standard formula:

Basal Area (m^2 ha^{-1}) = πr^2 × area (ha)

Growing stock (volume) estimation

Volume of each tree was estimated using the selected species specific volumetric equation developed and compiled by FSI (1996).

Specific gravity

Specific gravity values of different species were selected from literature (Reyes et al., 1992; FRI, 1996; Mani and Parthasarathy, 2007). For stems with unknown specific gravity, the arithmetic mean of all known species was substituted and used in particular sample plot following Brown et al. (1989).

Estimation of above ground biomass

Bole biomass ≥10 cm diameter

The estimated volume was converted into biomass by multiplying with specific gravity (Rajput et al., 1996; Limaye and Sen, 1956). Biomass of all the trees was summed to obtain biomass for 1 ha.

Biomass (tons) = Volume (m^3) × Specific gravity

Bole biomass <10 cm diameter

Volume equations for trees <10 cm diameter are not available, hence a methodology for trees of this class developed in Vegetation Carbon Pool Assessment

Project (Singh and Dadhwal, 2008; Dadhwal et al., 2009; Patil et al., 2011) by relating basal area and biomass has been followed. The model developed was Y=3.6808*X+0.264 and used for assessing the AGB of trees <10cm diameter. Where, Y=Biomass, X= Basal of trees (>10cm diameter and <10cm diameter), 3.6808 and 0.264 = Coefficients.

Estimation of total above ground biomass, below ground biomass and total biomass

The biomass of trees having >10cm diameter and <10cm diameter in each plot were added together to get biomass of one ha plot. In the present study, 26% of the total agb was considered as root biomass following Houghton et al. (2001) and Ramankutty et al. (2007). Total biomass for each one ha plot was obtained by the addition of total agb and bgb. Further the mean was calculated and extrapolated for the whole study area.

Estimation of carbon stocks

Extrapolated biomass was estimated by multiplying the tree covered area with mean biomass of sampled plots of respective category.

Extrapolated biomass (tons) = Tree covered area x mean biomass of sampled plots

Carbon stocks was estimated by multiplying the extrapolated biomass with IPCC default carbon fraction of each category and finally, all TOF categories are added to get the carbon stocks of TOF of the Prakasam district. Carbon stock (tons) = Extrapolated biomass (tons) × IPCC default carbon fraction (0.475). To determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.6663.

(http://www.ncsec.org/cadre2/team18_2/students/helpCalcCO2.htm).

Results and discussion

In scattered category, 57 species of angiosperms belonging to 53 genera and 27 families. Total number of individuals recorded in the sampled plots are 5014 with a mean stem density, 43.22 in a range of 18-92 per ha plot (Table 1).

Basal area and volume

The mean basal area is 5.08 m^2 ha^{-1} varied between 0.6-15.22 m^2 ha^{-1} Trees having >10 cm diameter shared 99.72% with mean basal area 5.08 m^2 ha^{-1} and remaining 0.28% shared by the trees with <10 cm diameter. The dominant tree species share is 66.45% of the total basal area. The mean volume of trees having >10cm diameter is 37.28 m^3 ha^{-1}, ranging between 3.55-123.47 m^3 ha^{-1} in the plots sampled (Table 2). The total wood volume of sampled plots is 4324.48 m^3.

Above ground biomass

Bole biomass > 10 cm diameter

The trees with > 10 cm diameter are major contributors of total above ground biomass with 99.95% share. The mean is 25.19 Mg ha^{-1} and ranges between 3.55 – 123.47 Mg ha^{-1} (Table 2) in sampled plots. Correlation of basal area and biomass of trees with > 10 cm diameter revealed a determination coefficient of R^2 is 0.765 for 116 plots (Fig. 1).

Bole biomass < 10 cm diameter

The biomass for trees having <10 cm diameter was calculated by using regression equation and coefficients developed between basal area and biomass of trees >10 cm diameter. The mean biomass of these trees is 0.018 Mg ha^{-1} ranges between 0.04 – 0.23 Mg ha^{-1} in the sampled plots inventoried, which accounts for 0.05% of the total above ground biomass (Table 2).

Total above-ground biomass

It is the sum of biomass of trees with >10 cm diameter and the biomass of trees with <10 cm diameter in each plot. The mean total above- ground biomass (TAGB) is 25.21 Mg ha^{-1} ranges between 23.64 and 123.47 Mg ha^{-1} in the sampled plots. The TAGB of sampled area is 2925.1 Mg (Table 2).

Below ground biomass

Below ground biomass was calculated by multiplying the total above ground biomass with 0.26. The mean of below ground biomass is 6.55 Mg ha^{-1} varied across the sampled plots between 0.95- 32.10 Mg ha^{-1} (Table 2) and accounts for 760.5 Mg.

Table 1. List of tree species encountered in the present study.

S. No.	Name of the Species	Family	No. of tree individuals in all inventoried plots
1	*Acacia auriculiformis* Benth	Fabaceae - Mimosoideae	1
2	*Acacia nilotica* (L.) Deliles	Fabaceae - Mimosoideae	47
3	*Aegle marmelos* (L.) Correa	Rutaceae	3
4	*Ailanthus excelsa* Roxb.	Simaroubaceae	1
5	*Albizia lebbeck* (L.) Benth	Fabaceae - Mimosoideae	164
6	*Albizia amara* (Roxb.) B.Bovin	Fabaceae - Mimosoideae	2
7	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	67
8	*Annona squamosa* L.	Annonaceae	3
9	*Azadirachta indica* A.Juss.	Meliaceae	1562
10	*Bambusa arundinacia* (L.) Voss.	Poaceae	1
11	*Borassus flabellifer* L.	Arecaceae	220
12	*Carica papaya* L.	Caricaceae	8
13	*Casuarina equisitifolia* L.	Casuarinaceae	14
14	*Ceiba pentandra* (L.) Gaertn	Malvaceae	2
15	*Citrus aurantifolia* (Christm) Swingle	Rutaceae	1
16	*Cocos nucifera* L.	Arecaceae	504
17	*Cordia dichotoma* G.Forst	Boraginaceae	6
18	*Dalbergia sissoo* DC.	Fabaceae - Faboideae	7
19	*Delonix regia* (Hook.) Raf.	Fabaceae - Caesalpinioideae	85
20	*Dendrocalamus strictus* (Roxb.) Nees.	Poaceae	7
21	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	135
22	*Ficus benghalensis* L.	Moraceae	106
23	*Ficus racemosa* L.	Moraceae	5
24	*Ficus religiosa* L.	Moraceae	105
25	*Gliricidia sepium* (Jacq.) Walp.	Fabaceae - Faboideae	3
26	*Hardwickia binata* Roxb.	Fabaceae - Caesalpinioideae	1
27	*Holoptelea integrifolia* Planch.	Ulmaceae	1
28	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	1
29	*Lawsonia inermis* L.	Lythraceae	4
30	*Leucaena leucocephala* (Lam.) de Wit	Fabaceae - Mimosoideae	241
31	*Limonia acidissima* Groff	Rutaceae	1
32	*Mangifera indica* L.	Anacardiaceae	5
33	*Manilkara zapota* (l.) P.Royen	Sapotaceae	1
34	*Melia azadirach* L.	Meliaceae	9
35	*Millingtonia hortensis* L.f.	Bignoniaceae	10
36	*Morinda pubescens* Sm.	Rubiaceae	4
37	*Moringa oleifera* Lam.	Moringaceae	58
38	*Murraya koenigii* (L.) Spreng	Rutaceae	1
39	*Nyctanthes arbor-tristis* L.	Oleaceae	1
40	*Peltophorum pterocarpum* (DC.) K.Heyne	Fabaceae - Caesalpinioideae	131
41	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	7
42	*Phyllanthus emblica* L.	Euphorbiaceae	5
43	*Pithecellobium dulce* (Roxb.) Benth	Fabaceae - Mimosoideae	26
44	*Plumeria alba* L.	Apocynaceae	3
45	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	57
46	*Pongamia pinnata* (L.) Pierre	Fabaceae - Faboideae	428
47	*Prosopis cineraria* (L.) Druce	Fabaceae - Mimosoideae	7
48	*Psidium guavaja* L.	Myrtaceae	2
49	*Punica granatum* L.	Lythraceae	2
50	*Sapindus emarginatus* Vahl, Symb.	Sapindaceae	3
51	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Fabaceae - Caesalpinioideae	46
52	*Syzygium cumini* (L.) Skeels	Myrtaceae	24
53	*Tamarindus indica* L.	Fabaceae - Caesalpinioideae	373
54	*Tectona grandis* L.f.	Verbenaceae	420
55	*Teminalia catappa* L.	Combretaceae	9
56	*Thespesia populnea* (L.) Sol. ex Correa	Malvaceae	64
57	*Ziziphus jujuba* Mill.	Rhamnaceae	10

Table 2. Category-wise tree density, basal area, volume, biomass and carbon stock.

Category	Sub category	TNI ha^{-1}	Basal area (m^2 ha^{-1})	Volume (m^3 ha^{-1})	Above ground biomass (t ha^{-1})	Below ground biomass (t ha^{-1})	Total tree biomass (t ha^{-1})	Carbon (t ha^{-1})
Settlements	Village	47.81	6.42	46.80	46.75	12.15	39.77	18.89
	Town	62.15	8.09	64.10	64.10	16.67	54.08	25.69
Agriculture	Field Bund	35.83	3.46	24.75	24.72	6.43	21.21	10.078
Mean		43.22	5.08	37.28	25.21	6.55	31.77	15.09

Table 3. Biomass and carbon stock of TOF (Scattered) of Prakasam district.

Category	Sub category	Estimated TOF area (ha^{-1})	Sampled area	Mean biomass	Extrapolated biomass (tons)	Carbon stock
Settlements	Village	993.55	43	703.143	39706.58	18860.62
	Town	1085.22	13	1710.274	58770.21	27915.84
Agriculture	Field bund	31.5	60	1273.066	10051.04	4774.24
Sub total		2110.27	116	-	-	51550.71 (0.0515 Mt)

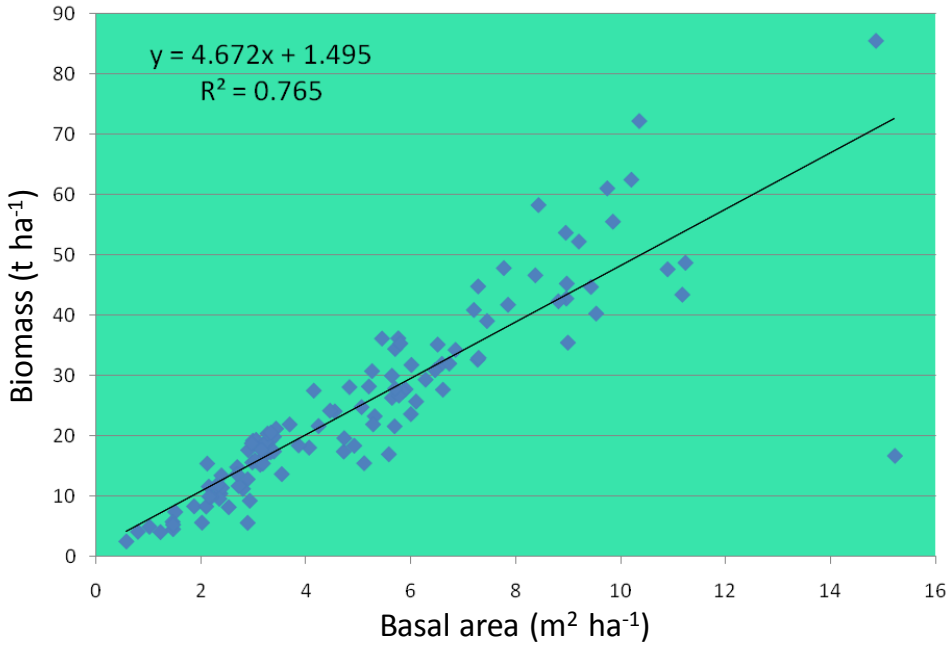


Fig. 1: Correlation between basal area (m^2 ha^{-1}) and biomass (t ha^{-1}) of ≥10 cm diameter of trees sampled in scattered plots.

Total tree biomass

The total tree biomass density is 31.77 Mg ha^{-1} varies between 4.59 – 155.57 Mg ha^{-1} in the plots sampled (Table 2) and accounts for 3685.6 Mg.

Carbon pool

The mean carbon pool density of the sampled plots is 15.09 Mg ha^{-1} ranges between 2.18 and 73.90 Mg ha^{-1} (Table 3). Total carbon pool for the sampled area (15.09 × 116 ha) = 1750.44 Mg.

In Andhra Pradesh, till date only two districts (Kurnool and Ananthapuramu) TOF biomass was worked out. When compared with Kurnool and Ananthapuramu district TOF (Ramesh, 2016; Kavitha, 2017), the scattered blocks represent is about 30% less in terms of area and number of individuals in Prakasam district. However, the mean carbon pool density is 15.09 t/ha for

Prakasam district is higher than Ananthapuramu district (9.56 t/ha), but lesser than Kurnool district, 28.0 t/ha.

Acknowledgments

Authors are grateful to university administration for providing research facilities.

Conflict of interest statement

Authors declare that there is no conflict of interest in this work.

References

Beckschafer P., Schnell, S., Kleinn C., 2017. Monitoring and Assessment of Trees Outside Forests (TOF). In: Dagar J., Tewari V. (eds), Agroforestry. Springer, Singapore. https://doi.org/ 10.1007/978-981-10-7650-3_5.

Brown, S., Gillespie, A. J. R., Lugo, A. E., 1989. Biomass estimation methods for tropical forests with applications to forest inventory data. Forest Sci. 35(4), 881-902.

Dadhwal, V. K., Singh, S., Patil, P., 2009. Assessment of phytomass carbon pools in forest ecosystems in India. NNRMS Bulletin: 41-57.

FAO., 2010. Global Forest Resources Assessment 2010: Main Report. FAO Forestry Paper. Rome. 163.

Forest Survey of India., 2019. India State of Forest Report, Ministry of environment and climate change, Dehra Dun, ed 16, 1-24. Available in internet. https://fsi.nic.in/isfr19/Vol1/chapter2.pdf.

FRI., 1996. Indian Woods. Volume I-VI. Forest Research Institute, Ministry of Environment and Forests, Dehra Dun, India.

FSI., 1996. Volume Equations for Forest of India, Nepal and Bhutan. Forest Survey of India, Ministry of Environment and Forests, Dehra Dun, India.

Houghton, R. A., Hackler, J. L., 2001. Carbon Flux to the Atmosphere from Land-Use Changes: 1850 to 1990. ORNL/CDIAC-131, NDP- 050/R1. Carbon Dioxide Information Analysis Center, US Department of Energy, Oak Ridge National Laboratory, Oak Ridge, TN, USA.

IPCC., 2014. Climate Change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151.

Kavitha, G., Salamma, S., Ramesh, M., Ravi Prasad Rao, B., 2017. Carbon stocks of trees outside forests in Anantapuramu District, Andhra Pradesh. Plant Sci. Res. 39(1&2), 24-34.

Limaye, V.D., Sen, B.R., 1956. Indian Forest Records: Timber Mechanics, Manager of publications, Delhi.

Mani, S., Parthasarathy, N., 2007. Above-ground biomass estimation in ten tropical dry evergreen forest sites of peninsular India. Biomass and Bioenergy 31, 284-290.

Patil, P., Singh, S., Dadhwal, V. K., 2011. Above Ground Forest Phytomass Assessment in Southern Gujarat. J. Indian Soc. Rem. Sens. 40(1), 37-46. DOI 10.1007/s12524-011-0121-3.

Rajput, S. S., Sulkha, N. K. Gupta, V. K., Jain, J. D., 1996. Timber Mechanics: Strength Classification and Grading of Timber. ICFRE Publication-38, ICFRE, Dehra Dun, India. 103.

Ramankutty, N., Gibbs, H. K., Achard, F., DeFries, R., Foley J. A., Houghton R. A., 2007. Challenges to estimating carbon emissions from tropical deforestation. Global Change Biol. 13, 51-66. https://doi.org/10.1111/j.1365-2486.2006.01272.x

Ramesh, M., Ravi Prasad Rao, B., 2016. Carbon stocks of trees outside forests in Kurnool district, Andhra Pradesh, India. Indian J. For. 39(3), 203-210.

Reyes, G., Brown, S., Chapman, J., Lugo, A. E., 1992. Wood densities of tropical tree species. (88) U.S. Department of Agriculture, Forest Service, New Orleans, LA.

Singh, S., Dadhwal, V. K., 2008. Vegetation Carbon Pool Assessment in India (Field manual). Department of Space, Government of India, Dehra Dun, India.

How to cite this article:
Ramanjaneyulu, D., Sreenath, A., Ramesh, M., Ravi Prasad Rao, B., 2022. Carbon stocks of scattered category of trees outside forest in Prakasam District, Andhra Pradesh, India. Int. J. Curr. Res. Biosci. Plant Biol., 9(3): 10-15.
doi: https://doi.org/10.20546/ijcrbp.2022.903.002