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STUDIES ON TREE BIOMASS FOR ASSESSING CARBON DENSITY IN TROPICAL FOREST ECOSYSTEM OF CENTRAL INDIA

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ABSTRACT: The studies on tree biomass for assessing carbon density in tropical forest ecosystem of central India was undertaken during 2009-11 in forest area of eight districts [Jabalpur, Seoni, Balaghat, Narsinghpur, Mandla, Dindori, Shahdol and Umaria] at 30 adopted representative sites at varying latitudes and longitudes. The annual rainfall of their study area was 1000-1600 mm. The soils of the study sites were alluvial, light to medium black as well as red and yellow with pH value ranging from 5.5 to 80. The study was confined in three vegetation type *viz*., teak mixed, salmixed and mixed forest. In the study new approach was adopted by using ground data as well remote sensing data to get an accurate estimate of vegetation carbon pool in the region. Among the 30 selected site ID, *Tectona grandis* was dominated at 10 side. The basal area and volume of tree species in forest study sites ranged between 0.8 to 169.68 m^2/ha and 0.11 to 2, 31299.82 m^3/ha. The maximum tree biomass/ha recorded for *Shorea roubsta* (203.54 t/ha). The carbon density was ranged between 3.0 to 33.21 t/ha in mixed forest, 5.17 to 67.78 t/ha in teak forest and 36.10 to 102.39 t/ha in sal forest. From the investigation it can be stated that national coverage for tropical forest will improve, if successive survey of forest carbon sequestration are conducted in future to assess carbon stocks for mitigating the ill effect of climate change.

INTRODUCTION: The concentration of atmospheric CO_2 has increased from 315 ppm to 387.35 ppm in last 51 years [1], which causes dramatic effect on climate change. As a result of which food productivity decline with adverse effect on biodiversity at every organizational levels.

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Among all the terrestrial ecosystems, forest contain the largest store of carbon [2, 3]. The main carbon pools in forest are plant biomass (above and below ground), coarse woody debris, litter and soil [4, 5]. Variability in climatic conditions due to increase concentration in CO_2 bring about drastic change in the forest types of the Madhya Pradesh state with change in biodiversity at all the organizational levels. Understanding of forest structure is a pre-requisite to described various ecological process and dynamics of forest [6]. Species diversity has functional consequences because the number and kinds of species present in any area determine the organizational traits, which influences the

resilience and resistance of ecosystem to environmental change [7]. Keeping in view of the above facts, the present investigation entitled "Studies on tree biomass for assessing carbon density in tropical forest ecosystem of central India" was under taken.

MATERIALS AND METHOD: The present investigation was conducted during 2009-2011 in forest area of eight districts (Jabalpur, Seoni, Balaghat, Narsinghpur, Mandla, Dindori, Shahadol and Umaria) of south eastern parts of Madhya Pradesh at different 30 adopted representative sites at different latitudes and longitudes. However, the study lies between 21° 38' to 230 33' N latitude and 79° 17' to 810 46' E longitude with altitude ranging from 316.15 to 1063.2 m above mean sea level. Annual rainfall of the study area was 1000-1600 mm, with minimum temperature ranging from 7.5 °C to 8.0 °C and maximum temperature from 35.5 °C to 42.5 °C. Soils of the study sites were alluvial, light to medium black as well as red and yellow with pH range from 5.5 to 8.0. Present study covered with three vegetation type namely teak mixed forest, salmixed forest and mixed forest distributed in eight districts.

In the present study a new approach was adopted which used ground data as well as remote sensing data to get an accurate estimate of vegetation carbon pool in the region. An attempt was made to select sample plots in all forest types and in all density classes. Nested two stage sampling method was adopted to sample trees, herb and shrubs. One super plot of 250 m x 250 m size which is equivalent to MODIS Pixel size was laid out in each super plot. Thus, the total sample size consisted of 30 super plots and 120 sample plots within super plots.

Height and diameter at breast height (DBH) of all trees of ≥18 cm DBH in 4 sample plots within each super plot were measured using Blume Leiss Hypsometer and digital tree caliper, respectively. The data thus collected were used for volume estimation using local volume equation published by Forest Survey of India [8]. The standard multiple factor of 0.5 was used for conversion of biomass to total carbon as reported by Water Worth, 2001.

RESULTS AND DISCUSSION:

Number of tree species and their dominancy: Data presented in **Table 1** indicated that the total number of tree species recorded in range between 4 to 38 in forest study sites of tropical forest ecosystem. Maximum trees species investigated in the site IDJBP-3 of Jabalpur district where *Anogeissus latifolia* was dominated and minimum in the site IDUMA-9 of Umaria district, where dominant species was *Tectona grandis*. Among the 30 selected site ID, *Tectona grandis* was dominated at 10 site ID followed by *Shorea robusta* at 4 site ID (SDL-16, DIN-1, SDL-1 and DIN-7).

Total basal area and volume of tree species: Basal area and volume of the tree species in forest study sites ranged between 0.8 to 169.68 m^2/ha and 0.11 to 2, 31, 299.82 m^3/ha, respectively. Maximum basal area of tree species was recorded in the study site ID SDL-1 of Shahdol district and minimum in five study site. These are JBP-8, JBP-9, BAL-9, DIN-1 and DIN-7. Among the 30 study site, DIN-1 of Dindori district where dominant species was *Shorea robusta* recorded highest tree volume where as lowest was found in study site BAL-11 of Balaghat district.

Total biomass of the tree species: From the investigation study, it had found that maximum biomass of the tree species was recorded in the study site ID DIN-1 (203.54 t/ha) followed by DIN-7 (152.75 t/ha) of the Dindori district and SDL-1 of Shahdol district, where *Shorea robusta* was dominant tree species at all the three study sites. However, study site ID UMA-8 of Umaria district recorded lowest tree biomass (0.00007 t/ha) where dominant tree species was *Madhuca indica*. Thus total tree biomass in the 30 study sites ranged between 0.00007 to 203.54 t/ha. The maximum tree biomass per hectare recorded for *Shorea robusta* (203.54 t/ha) followed by *Tectona grandis* (41.15 t/ha) in MAN-12 study sites of Mandla district and *Terminalia tomentosa* (22.31 t/ha) in BAL-11 of Balaghat district.

Carbon and Crown density: Investigation result revealed that the carbon density ranged between 3.03 to 102.39 t/ha in study area of different vegetation type.

The maximum carbon density (102 t/ha) recorded in sal forest in site ID DIN-1 of Dindori district where *Shorea robusta* was dominant tree species. The carbon density was found in the range between 3.0 to 33.21 t/ha in mixed forest, 5.17 to 67.78 t/ha in teak forest and 36.10 to 102.39 t/ha in sal forest. Thus, from the present investigation it was clearly showed that the carbon density range was distributed in the order of sal forest ≥ teak forest ≥ mixed forest. Among 320 study sites, maximum crown density (93.75%) of the tree species was found in site ID DIN-1 of Dindori district followed by UMA-2 of Umaria district (87.54%) where as minimum crown density (11.80%) was recorded in site ID JBP-9 of Jabalpur district. Thus, from the above result, it has been found that *Shorea robusta* species of sal forest ecosystem contributed highest crown density.

TABLE 1: TREE BIOMASS STUDIES IN TROPICAL FOREST ECOSYSTEM OF CENTRAL INDIA

Site	Selected site ID	Total number of tree species	Name of dominant tree species	Total basal area (m^2/ha) of tree species		Total tree volume (m^3/ha)		Total biomass of tree species (t/ha)		Carbon density (t/ha) of different species	Crown density (%)
				Min.	Max.	Min.	Max.	Min.	Max.		
1	JBP-2	15	*Ougeinia oojeinesis*	0.14	7.08	0.63	1298.94	0.01	1.09	27.25	80
2	JBP-3	38	*Anogeissus latifolia*	0.11	27.18	0.38	3444.70	0.01	2.68	5.79	80
3	JBP-4	26	*Adina cordifolia*	0.35	2.33	29.97	5990.50	0.01	22.29	33.65	77.9
4	JBP-5	24	*Xylia xylocarpas*	0.10	3.52	0.24	200.64	0.0001	0.12	12.58	81.25
5	JBP-6	10	*Tectona grandis*	0.09	82.96	0.31	42911.89	0.0002	25.90	23.10	62.5
6	JBP-7	17	*Butea monosperma*	0.10	26.56	0.40	9045.27	0.0010	5.06	6.31	50.0
7	JBP-8	11	*Tectonia grandis*	0.08	38.72	0.24	7696.32	0.03	4.65	6.8	36.25
8	JBP-9	10	*Butea monosperma*	0.08	39.80	1.51	679.40	0.0001	0.38	4.03	11.86
9	BAL-9	34	*Lannea coromandelia*	0.08	20.27	0.22	3151.31	0.0001	1.70	33.21	80
10	BAL-10	24	*Lagerstroemia purviflora*	0.31	15.16	5.30	5487.67	0.0040	3.40	7.94	70
11	BAL-11	30	*Terminolia tomentosa*	0.01	102.67	0.11	29363.20	0.01	22.31	17.53	62.5
12	BAL-12	13	*Tectona grandis*	0.31	68.03	2.16	37868.90	0.0017	22.87	67.68	70
13	BAL-14	15	*Cleistanthus collinus*	0.65	20.20	7.73	9696.54	0.0062	8.53	9.31	55
14	BAL-15	14	*Lannea coromandelica*	0.13	31.70	0.49	1869.66	0.0003	0.91	4.52	35
15	BAL-16	20	*Cleistanthus collinus*	0.13	23.46	0.54	6647.62	0.0003	5.85	6.50	50
16	SDL-16	14	*Shorea robuta*	0.19	75.52	0.95	32207.83	0.0005	64.42	36.10	55
17	UMA-2	23	*Terminalia tomentosa*	0.18	20.10	0.90	3863.25	0.0007	2.93	14.81	87.5
18	UMA-5	16	*Tectona grandis*	0.28	33.67	5.81	64909.02	0.0029	39.20	23.04	82.5
19	SEN-8	17	*Emblika officinalis*	0.38	31.53	2.85	6847.12	0.0018	5.48	8.43	57.5
20	MAN-12	19	*Tectona grandis*	0.14	91.75	0.87	68124.37	0.00059	41.15	23.32	47.5
21	DIN-1	18	*Shorea robusta*	0.08	156.34	0.28	231299.82	0.0002	203.54	102.39	93.75
22	SDL-1	5	*Shorea robusta*	3.30	169.68	23.10	97826.17	0.01	86.09	40.73	85

23	MAN-13	17	*Tectona grandis*	0.12	62.29	0.39	47315.48	0.0003	28.58	17.76	45
24	MAN-15	6	*Tectona grandis*	0.13	26.88	0.49	5969.60	0.0003	3.60	5.17	27.5
25	SEN-2	24	*Terminalia tomentosa*	0.37	43.96	6.06	8848.14	0.0032	6.72	22.17	77.5
26	DIN-7	7	*Shorea robusta*	0.08	79.48	0.28	173584.32	0.0002	152.75	73.82	80
27	UMA-8	5	*Madhuca indica*	0.66	13.49	4.95	1193.86	0.00007	0.88	3.03	26.25
28	NSP-6	29	*Tectona grandis*	0.16	23.67	0.32	2007.03	0.0002	1.21	14.89	62.50
29	UMA-9	4	*Tectona grandis*	3.29	40.34	24.67	31496.45	0.02	19.02	12.52	52.5
30	NSP-11	10	*Tectona grandis*	0.57	61.87	3.24	42458.29	0.0017	25.64	20.63	45

CONCLUSION: From the present investigation, it was concluded that national coverage for tropical forest will improve, if successive survey of forest carbon sequestration are conducted in future to assess carbon stocks for mitigating the ill effect of climate change.

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