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Assessment of Tree Species Diversity, Biomass, C and N Storage in Two Sites of Dry Tropical Forest of Chhattisgarh, India

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Abstract

The present study was conducted in Katghora and Pali Sites in the dry tropical forest of Chhattisgarh, India. The experiment was conducted on Katghora Forest division in July 2018 to June 2019. The stratified random sampling technique was used for quantifying the tree layer vegetation. The results revealed that density and basal area varied from 278 to 333 stems ha^{-1} and 16.18 to 19.38 m^2 ha^{-1} and was more in Katghora site as compare to Pali site. The concentration of dominance, Shannon index, equitability, species richness and beta diversity ranged from 0.33–0.60, 1.43–2.31, 0.57–0.88, 3.95–4.39 and 2.94–4.17, respectively in Katghora and Pali sites. The stand biomass of tree layer vegetation ranged from 214.65–246.06 t ha^{-1} in which above ground tree component (AGTC) ranged from 149.66–171.25 t ha^{-1} and below ground component (BGTC) ranged from 64.99-74.83 t ha^{-1}. The similar pattern in total C storage of tree layer component ranged from 90.51–103.64 t ha^{-1} in which AGTC of C storage ranged from 67.29-76.91 t ha^{-1} and BGTC of C storage ranged from 23.22–26.74 t ha^{-1}. The total N storage of tree layer vegetation ranged from 1277.70–1451.93 kg ha^{-1} in which AGTC of N storage ranged from 913.78–1032.90 kg ha^{-1} and BGTC of N storage ranged from 363.92–419.03 kg ha^{-1}. The density, basal area, biomass, C storage and N storage was more in Katghora site as compare to Pali site due to more disturbance such as cattle grazing, illegal felling, collection of fuel wood, fodder and NTFPs etc.

Keywords: Density, biomass, carbon component, vegetation, basal area

1. Introduction

Global warming and climate change are perhaps the most pressing global issues in the present scenario. The carbon dioxide (CO_2) concentration in the atmosphere has lifted from 277 ppm in 1750 (Joo and Spahni, 2008) to 403.64 ppm on November 2016 (Anonymous, 2016), leading to a subsequent escalation of global temperature. Due to anthropogenic activities such as burning of fossil fuels, deforestation, urbanization, etc., earth's temperature has significantly risen over the last 50 years that pose great challenges for carbon mitigation strategies, besides socioeconomic, biological problems(Sicard and Dalstein-Richier, 2015), and origin of new catastrophic diseases(Anonymous, 2015). IPCC in its 4th and 5th assessment reports recommended the member nations to take adequate steps to reduce global warming, which causes severe ecological, social, and economic consequences (Sharma et al., 2011; Anonymous, 2014). All of the recent years, the industrialized countries have maybe taken initiatives to plan for carbon mitigation, management and policy initiatives. One of the policy measures was Kyoto Protocol which was ratified by most of the industrialized countries to reduce their carbon outputs, carbon taxes, and subsidy systems in support of carbon mitigation targets (Cao et al., 2010).

Deforestation and degradation of tropical forests play a vital role in enhancing atmospheric carbon dioxide (Singh et al., 2020). Continuation of such malicious practices in the forest vicinity causes land use change and disturbs the carbon dynamics (Lai et al., 2016). Notably, major drivers of the land use change (LUC) are conversion of forest lands to commercial agriculture (55%), pastures (20%), logging, infrastructure and mining (12% each) (Hosonuma et al., 2012; Curtis et al., 2018). In the developing countries like India and China, degradation and deforestation of urban forest, agriculture, transport, industries, and household sectors accelerate the LUC and disturb the carbon balance (Dooley et al., 2022). Tropical forests are a large reservoir of biodiversity and source of livelihoods, which store ~68% of global forest C stocks, of which 45–55% are captured as vegetation biomass and remaining 10–30% are in the soil thus play a key role in the terrestrial C cycle (Pan et al., 2011; Anonymous, 2019).

The global carbon cycle includes forest vegetation as a substantial contributor to the C pool and nutrient stocks. Nowadays, there has been increasing interest in quantification of forest biomass and its potential C fixation (Yadav et al., 2017). C storage and sequestration were delicate concerns that were prone to global change because to anthropogenic changes in forest cover. The C is the major component of all cellular life forms; they utilize C and store it in different plant parts (Kiran and Shah, 2011). The C in an ecosystem flows and sinks in the form of biomass by photosynthesis and the electron transport chain in plant system (Atkin et al., 2012). There are several pools and fluxes in the forest ecosystem that are associated with the C cycle, and each pool has a quantity called C stock. Finding sources and sinks of carbon has gained attention due to the enormous increase in GHG (Greenhouse gas) emissions in the environment. The present study provides valuable information about assessment of tree species structure, diversity, biomass, C and N storage in Katghora and Pali sites of dry tropical forest of Chhattisgarh, India. This research revealed that disturbances like as deforestation, fuel wood harvesting, and other biotic pressures are to blame for the decline in the forest. These disturbances also lead to a decrease in carbon sequestration, loss of biodiversity, and climate change.

2. Materials and Methods

2.1. *Study area*

The present study was conducted in Katghora and Pali sites of Korba forest division in Chhattisgarh, India during July 2018 to June 2019. The study area was located in 22°22’30” to 22°21’0” N Latitude and 82°23’30” to 82°18’30” E Longitude (Figure 1). The climate of Chhattisgarh is tropical. The forest type of area is tropical dry deciduous forest. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer temperatures in study area can reach 45°C and average temperature was recorded 26.2°C. The study area receives an average of 1,292 mm of rainfall. Winter is from November to January. Winters are pleasant with low temperatures and less humidity. About 80% of the annual rainfall in the study area is received during June to August.

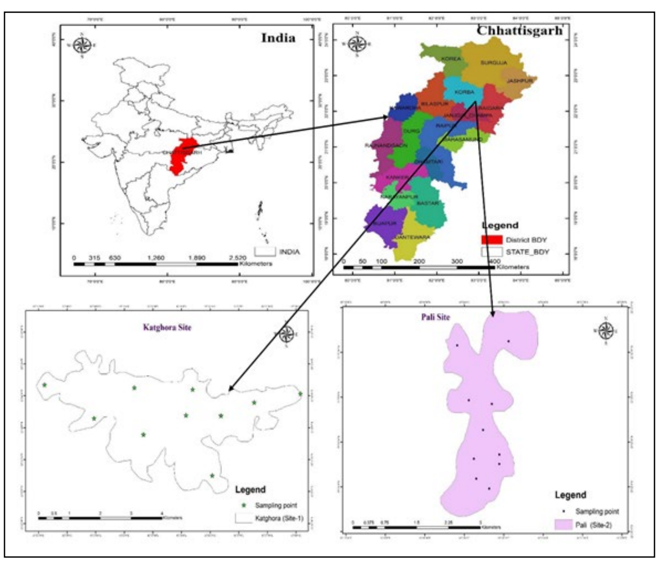

Figure 1: Location map of the study area

2.2. *Methods of data collection and analysis*

The forest vegetation was analysed using 10 quadrats (each 20×20 m^2 in size) within the representative one-hectare plot on each site. Girth at breast height (GBH) of trees was measured at 1.37 m on trunk of trees. The vegetation data was quantitatively analyzed for frequency, density and abundance (Curtis and McIntosh, 1950). An importance value was calculated as the sum total of relative frequency, relative density, and relative dominance (Phillips, 1959).

Species diversity indices for tree layers were determined, using basal cover values from Shannon-Wiener information function (Shannon and Weaner, 1963). Concentration of dominance was measured by Simpson’s index (Simpson, 1949), species richness following Margalef (Margalef, 1958), equitability following Pielou (Pielou, 1966), and beta diversity following Whittaker (Whittaker, 1972).

2.3. *Estimation of biomass*

The non-harvesting procedures for woody vegetation were employed for measuring biomass of different layers of vegetation. Allometric regression equations available for dry tropical species were used for the estimation of tree biomass(Singh and Mishra, 1979). Girth/diameter at breast height (GBH/DBH) of trees measured in quadrat was used as independent variable and component biomass as dependent variable. The biomass of stem, branch, foliage and root components was individually estimated and extrapolated to t ha^{-1} further component biomass summed together to obtain the standing biomass of trees. Total standing biomass of a vegetation type was calculated as the product of mean biomass and total area covered under that particular vegetation type.

2.4. *Estimation of C storage*

Carbon concentration values of different components viz.bole (43.50%), branch (45.67%), leaf (46.67%), and root (35.73%) were calculated (Singh, 2010). The C concentration estimated from similar dry tropical vegetation of Chhattisgarh employed for assessing C stocks. The standing C stock was calculated as a product of mean C concentration of component with its respective biomass.

2.5. *Estimation of N storage*

The mean nitrogen concentrations measured and by multiplying dry weights of components with their nitrogen concentrations, viz. bole (0.38%), branch (0.69%), leaf (1.46%) and root (0.56%), the storage of nitrogen were calculated

(Singh, 2010). By summing the quantities for nitrogen storage in different components, the overall nitrogen storage in the vegetation was estimated

3. Results and Discussion

3.1. Phytosociological analysis

The total number of tree species varied from 12–14 in Katghora and Pali sites. On the basis of IVI value, *Shorea robusta* was dominant species in both the sites and *Terminalia tomentosa* was codominant species. As per the frequency class distribution in Katghora site, the highest frequency was observed in *Shorea robusta* (100%) followed by *Terminalia tomentosa* (70%) and *Buchanania lanzan* (60%). In Pali site, highest frequency was recorded in *Shorea robusta* (100%) followed by *Terminalia tomentosa* (60%) and *Diospyros melanoxylon* (40%). The total density of Katghora and Pali sites was recorded in 333 stems ha^{-1} and 278 stems ha^{-1}, respectively. The total basal area was recorded 19.38 m^2 ha^{-1} and 16.18 m^2 ha^{-1} in Katghora and Pali sites, respectively (Table 1). The highest density and basal area was observed in Katghora site as compared to Pali site. It is might be due to less disturbance in Katghora site as compare to Pali site. In Pali site, highest anthropogenic disturbance viz; fuel wood collection, extraction of timber, cattle grazing, collections of non-wood forest products, fodder etc. were observed.

Tropical forests are structurally most complex, diverse and carbon-rich ecosystems and can vary dramatically even at very small spatial scales (Sulliven et al., 2017). Understanding of spatial heterogeneity in forest physiognomy is critical to address how these forests could be managed to mitigate global environmental change, as well as developing conservation strategies to improve carbon-biodiversity and co-benefits.

Table 1: Comparison of species structure in Katghora and Pali sites of dry tropical forest of Chhattisgarh, India

Species	Family	Sites							
		Site-I Katghora				Site-II Pali			
		F	D	BA	IVI	F	D	BA	IVI
Shorea robusta	Dipterocarpaceae	100	122.50	10.51	110.70	100	160.00	12.37	161.90
Madhuca longifolia	Sapotaceae	50	32.50	1.78	28.79	30	15.00	0.49	16.76
Buchanania lanzan	Anacardiaceae	60	27.50	0.37	21.92	20	7.50	0.12	8.99
Semecarpus anacardium	Anacardiaceae	20	7.50	0.08	6.61	30	10.00	0.28	13.65
Terminalia tomentosa	Combretaceae	70	50.00	2.95	44.01	60	40.00	1.36	39.49
Aegle marmelos	Rutaceae	20	12.50	0.39	9.71				
Anogeissus latifolia	Combretaceae	30	10.00	0.25	10.18	20	7.50	0.37	10.57
Lannea coromandelica	Anacardiaceae	30	17.50	0.65	14.52	10	2.50	0.04	3.93
Lagerstroemia parviflora	Lythraceae	40	15.00	0.65	15.70	20	5.00	0.11	8.05
Diospyros melanoxylon	Ebenaceae	30	15.00	1.24	16.78	40	17.50	0.78	22.24
Terminalia bellirica	Combretaceae	10	5.00	0.11	4.02	10	2.50	0.04	3.93
Cleistanthus collinus	Phyllanthaceae	10	5.00	0.06	3.77				
Desmodium oojeinense	Fabaceae	30	10.00	0.17	9.78				
Pterocarpus marsupium	Fabaceae	10	2.50	0.15	3.51	10	5.00	0.15	5.48
Phyllanthus emblica	Phyllanthaceae					10	5.00	0.07	5.03
Total		510	333	19.38	300	360	278	16.18	300

Abbreviations: F: Frequency (%), D: Density (stems ha^{-1}), BA: Basal area (m^2 ha^{-1}) and IVI: Importance value index

Density, basal area and frequency distributions of vegetation contribute to the structure of tropical forests. The present study revealed that density of trees ranged from 278 to 333 stems ha^{-1}. Densities of trees in the study area were similar to estimates from tropical forests within India. In a study, density of disturbed forest was 190 stems ha^{-1} and of undisturbed forests was 1090 stems ha^{-1} in a tropical dry deciduous forest of Barnawapara Wildlife Sanctuary (Thakrey et al., 2022). The mean stand density was 479 trees ha^{-1} and basal area was 15.20 m^2 ha^{-1} in Deogarh district, belonging to the Eastern Ghats of Odisha, India (Sahu et al., 2016). Similar results found in dry tropical forest in Barnawapara Sanctuary. The density of different forest types varied from 324 to 733 trees ha^{-1}, basal area from 8.13 to 28.87 m^2 ha^{-1} and 9 to 26 number of species were recorded (Thakur and Swamy, 2010). Density (individuals/ha) and basal area (m^2 ha^{-1}) varied from 710 to 1010 and 33.5–46.8 in tropical sal mixed forest in Chhattisgarh (Raj and Jhariya, 2021). The stand density varied in the range

Table 2: Comparison of diversity parameters in Katghora and Pali sites of dry tropical forest of Chhattisgarh, India

Parameters	Sites	
	Site-I Katghora	Site-II Pali
Concentration of dominance (Cd)	0.33	0.60
Shannon-Wiener Index (H')	2.31	1.43
Equitability (e)	0.88	0.57
Species richness (d)	4.39	3.95
Beta (β) diversity (Bd)	2.94	4.17

of 355.33–740.53 stems ha^{-1} while basal area ranged from 7.77 to 31.62 m^2 ha^{-1} in tropical forest of Nayagarh Forest Division of Odisha in Eastern Ghats of India (Sahoo et al., 2017). Tree stands density varied from 527 to 665 stems ha^{-1} with average basal area of 43.51 m^2 ha^{-1} in Tropical Forest of Similipal Biosphere Reserve, Orissa, India (Reddy et al., 2007). Tree density in the Vindhyan region ranges between 294–627 stems ha^{-1} for several dry tropical forest communities (Jha and Singh, 1990; Singh and Singh, 1991). Density and basal area ranged from 542.50–565 stems ha^{-1} and 26.07–27.57 m^2 ha^{-1}, respectively on two sites of buffer zone of AABR in Central India (Lal, 2022; Lal et al., 2022; Lal et al., 2024).

3.2. Diversity analysis

Shannon index (H'), concentration of dominance (Cd), equitability (e), species richness (d) and beta diversity (Bd) were found to be different in both the study sites and presented in Table 2. The Shannon index (H') value on various sites lies between 1.43 and 2.31. It was found highest on Katghora site as compare to Pali site. The concentration of dominance (Cd) varied from 0.33 to 0.60. It was found highest on Pali site as compare to Katghora site. The equitability (e) ranged from 0.57 to 0.88, it was maximum on Pali site as compare to Katghora site. The Margalef's index of species richness (d) varied from 3.95 to 4.39. It was recorded highest on Katghora site as compare to Pali site. The beta diversity (Bd) ranged from 2.94 to 4.17, it was maximum on Pali site as compare to Katghora site. Similar results were observed by different scientist of dry tropical forest. Similar results were measured for both disturbed and undisturbed forest in the dry tropical forest of Barnawapara Sanctuary (Thakrey et al., 2022). The forest had a Shannon species diversity index score of 3.84 and an evenness of 0.89 in natural forests in Awi Zone of Northwest Ethiopia (Yemata and Haregewoien, 2022). The Shannon's diversity index was 2.01±0.22 and Simpson's index was 0.85±0.03 of Tropical Dry Forests of Eastern Ghats, India (Sahu et al., 2016). Similarly, the diversity ranged from 1.36 to 2.98, concentration of dominance from 0.07 to 0.49, species richness from 3.88 to 6.86 and beta diversity from 1.29 to 2.21 of dry tropical forest ecosystem of Chhattisgarh (Thakur and Swamy, 2010). The Shannon diversity index (1.22) and the Simpson index (0.085) were significant in The Gibbon Wildlife Sanctuary while for the Kholahat Reserve Forest, these indices were insignificant (Borah et al., 2015). The Shannon's diversity index was highest (2.46) in dry mixed forest, whereas Simpson's dominance index was maximum (0.85) in teak plantation of tropical forest at Katerniaghat Wildlife Sanctuary (KWLS), India (Behera et al., 2017). The biodiversity indices were significantly higher in undisturbed forest stands and the Shannon–Wiener diversity index (H') ranged from 1.97 to 3.57, Simpson index (Cd) ranged from 0.76 to 0.88, and evenness index (e) ranged from 0.65 to 0.97 in all the stands in undisturbed and disturbed tropical forests of DibruSaikhowa biosphere reserve in Assam North East India (Joshi, 2020). Shannon index, concentration of dominance, Evenness, species richness and beta diversity ranged from 2.36–2.91, 0.21–0.37, 0.77–1.01, 5.13–6.13 and 3.33–4.56, respectively on two sites of buffer zone of AABR in Central India (Lal, 2022; Lal et al., 2022a; Lal et al., 2024).

3.3. Biomass of tree layer vegetation

Results on standing biomass of tree layer on Katghora and Pali sites are given in Table 3. Variation was found in biomass among different components of trees. The total tree biomass ranged from 214.65 to 246.06 t ha^{-1} on two sites. The bole biomass varied from 51.37 to 62.46 t ha^{-1}, branch from 93.05 to 102.92 t ha^{-1}, foliage from 5.24 to 5.85 t ha^{-1} and coarse roots from 64.99 to 74.83 t ha^{-1}. The biomass of above ground tree component (AGTC) ranged from 149.66 to 171.24 t ha^{-1} and below ground tree component (BGTC) ranged from 64.99 to 74.83 t ha^{-1}. The result of tree layer biomass of disturbed and undisturbed forest in 111.7 t ha^{-1} and 356.87 t ha^{-1}, respectively (Thakrey et al., 2022). The mean above ground biomass value was 98.87±68.8 t ha^{-1} in Tropical Dry Forests of Eastern Ghats, India (Sahu et al., 2016). The total biomass of tree layer in plantation site was 245.22 t ha^{-1} and natural forest 241.44 t ha^{-1} in Forest Ecosystem of Chhattisgarh, India (Jhariya and Yadav, 208). The above ground biomass measured 135.30-146.42 t ha^{-1} in Gibbon Wildlife Sanctuary and Kholahat Reserve Forest of Assam (Borah et al., 2015). The results of total biomass ranged from 103.32 (Renukhund range)–453.54 t ha^{-1} (Chitrange range) intropical dry deciduous forests in Central India (Joshi and Dhyani, 2019). The above ground biomass ranged from 290.82–455.99 t ha^{-1} in dry mixed, sal mixed and teak plantation at Katerniaghat Wildlife Sanctuary (KWLS) of Indian tropical deciduous forest (Behera et al., 2017). The mean value of estimated above-ground biomass and RS-based above-ground biomass 280 and 297.6 t ha^{-1}, respectively in deciduous forests of Western Ghats of Karnataka, India (Madugundu et al., 2008). The total biomass varied from 182.27 to 375.84 t ha^{-1} in four different site qualities (SQ) of Sal dominating tropical deciduous forest of Chhattisgarh, India(Raj and Jhariya, 2021). The biomass ranged from 338.40 t ha^{-1} to 438.17 t ha^{-1} in Moist Deciduous

Forests of Doon Valley, Western Himalaya, India (Shahid and Joshi, 2015). In the present study, highest total biomass was recorded in Katghora site as compare to Pali site due to less disturbance in Katghora site. In Pali site, high disturbance was observed viz; fuel wood collection, extraction of timber, cattle grazing, collections of non-wood forest products, fodder etc.

3.4. Carbon storage of tree layer vegetation

Results on standing carbon storage of tree layer on Katghora and Pali sites are given in Table 3. Variation was found in carbon storage among different components of trees. The total carbon storage of tree layer ranged from 90.51 to 103.64 t ha^{-1} on two sites. The carbon storage of bole varied from 22.35 to 27.17 t ha^{-1}, branch from 42.50 to 47.01 t ha^{-1}, foliage from 2.45 to 2.73 t ha^{-1} and coarse roots from 23.22 to 26.74 t ha^{-1}. The carbon storage of above ground tree component (AGTC) was ranged from 67.29 to 76.91 t ha^{-1} and below ground tree component (BGTC) was ranged from 23.22 to 26.74 t ha^{-1}. The results of C storage of tree layer were measured of disturbed and undisturbed forest in 47.45 t ha^{-1} and 152.13 t ha^{-1}, respectively of tropical dry deciduous forest in Chhattisgarh, India (Thakrey et al., 2022). The tree layer carbon storage was measured 105.74 t ha^{-1} and 106.02 t ha^{-1} in natural forest and teak plantation in Sarguja forest division of Forest Ecosystem of Chhattisgarh, India (Jhariya and Yadav, 2018). The above ground carbon storage measured 67.64–73.21 t ha^{-1} in two tropical forests of Assam (Borah et al., 2015). Total tree carbon density varied from 48.97 to 214.97 t C ha^{-1} in tropical dry deciduous forests in Central India (Joshi and Dhyani, 2019). The results of above ground carbon stock (t ha^{-1}) ranged between 207.52–220.34, 215.58–228.87, and 125.94–141.18 in dry mixed, sal mixed and teak plantation, respectively in Indian tropical deciduous forest (Behera et al., 2017). The results of total C in trees varied from 79.86 to 163.63 t ha^{-1}. Quantity of C in above ground and below ground portions in trees on different sites were 72.32–143.36 t ha^{-1} and 7.54–20.27 t ha^{-1}, respectively of tropical sal mixed deciduous forest ecosystem in Chhattisgarh, India(Raj and Jhariya, 2021). Average C stock of woody vegetation was reported to be 231.3 t ha^{-1} in tropical forests of Western Ghats, India (Kothandaraman et al., 2020). Tree carbon storage in undisturbed forest and disturbed forest ranged from 184–214.62 t C ha^{-1} and 124–137.53 t C ha^{-1}, respectively in DibruSaikhowa biosphere reserve in Assam NorthEast India (Joshi, 2020). The carbon storage of bamboo plantation of Central India was 30.01 t C ha^{-1} (Lal et al., 2022b). The carbon stocks in the moist deciduous forests of the Doon Valley, Western Himalaya, India, ranged from 169.20 t ha^{-1} to 219.08 t ha^{-1} (Shahid and Joshi, 2015).

Table 3: Comparison of biomass, C storage and N storage in Katghora and Pali sites of dry tropical forest of Chhattisgarh, India

Trees components	Sites					
	Katghora	Pali	Katghora	Pali	Katghora	Pali
	Biomass (t ha^{-1}) ±SD		C storage (t ha^{-1}) ±SD		N Storage (kg ha^{-1}) ±SD	
Bole	62.46±12.86 (25.39)[a]	51.37±10.58 (23.93)[a]	27.17±5.59 (26.22)[a]	22.35±4.60 (24.69)[a]	237.37±48.86 (16.35)[a]	195.21±40.20 (15.28)[a]
Branch	102.92±23.64 (41.83)[a]	93.05±35.76 (43.35)[a]	47.01±10.80 (45.35)[a]	42.50±16.33 (46.95)[a]	710.18±163.10 (48.91)[a]	642.05±246.76 (50.25)[a]
Foliage	5.85±0.86 (2.38)[a]	5.24±1.75 (2.44)[a]	2.73±0.40 (2.63)a	2.45±0.82 (2.70)[a]	85.36±12.52 (5.88)[a]	76.51±25.53 (5.99)[a]
Coarse root	74.83±14.01 (30.41)[a]	64.99±13.24 (30.28)[a]	26.74±5.01 (25.80)[a]	23.22±4.73 (25.65)[a]	419.03±78.46 (28.86)[a]	363.92±74.12 (28.48)[a]
Total	246.06±49.13 (100)[a]	214.65±57.57 (100)[a]	103.64±20.92 (100)[a]	90.51±24.97 (100)[a]	1451.93±290.99 (100)[a]	1277.70±363.45 (100)[a]
AGTC	171.24±37.35 (69.59)[a]	149.66±48.09 (69.72)[a]	76.91±16.79 (74.20)[a]	67.29±21.75 (74.35)[a]	1032.90±224.48 (71.14)[a]	913.78±312.49 (71.52)[a]
BGTC	74.83±14.01 (30.41)[a]	64.99±13.24 (30.28)[a]	26.74±5.01 (25.80)[a]	23.22±4.73 (25.65)[a]	419.03±78.46 (28.86)[a]	363.92±74.12 (28.48)[a]

Abbreviations: AGTC: Above ground tree components, BGTC: Below ground tree components, aPercent distribution

3.5. N storage of tree layer vegetation

Results on standing N storage of tree layer on Katghora and Pali sites are given in Table 3. Variation was found in N storage among different components of trees. The total N storage of tree layer ranged from 1277.70 to 1451.93 kg ha^{-1} on two sites. The N storage of bole varied from 195.21 to 237.37 kg ha^{-1}, branch from 642.05 to 710.18 kg ha^{-1}, foliage from 76.51 to 85.36 kg ha^{-1} and coarse roots from 363.92 to 419.03 kg ha^{-1}. The N storage of above ground tree component (AGTC) was ranged from 913.78 to 1032.90 kg ha^{-1} and below ground tree component (BGTC) was ranged from 363.92 to 419.03 kg ha^{-1}. The highest N carbon storage was recorded in Katghora site as compare to Pali site. The similar result of N storage of tree layer in disturbed and undisturbed forest was 651.39 kg ha^{-1} and 2117.76 kg ha^{-1}, respectively in tropical dry deciduous forest in Chhattisgarh, India (Thakrey et al., 2022). Disturbance alters stand structure and diameter class distribution resulting into the reduction of stand biomass, carbon, and nitrogen stock and dynamics (Kashin et al., 2006; Scheller et al., 2011). Some other studies also support that the access to forests increases biotic interference, which disturbs the environment and lowers C and N levels due to illegal felling, cutting, grazing, and collection of forest-based products (Adugna and Teshome, 2017). In the present study, Pali site observed more disturbance as compare to Katghora site than N storage of tree layer recorded highest in Katghora site as compare to Pali site.

4. Conclusion

The density, basal area, diversity indices, biomass, C and N storage was highest in Katghora site as compare to Pali site. In Pali site, more disturbance was observed like grazing, lopping, illicit felling, and fire wood collection and collection of non-wood forest products which significantly affected the structure, density, biomass, carbon storage and N storage of forest.

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