Journal homepage: http:/www.indianecol.org

Indian Journal of Ecology

DOI: https://doi.org/10.55362/IJECOL/2026/0156
Article Number: 0000

Phytosociology of Woody Species in the Bagnadi Range of Rajnandgaon Forest Division in Chhattisgarh, India

Nalish Kumar Anchal [1,*] and Mahendra Nath Naugraiya [2]

[1] *Indira Gandhi Agriculture University, Raipur, Chhattisgarh-492 012, India*

* Corresponding Author. Email: nkanchal2889@gmail.com

https://orcid.org/0009-0003-3139-5463 (Nalish Kumar Anchal)

Received: May 11, 2026 Revision Submitted: July 15, 2026 Accepted: July 16, 2026

ABSTRACT: Chhattisgarh is one of the most forest-rich states of India, with nearly 44% of its geographical area under forest cover, predominantly comprising tropical dry deciduous forests. However, information on the woody species composition and phytosociological characteristics of several forest ranges in central India remains limited. The present study was conducted in the Bagnadi Forest Range of Rajnandgaon Forest Division, Chhattisgarh, to document woody species diversity, community structure and phytosociological characteristics using standard quadrat sampling methods. Parameters including density, abundance, basal area, diversity indices and importance value index (IVI) were evaluated. A total of 43 woody species were recorded, comprising 41 tree species and 2 shrub species. The total woody species density, abundance, and basal area were estimated at 428 ha^{-1}, 4994.45 ha^{-1} and 23568.40 cm^2 ha^{-1}, respectively. Based on IVI, *Cordia myxa, Terminalia elliptica, Anogeissus latifolia, Buchanania latifolia, and Butea monosperma* were the most dominant species in the study area. The Shannon diversity index (1.53) and Simpson's dominance index (0.04) described the diversity and dominance patterns of the woody vegetation within the sampled area. These findings provide baseline information on the woody vegetation composition and phytosociological attributes of the Bagnadi Forest Range, which may support future ecological monitoring and forest management.

Keywords: Frequency, Density, Basal area, Abundance, Dominance, Diversity, Importance Value Index.

1. INTRODUCTION

Chhattisgarh is one of the most forest-rich states of India, with more than 44% of its geographical area under forest cover, predominantly comprising tropical dry deciduous forests dominated by *Shorea robusta* (sal), *Tectona grandis* (teak), bamboo species, and mixed deciduous vegetation. These forests are ecologically significant as they support rich biodiversity, provide habitat for diverse flora and fauna, regulate ecosystem processes and sustain rural livelihoods through the supply of timber and non-timber forest products (NTFPs) (Bardani, 2003). Earlier studies from Chhattisgarh have reported the importance of woody vegetation in maintaining forest structure and productivity, with Bardani (2003) documenting 84 NTFP species, including 38 tree species, from the Bhoramdeo Wildlife Sanctuary.

Species diversity and dominance are widely recognized as important indicators of forest community structure, ecological stability, and ecosystem functioning. Forests with high dominance by a few species often exhibit lower species richness, whereas higher species diversity generally reflects greater ecological resilience and stability (Putman, 1994). Recent studies conducted in tropical dry deciduous forests of Central India have further demonstrated that species composition, tree density, basal area and diversity are influenced by environmental conditions and disturbance regimes, emphasizing the need for periodic phytosociological assessments (Chaturvedi et al., 2019;

Available online: July 22, 2026

Dugaya et al., 2020; Dar et al., 2025).

Phytosociological investigations provide quantitative information on species composition, density, frequency, abundance, basal area, Importance Value Index (IVI), and community structure, which are essential for evaluating forest health, biodiversity status, and conservation priorities (Sagar & Singh, 2003; Chaturvedi et al., 2017). Such baseline information is increasingly important in tropical dry deciduous forests experiencing anthropogenic disturbances, habitat fragmentation, forest fires and climate variability, as it supports long-term ecological monitoring and sustainable forest management (Mansingh et al., 2025; Ray et al., 2025).

Although several phytosociological studies have been conducted in different forest ecosystems of Central India, published information on the woody species composition and phytosociological characteristics of the Bagnadi Forest Range of Rajnandgaon Forest Division is still limited. The absence of comprehensive baseline ecological information restricts effective biodiversity assessment, long-term vegetation monitoring, and the development of site-specific conservation and forest management strategies. Therefore, systematic phytosociological documentation of the Bagnadi Forest Range is necessary to characterize its woody vegetation, identify dominant species, and generate baseline ecological data for future monitoring, biodiversity conservation, and sustainable forest management.

The objectives of the present study were: (i) to document the woody species composition of the Bagnadi Forest Range; (ii) to evaluate the phytosociological characteristics of woody vegetation using standard ecological parameters; and (iii) to generate baseline ecological information to support biodiversity conservation, ecological monitoring and sustainable forest management.

2. MATERIALS AND METHODS

2.1. Study Area

Rajnandgaon district is situated in the central part of Chhattisgarh, India, between 20°07′08″–21°49′55″ N latitude and 80°23′20″–81°13′05″ E longitude, at an average elevation of 298 m above mean sea level. Tropical dry deciduous forests characterise the Bagnadi Forest Range and fall under the 5A/C3 Southern Tropical Dry Mixed Deciduous Forest type. The climate is sub-humid, with a mean annual rainfall of 1200–1400 mm, about 80% of which is received during the southwest monsoon. May is the hottest month, while December is the coldest. The soils are predominantly Inceptisols and Alfisols.

The study area map (Figure 1) was prepared using Survey of India topographic maps, Google Earth satellite imagery, Forest Department boundary maps, GPS-based field observations, and GIS software (QGIS version 3.34/ArcGIS 10.x) to delineate the study area and sampling locations (Figure 1).

2.2. Vegetation Sampling

The population structure of woody species was studied using a quadrat method following R. Mishra (1968). A total of 150 quadrats of 10 m × 10 m size were laid randomly in the Bagnadi Forest Range. In each quadrat, all woody species were identified and enumerated, and Diameter at Breast Height (DBH) was measured for basal area estimation.

Quadrat locations were selected using a random sampling approach. The forest area was first traversed to identify accessible forest patches, and quadrats were randomly established to obtain representative coverage of the woody vegetation throughout the study area. Sampling was conducted across different forest patches to capture variation in species composition and community structure. Within each quadrat, all woody species (trees and shrubs) were identified and enumerated. The Diameter at Breast Height (DBH) of each tree was measured at 1.37 m above ground level with a diameter tape to estimate basal area. Species identification was carried out using standard regional floras and verified with available botanical literature.

A quadrat size of 10 m × 10 m (100 m²) was adopted following standard phytosociological sampling procedures for woody vegetation (Misra, 1968; Mueller-Dombois & Ellenberg, 1974). This quadrat size is widely used to assess species composition, density, frequency, abundance, and community structure in tropical forest ecosystems. A total of 150 quadrats covering 1.5 ha were sampled to ensure adequate representation of woody species across the study area.

2.3. Data Collection and Phytosociological Analysis

The phyto-sociological parameters such as frequency, density, abundance, basal area, relative frequency, relative density, relative abundance, relative dominance and Importance Value Index (IVI) were calculated using standard as per the following ecological formulas:

Frequency (%)

Frequency = (Number of quadrats in which the species

occurred / Total number of quadrats studied) × 100 Eq. 1

Density (ha^{-1})

Density = Total number of individuals of a species / Total area sampled (ha) Eq. 2

Abundance (ha^{-1})

Abundance = Total number of individuals of a species / Number of quadrats in which the species occurred Eq. 3

Basal cover (cm^{2}ha^{-1})

Individual tree

Basal Area=πD²/ Eq. 4

where D = Diameter at Breast Height (DBH)

Species basal area = $\sum BAi$

Basal area per hectare

BA (cm² ha^{-1}) = ∑BAi/1.5

Relative frequency (%)

Relative Frequency = (Frequency of a species / Sum of frequencies of all species) × 100 Eq. 5

Relative density (%)

Relative Density = (Density of a species / Total density of all species) × 100 Eq. 6

Relative abundance (%)

Relative abundance = (Abundance of individual species/ Abundance of all the species) × 100 Eq. 7

Relative dominance (%)

Relative Dominance = (Basal area of a species / Total basal area of all species) × 100 Eq. 8

2.4. Diversity Indices

IVI = Relative density + Relative frequency + Relative dominance Eq. 9

Simpson (1949) index of Dominance:

The equation used to calculate Simpson's index was

D = Σ pi² Eq. 10

Where,

D = Simpson index of dominance

ni = the IVI of individual species

N= IVI of all the species

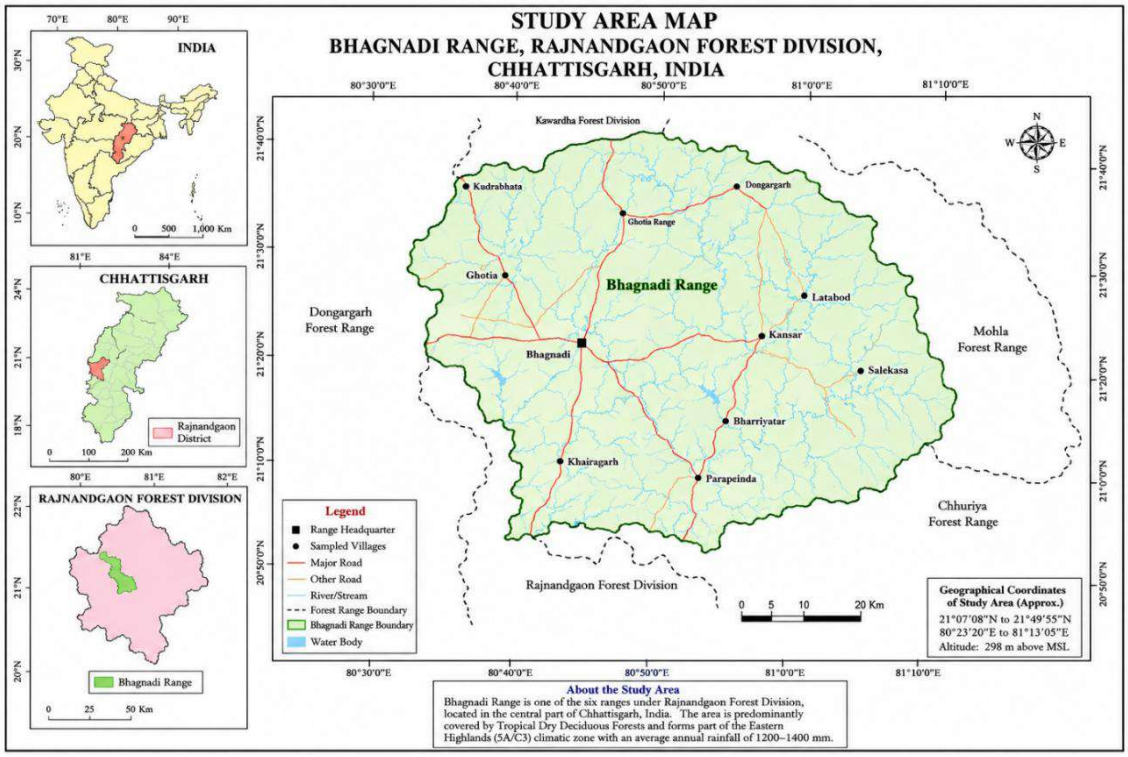
Margalef (1958) Diversity:

R = (S − 1) / ln(N) Eq. 11

where:

S = Total number of species

N = Total number of individuals



Source: Forest Department, Chhattisgarh; Survey of India; Google Earth imagery; author's field survey (2025)

Figure 1. Study area map of the Bagnadi forest range, Rajnandgaon Forest Division, Chhattisgarh, India. The map shows the geographical location and boundaries of the study area

3. RESULTS AND DISCUSSION

The phytosociological analysis of the Bagnadi Forest Range revealed considerable variation in the distribution, density, abundance and dominance of woody species. A total of 43 woody species were recorded, comprising 41 tree species and 2 shrub species, indicating moderate floristic diversity in the tropical dry deciduous forest ecosystem of the study area. Similar vegetation patterns have been reported in other dry deciduous forests of central India (Sagar & Singh, 2003), where a few dominant species contribute significantly to community structure and ecosystem functioning (Table 1).

3.1. Frequency and Relative Frequency

In the Bagnadi forest range, the maximum frequency was found in *Cordia myxa* (44.67%), followed by *Terminalia elliptica* (36.67%) and afterward, the species *Anogeissus latifolia, Buchanania latifolia, Butea monosperma, Madhuca indica, Diospyros melanoxylon, Tectona grandis* and *Semecarpus anacardium* were lodged with a frequency between 15 and 25%. In comparison, species showed a frequency between 10 and 15%: *Holarrhena antdysenteria, Lannea cormandalica, Pterocarpus marsupium, Schleichera oleosa* and *Syzygium cumini.* There were 26 woody species with less than 5% frequency, and among them, the producing woody species were *Aegle marmelos, Emblica officinalis, Anona squamosa* and *Terminalia belirica* (Table 2).

Table 1. Summary of phytosociological structure of woody minor forest species in the Bagnadi forest range of Rajnandgaon forest division in Chhattisgarh, India

Parameters	Bagnadi Forest Range
Total Species	43
Trees	41
-Shrubs	2
Density(ha^{-1})	
-Total Species	428.00
-Trees	425.33
-Shrubs	2.67
Abundance (ha^{-1})	
-Total Species	4994.45
-Trees	4794.45
-Shrubs	200.00
Basal Area (cm^2ha^{-1})	
-Total Species	23568.40
-Trees	23560.29
-Shrubs	8.11
Similarity index (%)	81.25
Dominance	0.04
Diversity	1.53

Source: Author's field survey and analysis

The relative frequency of woody species in the Bagnadi forest range was found to be the highest in *Cordia myxa* (11.96%), followed by *Terminalia elliptica* (9.82%) and between 3–7% in *Anogeissus latifolia, Buchanania latifolia, Butea monosperma, Diospyros melanoxylon, Holarrhena antdysenteria, Madhuca indica, Pterocarpus marsupium, Semecarpus anacardium* and *Tectona grandis.* The relative frequency of the less-than-1 % distribution was recorded in 18 woody species, which accounted for 41.9% of the community's woody species (Table 2).

3.2. Density and Relative Density

In the Bagnadi forest range, the maximum density was found in *Cordia myxa* (56 ha-1), followed by *Terminalia elliptica* (43.33 ha^{-1}), *Madhuca indica* (34 ha^{-1}), *Anogeissus latifolia* (26.67 ha^{-1}), *Buchanania latifolia* (24.67 ha^{-1}), *Semecarpus anacardium* (24.67 ha^{-1}), *Diospyros melanoxylon* (20.67 ha^{-1}), *Butea monosperma* (20.00 ha^{-1}) and *Tectona grandis* (19.33 ha^{-1}). Afterwards, 10 to 15 ha^{-1} population density was recorded in *Cassia fistula, Holarrhena antdysenteria, Lannea cormandalica, Pterocarpus marsupium, Schleichera oleosa* and *Syzygium cumini.* The next-level density of woody species, between 4 and 8 plant ha-1, was found in 11 species, which accounted for 25.5% of the community's woody species contribution: Emblica officinalis, Terminalia chebula, and Terminalia belerica. While population per hectare was found to be less than 4 ha^{-1} for 17 woody species, among them *Azadirachta indica, Pongamia pinnata* and *Zizyphus jujube are the* major ones.

The relative density is the share of an individual species in terms of numerical strength within the total population. In the Bagnadi forest range, the maximum relative density was found in *Cordia myxa* (13.08%), followed by *Terminalia elliptica* (10.12%), *Madhuca indica* (7.94%), *Anogeissus latifolia* (6.23%), *Buchanania latifolia* (5.76%), *Semecarpus anacardium* (5.76%), *Diospyros melanoxylon* (4.83%), *Butea monosperma* (4.67%) and *Tectona grandis* (4.52%). The 22 woody species shared a presence of less than 1.0%, with an aggregated 51.1 % contribution to the community woody species being Shorea robusta, Terminalia belirica and Aegle marmelos (Table 2).

Table 2. Distribution of woody minor forest species in the Bagnadi forest range of Rajnandgaon forest division in CG

Botanical name	Frequency (%)	Density (ha^{-1})	Abundance (ha^{-1})	Basal area (cm^2 ha^{-1})	Relative			IVI
					Frequency	Density	Dominance	
Aegle marmelos (L.) Correa	1.33	1.33	66.67	6.26	0.36	0.31	0.03	0.7
Adina cordifolia (Roxb.) Ridsdale	1.33	1.33	66.67	22.01	0.36	0.31	0.09	0.76
Anogeissus latifolia (Roxb. ex DC.) Wall. Ex Guillem. & Perr.	22.67	26.67	78.43	2380.09	6.07	6.23	10.10	22.4
Annona squamosa L.	2.67	3.33	83.33	101.22	0.71	0.78	0.43	1.92
Azadirachta indica A. Juss.	0.67	1.33	133.33	18.19	0.18	0.31	0.08	0.57
Bauhinia variegata L.	4.00	4.00	66.67	32.71	1.07	0.93	0.14	2.14
Bombax ceiba L.	1.33	2.00	100.00	85.41	0.36	0.47	0.36	1.19
Bridelia retusa (L.) A. Juss.	5.33	6.00	75.00	126.30	1.43	1.40	0.54	3.37
Buchanania latifolia Roxb.	23.33	24.67	70.48	927.56	6.25	5.76	3.94	15.95
Butea monosperma (Lam.) Taub.	17.33	20.00	76.92	583.10	4.64	4.67	2.47	11.78
Capparis decidua (Forssk.) Edgew.	2.00	2.67	88.89	60.53	0.54	0.62	0.26	1.42
Careya arborea Roxb.	3.33	3.33	66.67	24.28	0.89	0.78	0.10	1.77
Casearia graveolens Dalzell	4.67	5.33	76.19	71.88	1.25	1.25	0.31	2.81
Cassia fistula L.	9.33	12.00	85.71	142.59	2.50	2.80	0.61	5.91
Chloroxylon swietenia DC.	4.67	4.67	66.67	54.70	1.25	1.09	0.23	2.57
Cordia myxa L.	44.67	56.00	83.58	4943.82	11.96	13.08	20.98	46.02
Dalbergia paniculata Roxb.	2.67	4.00	100.00	217.67	0.71	0.93	0.92	2.56
Diospyros melanoxylon Roxb.	16.67	20.67	82.67	2441.89	4.46	4.83	10.36	19.65
Ehretia laevis Roxb.	1.33	2.67	133.33	2.92	0.36	0.62	0.01	0.99
Elaeodendron glaucum Pers.	4.00	5.33	88.89	24.59	1.07	1.25	0.10	2.42
Emblica officinalis L.	4.67	6.00	85.71	374.41	1.25	1.40	1.59	4.24
Ficus benghalensis L.	1.33	1.33	66.67	50.52	0.36	0.31	0.21	0.88
Ficus racemosa L.	2.00	2.00	66.67	13.56	0.54	0.47	0.06	1.07
Gardenia latifolia Aiton	0.67	0.67	66.67	1.46	0.18	0.16	0.01	0.35
Holarrhena antidysenterica (L.) Wall. ex A.DC.	11.33	12.67	74.51	92.98	3.04	2.96	0.39	6.39
Lagerstroemia parviflora Roxb.	2.67	4.00	100.00	57.01	0.71	0.93	0.24	1.88
Lannea coromandelica (Houtt.) Merr.	10.67	10.67	66.67	284.71	2.86	2.49	1.21	6.56
Madhuca indica (J. Koenig ex L.) J.F. Macbr.	29.33	34.00	77.27	4109.71	7.86	7.94	17.44	33.24
Pongamia pinnata (L.) Pierre	4.67	4.67	66.67	87.14	1.25	1.09	0.37	2.71
Pterocarpus marsupium Roxb.	11.33	11.33	66.67	444.10	3.04	2.65	1.88	7.57
Schleichera oleosa (Lour.) Oken	10.67	10.67	66.67	386.31	2.86	2.49	1.64	6.99
Semecarpus anacardium L.f.	23.33	24.67	70.48	1070.88	6.25	5.76	4.54	16.55
Shorea robusta Gaertn.	2.00	2.00	66.67	14.94	0.54	0.47	0.06	1.07
Sterculia urens Roxb.	3.33	3.33	66.67	64.82	0.89	0.78	0.28	1.95
Syzygium cumini (L.) Skeels	10.67	10.67	100.00	257.15	2.86	2.49	1.09	6.44

Cont...

Table 2. Distribution of woody minor forest species in the Bagnadi forest range of Rajnandgaon forest division in CG

Botanical name	Frequency (%)	Density (ha^{-1})	Abundance (ha^{-1})	Basal area (cm^2 ha^{-1})	Relative			IVI
					Frequency	Density	Dominance	
Tectona grandis L.f.	16.00	19.33	80.56	788.23	4.29	4.52	3.34	12.15
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	1.33	1.33	66.67	1.71	0.36	0.31	0.01	0.68
Terminalia elliptica Willd.	36.67	43.33	78.79	2918.68	9.82	10.12	12.38	32.32
Terminalia bellirica (Gaertn.) Roxb.	4.00	4.00	66.67	56.96	1.07	0.93	0.24	2.24
Terminalia chebula Retz.	8.00	8.67	72.22	174.37	2.14	2.02	0.74	4.9
Tinospora cordifolia (Willd.) Hook.f. & Thomson	2.67	2.67	66.67	42.95	0.71	0.62	0.18	1.51
Ziziphus jujuba Mill.*	2.00	2.00	66.67	5.65	0.54	0.47	0.02	1.03
Ziziphus rotundifolia (Forsk.) Lam.*	0.67	0.67	66.67	2.46	0.18	0.16	0.01	0.35

Note: The mark * is a shrub (Source: Author's field survey and analysis)

3.3. Abundance and Relative Abundance

The abundance of woody species in the Bagnadi forest range was found in the range of 100–135 plants ha^{-1}, where the maximum abundance was found in Azadirachta indica (133.3 plants ha^{-1}), followed by 100 plants ha-1 in *Bombax ceiba, Dalbergia paniculata, Syzygium cumini,* and *Lagerstroemia parviflora.* The large number of woody species 37 showed their abundance between 100 plant ha^{-1}, where *Anogeissus latifolia, Anona squamosa, Bridelia retusa, Buchanania latifolia, Butea monosperma, Capparis deciduas, Casaria graveolens, Cassia fistula, Cordia myxa, Diospyros melonoxylon, Emblica officinalis, Holarrhena antdysenterica, Madhuca indica* and *Terminalia elliptica* have importance for the production of MFP in the area.

The relative abundance refers to the actual numerical strength of a species among the total species available in a defined community. Here the maximum relative abundance was found in *Azadirachta indica* and *Ehretia laevis* (4.0%), followed by *Bombax ceiba, Dalbergia paniculata* and *Lagerstroemia parviflora* (3.0%), and the rest of the 38 woody species showed between 2 and 2.67% abundance, which aggregated 83% of the community woody species contribution (Table 2).

3.3. Basal area and Relative Dominance

In Bagnadi forest range, the maximum basal area was found in *Cordia myxa* (4943.8 cm2ha-1), followed by *Madhuca indica* (4109.71 cm^2ha^{-1}), *Terminalia elliptica* (2918.7 cm^2ha^{-1}), *Diospyros melonoxylon* (2441.89 cm^2ha^{-1}), *Anogeissus latifolia* (2380.09 cm^2 ha^{-1}), and *Semecarpus anacardium* (1070.88 cm2ha-1), respectively. Basal area was recorded between 100 and 927.56 cm^2ha^{-1} by 13 woody species, and out of them, *Buchanania latifolia* (927.56 cm^2 ha^{-1}), *Tectona grandis* (788.33 cm^2ha^{-1}), *Butea monosperma* (583.10 cm^2ha^{-1}), *Pterocarpus marsupium* (444.10 cm^2ha^{-1}), *Schleichera oleosa* (386.31 cm^2 ha^{-1}) and *Emblica officinalis* (374.41 cm^2ha^{-1}) were major woody species. The basal area occupied ranged from 40 to 100 cm2 ha1 among 10 woody species. While less than 40 cm2 ha-1 basal area was occupied by 13 woody species, among them minor forest-produced woody species, *Aegle marmelose* and *Azadirachta indica* were major ones.

The total land area occupancy of woody species by their basal area was 4994.45 cm^2 ha^{-1} in the Bagnadi forest range, which was contributed highest by *Cordia myxa* (20.98%), followed by *Madhuca indica* (17.44%), *Terminalia elliptica* (12.38%), *Diospyros melanoxylon* (10.36%) and *Anogeissus latifolia* (10.10%), respectively. The basal area contribution of nine woody species ranges from 1 to 4.5%, aggregating 21.7% of the total basal area. The population of 29 woody species occupied 7.04% basal cover in the range of Baghnadi forest (Table 2).

3.5. Importance value index (IVI)

The IVI of woody species in the Bagnadi forest range was found to be highest in *Cordia myxa* (46.02), followed by *Terminalia elliptica* (32.32). Afterwards, the importance value index between 10 and 20 occurred in *Anogeissus latifolia, Buchanania latifolia, Butea monosperma, Diospyros melanoxylon, Semecarpus anacardium,*

Madhuca indica and *Tectona grandis.* IVI less than 10 was shared by 23 woody species, which aggregated a (23.2%) contribution in the community woody species, while it was recorded very low (0.35) in *Gardenia latifolia* and *Zizyphus rotundifolia*. The Importance Value Index (IVI) revealed that *Cordia myxa* was the most dominant woody species in the Bagnadi Forest Range, followed by *Terminalia elliptica*. The high IVI of these species indicates their greater ecological importance and successful adaptation to the prevailing environmental conditions of the study area. Their dominance reflects a substantial contribution to the forest community in terms of density, frequency, and basal area, suggesting that they play a key role in maintaining the structural composition of this tropical dry deciduous forest. Similar dominance of *Terminalia elliptica* and *Anogeissus latifolia* has been reported from other tropical dry deciduous forests of Central India, where these species are recognized as characteristic components of relatively stable forest communities (Sagar & Singh, 2003; Chaturvedi et al., 2019).

Species with intermediate IVI values (10–20), including *Anogeissus latifolia, Buchanania latifolia, Butea monosperma, Diospyros melanoxylon, Semecarpus anacardium, Madhuca indica* and *Tectona grandis*, represent important associated species that contribute substantially to overall community structure and species diversity. Several of these species, particularly *Madhuca indica, Diospyros melanoxylon*, and Buchanania latifolia, are economically important non-timber forest products (NTFPs) that provide food, medicine, and livelihood resources for local communities. Their relatively high IVI suggests that the forest continues to support ecologically and socio-economically valuable woody species, highlighting its importance for biodiversity conservation and sustainable resource management. In contrast, twenty-three woody species exhibited IVI values below 10, indicating their comparatively lower abundance and ecological dominance within the community. Species such as *Gardenia latifolia* and *Ziziphus rotundifolia* recorded the lowest IVI values, which may reflect their restricted distribution, low population density, or specific habitat requirements within the study area. Low IVI values do not necessarily indicate poor ecological significance; rather, such species contribute to overall species richness and should be considered in conservation planning because rare and less abundant species are generally more susceptible to habitat alteration and anthropogenic disturbances.

Overall, the observed IVI pattern indicates that the Bagnadi Forest Range is characterized by a few dominant woody species accompanied by a relatively large number of less abundant associated species, a pattern typical of tropical dry deciduous forests. This community structure suggests moderate species diversity with clear dominance by a limited number of species, reflecting the existing environmental conditions and disturbance regime. The baseline information generated through the present study will be valuable for long-term ecological monitoring, biodiversity conservation, and the development of site-specific forest management strategies. The importance value index (IVI) was calculated using Eq. 9. The importance value index (IVI) values of woody species are presented in Table 2 and illustrated in Figure 2.

3.6. Species Diversity and Dominance

The Shannon–Wiener diversity index (H′) was recorded as 1.53*, while Simpson's dominance index (D) was* 0.04*. These values describe* the diversity and dominance characteristics of the woody vegetation in the Bagnadi Forest Range. The observed community was characterized by the dominance of a few woody species with relatively high Importance Value Index (IVI) values. In contrast, many other species occurred with comparatively lower abundance and IVI. Similar diversity and dominance patterns have been reported for tropical dry deciduous forests by Sagar & Singh (2003) and Putman (1994). However, the present study is descriptive and does not evaluate statistical relationships among species diversity, dominance, and density; therefore, no causal relationship is inferred from these observations (Table 1).

The study documented several woody species widely recognised as important non-timber forest products (NTFPs) in Central India. Species such as *Madhuca indica, Diospyros melanoxylon, Buchanania latifolia,* and *Emblica officinalis* are reported in the literature as valuable sources of flowers, fruits, seeds, leaves, and other forest products (Naugraiya & Pathak, 1986; Naugraiya & Pathak, 1993; Tripathi et al., 2000). Their occurrence and relatively high Importance Value Index (IVI) in the Bagnadi Forest Range highlight their ecological significance and their recognized importance in the regional NTFP resource base. However, the present study was limited to the phytosociological assessment of woody vegetation and did not evaluate livelihood dependence, harvesting intensity, extraction pressure or the economic value of these species. Therefore, any socio-economic implications are discussed only in the

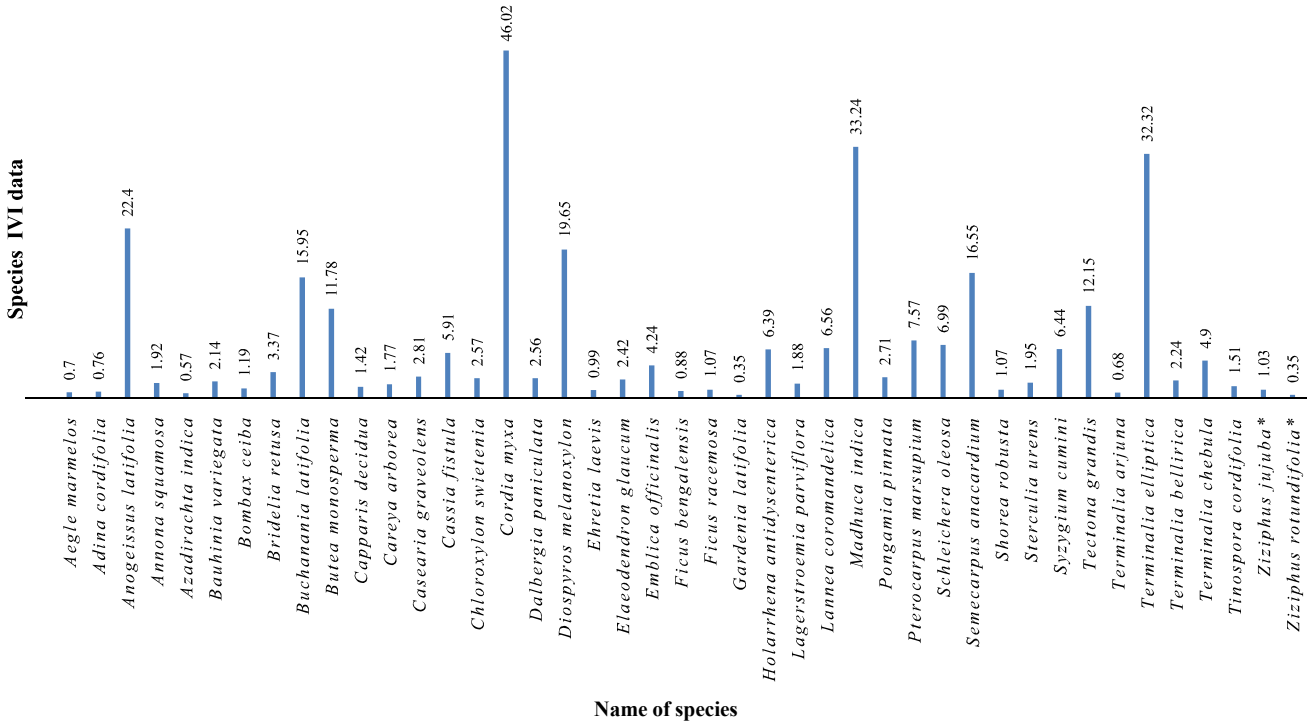


Figure 2. Importance Value Index (IVI) of woody species in the Bagnadi Forest Range, Rajnandgaon Forest Division, Chhattisgarh, India. The figure compares the IVI values of all recorded woody species, indicating their relative ecological importance based on relative density, relative frequency, and relative dominance

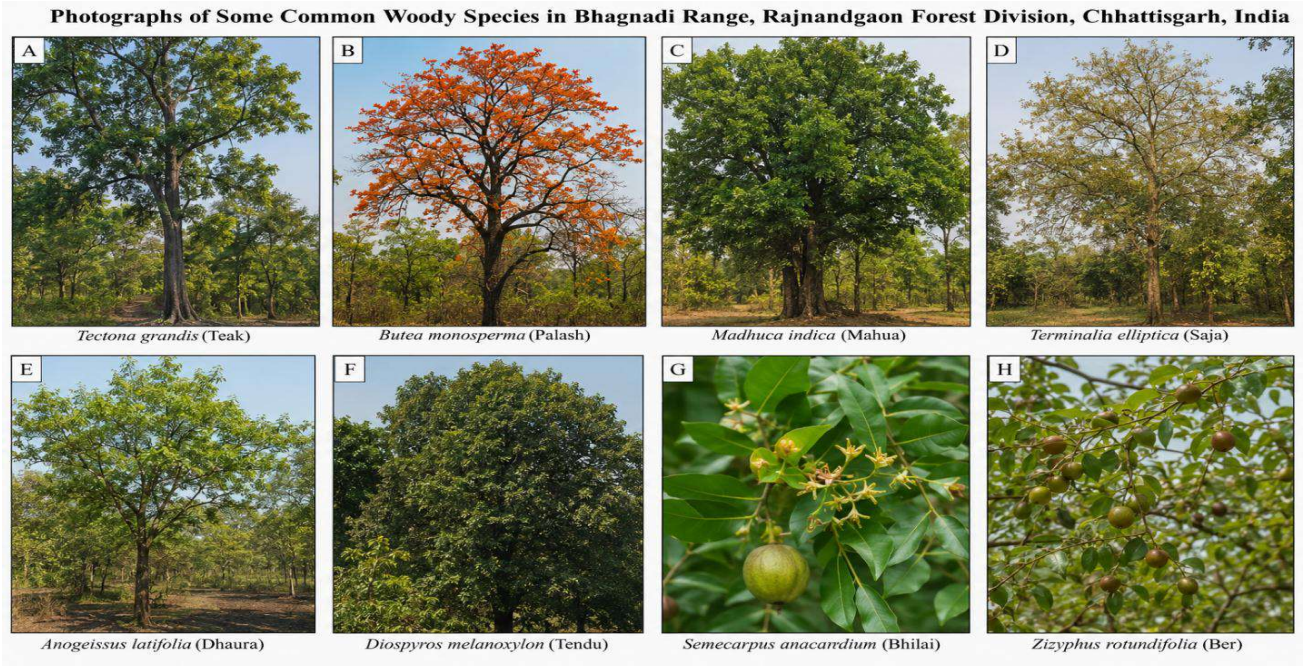


Figure 3. Photographs of representative woody species recorded in the Bagnadi Forest Range, Rajnandgaon Forest Division, Chhattisgarh, India. The photographs illustrate the dominant and ecologically important woody species observed during the phytosociological survey. (A) Cordia myxa, (B) Terminalia elliptica, (C) Anogeissus latifolia, (D) Buchanania latifolia, (E) Madhuca indica, (F) Diospyros melanoxylon, (G) Butea monosperma, and (H) Tectona grandis. These images provide visual identification of representative species contributing to the forest community

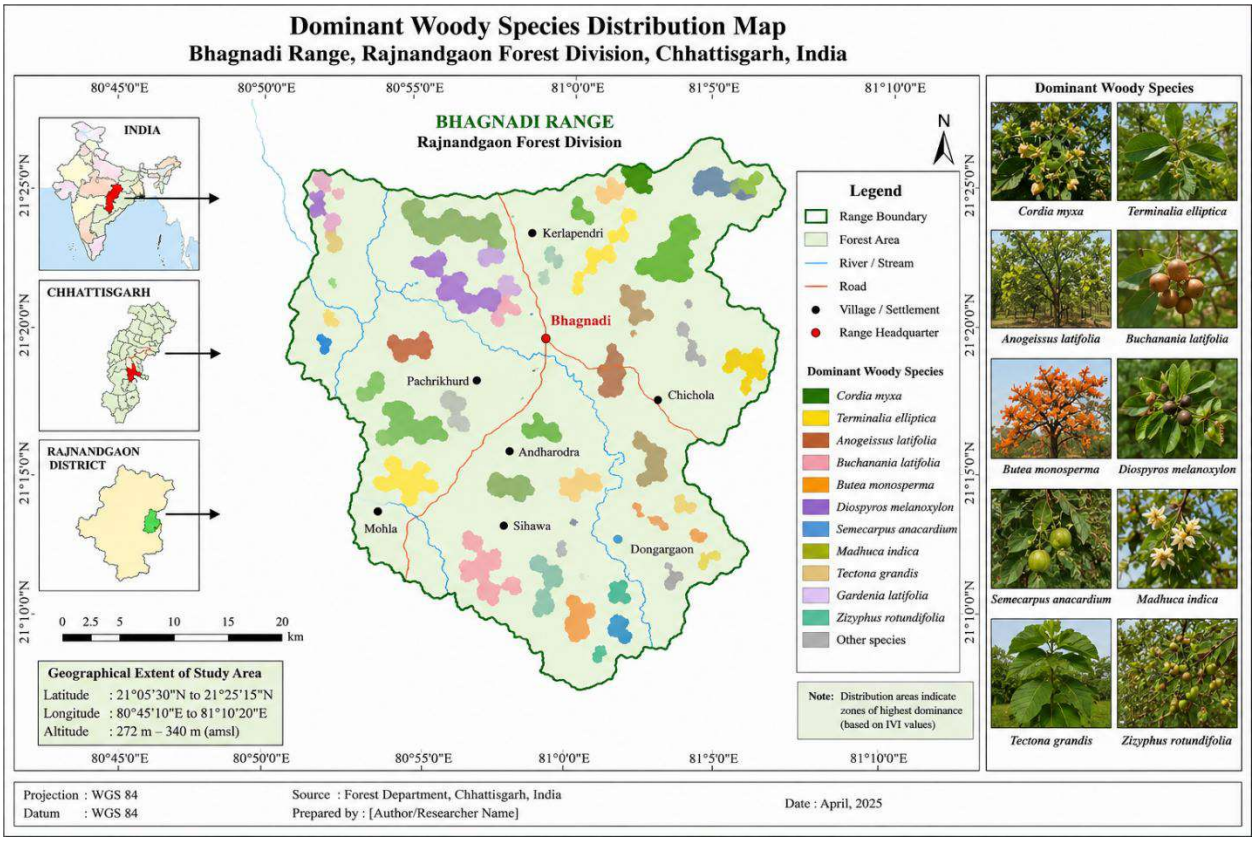


Figure 4. Distribution map of the dominant woody species in the Bagnadi Forest Range, Rajnandgaon Forest Division, Chhattisgarh, India. The map illustrates the spatial distribution of the major woody species recorded during the phytosociological survey, based on field observations. Source**:** Forest Department, Chhattisgarh (2025); Survey and mapping prepared by the authors using GPS field data and GIS analysis

context of published literature and should not be interpreted as direct evidence from the present study (Figures 3 and 4).

4. CONCLUSION

The present study provides baseline information on the woody species composition and phytosociological characteristics of the Bagnadi Forest Range in the Rajnandgaon Forest Division, Chhattisgarh. A total of 43 woody species were recorded, with *Cordia myxa, Terminalia elliptica, Madhuca indica,* and *Anogeissus latifolia* exhibiting the highest Importance Value Index (IVI), indicating their ecological prominence within the woody community. The observed Shannon–Wiener diversity and Simpson's dominance indices indicate a community characterised by the dominance of a few species alongside the presence of several less abundant species. However, the present study did not evaluate statistical relationships among diversity, dominance and density; therefore, no causal relationship is inferred.

The findings provide useful baseline ecological information that may support future biodiversity monitoring, conservation planning, and sustainable forest management in the Bagnadi Forest Range. Although several recorded species are recognised as important non-timber forest products (NTFPs) in Central India, the present study did not assess livelihood dependence, harvesting intensity or economic value; therefore, no direct socio-economic conclusions are drawn. Furthermore, the study was limited to phytosociological assessment and did not include regeneration status, disturbance assessment or detailed statistical analyses of ecological relationships. Future investigations incorporating these aspects, together with long-term vegetation monitoring, will provide a more comprehensive understanding of forest dynamics and strengthen conservation and management strategies.

Acknowledgments

The authors express their deep sense of gratitude to DRS,

IGKV, Raipur (CG), the Dean, College of Agriculture, Raipur, and the Head of the Forestry Department for providing the opportunity to study in other departments. I extend my gratitude to the CCF, CF, DFO, range officers, and other field officers of the Rajnandgaon forest division of the State Forest Department of Chhattisgarh for their support in identifying the species and for their guidance in navigating the forest during the course of study in the Bagnadi forest ranges. Without their support, we would not have been able to commence the work smoothly.

CRediT authorship contribution statement

Nalish Kumar Anchal: Conceptualisation, Data collection, Writing original draft, Formal analysis, Data curation. **Mahendra Nath Naugraiya:** Reviewing and editing, Visualization, Tabulation, Data curation. Methodology, Software, Supervision,

Funding

No funding was obtained for this study.

Conflict of interest

The authors declare that they have no competing interests.

Declaration of generative AI and AI-assisted technologies in the writing process

The authors used AI-assisted tools only for language improvement and grammatical correction during manuscript preparation. All scientific interpretations, analysis and conclusions are solely the responsibility of the authors.

Data availability statement

The data and material are available from the first author.

Ethical approval and consent to participate

This study did not involve human participants or animal experimentation; therefore, ethical approval and consent to participate were not required.

REFERENCES

Bhattacharya, P. & Hayal, S.F. (2004). Sustained NTFP management for rural development: A case study from Madhya Pradesh, India. *International Forestry Review, 6(2)*, 161-168.

Bardani, A. (2003). Survey of non-timber forest products in Bhoramdeo Wildlife Sanctuary of Chhattisgarh. *Journal of Forestry Research, 12(3)*, 112-118.

Chaturvedi, R.K., Raghubanshi, A.S., Tomlinson, K.W., & Singh, J.S. (2017). Impacts of human disturbance in tropical dry forests increase with soil moisture stress. *Journal of Vegetation Science*, 28(5), 997-1007.

Chaturvedi, R.K., et al. (2019). Biomass, carbon density and diversity of tree species in tropical dry deciduous forests in Central India. *Acta Ecologica Sinica*, *39*(4), 289-299.

Dugaya, D., Kiran, P.V., Singh, R.K., Kaur, M., & Chaudhry, P. (2020). Phytosociological observations on tree species diversity of an urban tropical dry deciduous forest of Central India. *Advances in Forestry Science*, *7*(3), 1121-1130.

Mansingh, A., Pradhan, A., Sahoo, S.R., Cherwa, S.S., Mishra, B.P., Rath, L.P., Ekka, N.J., & Panda, B.P. (2025). Tree diversity, population structure, biomass accumulation, and carbon stock dynamics in tropical dry deciduous forests of Eastern India. BMC Ecology and Evolution, 25(1), Article 48.Mishra, R. (1968). Ecology Workbook. *Oxford and IBH Publishing Co.*, New Delhi, India.

Murthy, I.K. & Sukumar, R. (2005). Financial valuation of non-timber forest product flows in Uttara Kannada district, Western Ghats, Karnataka. *Current Science, 88(10)*, 1573-1579.

Mueller-Dombois, D., & Ellenberg, H. (1974). *Aims and Methods of Vegetation Ecology*. John Wiley & Sons, New York, USA.Naugraiya, M.N. & Pathak, P.S. (1986). Analysis of grassland vegetation on a top sequence. *Indian Journal of Range Management, 7*(1), 27-32.

Naugraiya, M.N., & Pathak, P.S. (1993). Post-felling colonization and production of winter annuals in Leucaena forest. *International Journal of Ecology and Environmental Sciences, 19*, 213-217.

Putman, R.J. (1994). Community Ecology. *Chapman and Hall*, London, UK.

Ray, T., Mohanasundari, T., Madguni, O.D., & Rajkumar, M. (2025). Forest fire regimes and plant diversity in tropical dry deciduous forests of Central India. *Journal of Sustainable Forestry*, *44*(10), 1203-1217.

Rathaude, S.K., Irtiqa, S., Abdul Rahim, P.P., Wani, Z.A., Kothandaraman, S., & Dar, J.A. (2025). Disturbance intensity drives structural, compositional and diversity attributes in tropical dry forests of Central India. *Trees, Forests and People*, *20*, 100864.

Sagar, R., & Singh, J.S. (2003). Tree species composition, dispersion and diversity along a disturbance gradient in a dry tropical forest region of India. *Forest Ecology and Management, 186*, 61-71.

Tripathi, S., Verma, S., & Goldey, P. (2000). Using plants for health: Indigenous knowledge in health care in a tribal region of Bihar, India. *International Journal of Sustainable Development and World Ecology, 7*, 321-333.