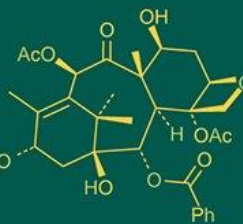
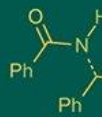
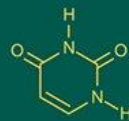
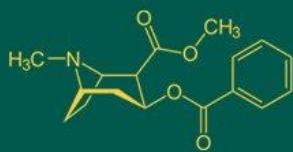


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Plant diversity and vegetation composition of the Chilphi Range, Kawardha forest division, Chhattisgarh

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Abstract

The present study was undertaken in the Central Indian landscape of Chilphi Range of Kawardha Forest Division, Chhattisgarh to assess the rich floristic composition and plant diversity of the region. Field surveys were conducted during the year 2024-2025 across four cardinal zones (north, south, east, and west) and quadrats of size 10 x 10 m for trees, 5 x 5 m for shrubs and 1 x 1 m for herbs were laid. A total of 63 plant species belonging to 58 genera and 34 families were documented, comprising 28 tree species, 15 shrub species, and 20 herb species. Tree density varied from 710 to 980 stems ha⁻¹, while basal area ranged between 42.10 and 48.69 m² ha⁻¹, with *Shorea robusta* emerging as the most dominant species in three of the four zones. Shrub density ranged from 1440 to 2480 individuals ha⁻¹, dominated by *Vernonia divergens*, *Colebrookea oppositifolia*, and *Phoenix acaulis*, whereas the herb layer (57,000-87,000 individuals ha⁻¹) showed spatial heterogeneity with *Pogostemon benghalensis*, *Elephantopus scaber*, and *Curculigo orchoides* as dominant species. Diversity analysis revealed significant inter-zonal variation, with the highest tree and shrub diversity in the East and West zones, while the North zone showed the lowest tree diversity (Shannon Index: 1.43) and highest dominance. High beta diversity values confirmed substantial species turnover across the landscape. The findings underscore the ecological significance and complex mosaic structure of the Chilphi Range, providing a crucial baseline for conservation planning and sustainable management.

Keywords: Central Indian landscape, Chilphi Range, floristic composition, plant diversity

Introduction

Tropical forests are among the most structurally complex and species-rich ecosystems on Earth and exhibit substantial heterogeneity even across small spatial scales (Sullivan *et al.*, 2017) [1]. Understanding this plant diversity and vegetation composition is fundamental to the conservation and sustainable management of these critical ecosystems. Floristic surveys serve as a primary tool in this endeavor, providing essential data not only on species richness but also on ecological stability, successional stages, and the impacts of anthropogenic disturbance on vegetation dynamics (Chiarucci A & Bonini, 2005; Nicholas *et al.*, 2006) [2, 3]. In India, tropical dry deciduous forests constitute a major portion of the country's forest cover, recognized for their ecological significance and substantial resource value (Champion & Seth, 1968; Bahuguna *et al.*, 2016) [4, 5]. These forests harbor a wide variety of timber-yielding, medicinal, and non-timber forest product (NTFP) species that sustain the livelihoods of rural and tribal communities, thereby contributing to both biodiversity conservation and socio-economic resilience. The state of Chhattisgarh is characterized by a mosaic of such forest types, among which dry deciduous formations are the most extensive. The Kawardha Forest Division, forming part of the biodiverse Maikal Range, supports Sal dominated vegetation with notable floristic diversity.

Previous studies in central India have documented considerable variation in forest composition across different regions, attributed to differences in topography, soil characteristics, and varying degrees of anthropogenic pressure (Dutta & Devi, 2017; Lal *et al.*, 2022; Panda *et al.*, 2023) [6, 7, 8]. However, despite its ecological importance, systematic and quantitative studies on the species composition and diversity of the Kawardha Forest

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Division remain limited. The Chilphi Range within this division represents a significant but understudied landscape. Documenting the floristic composition of such lesser-explored areas is crucial for understanding regional biodiversity patterns and for developing effective, site-specific conservation strategies.

In this context, the present study was conducted to document and analyze the plant species composition and diversity of the Chilphi Range. The study also seeks to evaluate spatial variation in vegetation structure across four zones-north, south, east, and west, representing distinct vegetation conditions within the landscape. The findings are expected to contribute to baseline ecological knowledge essential for long-term forest monitoring, biodiversity assessment, and sustainable management planning in central India's dry deciduous ecosystems.

Materials and Methods

Study Area

The study was conducted in the Chilphi Range of the Boramdev Wildlife Sanctuary, Kawardha Forest Division, Chhattisgarh, India (21°57'-22°15'N; 80°53'-81°10'E). The site covers an area of 192 km², located approximately 148 km from Raipur. Geographically, it forms part of the Maikal hills within the Central Indian Highlands. The landscape is topographically diverse, with elevations ranging from 320 to 925 meters above sea level and experiences a subtropical climate with a mean annual temperature range of 21.6-33.6 °C and occasional winter frost. This varied environment supports a rich biodiversity, including three distinct forest types: Dry Teak Forest (5A/C1b), Moist Peninsular High-Level Sal Forest (3C/C2e(i)), and Southern Dry Mixed Deciduous Forest (5A/C3).

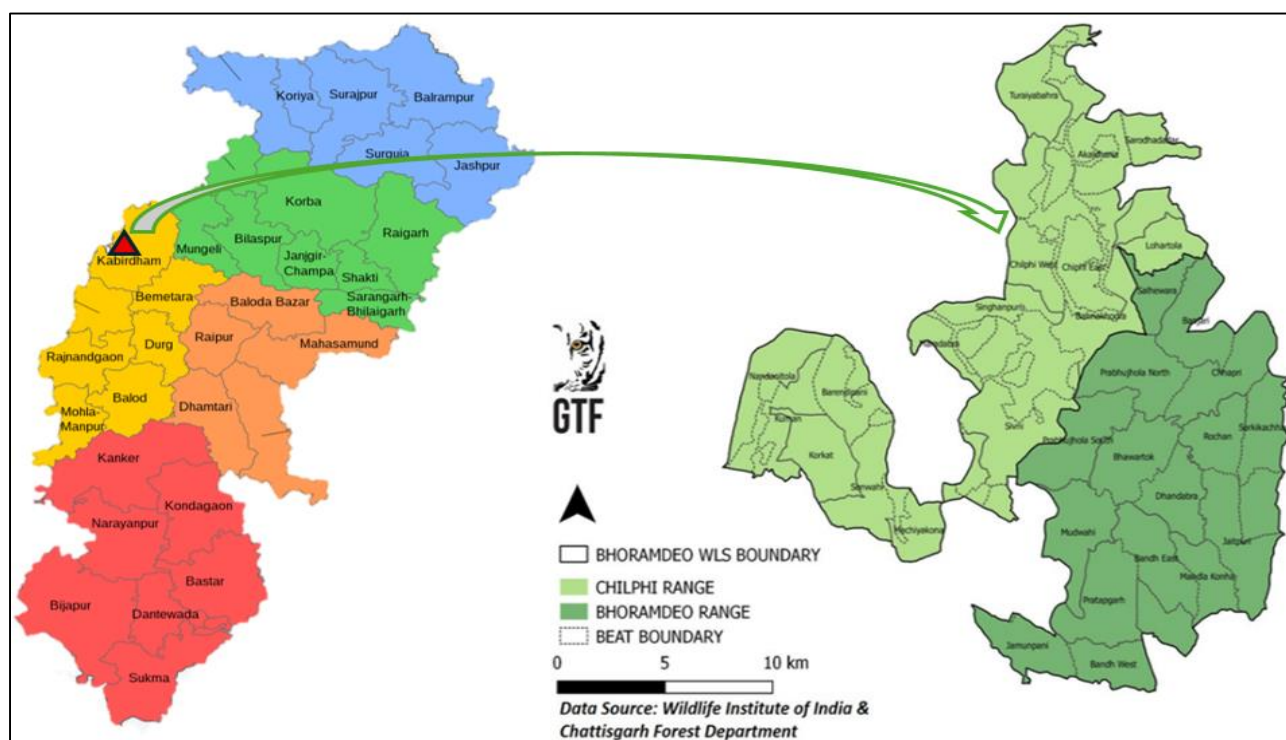


Fig 1: Map of the Study Area

Methods of Data Collection and Analysis

Field sampling was conducted between 2023 and 2024. Following an initial reconnaissance survey, the study area was stratified into four cardinal zones (North, South, East, and West) to ensure comprehensive spatial coverage. Within each zone, vegetation was sampled using a nested-quadrat approach. Ten 10 m × 10 m quadrats were established for the enumeration of trees. The Girth at Breast Height (GBH) of every individual tree was measured at 1.37 m above ground level and subsequently converted to Diameter at Breast Height (DBH) for analysis. Concentrically nested within each major quadrat, a 5 m × 5 m sub-quadrat was established for shrub sampling, and a 1 m × 1 m sub-quadrat was established for herbs. The collar diameter was recorded for every individual shrub and herb within their respective sub-quadrats.

The collected vegetation data were quantitatively analyzed for frequency, density, and abundance (Curtis & McIntosh, 1950)^[9]. The Importance Value Index (IVI) was calculated as the sum of relative frequency, relative density, and relative basal area (Phillips, 1959)^[10]. Plant diversity across

the different layers and zones was assessed using Shannon Index (Shannon and Weaver, 1963)^[11], Simpson's Index of Dominance (Simpson, 1949)^[12], Pielou's Evenness Index (Pielou, 1966)^[13], Species richness (Margalef, 1958)^[14] and Beta Diversity (Whittaker, 1972)^[15].

Results

Species Composition of Chilphi Range

A total of 63 plant species belonging to 58 genera and 34 families were recorded from the study area. Of these, 28 were trees (26 genera and 20 families), 15 shrubs (14 genera and 12 families), and 20 herbs (19 genera and 11 families). The family Fabaceae contributed the highest number of species (8), followed by Combretaceae (4) and Asteraceae (4).

Tree Layer

The tree species composition varied markedly across the four cardinal zones of the study area (Table 1). Total stem density was highest in the North zone (980 stems ha⁻¹), followed by the West (940 stems ha⁻¹), while the South and

East zones were less densely stocked (730 and 710 stems ha^{-1} , respectively). In contrast, the East zone possessed the greatest stand basal area (48.69 $\text{m}^2 \text{ha}^{-1}$), while the West, North, and South zones exhibited remarkably similar basal areas as 42.10 $\text{m}^2 \text{ha}^{-1}$, 42.25 $\text{m}^2 \text{ha}^{-1}$ and 42.42 $\text{m}^2 \text{ha}^{-1}$ respectively. This discrepancy indicates that the East zone was characterized by fewer but larger trees, whereas the North zone comprised a higher number of smaller-diameter individuals.

A few key species dominated the study area, as reflected by the Importance Value Index (IVI). *Shorea robusta* consistently achieved the highest Importance Value Index (IVI) in the West (95.24), North (170.05), and South (105.36) zones. Its dominance was particularly pronounced in the North zone, where its stem density and basal area

were 630 stems ha^{-1} and 32.62 $\text{m}^2 \text{ha}^{-1}$ respectively, indicating a near-monospecific stand structure. In the East zone, however, *Diospyros melanoxylon* was the most important species with IVI as 58.26. Despite this, the stand structure was still influenced by larger individuals of *Shorea robusta* and *Anogeissus latifolia*, which recorded the highest basal areas in that zone (12.57 and 9.01 $\text{m}^2 \text{ha}^{-1}$, respectively).

The West zone supported the highest number of tree species (16 species), followed by the East zone (10 species). Across all zones, low-density species such as *Cassia fistula*, *Bauhinia roxburghiana*, and *Schrebera swietinioides* occurred sporadically, contributing little to total basal area and IVI but enhancing overall species diversity.

Table 1: Species composition of tree layer in different study sites of Chilphi Range of Kawardha Forest Divison

S. No	Scientific Name	Family	EAST ZONE				WEST ZONE				NORTH ZONE				SOUTH ZONE			
			F	D	BA	IVI	F	D	BA	IVI	F	D	BA	IVI	F	D	BA	IVI
1	<i>Diospyros melanoxylon</i> Roxb.	Ebenaceae	60	210	5.37	58.26	20	60	0.89	12.76	20	30	0.27	9.41				
2	<i>Lagerstroemia parviflora</i> Roxb.	Lythraceae	50	80	3.25	32.64	10	20	0.15	4.62								
3	<i>Schleichera oleosa</i> Lour.	Sapindaceae	20	30	4.89	20.16	20	30	1.08	10.02								
4	<i>Anogeissus latifolia</i> (Roxb. ex DC.) Wall. ex Guill. & Perr.	Combretaceae	60	110	9.01	51.65					10	10	1.22	6.77	10	10	0.48	5.84
5	<i>Terminalia tomentosa</i> Willd.	Combretaceae	30	40	4.20	23.08	70	110	4.87	38.17	20	30	2.94	15.74	40	60	4.42	31.97
6	<i>Cassia fistula</i> L.	Fabaceae	20	20	0.14	8.99					10	20	0.15	5.26	10	10	0.07	4.87
7	<i>Shorea robusta</i> Gaertn.	Dipterocarpaceae	30	120	12.57	51.54	70	300	20.39	95.24	100	630	32.62	170.05	60	300	18.78	105.36
8	<i>Buchanania lanzan</i> Spr.	Anacardiaceae	30	40	2.92	20.45	80	140	4.12	41.70	50	50	1.14	22.07	10	10	0.51	5.90
9	<i>Ougeinia oojeinensis</i> (Roxb.) Hotch	Fabaceae	20	40	3.42	18.53	20	40	1.21	11.38	10	10	0.20	4.35				
10	<i>Strychnos potatorum</i> L.f.	Loganiaceae	20	20	2.92	14.70												
11	<i>Bauhinia roxburghiana</i> Voigt.	Fabaceae					10	10	1.56	6.90	10	10	0.07	4.05	10	10	1.22	7.59
12	<i>Syzgium cumini</i> (L.) Skeels.	Myrtaceae					40	70	2.29	21.39	10	20	0.33	5.67				
13	<i>Haldina cordifolia</i> (Roxb.) HK. F. ex Bradis	Rubiaceae					20	20	1.70	10.41								
14	<i>Milusa tomentosa</i> Roxb. J. Sincl.	Annonaceae					30	50	1.34	14.89	10	10	0.10	4.12				
15	<i>Schrebera swietinioides</i> Roxb.	Oleaceae					10	10	0.33	3.97								
16	<i>Radermachera xylocarpa</i> (Roxb.) K. Schum.	Bignoniaceae					10	10	0.59	4.59								
17	<i>Madhuca longifolia</i> (Koen.) Macbr.	Sapotaceae					20	20	0.68	7.99					10	10	0.64	6.22
18	<i>Casearia graveolens</i> Dalzell	Salicaceae					20	20	0.28	7.05	40	40	0.25	16.09				
19	<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae					20	30	0.62	8.92	30	70	2.02	20.49	20	20	0.30	10.12
20	<i>Zizyphus mauritiana</i> Lam.	Rhamnaceae									10	10	0.10	4.12				
21	<i>Terminalia chebula</i> Retz.	Combretaceae									20	40	0.85	11.80				
22	<i>Semecarpus anacardium</i> L.	Anacardiaceae													10	30	2.21	12.64
23	<i>Aegle marmelos</i> (L.) Corr.	Rutaceae													30	70	4.07	29.19
24	<i>Mallotus philippinesis</i> (Lam.) Mull. Arg.	Euphorbiaceae													10	20	0.58	7.45
25	<i>Cleistanthus collinus</i> (Roxb.) Benth. ex Hook.f.	Phyllanthaceae													10	20	0.80	7.95
26	<i>Boswellia serrata</i> Roxb.	Burseraceae													20	30	2.17	15.89
27	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Combretaceae													20	20	0.80	11.29
28	<i>Tectona grandis</i> L.f.	Lamiaceae													30	110	5.36	37.70
	Total		340	710	48.69	300	470	940	42.10	300	350	980	42.25	300	300	730	42.42	300

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

Shrub Layer

Shrub composition varied across the four zones of the Chilphi Range (Table 2). Overall, shrub density ranged between 1440-2480 shrubs ha^{-1} , while basal area varied

from 0.08-1.12 $\text{m}^2 \text{ha}^{-1}$ across zones. The highest shrub density was recorded in the North zone (2480 shrubs ha^{-1}), followed by the East (2400 shrubs ha^{-1}), West (1880 shrubs ha^{-1}), and South (1440 shrubs ha^{-1}). Conversely, basal area

was greatest in the South zone (1.12 m² ha⁻¹) and lowest in the North (0.08 m² ha⁻¹), indicating thicker stems in the former and slender individuals in the latter.

In the East zone, 6 shrub species belonging from 5 families were recorded, dominated by *Colebrookea oppositifolia* (1120 stems ha⁻¹, IVI 136.75) and *Lantana camara* (560 stems ha⁻¹, IVI 70.62). The West zone supported 10 species (8 families), with *Vernonia divergens* (360 stems ha⁻¹, IVI 64.34) and *Colebrookea oppositifolia* (320 stems ha⁻¹, IVI

59.78) as dominants. In the North zone, 7 species were recorded, with *Phoenix acaulis* (960 stems ha⁻¹, IVI 123.51) and *Vernonia divergens* (920 stems ha⁻¹, IVI 85.33) as major contributors. The South zone contained 4 species from 4 families, dominated by *Vernonia divergens* (960 stems ha⁻¹, IVI 141.65) and *Zizyphus xylopyrus* (basal area 0.662 m² ha⁻¹). The results indicate marked spatial heterogeneity, with denser but smaller shrubs in the North and fewer but thicker shrubs in the South.

Table 2: Species composition of shrub layer in different study sites of Chilphi Range of Kawardha Forest Division

S. No.	Scientific Name	Family	East Zone				West Zone				North Zone				South Zone			
			F	D	BA	IVI	F	D	BA	IVI	F	D	BA	IVI	F	D	BA	IVI
1	<i>Vernonia divergens</i> (Roxb.) Edgew.	Asteraceae	20	280	0.023	32.98	20	360	0.058	64.34	20	920	0.0247	85.33	40	960	0.280	141.65
2	<i>Colebrookea oppositifolia</i> Sm.	Lamiaceae	40	1120	0.234	136.75	20	320	0.054	59.78					10	200	0.092	34.58
3	<i>Triumfetta rhomboidea</i> Jacq.	Malvaceae	10	40	0.003	10.15												
4	<i>Lantana camara</i> L.	Verbenaceae	20	560	0.126	70.62	10	200	0.048	43.58					10	120	0.087	28.57
5	<i>Sida acuta</i> Burm. F.	Malvaceae	20	200	0.002	24.31	10	80	0.002	12.12								
6	<i>Randia dumetorum</i> Lam.	Rubiaceae	20	200	0.006	25.20	10	120	0.004	15.28	20	200	0.0053	30.45				
7	<i>Flemingia strobilifera</i> (L.) W.T. Aiton	Fabaceae					20	280	0.002	29.40	20	200	0.0012	25.03				
8	<i>Eranthemum pulchellum</i> Andrews	Acanthaceae					20	160	0.002	22.90								
9	<i>Phoenix acaulis</i> Buch.	Arecaceae					20	120	0.008	23.87	40	960	0.0407	123.51				
10	<i>Ocimum gratissimum</i> L.	Lamiaceae					10	160	0.003	16.59								
11	<i>Abelmoschus moschatus</i> Medik.	Malvaceae					10	80	0.002	12.14								
12	<i>Embelia robusta</i> auct. non Roxb.	Myrsinaceae									10	80	0.0017	13.14				
13	<i>Zizyphus rotundifolia</i> Lam.	Rhamnaceae									10	80	0.0013	12.64				
14	<i>Petalidium barlerioides</i> (Roth) Nees.	Acanthaceae									10	40	0.0005	9.91				
15	<i>Zizyphus xylopyrus</i> (Retz.) Willd.	Rhamnaceae													20	160	0.662	95.19
Total			130	2400	0.39	300	150	1880	0.18	300	130	2480	0.08	300	80	1440	1.12	300

Abbreviations: F = Frequency (%), D = Density (stems ha⁻¹), BA = Basal area (m² ha⁻¹) and IVI = Importance value index

Herb Layer

Herbaceous species composition showed considerable variation across the four zones of the Chilphi Range (Table 3). Herb density ranged from 57,000 to 87,000 individuals ha⁻¹, being highest in the West zone (87,000 ha⁻¹) and lowest in the South zone (57,000 ha⁻¹). The East zone recorded the highest basal area (0.71 m² ha⁻¹), followed by the West (0.53 m² ha⁻¹), while the North (0.23 m² ha⁻¹) and South (0.20 m² ha⁻¹) zones exhibited lower values.

In the East zone, 7 species belonging from 3 families were recorded, dominated by *Pogostemon benghalensis* (29,000 stems ha⁻¹, IVI 101.45) and *Ageratum houstonianum* (26,000 stems ha⁻¹, IVI 95.16). The West zone supported 12 species (8 families), dominated by *Pogostemon benghalensis* (18,000 stems ha⁻¹, IVI 75.08) along with *Curculigo orchoides* and *Andrographis paniculata*. The North zone (13 species, 10 families) was dominated by *Elephantopus scaber* (26,000 stems ha⁻¹, IVI 82.92) and *Ageratum houstonianum*, while the South zone (8 species, 5 families) showed dominance of *Curculigo orchoides* (15,000 stems ha⁻¹, IVI 71.40) and *Elytraria acaulis* (IVI 66.35).

Overall, the herb layer was characterized by high species turnover and spatial heterogeneity. *Pogostemon benghalensis* dominated the East and West zones, *Elephantopus scaber* the North, and *Curculigo orchoides* the South. The results indicate that while the East zone had the most productive herb layer (highest basal area), the West supported greater number of species.

Diversity Analysis

The diversity indices of tree, shrub, and herb layers

exhibited notable spatial variation across the four zones of the Chilphi Range (Table 4). The Shannon diversity index (H') for trees ranged from 1.43 to 2.98, being highest in the east zone and lowest in the north. Shrubs showed moderate variation (1.40-2.25), with the west zone showing the highest diversity, while herbs displayed the widest range (1.88-3.02), attaining maximum diversity in the north zone. Simpson's dominance index (Cd) for trees varied between 0.15 and 0.61, indicating maximum dominance in the north and minimum in the east zone. Shrub dominance ranged from 0.26 to 0.46, being highest in the east and lowest in the west, whereas for herbs, it varied between 0.15 and 0.32, with the greatest dominance in the east zone.

Equitability (e) values for trees ranged from 0.54 to 1.30, with the east and south zones showing a more even distribution of individuals among species. Shrubs showed relatively uniform evenness (0.78-1.10), while herbs exhibited consistently high values (0.96-1.18), indicating a fairly even species distribution across zones.

Margalef's species richness index (d) for trees ranged from 9.77 to 15.78, being highest in the west zone and lowest in the east. Shrubs followed a similar pattern, with richness values between 3.72 and 9.74, and herbs between 6.77 and 14.77, the latter being highest in the south zone.

Beta diversity (β) values indicated considerable habitat heterogeneity. For trees, β ranged from 2.94 to 5.00, with the south zone showing the highest heterogeneity. Shrub β values (5.00-6.67) were maximum in the west, whereas herb β (2.59-4.48) peaked in the north zone. Overall, diversity and richness were highest in the east and west zones, while dominance was most pronounced in the north, reflecting clear ecological differentiation across the study area.

Table 3: Species composition of herb layer in different study sites of Chilphi Range of Kawardha Forest Division

S. No.	Scientific Name	Family	EAST ZONE				WEST ZONE				NORTH ZONE				SOUTH ZONE			
			F	D	BA	IVI	F	D	BA	IVI	F	D	BA	IVI	F	D	BA	IVI
1	<i>Ageratum houstonianum</i> Mill.	Asteraceae	90	26000	0.213	95.16					30	11000	0.0131	30.07	30	10000	0.009	38.93
2	<i>Pogostemon benghalensis</i> (Burm.f.) Kuntze	Lamiaceae	60	29000	0.310	101.45	30	18000	0.234	75.08								
3	<i>Parthenium hysterophorus</i> L.	Asteraceae	40	7000	0.137	42.71	20	4000	0.078	25.99								
4	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Amaranthaceae	30	7000	0.013	21.49									10	3000	0.005	13.59
5	<i>Acmella paniculata</i> (Wall. ex DC.) R.K. Jansen	Asteraceae	10	1000	0.002	5.26	30	6000	0.015	19.78	10	2000	0.0027	7.16	10	7000	0.038	37.16
6	<i>Achyranthes aspera</i> L.	Amaranthaceae	30	7000	0.010	21.12	10	3000	0.003	7.37					20	6000	0.006	24.54
7	<i>Elephantopus scaber</i> L.	Asteraceae	10	5000	0.021	12.79	30	8000	0.028	24.48	70	26000	0.0595	82.92	10	4000	0.023	24.28
8	<i>Andrographis paniculata</i> (Burm.f.)	Acanthaceae					30	10000	0.067	34.29	20	6000	0.0304	27.59				
9	<i>Oplismenus burmannii</i> (Retz.) P. Beauv.	Poaceae					30	6000	0.019	20.42	20	8000	0.0192	25.37	10	5000	0.018	23.74
10	<i>Cyanthillium cinereum</i> (L.) H. Rob.	Asteraceae					30	7000	0.012	20.32								
11	<i>Curculigo orchoides</i> Gaertn.	Hypoxidaceae					40	11000	0.008	27.41	70	9000	0.0072	38.77	70	15000	0.012	71.40
12	<i>Cyperus rotundus</i> L.	Cyperaceae					20	5000	0.036	19.31	10	3000	0.0457	26.84				
13	<i>Cyclospermum leptophyllum</i> (Pers.) Sprague ex Britton & P. Wilson	Apiaceae					10	2000	0.009	7.38								
14	<i>Blumea axillaris</i> (Lam.) DC.	Asteraceae					20	7000	0.018	18.17	10	3000	0.0245	17.77				
15	<i>Evolvulus nummularius</i> L.	Convolvulaceae									10	2000	0.0023	7.00				
16	<i>Alternanthera sessilis</i> (L.) R. Br. ex DC.	Amaranthaceae									10	1000	0.0020	5.59				
17	<i>Urginea indica</i> Kunth.	Liliaceae									10	2000	0.0214	15.17				
18	<i>Cleome viscosa</i> L.	Cleomaceae									10	1000	0.0003	4.85				
19	<i>Leucas glabrata</i> R. Br.	Lamiaceae									10	4000	0.0054	10.89				
20	<i>Elytraria acaulis</i> (Lam.) Lindau	Acanthaceae													20	7000	0.084	66.35
Total			270	82000	0.71	300	300	87000	0.53	300	290	78000	0.23	300	180	57000	0.20	300

Abbreviations: F = Frequency (%), D = Density (stems ha⁻¹), BA = Basal area (m² ha⁻¹) and IVI = Importance value index**Table 4:** Species diversity parameters of the various study sites in Chilphi Range of Kawardha Forest Division

Vegetation Layers	Study Sites	H'	Cd	e	d	β
Tree	East	2.98	0.15	1.30	9.77	2.94
	West	2.75	0.27	0.99	15.78	3.40
	North	1.43	0.61	0.54	13.78	4.12
	South	2.76	0.24	1.02	14.77	5.00
Shrub	East	1.40	0.46	0.78	5.76	5.00
	West	2.25	0.26	0.98	9.74	6.67
	North	1.64	0.41	0.84	6.76	5.38
	South	1.53	0.42	1.10	3.72	5.00
Herb	East	1.88	0.32	0.96	6.77	2.59
	West	2.64	0.25	1.06	11.78	4.00
	North	3.02	0.15	1.18	12.77	4.48
	South	2.41	0.25	1.16	14.77	4.21

Abbreviations: H' = Shannon index, Cd = Simpson's dominance index, e = Pielou's equitability, d = Margalef's richness index, β = Beta diversity

Table 5: Comparison of species diversity parameters of tropical dry deciduous forest of Chilphi Range with past studies of different regions.

Location	Layers	H'	Cd	e	d	β	Source
Tropical Dry Deciduous Forest, Chilphi	Tree	1.43-2.98	0.15-0.61	0.54-1.30	9.77-15.78	2.94-5.0	Present Study
	Shrub	1.40-2.25	0.26-0.46	0.78-1.10	3.72-9.74	5.0-6.67	
	Herb	1.88-3.02	0.15-0.32	0.96-1.18	6.77-14.77	2.59-4.48	
Dry Tropical Forest, Korba Forest Division, C.G.	Tree	1.43-2.31	0.33-0.60	0.57-0.88	3.95-4.39	2.94-4.17	Mexudhan <i>et al.</i> , (2024) ^[16]
Tropical Dry Deciduous Forest, Achanakmaar Amarkantak Biosphere Reserve (AABR)	Tree	2.36-2.91	0.21-0.37	0.77-1.01	5.13-6.13	3.33-4.56	Lal <i>et al.</i> , (2022) ^[7]
Dry Tropical Forest, Achanakmaar Amarkantak Biosphere Reserve (AABR)	Herb	2.18-3.64	0.045-0.17	0.81-0.95	16.69-30.52	3.12-7.36	Thakur (2018) ^[17]
Tropical Dry Deciduous Forest, Jharsuguda, Odisha	Tree	3-3.45	0.05-0.08	0.86-0.88	-	-	Mansingh <i>et al.</i> , (2025) ^[18]
Tropical Moist Deciduous Forest, Similipal Biosphere Reserve, Odisha	Tree	1.8-3.11	0.07-0.316	0.611-0.951	3.36-6.59	-	Mishra <i>et al.</i> , (2012) ^[19]
	Shrub	1.76-2.37	0.102-0.216	0.76-0.96	1.66-2.92	-	
	Herb	1.57-2.99	0.053-0.323	1.24-4.24	1.24-4.24	-	
Tropical Dry Deciduous Forest, Ranchi	Tree	2.43-2.97	0.24-0.33	0.92-0.99	1.79-2.53	-	Panda <i>et al.</i> , (2023) ^[8]
Tropical Dry Deciduous Forest, Ranchi	Shrub	1.53-1.65	0.46-0.48	0.85-0.86	0.56-0.67	-	Panda <i>et al.</i> , (2020) ^[20]
	Herb	3.30-3.39	0.13-0.14	1	1.27-1.6	-	
Tropical Moist Deciduous Forests of Ranchi, Jharkhand	Tree	2.25	0.32	0.49	10.28	-	Kumar & Saikia (2020) ^[21]
	Shrub	2.72	1.1	0.76	4.88	-	
	Herb	2.98	0.08	0.78	5.85	-	
Tropical Deciduous Forest, Jaipur, Rajasthan	Tree	1.64-2.57	0.12-0.4	0.45-0.78	3.09-6.15	-	Kumar <i>et al.</i> , (2024) ^[22]
	Shrub	1.81-2.12	0.17-0.24	0.64-0.74	2.17-2.52	-	
Tropical Moist Mixed Deciduous Forest, Assam	Tree	3.63	0.03	0.89	-	-	Dutta & Devi (2017) ^[6]
	Shrub	2.26	0.13	0.8	-	-	
	Herb	2.32	0.15	0.71	-	-	

Abbreviations: H' = Shannon index, Cd = Simpson's dominance index, e = Pielou's equitability, d = Margalef's richness index, β = Beta diversity

Discussion

The vegetation composition of the Chilphi Range represents a typical tropical dry deciduous forest of central India, dominated by *Shorea robusta* and *Terminalia tomentosa*. This dominance pattern is consistent with observations from similar forest types in Chhattisgarh and Jharkhand (Dutta & Devi, 2017; Panda *et al.*, 2023)^[6, 8]. The predominance of Fabaceae and Combretaceae among trees reflects their wide ecological amplitude and adaptation to seasonal drought (Lal *et al.*, 2022)^[7], while the herbaceous dominance of Asteraceae and Poaceae suggests secondary successional stages influenced by recurring fire and grazing pressures. Spatial variation in density and IVI across zones reflects the mosaic character of the landscape and management history. The North zone exhibited a Sal-dominated composition typical of relatively closed Sal stands, the South zone combined Sal dominance with teak plantations, the West zone comprised Sal-mixed forest and the East zone consisted of mixed forest interspersed with dry grasslands. These structural differences explain observed patterns in density and IVI. *Shorea robusta* dominates most zones due to its regeneration capacity under disturbance, while the East zone's mixed composition (including *Diospyros melanoxylon* and *Anogeissus latifolia*) indicates greater microhabitat heterogeneity.

Tree density (710-980 stems ha⁻¹) and basal area (42.10-48.69 m² ha⁻¹) in the Chilphi Range are comparable to values reported from other tropical dry deciduous forests in central India (Panda *et al.*, 2023; Kumar *et al.*, 2024; Mansingh *et al.*, 2025)^[8, 22, 18] but lower than those reported from moist deciduous forests (Mishra *et al.*, 2012; Dutta & Devi, 2017; Kumar & Saikia, 2020)^[19, 6, 21], where higher rainfall and humidity promote vigorous tree growth and greater stand biomass. The relatively moderate basal area and density recorded in the present study are characteristic

of seasonally dry environments where fire, grazing, and resource extraction restrict regeneration and tree girth increment.

Shrub density (1440-2480 shrubs ha⁻¹) was consistent with reports from Boramdeo Wildlife Sanctuary (Jhariya, 2017)^[23], though basal area was comparatively lower. The widespread occurrence of *Vernonia divergens*, *Colebrookea oppositifolia*, and *Lantana camara* indicates partial invasion, suggesting the need for management to restore native understorey diversity. Herb density and basal area were relatively lower than those reported by Panda *et al.* (2020)^[20] and Dutta & Devi (2017)^[6], likely due to frequent fires and lateritic soils that limit herb regeneration.

The Shannon diversity index (H') for trees (1.43-2.98) corresponds with values reported from dry tropical forests of Korba (Mexudhan *et al.*, 2024)^[16], Ranchi (Panda *et al.*, 2023)^[8], and Achanakmaar-Amarkantak Biosphere Reserve (Lal *et al.*, 2022)^[7], though lower than moist deciduous forests of Assam (Dutta & Devi, 2017)^[6]. Moderate to high heterogeneity was observed in shrubs and herbs, with an inverse relationship between tree canopy density and herb diversity, suggesting that dense stands reduce understorey light penetration and thereby limit herbaceous growth. The inverse trend between Shannon and Simpson indices further confirms the absence of extreme dominance, particularly in the herb layer. Equitability (0.54-1.30 across layers) and species richness (3.72-15.78 across layers) indicate a balanced community structure typical of semi-disturbed dry deciduous systems.

Beta diversity values (2.94-5.00 for trees; 5.00-6.67 for shrubs; 2.59-4.48 for herbs) denote considerable species turnover and habitat heterogeneity, comparable to other studies from Korba and AABR (Lal *et al.*, 2022; Mexudhan *et al.*, 2024)^[7, 16]. This variability reflects the mosaic landscape character of the Chilphi Range, shaped by

microclimatic and disturbance gradients.

Overall, the Chilphi Range sustains a relatively intact Sal-dominated forest with diverse understorey vegetation, functioning as an important ecological corridor adjoining the Kanha Tiger Reserve. Targeted management focusing on fire control, invasive species removal, and enrichment planting of native species could further enhance its ecological resilience and biodiversity value.

Conclusion

The Chilphi Range of the Kawardha Forest Division represents a characteristic tropical dry deciduous forest of central India, predominantly composed of *Shorea robusta* with associates such as *Terminalia tomentosa*, *Diospyros melanoxylon*, and *Anogeissus latifolia*. Variation in species composition and structural attributes among the four zones reflects the combined influence of edaphic factors, canopy cover, and human disturbance. The East and West zones exhibited relatively higher species diversity and evenness, whereas the North zone was dominated by *Sal*, and the South zone represented a Sal-Teak mixed formation. Moderate tree density and basal area values indicate a stable yet disturbance-influenced ecosystem where recurrent fire and grazing constrain regeneration. The shrub and herb layers showed notable heterogeneity and partial invasion, suggesting altered successional dynamics. Overall, the Chilphi Range maintains substantial floristic diversity and ecological significance, serving as a vital transitional corridor adjoining the Kanha Tiger Reserve. Effective management focusing on fire prevention, invasive species control, and enrichment of native flora is crucial for sustaining its ecological resilience.

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