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Studies of Phytodiversity of Nayagaon Beat of Chitrakoot Forest Range for the Forest Ecosystem Management

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ABSTRACT

The many resource benefits and environmental services provided by current forests must be sustained, Forests must be replenished for the projected three to four billion increase in global human population by the end of this century. In order to maintain the long term conditions, functions, and creatures of forest ecosystem, forestry must strike a balance between the short term wants and desires of the current human population and the expected needs of future generations. In the current scenario the most efficient way to fulfil these duties is the use of forest ecosystem management (FEM) as the template of forestry. FEM calls for long-term tenure, the management of all desired values and services, and input from numerous stakeholders. It also calls for an integrated management plan for the sustainable conservation of forest, a designated forest area that is sufficiently large to allow for the control of important ecological processes should be covered by a FEM plan. The explicit definition of a "Desired Forest Future" & appropriate tenure systems with sufficient duration & area, the participation of numerous stakeholders in the setting of management objectives, these all are essential to achieving FEM. Such tools must take into social ideals, economic sustainability & the ecosystem processes responsible for biophysical sustainability. In this research Phytodiversity study of forest ecosystem has been provided. The study area Nayagaon beat has 615.70 ha area which is consisting of 1 block & 2 compartments. Where the data shows primarily 23 types of tree species, 9 types of shrub species and 23 types of herbaceous species with several unique type of species. Dominance of *Diospyros melanoxylon, Anogeissus latifolia* & *Lagerstroemia parviflora* has been noted. Presence of higher number of seedling & sapling shows higher capacity of regeneration of this forest area. The study also describes the relationships between **α, β and γ** forest biodiversity & multi functionality & trade-offs among ecosystem services.

Keywords – FEM (Forest Ecosystem Management), Phytodiversity, Ecosystem.

Introduction

The field of forestry is always subject to changing social influences, concepts, lingo and paradigms. Before proposed new paradigms, such as FEM are adopted, it is imperative that their definitions should be cleared & that their social and environmental effects are predicted over short and long term horizons.[1]

Since the forest is a highly integrated, complex, typically resilient, multi-valued biophysical system with thresholds of tolerating disturbance beyond which its resilience and certain values and environmental services are changed and frequently reduced, Forest Ecosystem Management approaches forest conservation, utilization, administration, and regulation on the basis of this premise.[2] FEM is the management of the processes and disturbance regimes that make up the forest ecosystem in order to maintain the desired values and ecosystem services from a changing mosaic of various ecosystem conditions across the landscape and a non-declining pattern of change over time in the values and services that are offered by each stand in that landscape. Because people are a vital component of the forest ecosystem, it is also about managing how we interact with and use the forest.[3]

These trends in forest cover a conditions plays a major role not only because of the implications for the conservation of biodiversity, but also forests provide a wide range of critically important ecosystem services such as climate regulations, water supply, purification, pollination and the provisions of habitats for forest species. Furthermore, there is growing evidence that many aspects of biodiversity are linked to the provision of ecosystem services; biodiversity and the bulk of ecosystem services have a positive relationship. Numerous processes have been used to explain how biodiversity and ecosystem services relate to one another. Niche complementarity in time and space, a complementarity of functional response traits is likely to be involved.[4]

The role of biodiversity in the provision of ecosystem services, the widespread degradation of forests is likely to have far reaching effects such as reduced resistance to natural or anthropogenic disturbance. As such disturbance appear to be increasing in frequency and intensity, declines in biodiversity are likely to reduce forests resistance to climate extremes and to invasive species, other disturbance factors and to reduce the provision of ecosystem services in general.[5]

We focus on India because; India is home to nearly 8% of global biodiversity on just 2.5% of global land area. India is one of Vavilov's eight centres of global crop diversity and contains sections of four of the 36 global biodiversity hotspots. India's unique and diverse ecosystems, distributed across man landscapes, rivers and oceans are economically valuable too.[6]

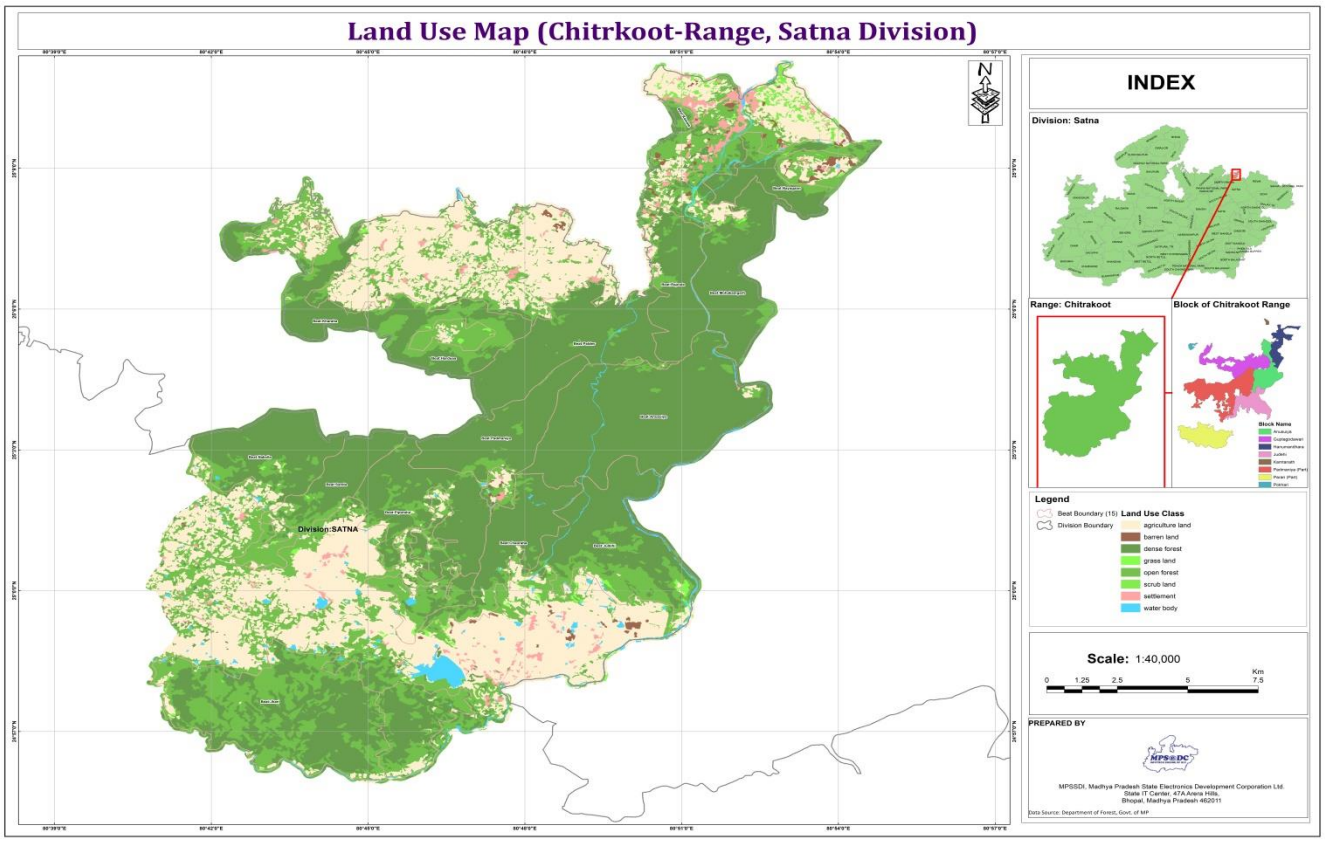
India faces a number of challenges in the sustainable use of biodiversity, but the country's investments in trans disciplinary biodiversity sciences are not commensurate with the severity of these challenges. Terrestrial and marine habitats are being lost at rapid rates. India is among the countries with the highest rates of habitat conservation.[7]

- **STUDY AREA:** Satna district is located in between $23^0 58'$ to 25^0 12'N and 80^0 21'to $81^0 23'$ E in Madhya Pradesh. Satna district has 7502 km^2 geographical area with 2037 km^2 forest area. The total forested area is (27.15%) divided in to 10 forest ranges and 150 forest beats.

The study area is Nayagaon Beat of Chitrakoot forest range. The study area Nayagaon beat has 615.700 ha area which consists of 1 block and 2 compartments. The vegetation of Satna forest is tropical dry deciduous type (Champion and Seth 1968). It is Vindhyan range of forest. They are functioning like lungs and help to maintain its environment.[8]

- **VEGETATION TYPE:** Vegetation of Nayagaon Beat of Chitrakoot are tropical deciduous mixed type. In Chitrakoot forest range 41% area is covered is covered by the forests out of total area of 1584 sq.km. As far as the vegetation of the Chitrakoot is concerned, topography, climate and soil from base to summit and hilly terrain show great variation resulting in enormous diversity at species and habitat levels.[8]

The forest areas are mainly concentrated towered Madhya Pradesh comprising of about 3 lakh acres of land. Topographically the area is undulating and hilly varying from 500 ft. to 2354 ft. in Manjhgawan block of Satna range. Geologically the area consists of Vindhyan sediment and Bundelkhand granite and Gneisses.[8]



MATERIALS & METHODS

❖ CHARACTERIZATION OF STUDY AREA:

This study was conducted on Nayagaon beat of Chitrakoot Forest range, administrated by Department of Biological Sciences, Mahatma Gandhi Chitrakoot Gramodaya University, Chitrakoot.

The flora is located in northeast of the State of Madhya Pradesh, in Central India, in the city of Satna, in the Chitrakoot Forest range. The study area Nayagaon beat has 615.700 ha area which is consisting of 1 block & 2 compartments. In which 430.99 ha is dense forest which are occupied by native forests and remaining part is open type of forest where planted forests, disturbed regimes were presented.

The region is one of drier region of the state, with lesser than 800 mm per year and with annual average temperature 26^0C, although it goes 35^0C – 45^0C in summer. The average annual humidity of the area is 56.29%. The area's climate conditions are classified as Semi-arid climatic condition. Water scarcity is a key factor of this area.[9]

The Nayagaon beat of Chitrakoot Forest range is predominantly consist of tropical deciduous & mixed forest types. Mixed forests occur on underlying rock which is generally sand stones and shales. The soil is sandy to sandy loam, fine to coarse grained and red lateritic. The areas having shallow, coarse-grained sandy and red lateritic soil bear very poor quality forests.

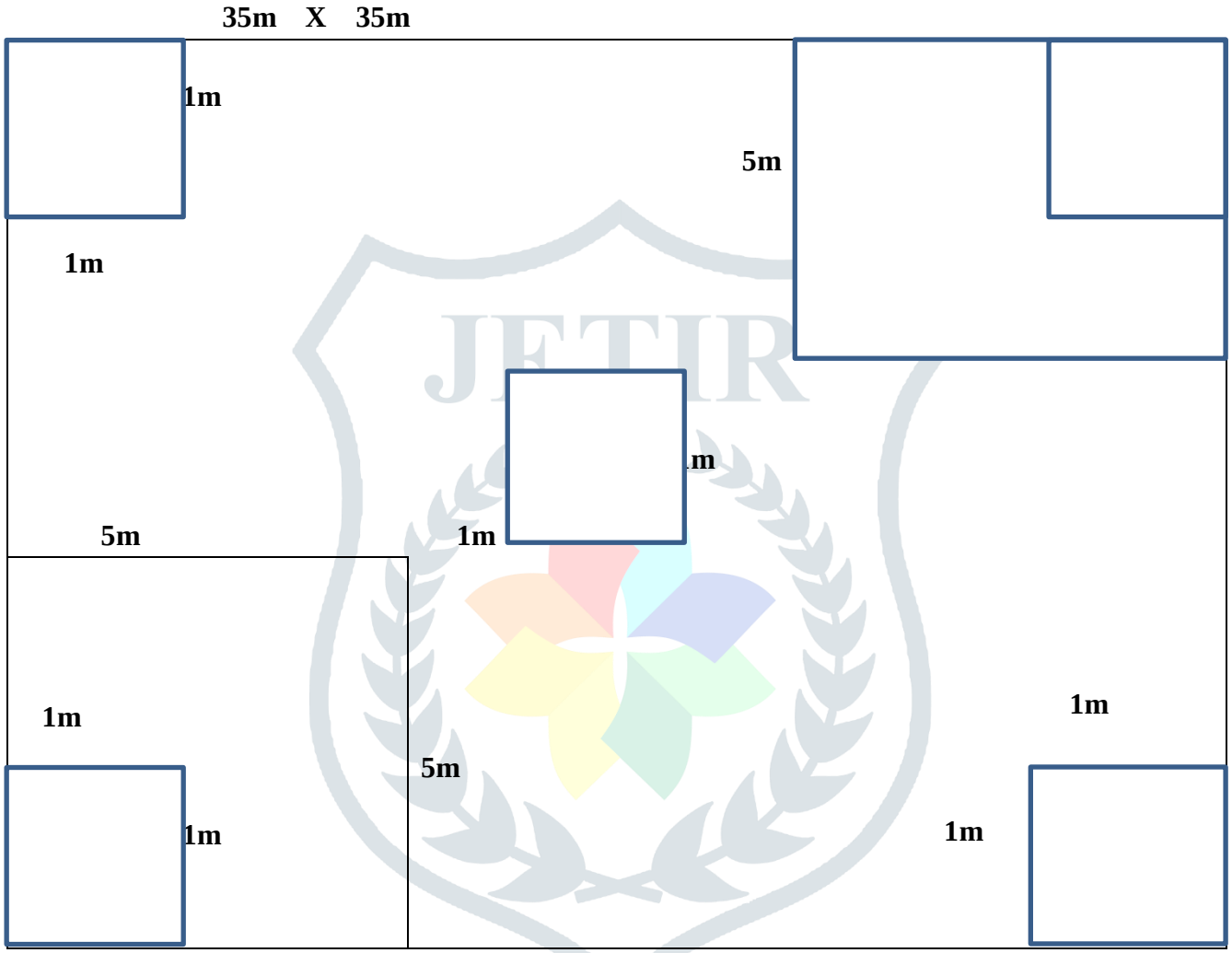
A large number of species constitute mixed forests, out of which *Diospyros melanoxylam, Anogesissus latifolia* and *Lagerstromia parviflora* are predominant. Where we primarily seen 23 types of tree species, 9 types of shrub species and 23 types of herbaceous species with several unique type of species. Presence of higher number of seedling & sapling shows higher capacity of regeneration of this forest area.

There is insufficient stock in mixed forests. The woodlands are open and have low growth as a result of prevailing dry weather. Due to the overabundance tree development is slowing down at an alarming rate due

to biotic interference like as frequent fires, unrestrained heavy grazing, overexploitation, and indiscriminate felling under nectar.

❖ **Sampling:**

The work was performed in quadrats of 35 x 35 m (1225 m^2), which were divided into 8 tracks and these subdivided into 2 + 5 subunits of 5 x 5 m (25 m^2) and 1 x 1 m (1 m^2). Within each plot, 8 sub units were drawn, where vegetation surveys and environmental parameters were made.[10]



❖ **Data Collection:**

Initially bird eye surveyed was performed for the classification of vegetation and vegetation type. The literature revealed that the method is non-destructive and is most suitable method (FAO 1997). The selection of the appropriate allometric equation is a crucial step in estimating aboveground tree biomass (AGTB). Allometric equations for biomass usually include information on bole diameter at breast height (DBH) (CM), total tree height (Meter) and wood density (in gm/cm^3). The use of tree height as a predictive variable also improves the quality of the allometric equation. Hence the allometric equation enable AGTB to be easily estimated, provided the diameter, total height and wood density of the available trees.

$Y = \exp [-2.4090 + 0.9522 \ln (D^2HS)]$

Where Y = above ground biomass in kg and **D** is diameter at breast height in cm, **H** is height of trees in meters and **S** is the wood density in gm/cm^3. Wood density (gm / cm^3) value for the species obtained from the web (www.worldargroforestry.org)

Below ground biomass (BGB) was calculated by using simple default value of 25% of the aboveground biomass (IPCC, 2006). Total biomass was measured as sum above and below ground biomass (Sheikh *et al*, 2011). Carbon was considered as 50 % of its biomass (Pearson *et al*, 2005)

❖ **Biodiversity Indices:**

Biodiversity indices that provided the evaluation for this work were presented by tables. These were calculated for each sampling unit leased in the study area, both for natural regeneration and for arboreal component. Which are follows: -

(A) **Alpha diversity:** The majority of the proposed methods to quantify the biodiversity of species refer to the diversity within communities, namely as alpha diversity. Within this, there are methods based on quantification of the number of the species (richness) & those based on community structure, these can still be based on the information, on dominance or equity of the community.

(1) **Species richness:** The metrics for species richness give diversity an immediate and comprehensible expression. We might mention the Margalef and Menhinic indices while discussing species richness indicators. These indices do a relationship between the numbers of individuals, and the larger the area of the sampling unit. The value of index increases with the number of species entered. The straight forward calculation of the Margalef and Menhinick index, which has been used effectively in academic papers, is one of its major merits.

(2) **Information:** The indices based on information theory that are used the most frequently. These metrics are followed are founded on idea that information contained in a code may be quantify similarly to variety or information found in a natural system. The Shannon-Wiener index function was developed by Shannon and Wiener. Researchers have incorrectly referred to it as “Shannon-weaver” in various studies. This index assumes that individuals are chosen at random from an “infinitely huge” population.

When there is just one species present and when all species are represented by the same number of in individuals, the Shannon index assumes a vale of zero. Shannon values typically range between 1.3 and 3.5, but they can exceed 4.0 and become as high 4.5 in areas with tropical forest. If there is no objective way to differentiate between abundance and rarity, the authors even assert that this index gives rare species a higher value and is one of the finest indices to employ in comparisons

(3) **Dominance:** The concepts of uniformity are inverse parameter to the dominance based indexes. Without assessing the contribution of other species, these indexes consider the representativeness of the species with the highest value of importance. We can mention the Simpson and MacIntosh indices as examples of this. The Simpson index displays the likelihood that two randomly selected individuals from a particular community belong to a different species. The most prevalent species in the sampling unit has a significant impact on this score, whereas species richness has the least impact. From 0 to 1, the Simpson index scales; the closer it is to 1, the greater dominance. On the other hand, as their values get nearer to 0, the MacIntosh will exert more control. The index of MacIntosh can be calculated as a measure of diversity or dominance that is independent of the overall population size even if it is not a dominance index.

(4) **Equity:** The equity indices reflect how the population of each species is spread, indicating whether the composition of the parcels is more or less uniform. We can name the Pielou, Hill and Alatalo. Pielou index is the most commonly used within the category equity, and measures the proportion of diversity observed with respect to the maximum expected diversity. The value of this index varies from 0 to 1, and when it reaches the value 1, it means that all species are equally abundant.

The Hill index is more frequently employed in studies of wildlife than in vegetation. This index describes how the abundance of the species is spread within a community. The equity inex must take the greatest value when every species in the sample is plentiful, and it falls until it reaches zero as the relative abundances of species depart from equality. The Simpson and Shannon indices are its input parameters. The Hill index, which reaches high value when equity is strong or when a species dominates the community, might lead to misunderstanding in some specific situations.

(B) Beta diversity:

The degree of species changes and biotic change brought about by environmental gradients is represented by beta diversity, or the diversity of habitats. It is based on properties of differences, which can be measured using beta diversity indices as well as similarity coefficients of dissimilarity between the plots, depending on qualitative or quantitative data. It is also based on proportions, which can be measured using beta diversity indices as well as similarity coefficient of distance between the plots, depending on qualitative or quantitative data.

The use of similarity coefficients is the simplest methods for measuring beta diversity between pairs of localities. The Jaccard and Sorensen indexes are the most popular. These indices are intended to equal 1 in complete similarity circumstances a zero in dissimilarity cases. The Simplicity of these methods is one of the major benefits. Since the coefficients do not account for species abundance, this could also be a drawback. Whether they are common or rare, all species are given the same importance in calculation.

Result & Discussion

The study has been taken place in different set of indices for 3 types of plants data which are divided in the form of herb, shrubs & trees. In findings we get 23 types of tree species which is consisting 465 numbers of trees, 9 types of shrub species which is consisting of 297 numbers of shrubs and 23 types of herb species which is consisting of 10064 numbers of herbs in various sampling stations. Those sampling sets have been setup between two compartments of this particular beat, also found 23 types of seedling and 30 types of sapling which is consisting total 163 numbers of trees by which higher capacity of regeneration has been shown in different part of study area. Other than seen 3 varieties of mushroom as unique nature species which is consisting 24 number of mushrooms and also seen the bamboo culm in particular sampling sites.

The various indices were shown the data of Herb, Shrub & Tree which gives the various results where Margalef and Mehinick indexes represents the higher & lower diversity of these herb, shrub & tree species. And Simpson and MacIntosh indexes represent the higher & lower dominance of these species. And Shanon values represents the lower diversity. And Pielou, Alatalo and Hill index represents the uniformity levels of these species. Jaccard and Sorensen indexes are representing the values for the higher and lower similarity rates between these herbs, shrubs and trees species with graphs as well which are follows-

Table 1: Total No. of Species of Trees in Nayagaon Beat

S. No.	Name of Species Local Name	Name of Species Botanical Name	Name of Compartment	
			P-2	P-3
	KOSAM	(*Scheichera oleosa)*	20	13
	TENDU	(*Diospyros melanoxylon)*	66	63
	TENDU	(Diospyros melanoxylon)		2
	SHAAL	*(Shorea robusla)*	17	5
	GURJA	(*Lannea coromandelica)*	26	28
	DHAWA	*(Anogeissus latrifolia)*	31	18
	MAHUA	(*Madhuca longifolia)*	23	12
	KIRWAR	*(Cassia fistula)*		4
	SEJH	(*Lagerstroemia parviflora)*	16	17
	GHOT	(*Zizyphus xylopyra)*	4	9
	KULLU	(*Sterculia urens)*	11	1
	HARDU	(*Haldinia cordifolis)*	27	6
	KAAPER	*(Gardenia latifolia)*	7	
	GUL SOKHRI		1	
	KAIMA	(*Mitragyna parviflora)*	5	2
	DHAMIN	(*Cordia macleodii)*	1	10
	BAKAYAN	(*Melia azedarach)*	1	
	ROHIN	(*Soymida febrifuga)*	1	3
	ACHAR	*(Buchanania lanzan)*		2
	KHARHAR	*(Catunareguum nilotica)*	4	2
	KARI	(*Miliusa tomentosa)*		1
	PATWAN	*(Diospyros montana)*		2
	GANGERUA	(*Grewia rothii)*		3
	BHOTHI	(*Enioiaena condollei)*		2
	REUNJHA	(*Acaia leucophloea*)		2
	Total		261	204

Table 2: Summarised Tree Data of Nayagaon Beat

Total Number of Organisms:	465
Total Number of Species:	25
Average population size:	20.22
Decimal Accuracy:	4
Total Number of Regions:	1
Total Number of Region Sets:	1

Table 3: Result of Indices showing Alpha [α] Biodiversity

	Alpha Biodiversity [α]
Simpson Index $\frac{\sum_i n_i(n_i-1)}{N(N-1)}$	0.1253
Simpson Index Approximation $\frac{\sum_i n_i^2}{N^2}$	0.1272
Dominance Index $1-\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)$	0.8747
Dominance Index Approximation $1-\left(\frac{\sum_i n_i^2}{N^2}\right)$	0.8728
Reciprocal Simpson Index $\frac{1}{\left(\frac{\sum_i n_i^2}{N^2}\right)}$	7.979
Alternate Reciprocal Simpson Index $\frac{1}{\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)}$	7.861
Shannon Index $-\sum_i\left(\frac{n_i}{N}\cdot\log_2\left(\frac{n_i}{N}\right)\right)$	3.523
Berger-Parker Dominance Index $\frac{n_{max}}{N}$	0.2774
Shannon Index $-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)$	2.442
Inverted Berger-Parker Dominance Index $\frac{N}{n_{max}}$	3.605
Shannon Index $\sum_i\left(\frac{n_i}{N}\cdot\log_{10}\left(\frac{n_i}{N}\right)\right)$	-1.061
Margalef Richness Index $\frac{S-1}{\ln N}$	3.582
Menhinick Index $\frac{S}{\sqrt{\sum_i n_i}}$	1.067
Rényi Entropy/Hill Numbers (r=0,1,2,∞) $\frac{1}{1-r}\cdot\ln\left(\sum_i p_i^r\right)$	23, 11.53, 7.861, ≈∞
Buzas and Gibson's Index $\frac{e^{-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}}{S}$	0.4999
Gini Coeffificient $\frac{2\sum_i in_i}{n\sum_i n_i}-\frac{N+1}{N}$	0.6165
Equitability Index $-\frac{\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}{\ln N}$	0.7789
ln() of Hill Numbers (0,1,2,∞):	3.135, 2.445, 2.062, ≈-∞

Table 4: Result of Indices showing Beta [β] Biodiversity

Beta [β] Biodiversity

Comparing two sample areas

Absolute beta Value ($(S_0$-c) - (S_1-c)...):	22
Whittaker's Index (S/alpha):	1
Sørensen's similarity index:	1
Alternate Whittaker's Index (S/alpha-1):	0
Sørensen's similarity index (%):	100%
Jaccard Index:	-1
Routledge beta-R Index:	7.667
Jaccard Index (%):	-100%
Mountford Index:	-0.09524
Number of Common Species:	23
Mountford Index (%):	-9.524%
Bray Curtis dissimilarity	0

Table 5: Result of Indices showing Gamma [γ] Biodiversity

Gamma Biodiversity [γ]

Comparing many sample areas

Absolute gamma (S_0+S_1...-c):	0

By the definitions used in this calculator, Alpha indices are for a single sample of a single region. This is the most typical way to study and measure biodiversity. These indices are calculated with *all* data provided to the calculator as a single sample, if you are unsure which indices to use, start with Alpha values. Beta diversity indices compare two sample regions for "similarity" and other correlations of biodiversity between *two different* areas/regions. This is less common and requires careful, consistent data collection to be useful. Gamma diversity indices calculator for large or global areas, where many samples are being compared, and are the rarest to use in published studies and articles.

Table 6: Integrated Diversity Interpretation of Trees

S. No.	Diversity Indices	Index	Standard Values	Inference	Result	Classification
1.	Species Richness	Margalef Index	0-8	Inversely Proportional	3.582	High Diversity
		Menhinick Index	0-8	Inversely Proportional	1.067	High Diversity
		Whittaker Index	0-8	Inversely Proportional	1	High Diversity
2.	Dominance	Simpson Index	0-1	Direct Proportional	0.12	Low Dominance
		Reciprocal Simpson Index	0-1	Direct Proportional	7.97	Very High Dominance
		Dominance Index	0-1	Direct Proportional	0.87	Medium Dominance
3.	Information	Shanon Index	1.5-3.5	Direct Proportional	3.52	High Diversity
4.	Equity	Equitability	0-1	Direct Proportional	0.77	Medium Uniformity
		Gini Coefficient Index	0-1	Direct Proportional	0.61	High Uniformity
5.	Similarity	Jaccard Index	0-1	Direct Proportional	-1	Very low similarity
		Sorensen Index	0-1	Direct Proportional	1	High Similarity
		Mountford Index	0-1	Direct Proportional	0.09	High Similarity
		Bray Curtis Index	0-1	Direct Proportional	0	Low Similarity

Table 7: Total No. of Species of Herbs in Nayagaon Beat

S. No.	Name of Species Local Name	Name of Species Botanical Name	Name of Compartment	
			P-2	P-3
	Chichri	(*Achyranthes aspera*)	98	146
	Chakauda	(*Cassia tora*)	213	204
	Hathi ghas	(*Pennisetum purpureum*)	605	640
	Sahsmuriya	(*Eliphantopus scaber*)	33	65
	Kankaua	(*Commelina tuberosa*)	198	165
	Patharchata	(*Boerhavia diffusa*)	5	
	Teenpatiya	(*Oxalis corniculata*)	191	386
	Vantulsa	(*Anisomeles indica*)	435	559
	Safed Pyaj	(*Urginea indica*)	188	182
	Bichhkhapri	(*Urtica dioica*)	115	310
	Gond		108	
	Kakraundha	(*Blumea lacera*)	3	28
	Chhalehta		32	24
	Sehdai	(*Vernonia cinerea*)	76	
	Gurij	(*Tinospora cordifolia*)	41	
	Satavar	(*Asparagus racemosus*)	47	
	Brahmi	(Bacopa monnieri)	20	
	Kamraj	(*Selaginella ciliaris*)	44	65
	Bhui Chipki	(*Goniogyne hirta*)	128	
	Vantulsa	(*Anisomeles indica*)	47	
	Van Adarak	(*Zingiberaceae*)	85	
	Bhuamla	(*Phyllanthus urlnaria*)	56	
	Junglii Gobhi		39	
	Safed Musli	(*Chlorophytm arundinaceum*)	37	29
	Bada Gokhru	(*Pedalium murex*)	51	
	Junglee Mool	(*Euphorbia fusiformis*)		136
	Chakanda	(*Cassia obtusifolia*)		128
	Doob	(*Cynodon dactylon*)	116	
	Kali Musli	(*Curculigo orchioides*)		12

Table 8: Summarised Herb Data of Nayagaon Beat

Total Number of Organisms:	10064
Total Number of Species:	29
Average population size:	437.6
Decimal Accuracy:	4
Total Number of Regions:	1
Total Number of Region Sets:	1

Table 9: Result of Indices showing Alpha [α] Biodiversity

Alpha Biodiversity [α]	
Simpson Index $\frac{\sum_i n_i(n_i-1)}{N(N-1)}$	0.1145
Simpson Index Approximation $\frac{\sum_i n_i^2}{N^2}$	0.1146
Dominance Index $1-\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)$	0.8855
Dominance Index Approximation $1-\left(\frac{\sum_i n_i^2}{N^2}\right)$	0.8854
Reciprocal Simpson Index $\frac{1}{\left(\frac{\sum_i n_i^2}{N^2}\right)}$	8.732
Alternate Reciprocal Simpson Index $\frac{1}{\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)}$	8.725
Shannon Index $-\sum_i\left(\frac{n_i}{N}\cdot\log_2\left(\frac{n_i}{N}\right)\right)$	3.469
Berger-Parker Dominance Index $\frac{n_{max}}{N}$	0.1833
Shannon Index $-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)$	2.405
Inverted Berger-Parker Dominance Index $\frac{N}{n_{max}}$	5.455
Shannon Index $\sum_i\left(\frac{n_i}{N}\cdot\log_{10}\left(\frac{n_i}{N}\right)\right)$	-1.044
Margalef Richness Index $\frac{S-1}{\ln N}$	2.387
Menhinick Index $\frac{S}{\sqrt{\sum_i n_i}}$	0.2293
Rényi Entropy/Hill Numbers (r=0,1,2,∞) $\frac{1}{1-r}\cdot\ln\left(\sum_i p_i^r\right)$	23, 11.11, 8.725, ≈∞
Buzas and Gibson's Index $\frac{e^{-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}}{S}$	0.4816
Gini Coeffificient $\frac{2\sum_i in_i}{n\sum_i n_i}-\frac{N+1}{N}$	0.6378
Equitability Index $-\frac{\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}{\ln N}$	0.767
ln () of Hill Numbers (0,1,2, ∞):	3.135, 2.408, 2.166, ≈∞

Table 10: Result of Indices showing Beta [β] Biodiversity

Beta Biodiversity [β]

Comparing two sample areas

Absolute beta Value ((S_0-c) -(S_1-c) ...):	22
Whittaker's Index (S/alpha):	1
Sørensen's similarity index:	1
Alternate Whittaker's Index (S/alpha-1):	0
Sørensen's similarity index (%):	100%
Jaccard Index:	-1
Routledge beta-R Index:	7.667
Jaccard Index (%):	-100%
Mountford Index:	-0.09524
Number of Common Species:	23
Mountford Index (%):	-9.524%
Bray Curtis dissimilarity	0

Table 11: Result of Indices showing Gamma [γ] Biodiversity

Gamma Biodiversity [γ]

Comparing many sample areas

Absolute gamma (S_0+S_1...-c):	0

By the definitions used in this calculator, Alpha indices are for a single sample of a single region. This is the most typical way to study and measure biodiversity. These indices are calculated with *all* data provided to the calculator as a single sample, if you are unsure which indices to use, start with Alpha values. Beta diversity indices compare two sample regions for "similarity" and other correlations of biodiversity between *two different* areas/regions. This is less common and requires careful, consistent data collection to be useful. Gamma diversity indices calculator for large or global areas, where many samples are being compared, and are the rarest to use in published studies and articles.

Table 12: Integrated Diversity Interpretation of Herbs

S. No.	Diversity Indices	Index	Standard Values	Inference	Result	Classification
1.	**Species Richness**	Margalef Index	0-8	Inversely Proportional	2.38	High Diversity
		Menhinick Index	0-8	Inversely Proportional	0.22	High Diversity
		Whittaker Index	0-8	Inversely Proportional	1	High Diversity
2.	**Dominance**	Simpson Index	0-1	Direct Proportional	0.11	Low Dominance
		Reciprocal Simpson Index	0-1	Direct Proportional	8.73	Very High Dominance
		Dominance Index	0-1	Direct Proportional	0.88	Medium Dominance
3.	**Information**	Shanon Index	1.5-3.5	Direct Proportional	2.40	Medium Diversity
4.	**Equity**	Equitability	0-1	Direct Proportional	0.76	Medium Uniformity
		Gini Coefficient Index	0-1	Direct Proportional	0.80	High Uniformity
5.	**Similarity**	Jaccard Index	0-1	Direct Proportional	-1	Very low similarity
		Sorensen Index	0-1	Direct Proportional	1	High Similarity
		Mountford Index	0-1	Direct Proportional	0.09	High Similarity
		Bray Curtis Index	0-1	Direct Proportional	0	Low Similarity

Table 13: Total No. of Species of Shrubs in Nayagaon Beat

S. No.	Name of Species Local Name	Name of Species Botanical Name	Name of Compartment	
			P-2	P-3
	CHITRAK	*(Plumbago zeylanica)*	8	5
	BHUIKHAJUR	*(Phoenix acaulis)*	10	
	VANKAPAS	*(Thespesia lampas)*	4	
	JUNGLI BHANTA	*(Solanum incanum)*		1
	ATHIL	*(Helicteres isora)*	3	4
	BADI KATAIYA	*(Solanum violaceum)*	6	
	KANGHI	*(Abutilon indicum)*	2	1
	KATSARAIYA	*(Barleria prionitis)*	12	
	MARODFALI	*(Helicteres isora)*	15	
	MAANKAND	*(Flemingia nana)*		9
	SAFED MADAR	*(Calotropis gigantea)*	2	
	GUDSANKRI	*(Grewia hirsuta)*	8	
	DHAWAII	*(Woodfordia fruticosa)*		2
	GHOTHAR	*(Ziziphus xylopytus)*	6	
	BARIYARI	*(Ziziphus oenoplia)*		2
	KARAUNDA	*(Carissa opaca)*	21	37
	DHATURA	*(Datura metel)*	3	
	NIRGUNDI	*(Vitex negundo)*		4

	HAR SINGAR	*(Nyctanthes arbortristis)*	5	4
	BER	(*Ziziphus nummularia)*	31	19
	GULABI MADAAR	(*Calotropis procera*)	1	2
	MAKOYE	(*Solanum nigrum*)	37	35
	GANDHATA	(*Lantana camara*)	157	159

Table 14: Summarised Shrub Data of Nayagaon Beat

Total Number of Organisms:	297	Total Number of Species:	23
Average population size:	33	Decimal Accuracy:	4
Total Number of Regions:	1	Total Number of Region Sets:	1

Table 15: Result of Indices showing Alpha [α] Biodiversity

Alpha Biodiversity [α]

Simpson Index $\frac{\sum_i n_i(n_i-1)}{N(N-1)}$	0.117	Simpson Index Approximation $\frac{\sum_i n_i^2}{N^2}$	0.1199
Dominance Index $1-\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)$	0.883	Dominance Index Approximation $1-\left(\frac{\sum_i n_i^2}{N^2}\right)$	0.8801
Reciprocal Simpson Index $\frac{1}{\left(\frac{\sum_i n_i^2}{N^2}\right)}$	8.55	Alternate Reciprocal Simpson Index $\frac{1}{\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)}$	8.338
Shannon Index $-\sum_i\left(\frac{n_i}{N}\cdot\log_2\left(\frac{n_i}{N}\right)\right)$	3.113	Berger-Parker Dominance Index $\frac{n_{max}}{N}$	0.1582
Shannon Index $-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)$	2.158	Inverted Berger-Parker Dominance Index $\frac{N}{n_{max}}$	6.319
Shannon Index $\sum_i\left(\frac{n_i}{N}\cdot\log_{10}\left(\frac{n_i}{N}\right)\right)$	0.937	Margalef Richness Index $\frac{S-1}{\ln N}$	1.405
Menhinick Index $\frac{S}{\sqrt{\sum_i n_i}}$	0.5222	Rényi Entropy/Hill Numbers (r=0,1,2,∞) $\frac{1}{1-r}\cdot\ln\left(\sum_i p_i^r\right)$	9, 8.651, 8.338, ≈∞
Buzas and Gibson's Index $\frac{e^{-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}}{S}$	0.9611	Gini Coeffificient $\frac{2\sum_i in_i}{n\sum_i n_i}-\frac{N+1}{N}$	0.1594
Equitability Index $-\frac{\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}{\ln N}$	0.982	ln() of Hill Numbers (0,1,2,∞):	2.197, 2.158, 2.121, ≈∞

Table 16: Result of Indices showing Beta [β] Biodiversity

Beta Biodiversity [β]

Comparing two sample areas

Absolute beta Value ($(S_0\text{-}c)\text{-}(S_1\text{-}c)...$):	8	Whittaker's Index (S/alpha):	1
Sørensen's similarity index:	1	Alternate Whittaker's Index (S/alpha-1):	0
Sørensen's similarity index (%):	100%	Jaccard Index:	-1
Routledge beta-R Index:	3	Jaccard Index (%):	-100%
Mountford Index:	-0.2857	Number of Common Species:	9
Mountford Index (%):	-28.57%	Bray Curtis dissimilarity	0

Table 17: Result of Indices showing Gamma [γ] Biodiversity

Gamma Biodiversity [γ]

Comparing many sample areas

Absolute gamma ($S_0+S_1...\text{-}c$):	0

By the definitions used in this calculator, Alpha indices are for a single sample of a single region. This is the most typical way to study and measure biodiversity. These indices are calculated with *all* data provided to the calculator as a single sample, if you are unsure which indices to use, start with Alpha values. Beta diversity indices compare two sample regions for "similarity" and other correlations of biodiversity between *two different* areas/regions.This is less common and requires careful, consistent data collection to be useful. Gamma diversity indices calculator for large or global areas, where many samples are being compared, and are the rarest to use in published studies and articles.

Table 18: Integrated Diversity Interpretation of Shrubs

S. No.	Diversity Indices	Index	Standard Values	Inference	Result	Classification
1.	**Species Richness**	Margalef Index	0-8	Inversely Proportional	1.40	High Diversity
		Menhinick Index	0-8	Inversely Proportional	0.52	High Diversity
		Whittaker Index	0-8	Inversely Proportional	1	High Diversity
2.	**Dominance**	Simpson Index	0-1	Direct Proportional	0.11	Medium Dominance
		Reciprocal Simpson Index	0-1	Direct Proportional	8.55	Very High Dominance
		Dominance Index	0-1	Direct Proportional	0.88	Medium Dominance
3.	**Information**	Shanon Index	1.5-3.5	Direct Proportional	2.15	Medium Diversity
4.	**Equity**	Equitability	0-1	Direct Proportional	0.98	High Uniformity

		Gini Coefficient Index	0-1	Direct Proportional	0.15	Low Uniformity
5.	**Similarity**	Jaccard Index	0-1	Direct Proportional	-1	Very low similarity
		Sorensen Index	0-1	Direct Proportional	1	High Similarity
		Mountford Index	0-1	Direct Proportional	0.28	Low Similarity
		Bray Curtis Index	0-1	Direct Proportional	0	Low Similarity

CONCLUSION

The Present study calculated the **α, β and γ** diversity indices of trees, values are follows. Species richness of trees are highly diversifying in the area but dominance of species is low according to Simpson index, on the other hand dominance index represents medium and Reciprocal Simpson index result is presenting very high dominance of species. Information regarding the diversity, Shanon index shows high diversity in studied area. In the context of equity, the equitability index shows medium uniformity and the Gini coefficient index represents the higher uniformity. Similarity index represents very low to high similarity by various indices, therefore the ecosystem of studied area is very diversified and its manageable for conservation of species.

Diversity of **α, β and γ in shrub species different indices represents the status of these diversity,** values are follows. Species richness of shrubs are highly diversifying in the area but dominance of species is medium according to Simpson index, on the other hand dominance index represents medium and Reciprocal Simpson index result is presenting very high dominance. Information regarding the diversity, Shanon index shows medium diversities. In the context of equity, the equitability index shows high uniformity and the Gini coefficient index represents the low uniformity. Similarity index represents very low to high similarity by various indices.

α, β and γ diversity indices tests has also been applied for the study of Herb species in the area, is as follows. Species richness of herbs are highly diversifying in the area but dominance of species is low according to Simpson index, on the other hand dominance index represents medium and Reciprocal Simpson index result is presenting very high dominance. Information regarding the diversity, Shanon index shows medium diversities. In the context of equity, the equitability index shows medium uniformity and the Gini coefficient index represents the high uniformity. Similarity index represents very low to high similarity by various indices.

This is how various indices were studies for Herb, Shrub and Trees respectively. It will help in the Forest Ecosystem Management with the accuracy to when is what needed. This study will be fruitful for the sustainability aspect which is good for humanitarian prospective. It will also give the accuracy of the dominant tree species, herbs species and shrubs species of this region.

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