

Inventory of forest growing tree species around Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India

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ABSTRACT

A quantitative inventory of tree species made in the tropical deciduous forest around NTPC Sipat. The assessment of tropical tree diversity is an instrument for quantitative studies of regional biogeographical patterns. Forests are the main repository of biodiversity and play an important role in maintaining the ecological balance of nature. The status of species diversity shows the health of the forest ecosystem. The study was conducted to investigate the tree species diversity and distribution around the National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India. The data on tree species was collected by lying the quadrates size of 10m-10m at random locations. To assess the tree species diversity and distribution complete enumeration of tree species was done on the basis of distance and in different directions collected around NTPC. In this study, all trees with a breast height (dbh) diameter > 10cm diameter were identified and data on the average height, Girth, were collected. Species richness, Density, Family Importance Value (FIV), and Importance Value Index (IVI), Simpson's diversity index, Shannon-Wiener Index (H), Shannon's maximum diversity index (H_{max}) was calculated. A total of 35 tree species belonging to 19 families was identified at different locations of the sampling sites around the NTPC Sipat. This study will provide baseline information for further studies and also for the good management of the forest ecosystem around NTPC.

Keywords: Tropical tree diversity, Inventory, Diversity index, Shannon-Weiner index, Simpson's diversity index, Importance Value Index (IVI), Family Importance Value (FIV), Thermal Power Plant.

Mathematics Subject Classification: 62J12, 62G07

Journal of Economic Literature (JEL) Classification : Q23

1. INTRODUCTION

The increasing demand of the electricity for developing countries for the development and for many other sources. The pollution density around thermal power plant is rapidly growing with every day for fulfilling the demand of electricity of the every individual in the region. The rapid growth of pollution is creating the high pressure on the trees, landscape and natural resources. The effects of climate

change are badly affects the dynamics of growing tree species. In India, Chhattisgarh play a very important role for the maintenance of forest cover, Chhattisgarh state has a very diverse forest communities and they covers ~55717 km² which is distributed into very dense forest ~7068 km², moderate dense forest ~32279 km², open forest ~16370 km² which is 41.21% of its geographical area and it is a 7.80% of the total forest cover of India.

The tropical forests are the most important areas of biodiversity with respect to the floristic richness (Vasantharaj and Chandrashekar, 2006) and they are famous for being the most species-rich ecosystem on the earth (Gentry, 1992). They harbour highest diversity and density of tree species, and most of these are locally rare (Clark et al., 1999). The diversity of trees is fundamental to total tropical forest biodiversity, because trees provide resources and habitats for almost all other forest species (Huston, 1994; Whitmore, 1998; Huang et al., 2003). Hence, Plant diversity inventories in tropical forests have mostly been concentrated on tree species than any other life-forms (Gentry, 1988). Chhattisgarh state has the best forest diversity, 41.21 % of its geological area and its 7.80% of the total forest cover of the India (ISFR 2021). The forest tree inventory are important for the understanding of the Composition of forest vegetation, variety of species, nature of species and the structure of the forest. The invasive exotic plants are another growing threat to the maintenance of native species and to the ecosystem integrity of wild lands (Sala et al., 2000; Denslow, 2007). The importance of biodiversity will never be fully known, but the reasons for its conservation are numerous (Burton et al., 1992; Pourbabaei et. al., 2005). Documenting basic patterns of biodiversity is fundamental for prioritizing areas for conservation and management action (Villaseiior et. al, 2007).

The present study was conducted in year of 2020-2021 as a part of tree species inventory around National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India. The purpose of this paper is to provide information on the density, frequency and richness of tree species, Abundance, Importance Value Index (IVI), Family Importance Value (FIV), Species Evenness, Simpson's diversity index, Shannon-Wiener Index (H), Shannon's maximum diversity index (H_{max}) based upto the 10 km in all four directions. This paper assesses the tree species diversity and its inventory and composition around the National Thermal Power Plant Corporation, Sipat, Bilaspur, Chhattisgarh, Central India. Previously this area was famous for its greenery, but due to the high level of population, urbanization, and industrialization, its vegetation cover has been badly affected.

2. MATERIALS AND METHODS

2.1 Study area

The area around National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India was selected for the study of research. The climate in the study area is subtropical, semi-arid, continental and monsoon. As a result, it has warm summers, cool winters and rainy monsoon seasons. The

present study was carried out at twelve sites on the basis of wind direction and distance from the National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India. Twelve study sites were located around the power plant on the basis of directions (East, West, North, South) and distance (3km, 6km & 10km) respectively. The climate of the study site is tropical hot. The annual ambient temperature of the sites varies between 15°C and 44°C. Thus, it has hot summer, moderate winter, and rainy monsoon season. Average annual rainfall is 1280mm year⁻¹ and relative humidity varies between 60% and 75%.

2.2 Data Collection

The data on tree diversity were collected using the forest tree inventory method.. The forty eight sampling sites were taken by the laid of 10m×10m, Ensure that a minimum distance between the sample panels is 200m. The sample plans (plot) for the assessment of tree diversity were determined according to the distance of the NTPC. In each sample collection plot, all trees were identified at the species level, and their breast height diameter (greater than 10cm dbh) and height were recorded accordingly.

2.3 Data Analysis

The tree inventory of tree species from the selected sampling sites around National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India. The vegetation data were quantitatively analyzed i.e., basal area, density, frequency, and dominance, species evenness, Abundance, Importance Value Index (IVI), Family Importance Value (FIV), Species Evenness, Simpson's diversity index, Shannon-Wiener Index (H), Shannon's maximum diversity index (H_{max}). The relative diversity of the family was evaluated as the number of species with the family expressed as a percentage of the total number of species within all the families represented in the community (Pandey & Barik, 2006). The data were used to calculate the diversity index of tree species in the study area.

Importance Value Index (IVI)

The importance value index (IVI) for each species was estimated through $IVI = R.F + R.D + R.Do$, where R.D is the relative density calculated as the number of individuals per species/ha, R.Do is the relative dominance defined as the basal areaper species/ha, and R.F is the relative frequency (per ha) estimated as the proportion of plot (Asigbaase et. al, 2019).

$$Relative\ Frequency\ (R.F) = \frac{Frequency\ of\ the\ species}{Total\ Frequency\ of\ all\ the\ species} \times 100$$

$$Relative\ Density\ (R.D) = \frac{Density\ of\ all\ the\ species}{Total\ Density\ of\ all\ the\ species} \times 100$$

$$Relative\ Dominance(R.Do) = \frac{Total\ Basel\ area\ of\ the\ species}{Total\ Basel\ area\ of\ all\ the\ species} \times 100$$

$$Importance\ Value\ Index\ (IVI) = R.F + R.D + R.Do$$

Family Importance Value (FIV)

The Importance Value Index (IVI) and Family Importance Value (FIV) of tree species were determined by the equation given by (Panda et al., 2013).

Species richness

Species richness or Margalef's diversity index (d) is one of the major components of species diversity (Margalef, 1958) as:

$$d = S - \frac{1}{\log N}$$

Species Evenness (e)

Another major component of diversity is evenness of equitability in the apportionment of individuals among the species (Pielou, 1966) as :

$$e = \frac{H}{\log S}$$

Where, H =Shannon-Wiener Index, S =Number of species

Shannon-Wiener Index (H)

"The Shannon-Wiener Index (H) was calculated by the equation given by Shannon and Wiener (1949) as:

$$H = -\sum \left(\frac{n_i}{N} \right) \times \log_2 \left(\frac{n_i}{N} \right)$$

Where =Shannon-Wiener Index, Ni =Importance value of each species, N = Total importance value"

Shannon's maximum diversity index (H_{max})

Shannon's maximum diversity index was calculated by the formula (Guo et al., 2003) as:

$$H = -\sum [(p_i) * \log(p_i)]$$

where:H - Shannon diversity index, p_i - Proportion of individuals of i-th species in a whole community, $p_i = n / N$, where n - individuals of a given type/species; and N - total number of individuals in a community,

Simpsons diversity index

This index of dominance also known as Simpsons diversity index is the sum of total of square of the proportion of the species in the that specific community and is calculated by the following equation (Simpson, 1949);

$$c = \left(\frac{n_i}{N} \right)^2$$

Where,c = Index of dominance,Ni =Importance value of each species,N = Total importance value

3. RESULT

Rich diversity of the tree species was found around National Thermal power Plant Corporation, Sipat, Bilaspur, Chhattisgarh, Central India. The tree species diversity around the NTPC is 35 species belonging to 19 families identified at different distances and directions. A total of 562 individual trees

were surveyed at all sample sites. The maximum observed tree species shown in Table:1 were *Mangifera indica* (n=72), followed by *Butea monosperma* (n=56), *Tamarindus indica* (n=35), *Diospyros melanoxylon* (n=34), *Terminalia arjuna* (n=34), *Ficus benghalensis* (n=32), *Aegle marmelos* (n=28), *Azadirachta indica* (n=27), *Acacia nilotica* (n=26), *Ficus religiosa* (n=26), *Chloroxylon swietenia* (n=18), *Alangium salviifolium* (n=14), *Pongamia pinnata* (n=14), *Ziziphus mauritiana* (n=10), *Holoptelea integrifolia* (n=9), *Lagerstroemia parviflora* (n=9), *Tectona grandis* (n=9), *Haldina cordifolia* (n=8), *Melia azedarach* (n=8), *Terminelia bellirica* (n=8), *Ficus racemosa* (n=7), *Lannea coromandelica* (n=7), *Mitragyna parvifolia* (n=7), *Antidesma acidum* (n=6), *Bombax ceiba* (n=6), *Limonia acidissima* (n=6), *Pithecellobium dulce* (n=6), *Albezia odoratissima* (n=5), *Albezia procera* (n=5), *Anogeissus latifolia* (n=5), *Bridelia retusa* (n=5), *Neolamarckia cadamba* (n=5), *Phyllanthus emblica* (n=5), *Sterculia urens* (n=5) and *Terminalia tomentosa* (n=5) (Table 1).

For the understanding of tree species diversity and dynamics it was very important for assessing sustainability of vegetation, conservation of tree species and ecosystems management (Kacholi, 2014). The present study describes the tree species diversity and dynamics around the Thermal Power Plant, Bilaspur, central India. The density, composition, abundance and distribution of individual growing tree species are the best indicators of plant diversity (Wattenberg and Breckle, 1995; Singh, H. et. al.,2022).

Table 1: List of tree species found around the National Thermal Power Plant Corporation, Sipat, Bilaspur, Chhattisgarh, Central India.

S.No.	Botanical Name	Family	Local Name	No. of Individuals
1	<i>Acacia nilotica</i>	Mimosaceae	Babool	26
2	<i>Aegle marmelos</i>	Rutaceae	Bel	28
3	<i>Alangium salviifolium</i>	Alangiaceae	Akol	14
4	<i>Albezia odoratissima</i>	Mimosoideae	Basin	5
5	<i>Albezia procera</i>	Fabaceae	White siris	5
6	<i>Anogeissus latifolia</i>	Combretaceae	Dhawada	5
7	<i>Antidesma acidum</i>	Phyllanthaceae	Amti	6
8	<i>Azadirachta indica</i>	Meliaceae	Neem	27
9	<i>Bombax ceiba</i>	Bombaceae	Semal	6
10	<i>Bridelia retusa</i>	Euphorbiaceae	Kashi	5
11	<i>Butea monosperma</i>	Fabaceae	Palas	56
12	<i>Chloroxylon swietenia</i>	Meliaceae	Bhirha	18
13	<i>Diospyros melanoxylon</i>	Benaceae	Tendu	34
14	<i>Ficus benghalensis</i>	Moraceae	Bargad	32
15	<i>Ficus racemosa</i>	Moraceae	Gular	7
16	<i>Ficus religiosa</i>	Moraceae	Peepal	26
17	<i>Haldina cordifolia</i>	Rubiaceae	Haldu	8
18	<i>Holoptelea integrifolia</i>	Ulmaceae	Chilbil	9

19	Lagerstroemia parviflora	Lythraceae	Seina	9
20	Lannea coromandelica	Anacardiaceae	Goonja	7
21	Limonia acidissima	Rutaceae	Kaith	6
22	Mangifera indica	Anacardiaceae	Aam	72
23	Melia azedarach	Meliaceae	Mahaneem	8
24	Mitragyna parvifolia	Rubiaceae	Mudhi	7
25	Neolamarckia cadamba	Rubiaceae	kadamb	5
26	Phyllanthus emblica	Euphorbiaceae	Amla	5
27	Pithecellobium dulce	Mimosaceae	Ganga Imli	6
28	Pongamia pinnata	Fabaceae	Karanj	14
29	Sterculia urens	Malbaceae	Kullu	5
30	Tamarindus indica	Fabaceae	Imli	35
31	Tectona grandis	Lamiaceae	Sagon	9
32	Terminalia arjuna	Combretaceae	Arjun	34
33	Terminalia tomentosa	Combretaceae	Saja	5
34	Terminalia bellirica	Combretaceae	Bahera	8
35	Ziziphus mauritiana	Rhamnaceae	Ber	10

Vegetation inventory of forest growing stock present in the all sampling sites showed 35 tree species in 48 quadrates. The total number of trees having DBH $\geq$ 10 cm were found to be 562 of which the maximum relative Density was shown by Mangifera indica (600) followed by Butea monosperma (466.667), Tamarindus indica (291.667), Terminalia arjuna (283.333), Diospyros melanoxylon (283.333), Ficus benghalensis (266.667), Aegle marmelos (233.333), Azadirachta indica (225), Ficus religiosa (216.667), Acacia nilotica (216.667), Chloroxylon swietenia (150), Pongamia pinnata (116.667), Alangium salviifolium (116.667), Ziziphus mauritiana (83.333), Lagerstroemia parviflora (75), Tectona grandis (75), Holoptelea integrifolia (75), Haldina cordifolia (66.667), Terminalia bellirica (66.667), Melia azedarach (66.667), Lannea coromandelica (58.333), Ficus racemosa (58.333), Mitragyna parvifolia (58.333), Bombax ceiba (50), Pithecellobium dulce (50), Limonia acidissima (50), Antidesma acidum (50), Anogeissus latifolia (41.667), Phyllanthus emblica (41.667), Albezia procera (41.667), Albezia odoratissima (41.667), Terminalia tomentosa (41.667), Sterculia urens (41.667), Neolamarckia cadamba (41.667) and Bridelia retusa (41.667) respectively (Table 2).

The maximum relative Frequency was shown by Mangifera indica (100) followed by Butea monosperma (100), Tamarindus indica (100), Terminalia arjuna (100), Ficus benghalensis (100), Aegle marmelos (100), Ficus religiosa (100), Azadirachta indica (91.667), Acacia nilotica (50), Diospyros melanoxylon (33.333), Pongamia pinnata (25), Bombax ceiba (25), Alangium salviifolium (16.667), Ziziphus mauritiana (16.667), Lagerstroemia parviflora (16.667), Tectona grandis (16.667), Haldina cordifolia (16.667), Terminalia bellirica (16.667), Melia azedarach (16.667), Lannea coromandelica (16.667), Pithecellobium dulce (16.667), Anogeissus latifolia (16.667), Phyllanthus emblica (16.667), Chloroxylon swietenia (8.333), Holoptelea integrifolia (8.333), Ficus racemosa

(8.333), *Mitragyna parvifolia* (8.333), *Albezia procera* (8.333), *Limonia acidissima* (8.333), *Antidesma acidum* (8.333), *Albezia odoratissima* (8.333), *Terminalia tomentosa* (8.333), *Sterculia urens* (8.333), *Neolamarckia cadamba* (8.333) and *Bridelia retusa* (8.333) respectively (Table 2).

The maximum relative Abundance was shown by *Ficus benghalensis* (17.493) followed by *Ficus religiosa* (13.687), *Albezia procera* (9.672), *Mangifera indica* (6.137), *Alangium salviifolium* (5.522), *Haldina cordifolia* (4.957), *Anogeissus latifolia* (4.697), *Terminalia bellirica* (4.607), *Pongamia pinnata* (3.288), *Albezia odoratissima* (2.826), *Tamarindus indica* (2.766), *Ficus racemosa* (2.725), *Diospyros melanoxylon* (2.39), *Bombax ceiba* (2.157), *Melia azedarach* (1.661), *Azadirachta indica* (1.528), *Terminalia arjuna* (1.515), *Phyllanthus emblica* (1.407), *Acacia nilotica* (1.125), *Aegle marmelos* (1.093), *Terminalia tomentosa* (0.837), *Lannea coromandelica* (0.802), *Limonia acidissima* (0.73), *Chloroxylon swietenia* (0.726), *Antidesma acidum* (0.726), *Sterculia urens* (0.698), *Lagerstroemia parviflora* (0.688), *Neolamarckia cadamba* (0.653), *Butea monosperma* (0.65), *Tectona grandis* (0.643), *Mitragyna parvifolia* (0.571), *Pithecellobium dulce* (0.492), *Ziziphus mauritiana* (0.231), *Bridelia retusa* (0.209), and *Holoptelea integrifolia* (0.09) respectively (Table 2).

The maximum IVI was shown by *Mangifera indica* (706.137) followed by *Butea monosperma* (567.317), *Tamarindus indica* (394.432), *Terminalia arjuna* (384.849), *Ficus benghalensis* (384.16), *Aegle marmelos* (334.427), *Ficus religiosa* (330.354), *Diospyros melanoxylon* (319.057), *Azadirachta indica* (318.195), *Acacia nilotica* (267.792), *Chloroxylon swietenia* (159.059), *Pongamia pinnata* (144.955), *Alangium salviifolium* (138.855), *Ziziphus mauritiana* (100.231), *Lagerstroemia parviflora* (92.355), *Tectona grandis* (92.31), *Haldina cordifolia* (88.29), *Terminalia bellirica* (87.941), *Melia azedarach* (84.995), *Holoptelea integrifolia* (83.423), *Bombax ceiba* (77.157), *Lannea coromandelica* (75.802), *Ficus racemosa* (69.392), *Mitragyna parvifolia* (67.238), *Pithecellobium dulce* (67.158), *Anogeissus latifolia* (63.03), *Phyllanthus emblica* (59.741), *Albezia procera* (59.672), *Limonia acidissima* (59.063), *Antidesma acidum* (59.059), *Albezia odoratissima* (52.826), *Terminalia tomentosa* (50.837), *Sterculia urens* (50.698), *Neolamarckia cadamba* (50.653) and *Bridelia retusa* (50.209) respectively (Table 2).

In the present study we found, *Mangifera indica* recorded the highest density values. However, the distribution of trees around NTPC is dominated by only a few tree species. The higher density of only few species around the NTPC might be due to human interference, level of pollutants through selective utilization and conservation of such species (Ahn, 1970) and the level of adaptability of these dominant tree species. Nagendra and Gopal (2010) recorded a same type of trend in tree species distribution in Bangalore city of Karnataka. This result shows that many tree species having much lower IVI value which suggested that these tree species should receive more attention for conservation. The rarity of IVI could be attributed to various, such as poor distribution of species, anthropogenic disturbances, competition between species, effect of pollutants etc. (Comita et al., 2007; Hubbell et al., 2001; Schwarz et al., 2003; Kacholi, 2014).

Table 2: Phytosociological parameters of tree species found around National Thermal Power Plant.

S.No.	Species	No. of individuals	Relative Density	Relative Frequency	Relative Abundance	IVI
1.	Acacia nilotica	26	216.667	50.000	1.125	267.792
2.	Aegle marmelos	28	233.333	100.000	1.093	334.427
3.	Alangium salviifolium	14	116.667	16.667	5.522	138.855
4.	Albezia odoratissima	5	41.667	8.333	2.826	52.826
5.	Albezia procera	5	41.667	8.333	9.672	59.672
6.	Anogeissus latifolia	5	41.667	16.667	4.697	63.030
7.	Antidesma acidum	6	50.000	8.333	0.726	59.059
8.	Azadirachta indica	27	225.000	91.667	1.528	318.195
9.	Bombax ceiba	6	50.000	25.000	2.157	77.157
10.	Bridelia retusa	5	41.667	8.333	0.209	50.209
11.	Butea monosperma	56	466.667	100.000	0.650	567.317
12.	Chloroxylon swietenia	18	150.000	8.333	0.726	159.059
13.	Diospyros melanoxylon	34	283.333	33.333	2.390	319.057
14.	Ficus benghalensis	32	266.667	100.000	17.493	384.160
15.	Ficus racemosa	7	58.333	8.333	2.725	69.392
16.	Ficus religiosa	26	216.667	100.000	13.687	330.354
17.	Haldina cordifolia	8	66.667	16.667	4.957	88.290
18.	Holoptelea integrifolia	9	75.000	8.333	0.090	83.423
19.	Lagerstroemia parviflora	9	75.000	16.667	0.688	92.355
20.	Lannea coromandelica	7	58.333	16.667	0.802	75.802
21.	Limonia acidissima	6	50.000	8.333	0.730	59.063
22.	Mangifera indica	72	600.000	100.000	6.137	706.137
23.	Melia azedarach	8	66.667	16.667	1.661	84.995
24.	Mitragyna parvifolia	7	58.333	8.333	0.571	67.238
25.	Neolamarckia cadamba	5	41.667	8.333	0.653	50.653
26.	Phyllanthus emblica	5	41.667	16.667	1.407	59.741
27.	Pithecellobium dulce	6	50.000	16.667	0.492	67.158
28.	Pongamia pinnata	14	116.667	25.000	3.288	144.955
29.	Sterculia urens	5	41.667	8.333	0.698	50.698
30.	Tamarindus indica	35	291.667	100.000	2.766	394.432
31.	Tectona grandis	9	75.000	16.667	0.643	92.310
32.	Terminalia arjuna	34	283.333	100.000	1.515	384.849
33.	Terminalia tomentosa	5	41.667	8.333	0.837	50.837
34.	Terminalia bellirica	8	66.667	16.667	4.607	87.941
35.	Ziziphus mauritiana	10	83.333	16.667	0.231	100.231

The results reveals that the families with an abundance of 562 individuals of the growing tree species found around National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh (Table:2). Across all the species total 19 families encountered i.e., Mimosaceae, Rutaceae, Alangiaceae, Mimosoideae, Fabaceae, Combretaceae, Phyllanthaceae, Meliaceae, Bombaceae, Euphorbiaceae, Benaceae, Moraceae, Rubiaceae, Ulmaceae, Lythraceae, Anacardiaceae, Malbaceae, Lamiaceae, Rhamnaceae (Table 3) around the National Thermal Power Plant Corporation, Sipat, Bilaspur, Chhattisgarh, Central India.

The value of family importance was used to show the composition of a family in terms of tree species and individual totality. The maximum Species richness was encountered by Combretaceae (4) followed by Fabaceae (4), Benaceae (3), Meliaceae (3), Rubiaceae (3), Anacardiaceae (2), Euphorbiaceae (2), Mimosaceae (2), Moraceae (2), Rutaceae (2), Alangiaceae (1), Bombaceae (1), Lamiaceae (1), Lythraceae (1), Malbaceae (1), Mimosoideae (1), Phyllanthaceae (1), Rhamnaceae (1), Ulmaceae (1) respectively (Table 3).

The maximum Basal area was encountered by Alangiaceae (4300.601) followed by Anacardiaceae (2701.926), Combretaceae (2636.019), Mimosoideae (2201.164), Euphorbiaceae (2157.919), Fabaceae (2083.872), Benaceae (1861.73), Bombaceae (1679.819), Moraceae (1087.679), Rubiaceae (610.797), Phyllanthaceae (565.087), Malbaceae (543.580), Lythraceae (535.911), Mimosaceae (535.151), Meliaceae (526.723), Lamiaceae (500.679), Rutaceae (395.212), Rhamnaceae (179.626) and Ulmaceae (69.896) respectively (Table 3).

The maximum Density was recorded Fabaceae (916.667) followed by Anacardiaceae (658.333), Moraceae (541.667), Meliaceae (441.667), Combretaceae (433.333), Benaceae (283.333), Rutaceae (283.333), Mimosaceae (266.667), Rubiaceae (166.667), Alangiaceae (116.667), Euphorbiaceae (83.333), Rhamnaceae (83.333), Lamiaceae (75.000), Lythraceae (75.000), Ulmaceae (75.000), Bombaceae (50.000), Phyllanthaceae (50.000), Malbaceae (41.667) and Mimosoideae (41.667) respectively (Table 3).

The FIV values ranged from 1016.932 to 50.03745 across all the trees family. The maximum FIV was encountered by Fabaceae (1016.932) followed by Anacardiaceae (758.627), Moraceae (641.938), Meliaceae (541.718), Combretaceae (533.482), Rutaceae (383.560), Mimosaceae (333.436), Benaceae (316.811), Rubiaceae (191.871), Alangiaceae (133.628), Euphorbiaceae (108.459), Rhamnaceae (100.112), Lamiaceae (92.149), Lythraceae (91.876), Ulmaceae (83.528), Bombaceae (75.107), Phyllanthaceae (58.416), Malbaceae (50.127) and Mimosoideae (50.037) respectively (Table 3).

Families with lower FIV need the kind attention of the forestry policy-making institutions in the future for sustainable forest management. The rarity of FIV also could be attributed to various, such as poor distribution of species, anthropogenic disturbances, competition between species and effect of pollutants etc. (Comita et al., 2007; Hubbell et al., 2001; Schwarz et al., 2003; Kacholi, 2014).

Table 3: The contribution of tree families to species richness, density, family importance value (FIV) and basal area around National Power Plant.

S.No.	Family	Species richness	Basal area	Density	FIV
1.	Alangiaceae	1	4300.601	116.667	133.628
2.	Anacardiaceae	2	2701.926	658.333	758.627
3.	Benaceae	3	1861.730	283.333	316.811
4.	Bombaceae	1	1679.819	50.000	75.107
5.	Combretaceae	4	2636.019	433.333	533.482
6.	Euphorbiaceae	2	2157.919	83.333	108.459
7.	Fabaceae	4	2083.872	916.667	1016.932
8.	Lamiaceae	1	500.679	75.000	92.149
9.	Lythraceae	1	535.911	75.000	91.876
10.	Malbaceae	1	543.580	41.667	50.127
11.	Meliaceae	3	526.723	441.667	541.718
12.	Mimosaceae	2	535.151	266.667	333.436
13.	Mimosoideae	1	2201.164	41.667	50.037
14.	Moraceae	2	1087.679	541.667	641.938
15.	Phyllanthaceae	1	565.087	50.000	58.416
16.	Rhamnaceae	1	179.626	83.333	100.112
17.	Rubiaceae	3	610.797	166.667	191.871
18.	Rutaceae	2	395.212	283.333	383.560
19.	Ulmaceae	1	69.896	75.000	83.528

The different diversity indices calculated on data from forest growing stock are shown in table 4. The total 35 tree species were found with 562 individuals trees. The species evenness was calculated to be 4.5579, the Shannon-Weiner Index (H) was calculated to be 159.5295 whereas Shannon maximum diversity index (H max) was calculated to be 3.1907 and the Simpson's diversity index was calculated to be 0.05422.

According to the many researchers the native tree species may be beneficial for some aspects of biodiversity (McIntyre and Hobbs 1999; Hunter 2007), but it is clearly reported that the presence of a large number of native species alters the function in a systematic way and the structure of ecosystem (McKinney 2006). Biodiversity indices around NTPC were calculated to assess the status of biodiversity conservation in this urban center and compare them with the biodiversity of other polluted sites (Singh et.al, 2022). The species diversity of any urban center depends upon adaptation of species and increases with stability of community (Singh et.al, 2022).. The Shannon maximum diversity index for studied area was measured to be 3.1907, which suggest a good and diverse tree species ecosystem around the NTPC. In, contrast the lower values of the species evenness recorded in the present investigation indicates that the tree species aren't uniformly distributed. (Agbelade et al., 2016) investigated the biodiversity indices of two cities of Nigeria and reported same type of trend as obtained in the present study. The Shannon-Wiener index found around the NTPC was higher than

those obtained in other studied sites (Cornelis, 2004; Hunter, 2007; Jim and Chen, 2009). The Shannon's maximum diversity index (H_{max}) and Simpsons diversity index (C) which indicates the index of dominance and index of diversity of the trees species (Tiwari, 1993).

Table 4: Different diversity indices for the forest growing stock around National Thermal Power Plant.

Diversity Index	Values
No. of species	35
No. of individual trees	562
Species evenness	4.5579
Shannon-Wiener Index (H)	159.5295
Shannon maximum diversity index (H_{max})	3.1907
Simpson's diversity index	0.05422

4. DISCUSSIONS AND CONCLUSION

Understanding the inventory of tree species and its dynamics is very important for the sustainable development and it's also important for the management of ecosystem (Kacholi, 2014). The present study describes the inventory of tree species diversity and dynamics of tree species found around National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh. The composition, density, abundance and distribution of individuals tree species are the best indicator of plant species (Wattenber and Breckle, 1995). Misra (1968) stated that the strongest tree species numerically dependent on their abundance. Worldwide, climate change has altered the structure and functioning of forest ecosystems. The substantial rise in global temperatures has the potential to impact various environmental factors, leading to shifts in local species composition and the overall structure of forest communities (Latt and Park, 2022). Our study involved a floristic enumeration around the Thermal Power plant, Sipat, Bilaspur, Chhattisgarh, Central India, with the aim of assessing Importance Value Index (IVI), Importance Family Index and diversity and many more important parameters which play a vital role for the inventory of tree species. The goal was to understand the patterns of species composition, structural characteristics, species diversity etc.

The inventory of growing tree species gives the information of the species richness, frequency, density, Abundance, Importance Value Index (IVI), Family Importance Value (FIV), Species Evenness, Simpson's diversity index, Shannon-Wiener Index (H), Shannon's maximum diversity index (H_{max}) etc. They should provide the data which may be useful for the forest management for the sustainable development and it will indicate the influence of the native population of tree species. More attention should be paid to the selection of trees planted around NTPC, not only with the aim of easy maintenance, but with some efforts to choose an appropriate combination of trees that supports

other biodiversity and provide better environmental and ecosystem services and can tolerate pollutants emitted by NTPC.

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