FLORISTIC COMPOSITION AND DIVERSITY IN THE FOREST FRAGMENTS OF DRY AND MOIST TROPICAL FOREST

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Received-16.02.2019, Revised-18.04.2019

Abstract: The stand attributes in terms of structure and diversity across the forest fragments by forest types have been poorly investigated previously. Therefore, in the present investigation stand attributes i.e., floristic composition, structure and diversity of vegetation growing into two different forest types viz., dry tropical forest (DTF) and moist tropical forest (MTF) of the Chhattisgarh, India is examined. By using field data, collected through random sampling techniques from forest fragmented landscape in the dry and moist forests of Chhattisgarh, India, we were able to visualize the effects and influence on tropical forests. We observed changes in species composition, stand structure and diversity of concerned forest types. The most diverse families were Leguminosae (10), Anacardiaceae (7), Euphorbiaceae (6), Combretaceae (3), Myrtaceae (3), Rhamnaceae (3), Rubiaceae (2) and Rutaceae (2). In the present study a total of 8120 trees ha⁻¹ in all the forest sites representing 50 species and 23 families were encountered. The total density of trees varied from 390-2130 trees ha⁻¹, being highest in DTF I while least in MTF II. The diversity indices values reflected that Shannon index recorded for various forest fragments ranged from 2.39-3.62, equitability from 0.75-1.25, species richness from 2.65-6.61, beta diversity from 6.02-20.0 and concentration of dominance from 0.12-1.0, respectively. The present reports highlights the sites conditions for phytosociological attributes at stand levels, which may enriched the information towards sustainable strategies, plan and management of these resource in addition to conservation priority.

Keywords: Biomass, C stock, Diversity, Forest fragments, Structure, Tropical forest

INTRODUCTION

Plants are the basis of life, assets in the landscape and central to people’s livelihoods. They deliver natural conservation, ecological balance and benefits in addition to aesthetic values on earth, and people are closely associated to their ecosystem and live in harmony with nature (Kumar et al. 2017; Yadav et al. 2017; Jhariya 2017a; Jhariya et al. 2019). Biodiversity is key aspect for human survival, economic well-being, ecosystem functioning and stability (Singh 2002). The local, regional and global biodiversity of the natural ecosystems is under threat due to forest fragmentation (Wu 2013). The process of forest fragmentation is detrimental and has been under alarming situation worldwide, especially in tropics (Yadav et al. 2017). Fragmentation leads towards reduction of habitat into smaller patches beside loss of forest cover and biodiversity (Collinge 2009). Naturally some habitats are patchy due to site conditions, but biotic interferences have laid noticeably fragmented world’s landscapes (Haddad et al. 2015). Consequently, knowing the origin and consequences of fragmentation is critical for biodiversity conservation and appropriate ecosystem functioning.

On a global scale 90% of tropical forests situated outside protected areas (WWF 2002), and it experienced with loss of forest cover as well as biodiversity due to biotic disturbances even within protected woodlands (Majumdar and Datta 2015; Oraon et al. 2014 & 2015; Jhariya and Yadav 2016; Yadav et al. 2019). The alteration in land-use is a determining factor which have key impact on vegetation, site conditions, ecosystems structure and functions (Pimm and Raven 2000; Bihan et al. 2008; Jhariya 2010, 2014; Jhariya et al. 2012, 2014; Kagezi et al. 2016; Jhariya 2017b). India houses nearly 47,513 species of plant (Singh and Dash 2014), which represents 11.40% of global flora (Arisdason and Lakshminarasimhan 2016). Tropical ecosystems are perceived to be rich biodiversity reserves due to diverse environmental and ecological conditions (Aguua et al. 2015; Gandiwa et al. 2016). Species diversity differs from site to site in tropics due to variation in bio-geography and disturbance regimes (Sundarapandian and Karoor 2013; Kumar et al. 2017; Jhariya 2017a). In India, habitat destruction, over-exploitation, deforestation and species introduction are identified as major causes of diversity loss (UNEP 2001; Panda et al. 2013; Mutiso et al. 2015), and nearly 3.5% annual loss of forest is reported for India (Puyravaud et al. 2010).

Increasing fragmentation resulted in the loss of a valuable portion of the forest ecosystem. Tree species with small populations, will be the first to be lost in the process of forest fragmentation. Information on vegetation structure is important key to understand the forest ecosystems (Naidu and Kumar 2016) and it correspondingly respond to

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alteration governed by natural or anthropogenic means (Sundarapandian and Karoor 2013; Jhariya et al. 2014; Yadav and Jhariya 2017; Yadav et al. 2019). The floristic composition of the forests stand depicts the health of these ecosystems (Krishnamurthy et al. 2010; Jhariya et al. 2012; Thinh et al. 2015; Yadav and Jhariya 2017). The assessment of stand biomass and vegetation carbon is key determinant which defining the role and function of vegetation stands towards global climate (Jhariya and Yadav 2018). In Indian perspectives, the precise estimation of vegetation attributes and ecological services assist by different vegetation in different forest types are limited. Measures of community structure and diversity may better inform how fragmentation affects these biotic communities (Haddad et al. 2015). Here, we present the forest fragments study related to its impact on structure and diversity in different sites by forest type in Chhattisgarh, India.

MATERIALS AND METHODS

Study Site

The study was carried out at Barnawapara wildlife sanctuary (North Raipur, Raipur Forest Division) and Achanakmar-Amarkantak biosphere reserve (Achanakmar, Bilaspur Forest Division). The study includes five site viz. DTF I (Bar), DTF II (Ravan) and DTF III (Lavan range) of Barnawapara wildlife sanctuary (BWS), and MTF I (Game range, Paschim Chaparawa) and MTF II (Shiv Tarai) range of Achanakmar-Amarkantak biosphere reserve (AABR). 

BWS is located between 21°20′0″ to 21°25′47″ north latitudes and 82°21′17″ to 82°26′27″ east longitudes. The general topography of area is undulating and the area adjoining Nawapara forest village has a number of hillocks scattered all over the area. Dry deciduous forest, grasslands, agriculture lands and human habitations surround the study area. The climate of study area is dry humid tropical. The average annual rainfall in the study area ranges from 1200-1350 mm. The mean monthly maximum temperature ranges from 27.3°C in January to 41.8°C in May and mean monthly maximum temperature ranges from 12.7°C in December to 27.3°C in May. Soils of study area are grouped into three classes viz., Inceptisols, Alfisols and Vertisols. The teak forest, sal forest, mixed dry forest and bamboo brakses are major vegetation types found in this region (Champion and Seth 1968).

AABR lies between 22° 15′ to 22° 58′ north latitude and 81° 25′ to 82° 5′ east longitude, having an area of 3835.51 km², partly falling in Madhya Pradesh and partly falling in Chhattisgarh state. This region comprised by varying topography, geology and variety of landforms are major attributes of AABR. The area has source of origin of Narmada, Sone and Johilla major river system. The biosphere area has a typical monsoon climate. The forest area of the AABR represents tropical deciduous vegetation and can be classified into Northern tropical moist deciduous and Southern dry mixed deciduous forests (Champion and Seth 1968).

Experimental Details

The study was conducted after repeated reconnaissance survey of BWS and AABR. The stratified random sampling procedure was adopted for characterization of vegetation. The phytosociological analysis in each forest fragment was carried by randomly laying sample plots of 10 x 10 m² in size. In each quadrat, GBH (Girth at Breast height) of each individual was measured at species level. The vegetation data in each forest fragment was quantitatively analyzed for frequency, density and abundance by using following expressions (Curtis and McIntosh 1950). Basal area of trees was calculated as cross sectional area of stem at breast height i.e. at 1.37 m from the ground level. The relative density, relative frequency, relative basal area, relative abundance was calculated. The Importance Value Index (IVI) was determined as the sum total of relative frequency, relative density and relative dominance (Phillips 1959). The diversity indices were calculated following Sagar and Singh (1999). The data thus generated were synthesized and diversity of each fragment was characterized and correlated with the structure parameters (IVI, basal area, density, etc.).

RESULTS AND DISCUSSION

Stand Structure

In the present study a total of 8120 trees ha⁻¹ in all the forest sites representing 50 species and 23 families were encountered. The most diverse families were Leguminosae (10), Anacardiaceae (7), Euphorbiaceae (4), Combretaceae (3), Myrtaceae (3), Rhamnaceae (3), Rubiaceae (2) and Rutaceae (2). Out of which 2130 trees ha⁻¹ were encountered in DTF I, 1930 trees ha⁻¹ in DTF II, 1030 trees ha⁻¹ in DTF III, 2640 trees ha⁻¹ in MTF I and 390 ha⁻¹ trees in MTF II was observed. Results on phytosociological analysis in various forest fragments are given in the table 1. In DTF I total of 25 species representing 14 families were encountered, in the DTF II 22 species comprising 13 families were recorded while in the DTF III total 10 species having 9 families were encountered. In MTF I total of 25 species distributed in 15 families were encountered whereas MTF II showed 11 species representing 8 families were noticed. The MTF I and DTF I were found to be most diverse and rich in terms of species richness and taxonomic family presence.

It is evident that in the DTF I Terminalia tomentosa was the most dominant tree followed by Cleisthenthus collinus and Lagerstroemia parviflora. Highest density was recorded in Cleisthenthus collinus
followed by Terminalia tomentosa, Lagerstroemia parviflora, Buchanania lanzan and Anogeissus latifolia. Lowest density was recorded for Ficus hispida, Holoptelea integrifolia, Shorea assamica and Delonix regia. In DTF II Cleisthenthus collinus was the most dominant species followed by Diospyros melanoxylon and Lagerstroemia parviflora. Lowest density was recorded by Syzygium cumini, Bridelia retusa, Pterocarpus marsupium, Emblica officinalis, Dalbergia paniculata, Buchanania lanzan and Andidesma acicular. It revealed that Lagerstroemia parviflora was the most dominant tree followed by Ougeinia ooejeinensis and Diospyros melanoxylon in DTF III. Lowest density was recorded for Terminalia tomentosa and Limonia acidissima. It observed in MTF I that Shorea robusta was the most dominant tree followed by Terminalia tomentosa and Milisusa tomentosa. Lowest density was recorded by Ventilago calyculata, Semecarpus anacardium, Zizyphus xylopyra, Garuga pinnata, Cassia fistula and Bauhinia racemosa. In MTF II Diospyros melanoxylon was the most dominant tree layer followed by Terminalia tomentosa and Buchanania lanzan. Lowest density was recorded for Anogeissus latifolia, Butea monosperma, Tectona grandis, Emblica officinalis and Semecarpus anacardium. In DTF I highest basal area was observed in Terminalia tomentosa followed by Cleisthenthus collinus, Anogeissus latifolia, Emblica officinalis and Terminalia chebula. Basal area and density of individual tree species varied from 0.02-12.72 m² ha⁻¹ and 10-410 stems ha⁻¹, respectively. In DTF II maximum basal area was observed in Cleisthenthus collinus followed by Terminalia tomentosa and Diospyros melanoxylon. Basal area and density of individual tree species varied from 0.02-8.54 m² ha⁻¹ and 10-850 stems ha⁻¹, respectively. It reflected that in DTF III higher basal area value was observed in Ougeinia ooejeinensis followed by Lagerstroemia parviflora and Diospyros melanoxylon. Basal area and density of individual tree species varied from 0.17-8.76 m² ha⁻¹ and 10-340 stems ha⁻¹, respectively. MTF I showed that highest basal area was observed in Shorea robusta followed by Terminalia tomentosa and Milisusa tomentosa. Lowest basal area was recorded in Semecarpus anacardium, Zizyphus xylopyra and Cassia fistula. Basal area and density of individual tree species varied from 0.01-22.77 m² ha⁻¹ and 10-1460 stems ha⁻¹, respectively. In MTF II highest basal area was observed in Diospyros melanoxylon followed by Terminalia tomentosa and Semecarpus anacardium. Basal area and density of individual tree species varied from 0.01-3.43 m² ha⁻¹ and 10-100 stems ha⁻¹. In DTF I Terminalia tomentosa showed highest value of I VI (53.67) followed by Cleisthenthus collinus (40.72) and Lagerstroemia parviflora (23.29). In DTF II Cleisthenthus collinus showed highest value of I VI (81.69) followed by Diospyros melanoxylon (33.24) and Lagerstroemia parviflora (27.29). In DTF III Lagerstroemia parviflora showed highest value of IVI (81.58) followed by Ougeinia ooejeinensis (63.87) and Diospyros melanoxylon (63.15). In MTF I Shorea robusta showed highest value of IVI (128.23) followed by Terminalia tomentosa (21.63) and Milisusa tomentosa (13.4). In MTF II Diospyros melanoxylon showed highest value of IVI (73.93) followed by Terminalia tomentosa (51.75) and Buchanania lanzan (47.25).

Tree basal cover in the present study varied from 10.61-50.90 m² ha⁻¹ for various forest fragments. These basal cover values were higher than the values reported for several dry tropical forest communities in Vindhyan region by Jha and Singh (1990) between 6.58 and 23.21 m² ha⁻¹ and from 3.84-10.36 m² ha⁻¹ by Singh and Singh (1991). The present values were comparable with 17-40 m² ha⁻¹ for dry tropical forest and 20-75 m² ha⁻¹ for wet forest (Murphy and Lugo 1986a). Basal cover in a Puerto Rican sub-tropical dry forest was 19.8 m² ha⁻¹ (Murphy and Lugo 1986b). In the present study, tree density ranged between 390-2640 for various forest fragments in dry and moist deciduous forest. Compared to the present study the density of forest in Thailand, of dry Dipterocarp forest, was 554-789 (Visaratana et al. 1986); of mixed deciduous forest was 253 (Sahunalu et al. 1979) and tropical rain forest was 818-1540 (Kiratiprayoon 1986). Tree density in the Vindhyan region ranges between 294-627 stems ha⁻¹ for several dry tropical forest communities (Jha and Singh 1990; Singh and Singh 1991). However, Rodgers (1990) reported a very high value of basal cover (131 m² ha⁻¹) for the forests of Sariska Tiger Reserve.

Inverse relationship between density and DBH showed small structure of the forests where only 28.57% individuals reflecting in the class exceeding 50 cm GBH. This may be related to faster turnover, biotic removal or low capacity of biomass accumulation. Relating tree density with GBH, in dry Dipterocarp forest, was 554-789 (Visaratana et al. 1986); of mixed deciduous forest was 253 (Sahunalu et al. 1979) and tropical rain forest was 818-1540 (Kiratiprayoon 1986). Tree density in the Vindhyan region ranges between 294-627 stems ha⁻¹ for several dry tropical forest communities (Jha and Singh 1990; Singh and Singh 1991). However, Rodgers (1990) reported a very high value of basal cover (131 m² ha⁻¹) for the forests of Sariska Tiger Reserve.

The inverse relationship between density and GBH distribution was found. The relationship between girth class (cm) and number of trees for the different forest fragments are illustrated in figure 1. The relationship followed an exponential model \([y = \exp(a-bx)]\) in DTF I, DTF II and DTF III, Logarithmic model in MTF I \((\ln y = a-b \ln x)\) and followed by the Linear model \((y = ax + b)\) in DTF III. The relationship for DTF I was \(y = \exp(80.69 - 6.028 x)\), for DTF II
y = \exp (51.03-0.026 \times) and for MTF II \ y = \exp (6.47 – 0.01 \times), respectively. The relationship for MTF I was logarithmic, \ln y = 98.28-20.37 \ln x) and in case of DTF III the relationship was linear, \ y = (17.15 – 0.12 \times). In all the forest sites studied most of the trees i.e. 71-90% species comes under middle girth class. This indicates that the forest of this study area is under middle aged. Hence, they should be managed on sustainable basis for the future use. Small fragments of forests have very different ecosystem characteristics than the large forest fragments, supporting more light loving species, more trees with wind or water dispersed seeds and relatively few understory species (Laurance 1999). Conservation strategies need to ensure the preservation and restoration of large un-fragmented forest habitats in each region (Aksins 1995). It is argued that if environmental changes produced by disturbance are large; it may become lethal to greater numbers of established species than are, or can be immediately replaced by immigrants. Disturbance such as logging, usually cause an immediate decline in biodiversity followed by a recovery, although not necessarily of the same species (Noble and Dirzo 1997). Species richness of the site experiencing disturbances, therefore, will be cumulative outcome of differential responses of species to disturbance. Some species may tolerate the disturbance and the other may disappear.

Collins et al. (2009) reported that forest fragmentation has great impact on populations, communities, ecosystems and suggesting that tract will continue to species loss and declines in ecosystem functions for long time. Pawar et al. (2014) reported that 6-12 species of trees were recorded among different sites. The density of tree varied from 100-510 stems ha\(^{-1}\) and value of basal area ranged from 11.47-26.67 m\(^2\) ha\(^{-1}\). Bargali et al. (2014) reported tree density was ranged from 650-1520 trees ha\(^{-1}\) in tropical forests of Chhattisgarh. Thakur and Swamy (2012) reported the number of species, tree density and basal area were ranged from 9-26, 324-733 trees ha\(^{-1}\) and 8.13-28.87 m\(^2\) ha\(^{-1}\), respectively. Yadav and Jhariya (2017) found a sum of 10 tree species in different site and tree density varied from 520-860 individuals ha\(^{-1}\) with the basal area of 19.807-40.21 m\(^2\) ha\(^{-1}\), which supports the present findings.

The presence of maximum number of species with only one or 1 to 10 individuals of all the forest sites may indicate the mixed nature of the forest (Richards 2002) and a marked diversity. In the present study the species represented by a single individual varied from 1-28%. Black et al. (1950) in the Amazonian rain forests found that among trees of at least 10 cmdbh, over one third of the species were represented by single individuals.

Many studies suggested that the heterogeneity of the environment as well as disturbance is the prime cause for patch formation in the forests (Jha and Singh 1990). A small number of unique species on the more disturbed sites and a decrease in the total number of species along the disturbance gradient may reflect high utilization pressure (Bhat et al. 2000). The recurrent human intervention for collection of fuel wood and minor forest products and the practice of grazing and trampling may change the habitat fitness for many species. In the natural environment clumped distribution of vegetation is common whereas in uniform condition random distribution is found. The clumped distribution of individuals of a species may be due to insufficient mode of seed dispersal (Richards 1996), or when death of trees creates a large gap encouraging recruitment and growth of numerous saplings (Armesto et al. 1986; Richards 1996). Vegetative reproduction by sucker and coppice also encourages clustering of species (Lieberman 1979). Anogeissus latifolia, Diospyros melanoxylon, Lagerstroemia parviflora, and Shorea robusta are the species, which form coppice and as a result of stem poaching, they either recover or increase in number through coppice when the disturbance is moderate. Of this coppice forming species, only Anogeissus latifolia and Shorea robusta are able to tolerate high degree of disturbance.

The uniform dispersion pattern of species in tropical forest largely enables the maintenance of high levels of diversity. The changes in the dispersion pattern may reflect the reactions of species to disturbance as well as to changes in the habitat conditions. For example, the stem density of species changing from clumped to uniform dispersion was lower and that of species changing from uniform to clumped dispersion was on the more disturbed sites. Uniform dispersion of species is possible in case of edible fruits by birds and animals e.g. Ziziphus xylopyrus, Diospyros melanoxylon, Buchanania lanzan, Grewia tilifolia, Terminalia chebula etc. The study of Ramirez-Marcial et al. (2001) showed decreasing density and basal area with disturbance intensity. Smiet (1992) correlated the basal area with disturbance. Current study also indicated that the stem density declined with disturbance. The decline in stem density along the disturbance gradient may be due to gradual increase in the extraction of firewood, small timbers, insect attack and rotting of boles.

Changes in density and basal area of trees in different forest fragments shows that prevailing biotic factors such as exploitation of forests to meet daily requirements of fuel wood, wood for agricultural implements and house hold construction, for preparation of boundaries along the houses and farm land, unregulated grazing by domestic cattle are the key determinants of structure and function of the forest. These factors in the absence of any viable alternatives defy all regulatory measures. As a result the forest goes on degrading year after year without any hope of rejuvenation without exclusion of these
pressures. Variation in vegetation attributes such as IVI, tree density, basal area and distribution of tree species at different sites in the forest indicate the complex plant succession resulting from varying degree of pressures at different sites.

**Species Diversity**

Species diversity, the number of species in a community is ecologically important. The valuations of species diversity (H') at different sites of same locality are not a good sign for better growth of forest of any area. Species diversity parameters are summarized in the table 2.

Shannon index was found to be variable from site to site in the study area of BWS and AABR. The Shannon index values recorded for various forest fragments were 3.62 for DTF I, 3.42 for DTF II, 2.39 for DTF III, 2.42 for MTF I and 2.99 for MTF II. Equitability (e) values were 1.04 for DTF III, 1.11 for DTF I, 1.12 for DTF I, 0.75 for MTF I and 1.25 for MTF II. Species richness was highest in MTF I (6.61) followed by DTF I (6.12), DTF II (5.80) and MTF II (4.24). However, the lowest value was recorded in DTF III (2.65). Beta diversity was highest in MTF II (20.0) followed by DTF III (11.36), DTF II (7.35) and MTF I (6.33) and the lowest value was recorded in DTF I (6.02). The values recorded for concentration of dominance in different forest fragments were 1.0 for DTF I, 0.12 for DTF II, 0.22 for DTF III, 1.0 for MTF I and 0.17 for MTF II.

Various reports are reflected that fragmentation can substantially modify biodiversity of a region as well as ecosystem functioning (Haddad et al. 2015). Moreover, beta diversity pattern can be changed by forest fragmentation overlaying successional dynamics (Alexander et al. 2012). The diversity parameters of these forests can be compared with the diversity indices reported in different tropical forests (Singh and Singh 1991). The Shannon index in the present study was low (2.39-3.62) in various forest fragments compared to Dry Dipterocarp forest and mixed deciduous forest of Thailand (3.75-4.49; Kiratiprayoon et al. 1995), tropical rain forest of silent valley, India (3.8-4.8; Singh et al. 1984) and of Barro Colorado Island (4.8; Knight 1975). In other studies, the Shannon index of Thailand forest was 1.9-4.0 for dry Dipterocarp forest (Sahunalu et al. 1979; Nilroung 1986) and 5.0-6.2 for tropical rain forest (Kiratiprayoon 1986).

Diversity parameters in the tropical dry forest communities of the Vindhyan region (Jha 1990) had ranges of 0.68-2.08 (Shannon-Wiener index), 0.75-1.75 (equitability), 1.62-7.77 (Simpson’s index) and 0.13-4.33 (beta diversity). Diversity in the dry forest of the Vindhyan hill as reported by Singh and Singh (1991) had ranged between 1.93-2.82 (Shannon-Wiener index), 0.83-1.04 (equitability), 0.18-0.39 (Simpson’s index) and 0.88-1.4 (Species richness). Prasad and Pandey (1992) in sal and teak forests of Madhya Pradesh found species diversity varying from 0.32-3.76 and concentration of dominance from 0.07-0.63 at different distances from habitation in Bilaspur, Mandla, Balaghat and Jabalpur districts of M.P., India. The forest within habitation recorded lower diversity and dominance compared to forests away from habitation. Sagar and Singh (2003) reported Shannon-Wiener index between 1.398-2.629 for dry tropical forest located along the disturbance gradient.

Singh et al. (1984) reported Shannon index value between 3.4-4.8 for tropical rain forests of Silent valley in Western Ghats, India. Similarly, Swamy (1998) reported 1.49-3.67 Shannon index values for tropical evergreen forests of Karnataka, India. It is also evident from the results that Shannon index values were higher than concentration of dominance in different forest fragments. The inverse relationship was found between Shannon index and Simpson’s index. These results are in agreement with earlier findings of Singh and Singh (1991) and Swamy (1998). Jhariya et al. (2012) reported the Shannon index value for tropical deciduous forest were ranged from 2.40-3.49, equitability from 0.89-1.28, species richness from 1.62-2.94, concentration of dominance from 0.10-0.32 and beta diversity from 1.35-2.70. Pawar et al. (2014) reported Shannon index ranged from 2.32-2.83, species richness from 1.08-1.91, C'd value from 0.20-0.24, equitability from 1.13-1.29 and beta diversity from 1.50-3.00, respectively which supports the present estimated values. Yadav and Jhariya (2017) found that the Shannon value ranged from 0.159-2.056, C'd from 0.402-0.955, species richness from 0.230-0.936, equitability from 0.148-1.279 and beta diversity from 1.11-5.0 in natural forest and plantation sites of Chhattisgarh, India.

### Table 1. Floristic composition and structure of vegetation on different sites

<table>
<thead>
<tr>
<th>Species</th>
<th>DTF I</th>
<th>DTF II</th>
<th>DTF III</th>
<th>MTF I</th>
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Note: The table represents the data in a structured format, where each species is listed with its corresponding values for the indicated properties.
Table 2. Diversity parameters of various forest fragments

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<th>Parameters</th>
<th>DTF I</th>
<th>DTF II</th>
<th>DTF III</th>
<th>MTF I</th>
<th>MTF II</th>
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![Graph of Density (stem ha⁻¹) vs Girth class for DTF I](image1)

![Graph of Density (stem ha⁻¹) vs Girth class for DTF II](image2)
Figure 1. Woody species density and mean girth classes (cm) relationship: 1 ≤10, 2(>10≤20), 3(>20≤30)......... and so on
CONCLUSION

The forest fragmentation significantly influenced the floristic structure, composition and diversity of studied sites. The increasing biotic interferences are degrading these forests and resulting in poor density, basal area and diversity. The changes in community and vegetation structure caused by disturbances have a significant effect on the ecosystem processes. Among the different forest fragments MTF II seems to be more affected as compared to other sites. Some species showed dominant position in forest stands, as revealed by the higher frequency, density and basal cover retained by them. If these species are protected or retained as such then it is possible to obtain long-term ecosystem services on sustainable basis. The study recommends adopting intensive conservation measures especially in degraded areas of the forest. Efforts are needed to regulate the biotic pressure in the vicinity of dwellings and protecting the forests would go a long way in rejuvenating the lost forest ecosystem.

REFERENCES


