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Influence of Forest Fire on Floral Diversity of the Degraded Shola Forest Ecosystem

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Abstract

Forest Fire is an important component in the development and sustainability of many forest ecosystems. With regard to the environmental aspect, the fire is known to alter the soil physical, chemical and biological properties besides influencing the vegetation pattern. However, information available on the nature and magnitude of changes brought out by forest fire on vegetation under degraded shola forest ecosystem is scanty. Keeping these points in view, the present investigation was carried out in the degraded shola forest ecosystem of the Nilgiris Eastern Slope Range situated in the Nilgiris North Division, Tamil Nadu, India to evaluate the effect of fire on the plant diversity of the area at two different periods (immediately after fire and after the monsoon). The effect of forest fire on the vegetation composition was studied using quadrate method by simple random sampling. The results were analyzed for various vegetational parameters and diversity indices. The study showed that the fire had severely affected the tree components in the vegetation when compared to herbs and shrubs. The research results also revealed that regeneration of herbs and shrubs occurred in the burned area after monsoon. The vegetation was already a degraded shola, regular occurrence of the fire is seriously damaging the vegetational composition enabling the further degradation of the vegetation. A good management plan for fire management will help to regain the vegetation through retrogression.

Keywords: Forest fire, vegetation, degradation, burned and unburned area.

Introduction

Fires have influenced the character of the forest ecosystem throughout the world. In fact, many forest communities around the world persist only under the influence of periodic wildfires. Forest fires caused ecological, social and economical damages to a greater extent. In tropical regions, fires are common in seasonally dry environments and rare in perennially moist areas. Even the wettest tropical rain forests may burn at a time scale of thousands of years and the annual extent of fire may be greater in tropical and sub-tropical regions than in the rest of the world[1]. On the basis of the place of their action, forest fires are classified into four types. They are creeping fire, ground fire, surface fire, and crown fire and among which, ground fire influences soil properties to the maximum. It burns the ground cover only, the carpet of herbaceous plants and low shrubs, which covers the soil. In other words, it refers to any fire that consumes the organic materials of the forest floor and also burns into the underlying soil itself[2]. Repeated low-intensity fires may shape the forest by killing small trees, rejuvenating fire-tolerant grasses and accelerating the cycling of nutrients. High-intensity fires kill the majority of trees, oxidize large quantities of nutrients such as nitrogen and disturb soil - plant interactions for decades. This great pressure on forest fire has resulted in the loss of biodiversity disturbing the eco-system dynamics[3]. In India, the inventories carried out by the Forest Survey of India[4] showed that on an average 54.7 per cent of the forest is affected by the fire, 77.6 per cent area has grazing incidence and 72.1 per cent forest area has no regeneration. It is also estimated that the proportion of forest area prone to forest fires annually ranges from 33 to 90 per cent. About 90 per cent forest fires in India are man-made. Out of 3,53,782 km^2 forest area in the country, 47.17 per cent (1,40,818 km^2) is annually affected by fire[5]. A characteristic feature of the Nilgiri Biosphere Reserve is the occurrence of 'sholas' (Montane forests) above 1,500 m. They are found in patches, in hollows and sheltered folds surrounded by rolling downs in the Anamalais, Nilgiri and Palani hills and the high ranges of Kerala and Karnataka. Montane evergreen forests have thick undergrowth; the trees are short bolded and attain a low height of 15-20 m. The shola forest community had wider distribution in the past which has been established through pollen analytical investigations. Forest fire occurs in one or the other part of Nilgiri Biosphere (approximately 1,000 ha area annually under heavy intentional fires), which not only retards the growth of existing vegetation but also not allowing new recruits to emerge out on the forest floor[6]. In the process, many endemic species of the area disappeared from their native habitat. Exotics such as *Wattle, Eucalyptus, Eupatorium, Cestrum, Eulex* species which were introduced long back in the Nilgiri plateau are invading the burnt areas very fast. The ill effects of this are well known and spread of alien weeds can be

destructive to native species. More importantly, species like *Lantana camara* and recently *Eupatorium odoratum, Mikania cordata, Parthenium hysterophorus, Eulex europeans, Cestrum nigrum, Cassia tora* have invaded the Nilgiri Biosphere Reserve and tend to smother the natural vegetation. Wattle, introduced long back, has now become a weed. Srivastva[7] found that the major cause for the depletion and loss of biodiversity in the Nilgiris is the fire originating from human causes. The recurrent fire set by grazers during the summer dealt a severe blow to the floristic composition. Though the incidence of forest fire is not a frequent phenomenon in the shola forest ecosystem which is known for its rich floristic diversity, it is frequent in the degraded sholas due to severe biotic interference. Hence, systematic experimental studies are needed to understand the effect of fire on the vegetation during different seasons. Keeping the above points in view, the present investigation was undertaken in the degraded shola forest ecosystem of Nilgiris Eastern Slope Range, Nilgiris North Division, Tamil Nadu, India with the following objective to study the effect of forest fire on the diversity status of vegetation.

Material and Methods

The present study was carried out to investigate the effect of forest fire on the vegetation status of the fire affected area. The details of the field studies conducted and the methods followed are presented in this chapter.

Location: The Niligiris North Forest Division is located between the latitudes 11° 14' North and 11° 36' North and the longitudes 76° 31' East and 77° 1' East. The geographical area of this division is situated in Udhagamandalam, Coonoor, Gudalur and Kotagiri taluks of Nilgiris revenue district. Nilgiris North Forest Division falls under the Coimbatore Circle. The headquarters of this division is Udhagamandalam. The total forest area of this division is 54,722.806 ha with forest boundary of 138 kilometers. The present study area is located between the latitudes 11° 26.272' North and 11° 26.516' North and the longitudes 76° 55.073' East and 76° 55.112' East of Kotagiri taluk in the Paravakkadavu Reserve Forest (271.387 ha) of the Kengarai beat which comes under the administration of Sholur Mattam section of the Nilgiris Eastern Slopes Range. Its headquarters is located at Sholur Mattam.

Vegetation: The forest types occurring in the Nilgiris North Forest Division generally falls within the following groups as shown in table 1[8]. These broad groups exhibit certain distinct types of vegetation along with its seral and transitional stages as well as their edaphic variations. The line of distinction between two types is not very clear in few cases, one type merge almost imperceptibly into another. The extensive artificial plantations of *Eucalyptus globules, E. grandis, Acacia mearnsii* and *Pinus* species have transformed the vegetational map of the division greatly.

Champion and Seth[8] have classified two more forest types under the sub group 11A (Southern montane wet temperate forest). They are i. Degraded stage of sholas (i.e. Southern montane wet scrub-type 11A/DS1) and ii. Degraded stage of grasslands (i.e. Southern Montane wet grasslands-type 11A/DS2).

Table-1
Forest types of the Nilgiris North Forest Division

Sl. No.	Forest type	Sub group
1	Southern montane wet temperate forest	11A
2	Southern tropical broad leaved hill forest	8A
3	Southern moist deciduous forest	3B
4	Southern tropical dry deciduous forest	5A
5	Southern tropical thorn forest	6A

Since the present study area comes under the degraded stage of sholas, it is classified into the forest type of Southern montane wet scrub-type (11A/DS1)[9].

Methods: The present study involves the vegetation analysis in the forest fire affected and unaffected areas of degraded shola forest ecosystem of the Nilgiris Eastern Slope Range, Nilgiris North Division, Tamil Nadu, India.

Assessment of floral diversity: The vegetation analysis was carried out twice (i.e.) immediately after fire and after monsoon period in the unburnt and burnt areas of degraded shola forest ecosystem. The following parameters were assessed. A variety of approaches exists to aid in the inventory and analysis of vegetation. All the methods of data analysis can be regarded as explicit forms of mathematical modeling. The most familiar models are equations, which specify the functional relationship between one or more controlling factors[10,11]. Floral diversity assessment was done using standard method established by Daniels *et al.*[12]. In the study site simple random sampling method was followed in laying the sample plots. The trees diversity was measured in 10 m x 10 m sample plot, smaller plots of 5 m x 5 m for shrubs and 1 m x 1 m for herbs were demarcated. In order to determine the quantitative relationship between the plant species, the following parameters were determined.

Density: Density is defined as the number of plants per unit area. Total absolute density of species is commonly measured per hectare.

$$\text{Density} = \frac{\text{Total number of all individuals of all species}}{\text{Total number of quadrates sampled}}$$

Relative density: Relative density is used to express the contribution of individuals of one species in relation to the total number of individuals of all species and is determined as follows:

$$\text{Relative density} = \frac{\text{Total number of individuals of a species}}{\text{Total number of individuals of all species}} \times 100$$

Abundance

$$\text{Abundance} = \frac{\text{Total no. of individuals of the species}}{\text{No. of quadrates of occurrence}}$$

Frequency: It is the measure of commonness and distribution of a species within a study area. Frequency is defined as the change of finding a species in a particular trial sample and expressed as a percentage of sample plots in which a species occurs[13].

$$\text{Frequency of a species} = \frac{\text{Number of sample plots in which a species occurs}}{\text{Total number of sample plots}} \times 100$$

Relative frequency: Frequency can also be expressed in relative terms.

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Sum of frequencies of all species}} \times 100$$

Dominance: Dominance is a measure of the size, bulk or weight of the vegetation. Three characteristics of the vegetation are commonly evaluated as a measure of dominance; they are weight or biomass, basal cover or basal area and canopy cover or canopy area. Total absolute dominance is equal to the total of all dominance values for all species divided by the total number of samples.

$$\text{Dominance} = \frac{\text{Total basal area of a species}}{\text{Area sampled}}$$

Relative dominance: Dominance is a measure of the size, bulk or weight of the vegetation. Three characteristics of the vegetation are commonly evaluated as a measure of dominance; weight or biomass, basal cover or basal area and canopy cover or canopy area. Canopy or basal cover of a species expressed as a percentage of canopy or basal cover for all species, gives the relative dominance.

$$\text{Relative dominance} = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100$$

Important value index: Girth, height and canopy cover of all the trees were measured. Girth class distribution of trees and Important Value Index (IVI) was calculated as

IVI = Relative dominance + Relative density + Relative frequency[14].

Relative Important Value Index: RIVI = IVI / 3

Study of Diversity indices: Species richness: The species richness was calculated using Margalef's and Menhinick's Index. Margalef's Index[15] $D_{Mg} = (S-1) / \ln N$

Menhinick's Index : $D_{Mn} = S / \sqrt{N}$

Where N = Total number of individual, S = Total number of species in this plot

α Biodiversity indices: Measure of diversity is frequently seen as indicators of the well being of any ecosystem. They also serve as a measure of the species diversity in the ecosystem. The following indices were worked out to assess and compare the diversity and distribution of plant species in different types of forests and at different altitudes. The species diversity was calculated using Shannon-Wiener Index and Simpson's Index[12,16,17].

Shannon-Wienner Index (1963)

$$H' = - \Sigma (Pi \times \ln Pi)$$

where, H' - the measure of diversity, Pi - the proportion of the i^{th} species in the landscape element, Ln Pi - natural logarithm of the proportion of each species.

Modified Simpson's Index (Simpson, 1949)

$$S = \frac{1}{\Sigma Pi^2}$$

Where, S - the measure of diversity, Pi - the proportion of i^{th} species sampled.

The above diversity indices take into account not only the number of species but also their relative abundance.

Evenness using Shannon – Wiener Index: The evenness of the species was calculated using Shannon-Wiener Index. It was worked out as follows: E=H' / Ln S

Where, H = Shannon index, S = Total number of species

β Diversity: β Diversity estimates the species turnover. Jaccard's index of similarity assesses comparative species turnover.

$$C_j = \frac{j}{(a+b-j)}$$

Where, j = number of species common to both plots, a = number of species in plot A, b = number of species in plot B

Results and Discussion

Effect of fire on diversity status of vegetation: The overall density of plants in the unburnt area was 3,55,610 plants ha^{-1} prior to monsoon. Of this there were 3,370 trees ha^{-1} (0.96 %), 10,240 shrubs ha^{-1} (2.86 %) and 3,42,000 herbs ha^{-1} (96.18 %). Among the trees *T. asiatica* had highest density of 2,600 stems ha^{-1}, among shrubs *Pteridium aquilinium* had highest density of 5,200 plants ha^{-1} and among the herbs *Cyonotis* sp. had highest density of 2,30,000 plants ha^{-1}. The result revealed that, among the different plant communities, trees were heavily affected by fire because it accounted only at 66 stems ha^{-1}, which is very low compared to the unburnt study area. The total plant density of fire affected area was 2,27,620 plants ha^{-1} which is lower than the unburnt site. The trees contribute a very meager, i.e.

0.026 per cent to the total density compared to 0.095 per cent in the unburnt plot. Shrubs had a density of 23,560 plants ha^{-1} (Relative density 10.35), while herbs contributed 89.64 per cent (Relative density) with a density of 20,400 plants ha^{-1}. Though, fire decreased the density of trees and overall plant density, it increased the density of shrubs and herbs. These results help to conclude that the forest fire in the study area was primarily the crown fire, which totally consumed the crown cover and the trees were worst affected compared to shrubs and herbs. After monsoon, overall density of vegetation in unburnt and burnt sites increased drastically. This is primarily due to the regeneration of herbs and shrubs favoured by fire and rain.

Vegetational study: The vegetational analysis of the present study includes assessment of density, relative density, dominance, relative dominance, frequency, relative frequency, important value index, species richness indices and the α diversity indices using Shannon-Wiener index and Simpson's index (table 3, 4, 5 and 6). The evenness was assessed using Shannon's-Wiener index and the β diversity was assessed using Jaccard's index of similarity. In the present study, the estimation of the above parameters in the unburnt area revealed that the shrubs and herbs dominated more in the vegetational composition. The results also explained that number of trees was very less and they were scantly and unevenly distributed. This result clearly confirms that the study area is a degraded forest and also it invites regular fire. It is also interesting to note that the vegetation composition study of the unburnt area immediately after fire as well as in the monsoon seasons revealed that there was no significant difference in the vegetational composition. Hence, this also helps to conclude that this forest is a degraded shola forest which has been regularly affected by fire and their retrogression is being deeply promoted. The study of the burnt area revealed that immediately after fire, trees are the worst affected component in the vegetational community which is observed interms of their lower density, frequency, dominance and abundance values compared to the unburnt area. The result also revealed that herbs and shrubs were comparatively less affected than trees. The vegetational analysis after fire showed comparatively higher vegetation value for shrubs and herbs. However, the study revealed that there was no significant change in the vegetational composition value for trees. The increase in composition of herbs and shrubs in the burnt area after monsoon favoured for their high regeneration with added advantage of increased N and K availability. This situation might have also favoured the regeneration of the tree species *Todalia asiatica*, *Rhodomyrtus tomentosa, Symplocos spicata* and *syzygium cumini*. Similar increase in herbaceous population after fire was also reported by Srivastava[18] in shola-grass land ecotone of Nilgiri Biosphere Reserve. Calvo *et al.*[19] also observed increase in herbaceous population after fire under *Pinus pinaster* and *Quercus pyrenaica* dominated forest. The observations drive to conclude that increase in herb and shrub population is helpful for protection of regenerated tree species and to tide over the ensuing summer season. Since the fire is the regular phenomenon in the study area and was seriously affecting the regeneration of tree species this study assuming importance on a larger perspective.

Diversity indices: The diversity indices of burnt and unburnt areas were analyzed and the results were presented in the table 2. The Simpson's index and Shannon-Wienner index, Simpson dominance index showed that high diversity was accounted in unburnt areas in both the seasons of study. It is important to note that high diversity status in terms of all the above indices was reflected in the burnt area after monsoon. This clearly shows that though the site is continuously disturbed, it is having the potential to recover its original vegetation. Unless the regular occurrence of fire is not stopped, the forest may develop into pre-climax vegetation and the vegetation composition may also end with fire hardy species alone.

The evenness indices showed very low evenness in the burnt area and very high evenness in the unburnt area reflecting that the species composition of the vegetation is totally affected between unburnt and burnt area. These indices help to predict that the vegetation composition is under serious threat of degradation. The Margalef's, Menhinick's and Jaccard's indices also revealed the similar trend like that of evenness index. The present findings are in accordance with the results of Swarupanandan *et al.*[20] and Thomas[21].

The vegetation analysis and diversity indices estimation repeatedly emphasized that the forest fire is totally changing the vegetation composition in the study site. They also indicated that forest fire is seriously promoting the retrogression, as the result the present state of the forest in the study site has developed into secondary and degraded forest. Serious efforts are needed to prevent fire occurrence in the study site to help the retrogression to be stopped, so as to enable the vegetation to regain its original status.

Table-2
Diversity indices for the unburnt and burnt areas

Diversity indices	Immediately after fire		After monsoon	
	Unburnt area	Burnt area	Unburnt area	Burnt area
Simpson's Index	0.831	0.530	0.863	0.86
Simpson's dominance Index	0.169	0.470	0.136	0.14
Shannon –Wiener Index	3.195	1.637	3.715	3.617
H max	4.755	3.907	5.209	5.426
Evenness Index	0.672	0.419	0.713	0.667
Maralef's Index	4.456	2.633	5.115	3.383
Menhinicks Index	1.465	1.050	1.096	0.075
Jaccard's Index	0.315	0.315	0.455	0.455

Table-3
Density and relative density for the unburnt and burnt areas

Species	Immediately after fire				After monsoon			
	Unburnt area		Burnt area		Unburnt area		Burnt area	
	D	RD	D	RD	D	RD	D	RD
TREES								
Todalia asiatica	2600.00	0.73	10.00	0.004	2410.00	0.400	20.00	0.002
Rhodomyrtus tomentosa	630.00	0.18	30.00	0.010	720.00	0.120	30.00	0.003
Symplocos spicata	70.00	0.02	10.00	0.004	60.00	0.010	10.00	0.001
Syzygium cumini	30.00	0.01	0.00	0.000	30.00	0.005	0.00	0.000
Acacia sp.	20.00	0.01	10.00	0.004	10.00	0.002	20.00	0.002
Glochidion malabaricum	20.00	0.01	0.00	0.000	20.00	0.003	0.00	0.000
Trees total	**3370.00**	**0.96**	**60.00**	**0.02**	**3250.00**	**0.54**	**80.00**	**0.01**
SHRUBS								
Dodonea viscosa	1040.00	0.29	600.00	0.260	560.00	0.090	520.00	0.050
Osbeckia sp.	1280.00	0.36	0.00	0.000	280.00	0.050	160.00	0.020
Berberis tinctorea	120.00	0.03	1040.00	0.460	160.00	0.030	1120.00	0.110
Desmodium rufescens	160.00	0.04	1120.00	0.490	480.00	0.080	760.00	0.070
Smilax zeylanica	160.00	0.04	0.00	0.000	200.00	0.030	0.00	0.000
Pteridium aquilinum	5200.00	1.46	20800.00	9.140	2600.00	0.440	15000.00	1.440
Myrsine sp.	80.00	0.02	0.00	0.000	120.00	0.020	0.00	0.000
Brachylepis nervosa	120.00	0.03	0.00	0.000	280.00	0.050	0.00	0.000
Rosa leschenaultii	200.00	0.06	0.00	0.000	200.00	0.030	0.00	0.000
Eupatorium glandulosa	1520.00	0.43	0.00	0.000	2480.00	0.420	1400.00	0.130
sclepiadaceae climber	160.00	0.04	0.00	0.000	840.00	0.140	0.00	0.000
Lantana camara	200.00	0.06	0.00	0.000	960.00	0.160	0.00	0.000
Shrubs total	**10240.00**	**2.86**	**23560.00**	**10.350**	**8200.00**	**1.540**	**18960.00**	**1.820**
HERBS								
Eragrostis nigra	22000.00	6.19	177000.00	77.760	34000.00	5.690	210000.00	20.110
Rubus racemosus	0.00	0.00	5000.00	2.200	0.00	0.000	5000.00	0.480
Vernonia cineraria	0.00	0.00	5000.00	2.200	0.00	0.000	15000.00	1.440
Cyperus angulatus	34000.00	9.56	0.00	0.000	41000.00	6.860	0.00	0.000
Mimosa sp.	0.00	0.00	7000.00	3.080	0.00	0.000	14000.00	1.340
Anaphalis sp.	0.00	0.00	0.00	0.000	5000.00	0.840	5000.00	0.480
Cyanotis sp.	230000.00	64.68	0.00	0.000	310000.00	51.890	217000.00	20.780
Blumea hieracifolia	5000.00	1.41	0.00	0.000	6000.00	1.004	3000.00	0.290
Emilia sonchifolia	3000.00	0.84	0.00	0.000	3000.00	0.500	7000.00	0.670
Cyperus rotundus	0.00	0.00	0.00	0.000	31000.00	5.190	48000.00	4.600
Solanum sp.	1000.00	0.28	4000.00	1.760	0.00	0.000	4000.00	0.380
Commelina sp.	0.00	0.00	0.00	0.000	12000.00	2.010	0.00	0.000
Centella asiatica	0.00	0.00	0.00	0.000	21000.00	2.520	0.00	0.000
Isachne sp.	0.00	0.00	0.00	0.000	19000.00	3.180	26000.00	2.490
Viola serpens	5000.00	1.41	0.00	0.000	2000.00	0.330	10000.00	0.960
Impatiens sp.	32000.00	9.00	0.00	0.000	56000.00	9.370	0.00	0.000
Impatiens tomentosa	0.00	0.00	0.00	0.000	0.00	0.000	4000.00	0.380
Polygala crotolaria	0.00	0.00	0.00	0.000	3000.00	0.500	7000.00	0.670
Oldenlandia heyni	10000.00	2.81	0.00	0.000	7000.00	1.170	34000.00	3.260
Impatiens crenata	0.00	0.00	0.00	0.000	3000.00	0.500	7000.00	0.670
Justicia simplex	0.00	0.00	0.00	0.000	14000.00	2.340	15000.00	1.440
Fimbriostylis sp.	0.00	0.00	0.00	0.000	4000.00	0.670	7000.00	0.670
Oxalis corniculata	0.00	0.00	0.00	0.000	0.00	0.000	265000.00	25.380
Rubus ellipticus	0.00	0.00	5000.00	2.200	0.00	0.000	6000.00	0.570
Rosa leschenaultii	0.00	0.00	1000.00	0.440	0.00	0.000	4000.00	0.380
Kyllinga sp.	0.00	0.00	0.00	0.000	0.00	0.000	17000.00	1.630
Tripogon	0.00	0.00	0.00	0.000	0.00	0.000	3000.00	0.290
Pennisetum grandestimum	0.00	0.00	0.00	0.000	0.00	0.000	7000.00	0.670
Themeda sp.	0.00	0.00	0.00	0.000	0.00	0.000	3000.00	0.290
Ulex europaeus	0.00	0.00	0.00	0.000	0.00	0.000	1000.00	0.095
Isachne kunthiana	0.00	0.00	0.00	0.000	0.00	0.000	6000.00	0.570
Setaria glauca	0.00	0.00	0.00	0.000	0.00	0.000	12000.00	1.150
Leucas aspera	0.00	0.00	0.00	0.000	13000.00	2.180	42000.00	4.020
Conyza ambigua	0.00	0.00	0.00	0.000	0.00	0.000	1000.00	0.095
Digitaria sp.	0.00	0.00	0.00	0.000	0.00	0.000	12000.00	1.150
Amaranthus sp.	0.00	0.00	0.00	0.000	0.00	0.000	5000.00	0.480
Anotis sp.	0.00	0.00	0.00	0.000	1000.00	0.170	3000.00	0.290
Herbs total	**342000.00**	**96.18**	**204000.00**	**89.64**	**585000.00**	**96.91**	**1025000.00**	**98.17**
Overall total	**355610.00**	**100.00**	**227620.00**	**100.00**	**596450.00**	**100.00**	**1044040.00**	**100.00**

Table-4
Abundance, frequency and relative frequency for unburnt and burnt areas

Species	Immediately after fire						After monsoon					
	Unburnt area			Burnt area			Unburnt area			Burnt area		
	Ab	F	RF	Ab	F	RF	Ab	F	RF	Ab	F	RF
TREES												
Todalia asiatica	26.00	100	8.13	1.00	10	1.47	24.10	100	5.41	2.00	10	0.52
Rhodomyrtus tomentosa	6.30	100	8.13	1.00	30	4.41	7.20	100	5.41	1.00	30	1.57
Symplocos spicata	1.75	40	3.25	1.00	10	1.47	1.50	40	2.16	1.00	10	0.52
Syzygium cumini	1.50	20	1.63	0.00	0	0.00	1.50	20	1.08	0.00	0	0.00
Acacia sp.	1.00	20	1.63	1.00	10	1.47	1.00	10	0.54	2.00	10	0.52
Glochidion malabaricum	2.00	10	0.81	0.00	0	0.00	2.00	10	0.54	0.00	0	0.00
Trees total	**38.55**	280	**23.58**	**4.00**	60	**8.82**	**37.30**	280	**15.14**	**6.00**	60	**3.13**
SHRUBS												
Dodonea viscosa	3.25	80	6.50	2.14	70	10.29	2.00	70	3.78	1.86	70	3.66
Osbeckia sp.	4.57	70	5.69	0.00	0	0.00	1.17	60	3.24	1.33	30	1.57
Berberis tinctorea	1.50	20	1.63	4.33	60	8.82	1.00	40	2.16	4.67	60	3.14
Desmodium rufescens	1.00	40	3.25	4.00	70	10.29	2.40	50	2.70	2.71	70	3.66
Smilax zeylanica	1.33	30	2.44	0.00	0	0.00	1.67	30	1.62	0.00	0	0.00
Pteridium aquilinum	13.00	100	8.13	52.00	100	14.71	6.50	100	5.41	37.50	100	5.24
Myrsine sp.	2.00	10	0.81	0.00	0	0.00	1.00	30	1.62	0.00	0	0.00
Brachylepis nervosa	1.00	30	2.44	0.00	0	0.00	1.40	50	2.70	0.00	0	0.00
Rosa leschenaultii	1.00	50	4.07	0.00	0	0.00	1.00	50	2.70	0.00	0	0.00
Eupatorium glandulosa	5.43	70	5.69	0.00	0	0.00	6.89	90	4.86	8.75	40	2.09
Asclepiadaceae climber	1.33	30	2.44	0.00	0	0.00	3.00	70	3.78	0.00	0	0.00
Lantana camara	2.50	20	1.63	0.00	0	0.00	4.80	50	2.70	0.00	0	0.00
Shrubs total	**37.92**	550	**44.72**	**62.47**	300	**44.11**	**32.83**	690	**37.27**	**56.82**	370	**19.36**
HERBS												
Eragrostis nigra	7.33	30	2.44	17.70	100	14.71	3.78	90	4.86	21.00	100	5.24
Rubus racemosus	0.00	0	0.00	1.00	50	7.35	0.00	0	0.00	1.25	40	2.09
Vernonia cineraria	0.00	0	0.00	1.25	40	5.88	0.00	0	0.00	1.88	80	4.19
Cyperus angulatus	6.80	50	4.07	0.00	0	0.00	4.10	100	5.41	0.00	0	0.00
Mimosa sp.	0.00	0	0.00	1.00	70	10.29	0.00	0	0.00	2.00	70	3.66
Anaphalis sp.	0.00	0	0.00	0.00	0	0.00	1.66	30	1.62	2.50	20	1.05
Cyanotis sp.	28.75	80	6.50	0.00	0	0.00	44.29	70	3.78	27.13	80	4.19
Blumea hieracifolia	1.00	50	4.07	0.00	0	0.00	1.20	50	2.70	1.00	30	1.57
Emilia sonchifolia	1.50	20	1.63	0.00	0	0.00	1.00	30	1.62	1.40	50	2.62
Cyperus rotundus	0.00	0	0.00	0.00	0	0.00	4.43	70	3.78	12.00	40	2.09
Solanum sp.	1.00	10	0.81	1.33	30	4.41	0.00	0	0.00	1.00	40	2.09
Commelina sp.	0.00	0	0.00	0.00	0	0.00	1.50	80	4.32	0.00	0	0.00
Centella asiatica	0.00	0	0.00	0.00	0	0.00	5.25	40	2.16	0.00	0	0.00
Isachne sp.	0.00	0	0.00	0.00	0	0.00	3.17	60	3.24	3.71	70	3.66
Viola serpens	1.25	40	3.25	0.00	0	0.00	2.00	10	0.54	1.67	60	3.14
Impatiens sp.	4.57	70	5.69	0.00	0	0.00	9.33	60	3.24	3.71	70	3.66
Impatiens tomentosa	0.00	0	0.00	0.00	0	0.00	1.00	30	1.62	1.33	30	1.57
Polygala crotolaria	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	1.75	40	2.09
Oldenlandia heyni	2.50	40	3.25	0.00	0	0.00	2.33	30	1.62	4.86	70	3.67
Impatiens crenata	0.00	0	0.00	0.00	0	0.00	1.50	20	1.08	1.75	40	2.09
Justicia simplex	0.00	0	0.00	0.00	0	0.00	2.00	70	3.78	3.00	50	2.62
Fimbriostylis sp.	0.00	0	0.00	0.00	0	0.00	4.00	10	0.54	1.75	40	2.09
Oxalis corniculata	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	33.13	80	4.19
Rubus ellipticus	0.00	0	0.00	2.50	20	2.94	0.00	0	0.00	1.20	50	2.62
Rosa leschenaultii	0.00	0	0.00	1.00	10	1.47	0.00	0	0.00	1.00	40	2.09
Kyllinga sp.	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	4.25	40	2.09
Tripogon	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	3.00	10	0.52
Pennisetum grandestimum	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	2.33	30	1.57
Themeda sp.	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	3.00	10	0.52
Ulex europaeus	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	1.00	10	0.52
Isachne kunthiana	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	3.00	20	1.05
Setaria glauca	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	1.71	70	3.66
Leucas aspera	0.00	0	0.00	0.00	0	0.00	6.50	20	1.08	8.40	50	2.62
Conyza ambigua	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	1.00	10	0.52
Digitaria sp.	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	2.40	50	2.62
Amaranthus sp.	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	1.25	40	2.09
Anotis sp.	0.00	0	0.00	0.00	0	0.00	1.00	10	0.54	1.50	20	1.05
Herbs total	**54.70**	390	**31.71**	**25.78**	320	**47.05**	**100.04**	880	**47.53**	**162.86**	1550	**81.11**
Overall total	**131.17**	1230	**100.00**	**92.25**	680	**100.00**	**170.17**	1850	**100.00**	**225.68**	1980	**100.00**

Table-5
Dominance and relative dominance for the trees of unburnt and burnt areas

Species	Immediately after fire				After monsoon			
	Unburnt area		Burnt area		Unburnt area		Burnt area	
	D (m^2/ha)	RD (%)	D (m^2/ha)	RD (%)	D (m^2/ha)	RD (%)	D (m^2/ha)	RD (%)
Todalia asiatica	0.00806	72.48	0.00003	17.65	0.00844	69.81	0.00006	24
Rhodomyrtus tomentosa	0.00239	21.49	0.00008	47.06	0.00302	24.98	0.00010	40
Symplcos spicata	0.00018	1.62	0.00004	23.53	0.00015	1.24	0.00003	12
Syzygium cumini	0.00040	3.60	-	-	0.00040	3.31	-	-
Acacia sp.	0.00004	0.36	0.00002	11.76	0.00002	0.17	0.00006	24
Glochidion malabaricum	0.00005	0.45	-	-	0.00006	0.50	-	-
Total	0.01112	100	0.00017	100	0.01209	100	0.00025	100

Table-6
Importance value index for trees in burnt and unburnt areas

Species	Immediately after fire				After monsoon			
	Unburnt area		Burnt area		Unburnt area		Burnt area	
	IVI	RIVI	IVI	RIVI	IVI	RIVI	IVI	RIVI
Todalia asiatica	123.170	41.055	56.780	18.926	123.468	41.156	65.749	21.916
Rhodomyrtus tomentosus	67.130	22.377	126.122	42.041	73.918	24.639	16.920	38.973
Symplcos spicatus	25.211	8.404	65.244	21.748	25.681	8.560	58.586	19.529
Syzygium cumini	56.247	18.749	0.000	0.000	55.129	18.376	0.000	0.000
Acacia sp.	14.870	4.957	51.857	17.286	11.138	3.713	58.745	19.582
Glochidion neiloghirensis	13.382	4.461	0.000	0.000	14.369	4.790	0.000	0.000
Total	300.01	100.00	300.00	100.00	300.00	100.00	300.00	100.00

Conclusion

The effect of forest fire has heavily influenced the vegetation composition of the study site. The diversity indices and the vegetation study help to conclude that the type of fire occurring in the study site is crown fire and seriously damaging the tree strata in the vegetation, consequently ended with change in vegetation composition. The analysis in the burnt and unburnt area showed that the forest has good regeneration potential especially after the monsoon period. However, the regeneration potential has been seriously affected due to regular occurrence of forest fire in study site. The diversity indices and vegetational study helps to conclude that the regeneration potential of the study site is good enough to regain its original vegetation status if the fire is prevented through good forest management plan.

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