Phytology

A study of phytosociological attributes of shrubs plant resources in nallamalais

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Abstract

Biodiversity is essential for human survival and economic wellbeing and for the ecosystem function and stability.forest in India are considered as a source of livelihood for forest department people, as repository of rich biodiversity and source of timber for industries. Nallamalla, the study area of the present work is one of the 234 Centres of Plant Diversity of the World. Heavy biotic interference primarily pertaining to over-exploitation of wild plant resources is leading to alarming loss of species population in the study area.The present study is based on ramdom sampling method by quadrates in different vegetation types of Nallamalais & documents the diversity of shrubs plant resources of the forest.The total number of individuals TNI of shrubs in the study site was 606. The total abundance value for all the 37 shrubs is 210.22 which are average of 5.68.

Keywords: biodiversitty, nallamalla, diversity, shrubs, TNI

Introduction

Biodiversity is essential for human survival and economic well-being and for the ecosystem function and stability. It has attracted world attention because of the growing awareness of its importance on the one hand, and the anticipated massive depletion on the other. In this regard natural forests are critically important for maintaining biological diversity as they not only contain half of the world's total biodiversity and also have the highest species diversity and endemism of any ecosystem type (CBD, 2012) [4].

Forests can release the stored carbon as CO_2 that form nearly 17-25% of the total greenhouse gas emissions, at the same time forest conservation, afforestation, reforestation and sustainable forest management can curb about 25% of emissions. Hence, forests besides being home to more than 50% of biodiversity on land also provides an opportunity to promote actions that simultaneously protect climate, biodiversity and provide sustainable livelihoods to forest dependent people. In this context, India has become one of the strong proponents for the idea of reducing emissions from tropical deforestation and degradation.

To integrate forests in to climate change activities by reduction in forest degradation, baseline information about the forest plant diversity, forest structure, carbon sequestration potential in above ground and below ground biomass will be of most useful. Degradation of the tropical forests and destruction of habitats due to anthropogenic disturbances are a major cause of decline biodiversity at global level (Reddy and Ugle, 2008) [33]. The dry tropical, subtropical and woodlands covered more than half of the world's tropics (Janzen 1988) [16] but have decreased considerably during the last decennia. A total of 52% of the forests are tropical in world and in India, approximately 86% are tropical (Singh and Singh 1988) [40]. These forests, however, are strongly impacted by anthropogenic activities (Champion and Seth 1968; Singh *et al.*, 1991) [5]. Because of high anthropogenic pressures in the past several decades, the dry deciduous forest cover in most parts of India is being converted into dry deciduous scrub, dry savannah and dry grasslands which are progressively species poor. This situation calls for in-depth study of dry deciduous forests with respect to species diversity, structure and regeneration. Nallamalais, the study area of the present work is one of the 234 Centres of Plant Diversity of the world (Davis *et al.*, 1995) [10] and they are rich with diversified habitats supporting a wide array of plant and animal life and provides livelihood for indigenous tribal communities as well other forest dwellers. The local chenchu tribe has rich traditional botanical knowledge and is using over 450 plant species for curing different ailments. Forest dwellers collect process and market different types of Non-Timber Forest Produce, worth to mention the fruits, herbaceous medicinal plants, gums and beedi leaf. Besides, large amounts of fuel wood, fodder harvested from the forested tracts form the basic livelihood of rural populations. Despite of the ecological and economic importance of forests of Nallamalais, these ecosystems have been subjected to great stress, and continue to face multiple threats. Deforestation and forest degradation in the Nallamalais continue unabated. Even the protected areas face tremendous pressures from local communities living inside and around the forests and other 'biosphere people'. Heavy biotic interference primarily pertaining to over-exploitation of wild plant resources is leading to alarming loss of species populations in the study area. Nallamalais of Telangana state are present above the river Krishna and is home for many wild animals especially Tiger, Panther, Bear, Sambar, Wild Boar, Deer and variety of birds, reptiles and insects.

Lack of complete and consolidated information on plant resource is a major stumbling block in the whole process of conservation and utilization of plant resources of Nallamalais

in Andhrapradesh State. It is important to have an assessment of the existing status of the natural strands of these resources, their geographic distribution and population structure to arrive at sustainable levels of harvesting and to develop working plans for the forest resources.

The present study is based by random sampling method by lying of nested quadrates in different vegetation types of Nallamalais documents the diversity of plants and structure of the forest. With this background, a holistic attempt has been made on plant diversity, distribution and the structure of Nallamalais to fulfil the following objectives:

Objectives

- Inventory of plant taxa encountered in the sampling units
- To know the structure of Northern Nallamala forests
- To determine the disturbance index of different forest sites in Nallamalais
- To know the threats to flora of Nallamalais and to propose effective strategies for its conservation.

Review of literature

The literature pertaining to the present work is presented below:

a) Floristic studies

According to Ellis (1987, 1990) [11, 12], studies on Nallamalais dates back to 1870's. R.H. Beddome during 1870-73 and 1881, Lushington in 1915; sporadic collections made by Hooker in 1883; J.S. Gamble during1883-87, C.A. Barber, in 1899, 1902 and 1906; Barber collections in Diguvametta and Gundlabrahmeswaram area during 1915-1920; Jacob 1917 and Fischer in 1921. Rangachari and personnel of the unit of Grass Survey of IARI also collected plants from Nallamalais. But no published data is available on any of these collections (Ellis, 1987) [11]. They made only random collections and kept in various herbaria in India as well as Royal Botanical Gardens, Kew, England (Raju & Pullaiah, 1995) [30].

The major studies on plant resources of Nallamalais in the past 25 years include Champion and Seth (1968) [5] recognized 6 major forest types in Nallamalis. Ellis (1987) [11] studied the flora of Nallamalais and reported 743 taxa. Raghava Rao (1989) studied the Flora of Mahabubnagar district collected most of the plants from Nallamalais. Shali Saheb (2008) [37] studied the medicinal plants of Nallamalais and reported 501 taxa. Murthy and Benjamin (2008) [27] made a critical study on floristic of Nagarjuna Sagar Tiger Reserve and reported 962 species. NRSA (2007) [28] using remote sensing and GIS has brought out an additional dimension to bio-resources management perspective. They recorded 252 economically important species from Eastern Ghats of Andhra Pradesh as a part of the Phase II biodiversity project including 123 trees. They also reported 261 medicinally important species and their indicative uses covering 93 tree species. Most of the above-mentioned works are done in Nallamalais of Andhra Pradesh except Raghava Rao.

b) Quantification studies

Vegetation mapping and monitoring is a primary requirement for management and planning activities at the local, modeling species distribution using environmental surrogates of known locations planning, when primary information is lacking (Anderson and Meyer, 2004) [1]. Association of a particular species with specific environmental conditions has been documented (Colding and Folke, 1997; Hubbell, 989) [6,], but quantitative analysis have been possible only recently (Cullen *et al.*, 2001) with advent of new tools, as well as availability of continuous spatial data on various environmental parameters (Keer and Ostrovsky, 2003).

Sampling inventories

Many quantitative ecological methods have been proposed to study plants of ethno botanical importance by Johns *et al.* (1990), Moerman (1991) [25] and Cotton (1997). Dallmeier (1992) opined that floristic inventories and studies on forest dynamics usually rely on sampling plots. He monitored various types of primary and secondary tropical forests through plotting method in biosphere reserves of Bolivia, Peru, Peurto Rico, US Virgin Islands and other sites. The effects of plot size and the influence of plot shape on the estimates of plant diversity were assessed by Kilburon (1966), Greg-Smith (1983) and Laurance *et al.*, (1998) respectively. Van Claster *et al.*, (2008) laid 255 plots of 10x10m for study the over storey and under storey. Zakaria *et al.*, (2009) analyses the plant communities from six study plots within the Penang Forest Reserves, Malaysia, through a sampling size of 20mx20m.

In India, quantitative inventory studies were initiated by Rai (1981) by studying all trees ≥10cm dbh in four plots of different sizes at Devimane, Malimane, Kodkami and Katleken areas of Western Ghats. Quantitative studies have been made through belt transect method in Chocopo tribe area in Northern Bolivia by Boom (1989) [3]. Most of the studies have followed the plot methods including square plots of 100mx100m (Gentry, 1988) [14]; 10mx10m (Shali Saheb, 2008) [37] to rectangular plots 10x1000m by Boom (1989) [3]. Kharkwal *et al.*, (2005) [20] examined the phytodiversity and growth form in relation to altitudinal gradient in the Central Himalayan (Kumaun) region of India. Supriya Devi and Yadava (2006) [41] studied the diversity index of shrubs and herbs were found to be higher than the tree species in Manipur. Mukesh Kumar *et al.*, (2008) [26] worked on sub-tropical Sal forest of Doon valley with 1x1m quadrates.

Sahu *et al.*, (2007) [35] made a study in the dry deciduous forests of Boudh district of Orissa in Northern Eastern Ghats. They used a nested quadrate of size 5x5m for quantifying the shrubs, climbers and also herbaceous flora.

Kadavul & Parthasarathy (1999) [19] suggested that the variation in species richness of various forest types is not only determined by edaphic factors but also by their proximity to village and the plot dimensions. NRSA (2007) [28] sampled 4170 plots in Eastern Ghats with a quadrat size of 20x20m for trees, one 10x10m for shrubs and for herbs five, 1x1m for each plot. Shali Saheb (2008) [37] quantified the medicinal plant resources of Nallamalais in 0.3ha area. The plant diversity inventories in dry forests revealed a varied range of plant diversity owing to different study sites and field methodology – Sacred groves in southern Eastern Ghats have 158 tree species. Nallamalais of Andhra Pradesh and Telangana constitute 729 herbaceous and 249 tree taxa (Sadasivaiah, 2009; Basha, 2009) [34, 2] and stressed that Northern Nallamalais harbor good forest pockets with good number of endemic species. But due to overexploitation of medicinal plants, fuel wood collection, habitat destruction and grazing, may lead to

extinction of many valuable species. Thus several authors have stressed the need for better conservation of the dry forests and especially in Eastern Ghats which includes good portion of dry deciduous forests with rich plant wealth of medicinal and economic value (Ellis, 1987; Rawat, 1997) [11].

Study area

Nallamalais are present in the southern parts of Eastern Ghats. Eastern Ghats are a discontinuous range of mountains along India's eastern coast. Southern Eastern Ghats in Andhra Pradesh comprises of a chain of ancient low hills that harbour tropical Moist deciduous, Dry deciduous forests and scrub (Champion and Seth, 1968) [5]. Geologically southern Eastern Ghats is made up of quartzite and slate formations with red, mixed red, black and lateritic soil and the forests in this area are unique in their composition specific to the rock formations. Nallamalais is one of the 234 Centres of Plant Diversity of the world identified worldwide (Davis *et al.*, 1995) [10]. Northern Nallamalais are situated north part of the river Krishna and are a group of moderately steep hills, encompassing major parts of Nagarkurnool district and in small patches in Nalgonda districts of Telangana. A thorough perusal of literature has revealed that the study area is currently known to harbour over 500 plant species. The local Chenchu tribe has rich traditional botanical knowledge is currently using over 250 plant species for curing different ailments. Despite the ecological and economic importance of the forests of Northern Nallamalais, no full-fledged quantification studies have been taken up so far to analyze the resource availability, and their conservation, and hence the present work has been taken up in Nallamalais.

Materials and methods

The present study aims at a first ever systematic attempt towards a fine scale assessment of the plant resources of Northern Nallamalais of Nagarkurnool district of Telangana state based on filed explorations and random sampling method.

a) Floristic studies

Before initiating the field work, a check list of plant taxa of Northern Nallamalais was prepared based on past literature and herbarium Further a through perusal of literature was done referring almost all recent publications published on plant taxa with references to taxonomy, quantification, economic importance plants of Nallamalais of Telangana state (Pullaiah, 2016, Reddy, 2002; Shali, 2008; Murthy and Benjamin, 2008; Reddy *et al.*, 2008) [29, 31, 37, 27, 32].

Inventory of plant resources

a) Quantitative studies

The field work plan carried out in Nallamalais of Telangana. A total of 2 hectare area of Northern Nallamalais was sampled by lying of 50 quadrates in the study area. Each quadrate size is 20×20m. All the life forms of plants such as trees, shrubs, climbers and herbs were enumerated. All trees with 10-30cm and ≥ 30 cm girth at 1.37m height (gbh) was enumerated in 20×20m quadrates, for multi stemmed trees girth was measured separately; shrubs and climbers in 5m×5m nested plot and herbs were studied in nested 1m×1m plot. The field work was carried out in two seasons to cover all the vegetation and phenology of trees.

Field work plan: 20X20 m^2 for trees, 5x5m^2 for shrubs, climbers and 1x1m^2 for herbs.

The quantitative characters of the plant species like abundance (A), density (D), frequency (F) was calculated for each species following Curits and Cottom (1956), Mueller- Dombois and Ellenberg (1974).

$$\text{Abundance} = \frac{\text{Total number of individuals in all sampling units}}{\text{Total number of sampling units in which species occur}}$$

$$\text{Density} = \frac{\text{Total number of individuals in all sampling units}}{\text{Total number of sampling units studied}}$$

$$\text{Frequency} = \frac{\text{Number of sampling units in which species occur}}{\text{Total number of sampling units}} \times 100$$

Importance Value Index (IVI)

It is the sum of relative values of any three quantitative characters: relative abundance (RA), relative density (RD) and relative frequency (RF). These quantitative characters are calculated for each species following Curits and Cottom (1956). IVI was calculated to known the dominant species in a community. IVI was computed by using the following formulae;

IVI = Relative Abundance + Relative density + Relative frequency

$$RA = \frac{\text{Abundance of the individual species}}{\text{Sum of abundance value of all species}} \times 100$$

$$RD = \frac{\text{Density value of the individual species}}{\text{Sum of density value of all species}} \times 100$$

$$RF = \frac{\text{Frequency value of the individual species}}{\text{Sum of frequency value of all species}} \times 100$$

Only the top 50 high IVI taxa are presented in the form of table and top 10 taxa are graphically represented.

A/F ratio (Distribution Pattern)

The distribution pattern of the species is interpreted based on Curtis & Cottam (1956). The pattern is determined by calculating the abundance to frequency ratio (A/F). Accordingly, if the value is <0.025, the dispersion of the species is considered regular; 0.025 to 0.05 for random dispersion and >0.05 represents the contagious dispersion pattern.

Diversity indices

Species diversity indices namely Shannon-Wiener index (Shannon and Weiner, 1962) [38], Simpson index (Simpson, 1949) [39] and Margalef Index (Margalef, 1980) [24] were calculated.

Simpson index

It is a measure of dominance since it weighted towards the abundances of commonest species. It is estimated by using following formula:

$D = \sum (ni/N)^2$ or Pi^2

Shannon-Wiener index

It is a measure of the average degree of 'uncertainty' in predicting to what species an individual chosen at random from a collection of S species and N individuals will belong. It is estimated by using following formula:

$H' = -\sum (ni/N) \ln (ni/N)$

Where, ni = number of individuals belonging to the ith species
N = Total number of individuals in the sample.

Results and discussion

SHRUBS

The total number of individuals (TNI), number of quadrates in which species occurred, and the quantitative characters like abundance (A), density (D), frequency (F), relative abundance (RA), relative density (RD), relative frequency (RF) and importance value index (IVI) of shrubs are given in Table-1.

Abundance

The total number of individuals (TNI) of shrubs in the study site was 606. The total abundance value for all the 37 shrubs is 210.22, with an average of 5.68. The highest abundance was recorded for *Barleria strigosa* (21) and lowest abundance was recorded for *Dendrocalamus strictus* (1.0).

Density

The total density of 37 taxa is 12.12, with an average of 0.32. The highest density value was recorded for *Grewia hirsuta* (2.12) and the lowest density was recorded for *Dendrocalamus strictus* (0.02).

Frequency

The total frequency for all the shrubs is 192, with an average of 5. The high frequency value was recorded for *Grewia hirsuta* with 30 and least frequency was observed in 18 taxa with 2 (e.g. *Indigofera cassioides*).

Importance Value Index (IVI)

Importance Value Index of individual shrubs encountered in the sampled quadrates of Northern Nallamalais revealed that, *Grewia hirsuta* (36.51) is the most important species followed by *Lanatana camara* (29.09) and *Phoenix louririi* (23.17). The lowest IVI value 1.68 was observed for *Dendrocalamus strictus.* The top 10 dominant IVI shrubs are presented in Fig. 1.

Diversity indices

The Sipmpson Index is 0.9198, Shannon-Wiener Index is 2.923 and Margalef Index is 5.618.

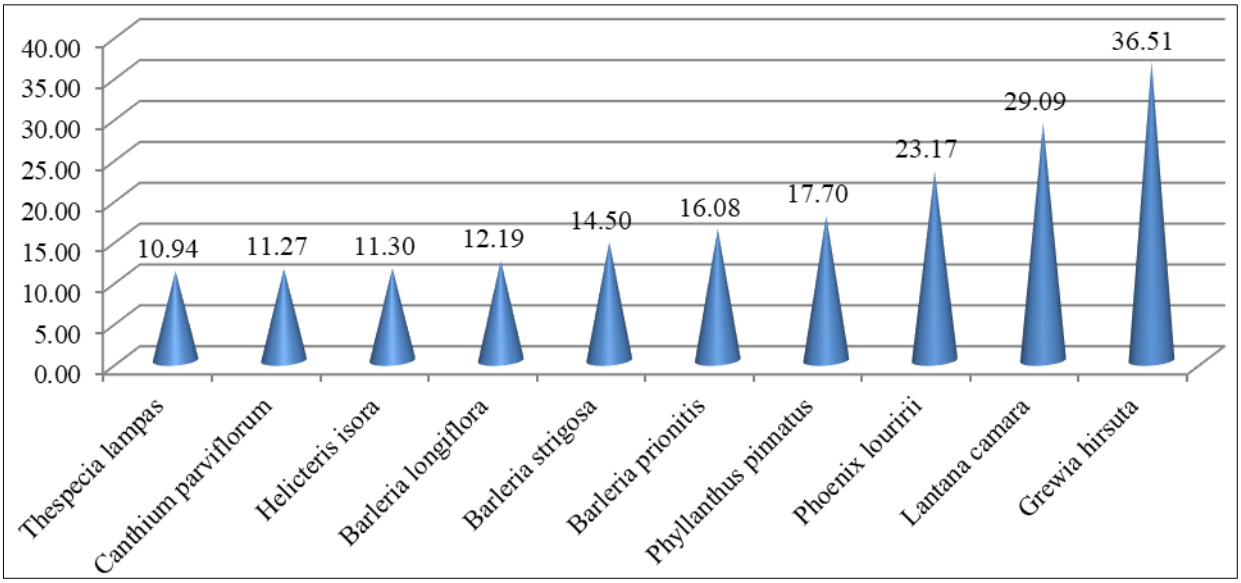

Fig 1: Top 10 IVI shrub species

Table 1: Phytosociological attributes of Shrubs

S. No.	Name of the taxon	TNI	Q	A	D	F	RA	RD	RF	IVI	A/F
1	*Abelmoschus ficulneus*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00
2	*Bambusa arundinacea*	13	2	6.50	0.26	4	3.09	2.15	2.08	7.32	1.63
3	*Barleria longiflora*	28	3	9.33	0.56	6	4.44	4.63	3.13	12.19	1.56
4	*Barleria prionitis*	40	3	13.33	0.8	6	6.34	6.61	3.13	16.08	2.22
5	*Barleria strigosa*	21	1	21.00	0.42	2	9.99	3.47	1.04	14.50	10.50
6	*Bridelia montana*	3	1	3.00	0.06	2	1.43	0.50	1.04	2.96	1.50
7	*Brynaea vitis-ideae*	4	2	2.00	0.08	4	0.95	0.66	2.08	3.70	0.50
8	*Canthium parviflorum*	25	4	6.25	0.5	8	2.97	4.13	4.17	11.27	0.78
9	*Carissa spinosum*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00

10	*Cassia auriculata*	3	1	3.00	0.06	2	1.43	0.50	1.04	2.96	1.50
11	*Catunaregum spinosa*	6	1	6.00	0.12	2	2.85	0.99	1.04	4.89	3.00
12	*Chomelia asiatica*	12	3	4.00	0.24	6	1.90	1.98	3.13	7.01	0.67
13	*Dendrocalamus strictus*	1	1	1.00	0.02	2	0.48	0.17	1.04	1.68	0.50
14	*Desmodium pulchellum*	12	2	6.00	0.24	4	2.85	1.98	2.08	6.92	1.50
15	*Dichrostachys cinerea*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00
16	*Dodonaea viscosa*	20	2	10.00	0.4	4	4.76	3.31	2.08	10.15	2.50
17	*Euphorbia cauducifolia*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00
18	*Grewia hirsuta*	106	15	7.07	2.12	30	3.36	17.52	15.63	36.51	0.24
19	*Grewia rothii*	4	2	2.00	0.08	4	0.95	0.66	2.08	3.70	0.50
20	*Grewia villosa*	4	2	2.00	0.08	4	0.95	0.66	2.08	3.70	0.50
21	*Helicteris isora*	16	1	16.00	0.32	2	7.61	2.64	1.04	11.30	8.00
22	*Indigofera cassioides*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00
23	*Lantana camara*	77	13	5.92	1.54	26	2.82	12.73	13.54	29.09	0.23
24	*Melhania hamiltoniana*	4	2	2.00	0.08	4	0.95	0.66	2.08	3.70	0.50
25	*Mimosa prainiana*	3	1	3.00	0.06	2	1.43	0.50	1.04	2.96	1.50
26	*Murraya koenigii*	20	2	10.00	0.4	4	4.76	3.31	2.08	10.15	2.50
27	*Osyris quadrifdata*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00
28	*Phoenix louririi*	66	8	8.25	1.32	16	3.92	10.91	8.33	23.17	0.52
29	*Phyllanthus pinnatus*	45	3	15.00	0.9	6	7.14	7.44	3.13	17.70	2.50
30	*Scutea myrtina*	12	1	12.00	0.24	2	5.71	1.98	1.04	8.73	6.00
31	*Solanum melangina var.incanum*	2	1	2.00	0.04	2	0.95	0.33	1.04	2.32	1.00
32	*Solanum pubescens*	4	1	4.00	0.08	2	1.90	0.66	1.04	3.61	2.00
33	*Sophora interupta*	4	1	4.00	0.08	2	1.90	0.66	1.04	3.61	2.00
34	*Thespecia lampas*	22	5	4.40	0.44	10	2.09	3.64	5.21	10.94	0.44
35	*Triumfetta rhomboidea*	5	2	2.50	0.1	4	1.19	0.83	2.08	4.10	0.63
36	*Urena lobata*	4	1	4.00	0.08	2	1.90	0.66	1.04	3.61	2.00
37	*Woodfordia fruiticosa*	8	3	2.67	0.16	6	1.27	1.32	3.13	5.72	0.44
		606		210.22	12.12	192	100.00	100.17	100.00	300.17	

TNI- Total Number of Individuals, Q- Number of quadrates, A- Abunadance, D- Density, F- Frequency, RA- Relative Abundance, RD- Relative Density, RF- Relative Frequency, IVI- Importance Value Index, A/F- Abundance/Frequency Ratio.

Conclusions and further scope to study

The field observations have strengthened that the herbs are habitat specific. Quadrates possessing high diversity in trees have registered greater diversity of herbaceous taxa along with diverse conditions of mechanisms to survive and disperse. Forests that are relatively undisturbed seem to possess these varied habitat conditions more. More upon certain specific areas should be with limited human and grazing animal's disturbance to conserve these taxa.

Ex-situ maintenance is one of the strategies to conserving the plants. This is mainly in gardens, germ-plasm banks. In the present investigation a total of 80 wild plants are conserving in Botanical garden of our college. A special care is being taken for maintenance of Orchid species. The following key strategies are proposed for effective conservation of plant resources in Nallamalais based on the present work sampling inventory.

1. State Forest department and GCC should ensure sustainable harvesting of medicinal plants. Towards this, intensive training programmes to be organized for tribal and other communities by governmental and non-governmental agencies for promoting awareness.
2. Focus immediate attention on the threatened plants identified as critically endangered by the forestry sector. The information in this regard will be communicated to Botanical Survey of India and IUCN by the investigator team.
3. *Ex situ* conservation of identified threatened species of Nallamalais should be maintained in Biodiversity Park near to Nallamalais and other botanical gardens of the state.
4. Regular monitoring of plant resources of the study area.
5. A highly coordinated action-oriented multi-disciplinary approach on plant resources conservation integrating the forest department, Non-Governmental Organizations, scientific bodies at universities and research institutions with the co-operation of local communities should be implemented.

Further scope

There is a need of indepth study of Disturbance factors that affecting the diversity of Nallamalais, regeneration capacity of trees, above ground biomass studies for trees, leaf litter composition, soil organic carbon, plant- animal interaction, ethnobotanical studies are reccomendable for the study area.

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