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Effect of Anthropogenic Disturbance on the Tree Diversity of Nokrek Biosphere Reserve in Meghalaya, India

Tremie M. Sangma[1] and B.P. Mishra[2]

[1,2]Department of Environmental Science Mizoram University, Aizawl- 796004, Mizoram, India
E-mail: [1]tremiemt@gmail.com

Abstract—*The Nokrek Biosphere Reserve is situated in the state of Meghalaya, North-East India. It harbors rich plant diversity and a number of rare and endangered species of plants and animals. The direct and indirect anthropogenic activity in the reserve has led to loss of biological diversity. To understand the impact of the anthropogenic disturbances in the reserve, vegetation analysis of 0.6 ha was carried out in each core and buffer zone of the reserve. Findings reveal that anthropogenic activity in buffer zone lead to forest fragmentation; resulting into depletion of dense forest cover and loss of biodiversity. The important tree species found in the Biosphere Reserve are Mallotusalbus, Saurauianepaulensis, Ligustrumrobustum, Schefflera venulosum, Eugenia claviflora, Heliciarobusta, Betulaalnoides. A total of 101 tree species belonging to 75 genera and 38 families were recorded from both sites. Of this, 62 species (50 genera and 32 families) present in buffer zone and 73 species (57 genera and 31 families) in core zone. The basal area was recorded as 83.96 m^2ha^{-1} in the core zone and 29.81 m^2ha^{-1} in the buffer zone. The species richness index was 11.59 in the core zone and 9.23 in the buffer zone. Similarly, Shannon diversity index was recorded as 3.65 in the core zone and 3.26 in the buffer zone. On the contrary, dominance index followed a reverse trend. The contagious distribution pattern was very common. The study reveals that human induced disturbance alters the vegetation composition and distribution of tree species to a great extent.*

Keywords*: Biosphere reserve, tree diversity, anthropogenic disturbance, Northeast India.*

1. INTRODUCTION

In the ecological system, disturbance has been the main factor. Destruction of habitat has been directly linked to the extinction of species. Biodiversity is presently critical since we live in the era of the Mass Holocene Extinction, a period of species loss caused by man, and unrivalled in rate of species loss. Tropical forest are major reservoir of plant diversity, as they harbour about 50% of the total plant species identified so far, with 12 % area of the earth [1]. A significant change on vegetation by human activities has been reported from different parts of the world [2-5].Forest cover of the country is 21.34% and the tree cover is 2.82% of the geographical area of the country [6]. In India, northeast region is an extension of eastern Himalaya, is a global hotspot of biodiversity because of its geographical position, climatic conditions and altitudinal variations [7-9].

Nokrek Biosphere reserve is an ecologically rich area of Meghalaya [10]. 90% of the National Park area is covered by evergreen forest. Anthropogenic activities have led to decline in the biodiversity of the region and have caused degradation of tropical forests and destruction of habitat [11-13]. Human activitiessuch as deforestation, shifting cultivation, urbanization and forestfragmentation has changed the primary forest of the region to a great extent [14-17]. With the degree of disturbance growing more day by day; developing effective conservationand management strategies for quantitative tree diversity studiesare essential for understanding the composition of particular forests. Considering the decline in plant diversity, the impact of the disturbance on tree diversity has been studied in the core and the buffer zone of the Nokrek Biosphere Reserve of Meghalaya.

2. STUDY AREA

The North-eastern part of India with its rich biological wealth and endemism is a part of the Indo-Burma hotspot [18]. NE with 7.76 % of the geographical area of the country accounts for nearly $1/4^{th}$ of its forest cover. Due to impact of human activities, biodiversity of Meghalaya is under great threat. Meghalaya harbours about 3,128 species of flowering plants and contributes about 18% of the total flora of the country, including 1,237 endemic species [19]. Jamirhas stated that Garo Hills is highin species diversity and some of them are confinedonly to this particular region of the hills [20].

TheNokrek Biosphere Reserve of Meghalaya covering an area of 820 km^2 was recognized by the UNESCO's World Network of Biosphere Reserve on 26^{th} May, 2009.The core zone is the Nokrek National Park covering an area of 47.48 Sq Km and the buffer zone has an area of 227.92 sq. km. TheNokrek Biosphere Reserve acts as a principal watershed for all the rivers of Garo Hills. It lies between $25^o20'$ to $25^o29'$

N Latitude and 90°13' to 90°35' E Longitude. The highest point of Garo Hills is the Nokrek peak with an altitude of above (1415 m asl). These forests have been free from human interference over the centuries. This has been mainly due to the less human population in the area and the location of the villages on the inaccessible hill top. So far, there is no record of any commercial exploitation of these forests.

3. METHODOLOGY

Vegetation analysis was done following the methods described by Misra, Muller-Dombois and Ellenberg [21,22]. 60 quadrats of 10m x 10m were laid for trees in each of the buffer and core zone covering an area of 0.6 hectare. CBH 30cm or above were considered as trees. The field data was computed for various phytosociological attributes namely Frequency, Density, Abundance, Basal area and IVI. Subsequently, Margalef index of speciesrichness, Shannon diversity, Simpson index of dominance and evenness index were determined [23-26]. The distribution pattern of species was determined by computing Whitford index [27]. The girth class distribution was also done across ten girth classesCollected plant species were mounted on herbarium sheets following the works of Jain and Rao[28].The herbarium of Botanical Survey of India Shillong (Shillong) was consulted along with the help of flora of Meghalaya [29] and Flora of Assam[30].

4. RESULTS AND DISCUSSION

Tree species richness

Altogether a total of 101 tree species belonging to 75 genera and 38 families were recorded from both sites of the core and buffer zone. Contagious distribution pattern was very common and was shown by 71 and 60 number of species in the core and buffer zone respectively indicating the mosaic nature of the forest stands [31,32]. 2 species each showed random distribution. Some of the important common species out of the 34 species are Elaeocarpusbraceanus, Betulaalnoides, Eugenia claviflora, Cinnamonumobtusifolium. The Shannon diversity value (H') of 3.65 and 3.26 in the core zone and buffer zone falls under the range of 3.21-4.12 reported by earlierworkers for subtropical forest [33-36].

Table 1: Plant diversity and phytosociological attributes of trees in the core and buffer zone of the Nokrek Biosphere Reserve

Serial no.	Parameters	Core zone	Buffer zone
1	Number of Family	32	32
2	Number of genera	58	53
3	Number of species	73	62
4	Tree density (individuals ha^{-1})	830	1237
5	Tree basal area (m^2 ha^{-1})	83.96	29.81
6	Shannon and Weiner (H')	3.65	3.26
7	Simpson Index of Dominance (Cd)	0.039	0.062
8	Evenness Index, (E)	0.85	0.78
9	Margalef Index of Species	12.37	9.23

Pielou's evenness index and Margalef index of species was also higher in the core zone similar to the work of Nizam in Malaysia [37]. On the contrary the Simpson index of dominance was higher in the buffer zone. (Table 1) The greater number of species in the core zone is mainly due to the undisturbed condition of the forest. The undisturbed stand showed high species richness and diversity compared to the disturbed stand. This could be due to the less degree of disturbance in the ecosystem .The disturbance in the buffer zone are mainly due to human induced disturbance such as shifting cultivation, timber extraction, firewood collection and developmental processes [12,13,38] whereas the core zone remains undisturbed mainly due to inaccessibility and rough terrain. Mostly mature and buttressed trees are found in the core zone. The entry into the National park is permitted only to the forest officials and research scholars and to a certain number of tourists.

5. FAMILY COMPOSITION

The total number of plant families in both the study sites was 38. Lauraceae with 10 species constitute(18%), Euphorbiaceae and Fagaceae 7 species each constitutes 12%. Similarly, Euphorbiaceae with 10 species (23%), Lauraceae with 6 species (14%) and Fagaceae 5 species(11%) constitute an important family of canopy trees in the buffer zone (Fig.1). Mishra et al. [39-41] reported that the changes in species and family composition could be attributed to anthropogenic disturbance.

6. STAND CHARACTERISTICS

The density of tree species (>- 30cm dbh) was greater in the buffer zone (1237 trees ha^{-1}) than the core zone (830 trees ha-1) which is similar to the subtropical forest of KhasiHils 810 - 1050 trees ha^{-1}[42,43]. Based on density,*Eugeniaclaviflora* (88.33trees ha^{-1}) and *Scheffleravenulosum* (65 trees ha^{-1}) were the dominant species in the core zone. Whereas in the buffer zone *Saurauiapunduana* and *Saurauianapaulensis* with 173.33 trees ha^{-1} and 135 trees ha^{-1} respectivelywere found in maximum numbers . The stand density was lower in core zone, but it has huge basal area that scored 83.96 m^2 ha^{-1} in the core zone compared to 29.81 m^2 ha^{-1} in the buffer zone(Fig.2&3). This shows the girth potential of the native, primary forest species, when left undisturbed [44-47].Reduction of basal area in the buffer zone could be due to shifting cultivation,felling of young and old trees for construction purposes, extraction of timber and fuel wood, debarking and grazing of livestock animals.

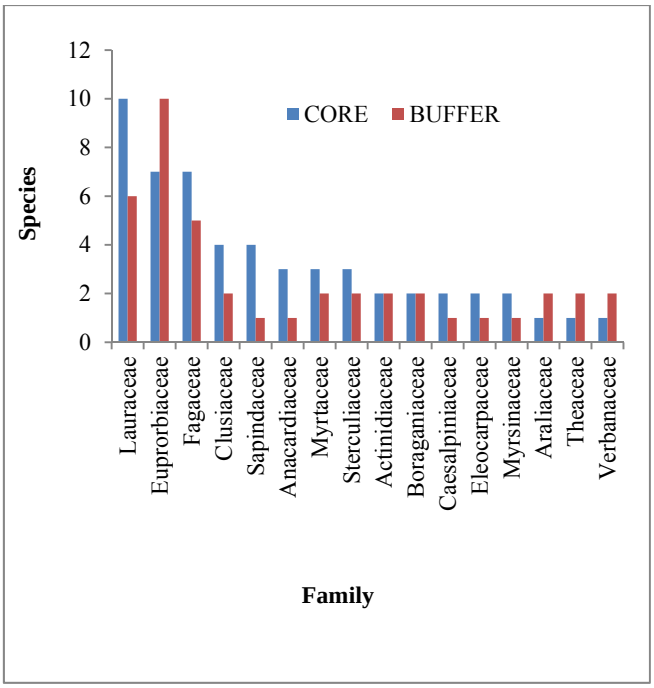

Fig. 1: Dominance distribution of species in the core and buffer zone of the biosphere reserve

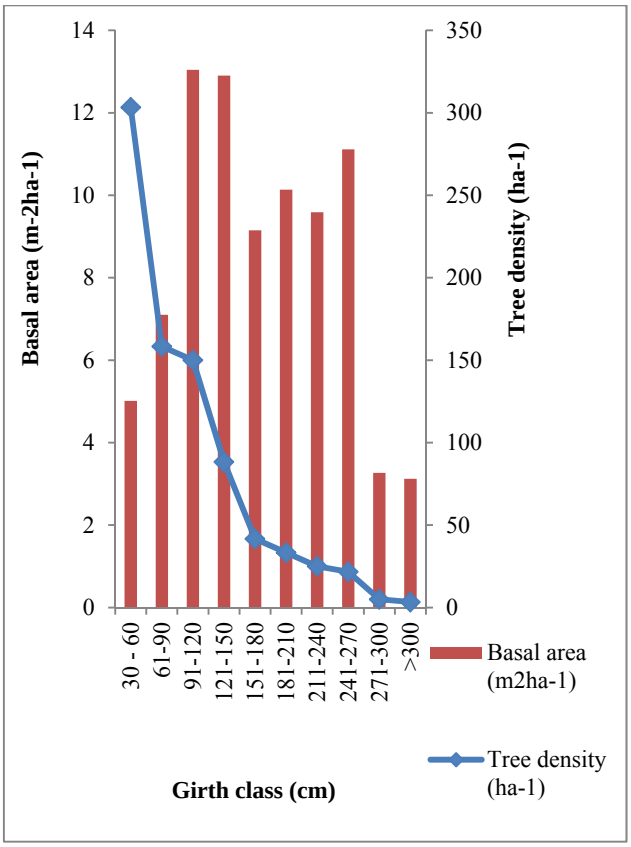

Fig. 2: Tree density and basal area in relation to girth class distribution in the core zone (Undisturbed stand)

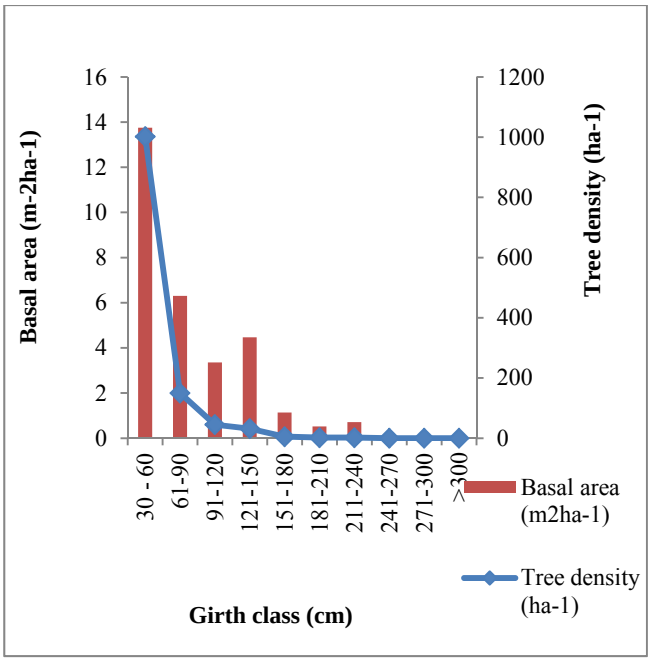

Fig. 3: Tree density and basal area in relation to girth class distribution in the buffer zone (Disturbed stand)

The tree density in the core zone irrespective of their girth class was lower than the buffer zone. The densities of young trees were higher than the older trees indicating a stable tree population [48]. The highest tree stand density and species richness were recorded in the smallest girth class (30-60) cm in all stands. The trees of medium girth class (91-150) cm were more dominant in the core zone in terms of basal area.In the disturbed stand no tree was recorded of more than 240 cm girth. Tree density and species richness decreased with the increasing girth class of tree species. It follows a reverse J-shaped curve indicating an evolving population [49,50].

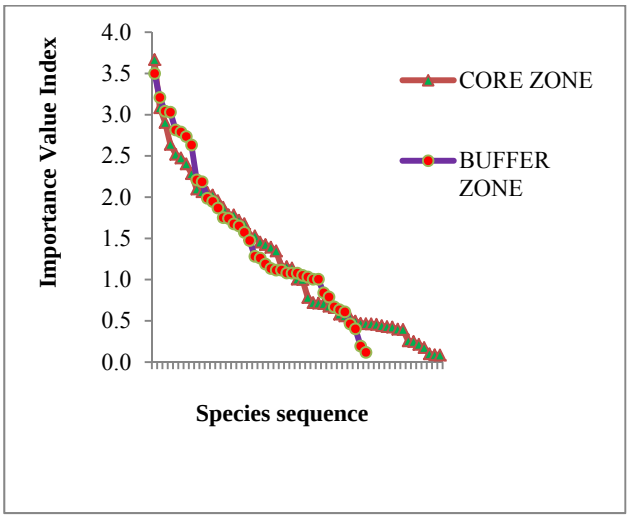

Fig. 4: Dominance-diversity curve for trees along disturbance gradient in the core and buffer zone.

7. DOMINANCE DIVERSITY PATTERN

The dominance diversity curve based on IVI was found to be short for the tree species in the buffer zone showing mild disturbance and instability (Fig.4). This could also be related to the disturbance which decrease the community niche space and cause loss of species whereas the curve for the core zone shows mature and stable vegetation [39].

Anthropogenic disturbance in and around the biosphere reserve is the main factor for the alteration in the vegetation. The buffer area which acts as a shield for the core zone needs to be protected to prevent the direct impact on the core of the Biosphere Reserve. If no protective measures are taken at the earliest the already dwindling ecosystem will deplete faster and in no time the rich ecosystem will vanish.

REFERENCES

[1] Whitmore, T.C. *An Introduction of tropical rain forest*, 2nd Edn, Oxford University Press, Oxford, 1998.

[2] Gairola, Sanjay, Ranbeer S. Rawal, and N. P. Todaria."Effect of anthropogenic disturbance on vegetation characteristics of sub-alpine forests in and around Valley of Flowers National Park, a world heritage site of India."*Tropical Ecology* 56.3.2015 pp. 357-365.

[3] Baithalu, S., M. Anbarashan, and N. Parthasarathy. "Two-decadal changes in forest structure and tree diversity in a tropical dry evergreen forest on the Coromandel Coast of India." *Tropical Ecology* 54.3.2013. pp. 397-403.

[4] Sarkar, Moumita, and Ashalata Devi."Assessment of diversity, population structure and regeneration status of tree species in Hollongapar Gibbon Wildlife Sanctuary, Assam, Northeast India."*Tropical Plant Research* 1.2. 2014. pp. 26-36.

[5] Dias, Eduardo, and CecíliaMelo. "Factors influencing the distribution of Azorean mountain vegetation: implications for nature conservation." *Biodiversity and conservation* 19.12. 2010. pp. 3311-3326.

[6] Indian State of Forest Report (IFSR,2015)

[7] Myers, Norman, et al. "Biodiversity hotspots for conservation priorities."*Nature* 403.6772. 2000. pp. 853-858.

[8] Upadhaya, K., S. K. Barik, H. N. Pandey, and O. P. Tripathi."Response of woody species to anthropogenic disturbances in sacred forests of northeast India."*Int J Ecol Environ Sci* 34. 3. 2008. pp. 245-257

[9] Behera, M.D., Kushwaha, S.P.S., Roy, P.S. "High plant endemism in an Indian hotspot – eastern Himalaya".Biodiversity and Conservation.2002 pp. 669-682.

[10] Krishnanjan, Pakrasi, V. S. Arya, and S. Sudhakar."Biodiversity hot-spot modeling and temporal analysis of Meghalaya using Remote sensing technique."*International Journal of Environmental Sciences* 4.5.2014 pp. 772-785.

[11] Sarma, K., and S. K. Barik."Coal mining impact on vegetation of the Nokrek Biosphere Reserve, Meghalaya, India."*Biodiversity* 12.3. 2011. pp. 154-164.

[12] Singh, Bikarma, and Sashin Kumar Borthakur. "Forest Issues And Challenges In Protected Area Management: A Case Study From Himalayan Nokrek National Park And Biosphere Reserve, India." *International Journal of Conservation Science* 6.2. 2015.

[13] Prabhu, S. D., S. K. Barik, H. N. Pandey, and R. S. Tripathi."Impact of Landuse Changes on Plant Species Diversity of Nokrek Biosphere Reserve, Meghalaya, India."*Journal of the Bombay Natural History Society* 107. 2. 2010. pp. 146.

[14] Upadhaya K, Choudhury H, Odyuo N. Floristic diversity of Northeast India and its conservation. International Environmental Economics: Biodiversity and Ecology. Discovery,2012.

[15] Upadhaya, Krishna, NamitaThapa, N. J. Lakadon, SarojKantaBarik, and KiranmaySarma. "Priority areas for conservation in northeast India: a case study in Meghalaya based on plant species diversity and endemism." *International Journal of Ecology and Environmental Sciences* 3. 2. 2013. pp. 125-136.

[16]Tripathi, O. P., K. Upadhaya, R. S. Tripathi, and H. N. Pandey. "Diversity, dominance and population structure of tree species along fragment-size gradient of a sub-tropical humid forest of northeast India." *Research journal of Environmental and Earth sciences* 2. 2. 2010.pp. 97-105.

[17] Kumar, Ashish, Bruce G. Marcot, and AjaiSaxena."Tree species diversity and distribution patterns in tropical forests of GaroHills." 2006.

[18]Mittermeier RA, Gil PR, Hoffmann M, Pilgrim J, Brooks T .Hotspot revisited. Garza Garcia N.L. Mexico.2004.

[19] Khan, M. Latif, ShailyMenon, and Kamaljit S. Bawa. "Effectiveness of the protected area network in biodiversity conservation: a case-study of Meghalaya state." *Biodiversity and Conservation* 6.6. 1997.pp 853-868.

[20] Jamir, S. Alemmeren, and H. N. Pandey."Vascular plant diversity in the sacred groves of Jaintia Hills in northeast India."*Biodiversity and Conservation* 12.7.2003.pp 1497-1510.

[21] Misra, R. "Ecology Work Book, 244 pp." 1968.

[22] Mueller-Dombois, Dieter, and Heinz Ellenberg."Aims and methods of vegetation ecology." 1974.

[23] Margalef, R. (1958) Information theory in Ecology.*Gen. Syst.***3.** pp36-71.

[24] Shannon, C.E and Weiner, W. (1963).*The mathematical theory of communication*.University of Illionis Press, Urbana.

[25] Simpson, E.H. (1949).Measurement of diversity.*Nature* **163**pp.688

[26] Pielou, E.C. (1969).*An introduction to mathematical ecology.*Wiley, New York.

[27]Whitford, Philip B. "Distribution of woodland plants in relation to succession and clonal growth."*Ecology* 30.2.1949.pp 199-208.

[28] Jain, S.K. and Rao, R.R. (1977).Handbook of Plant Collection and Herbarium Techniques.Today and Tomorrow Publishing Co. New Delhi

[29] Kanjilal, U.N., P.C. Kanjilal, A. Das, R.N. De& N.L. Bor.Flora of Assam. Vol. I-V. Government Press, Shillong, India. 1934-40

[30] Haridasan, K. & R.R. Rao.Forest Flora of Meghalaya, Vol.I-II.Bishen Singh Mahendra Pal Singh, Dehradun, India,1985-87.

[31] Sarma, Kiranmay. "Impact of coal mining on vegetation: A case study in Jaintia Hills District of Meghalaya, India." *International institute for geo-information science and earth observation enschede (The Nederlands) and Indian institute of remote sensing, national remote sensing agency (NRSA), Department of space, Dehradun, India.* 2005.pp. 1-85.

[32] Sarma, K..Spatio-temporal impact analysis of coal mining: a remote sensing and GIS based study in Jaintia Hills of Meghalaya, India. Saarbrucken, Germany: Lambert Academic Publishing. Grime,J.P. "Plant Strategies and Vegetation Processes". John Wiley and Sons, New York, 2010..

[33] Tripathi, O. P., K. Upadhaya, R. S. Tripathi, and H. N. Pandey. "Diversity, dominance and population structure of tree species

along fragment-size gradient of a sub-tropical humid forest of northeast India." *Research journal of Environmental and Earth sciences* 2. 2. 2010.pp. 97-105

[34] Gonmadje, Christelle F., Charles Doumenge, Doyle McKey, Gildas PM Tchouto, Terry CH Sunderland, Michael PB Balinga, and Bonaventure Sonké. "Tree diversity and conservation value of Ngovayang's lowland forests, Cameroon." *Biodiversity and Conservation* 20. 12. 2011. pp. 2627-2648

[35] Premavani, Dumpa, Maradana TARAKESWARA NAIDU, and MalleboyinaVenkaiah. "Tree species diversity and population structure in the tropical forests of north central Eastern Ghats, India." *NotulaeScientiaBiologicae* 6. 4. 2014.pp.448.

[36] Campbell, David G., Judy L. Stone, and Arito Rosas."A comparison of the phytosociology and dynamics of three floodplain (Várzea) forests of known ages, Rio Juruá, western Brazilian Amazon."*Botanical journal of the Linnean Society* 108.3.1992.pp. 213-237

[37] Nizam, M. S., A. R. Jeffri, and A. Latiff. "Structure of tree communities and their association with soil properties in two fan-palm dominated forests of east coast Peninsular Malaysia." *Tropical Ecology* 54. 2. 2013.pp. 213-226.

[38] Rao, P., S. K. Barik, H. N. Pandey, and R. S. Tripathi. "Community composition and tree population structure in a sub-tropical broad-leaved forest along a disturbance gradient." *Plant Ecology* 88. 2. 1990.pp. 151-162

[39] Mishra, B. P., O. P. Tripathi, R. S. Tripathi, and H. N. Pandey. "Effects of anthropogenic disturbance on plant diversity and community structure of a sacred grove in Meghalaya, northeast India." *Biodiversity and Conservation* 13.2 .2004.pp 421-436.

[40]Mishra, B. P., O. P. Tripathi, and R. C. Laloo. "Community characteristics of a climax subtropical humid forest of Meghalaya and population structure of ten important tree species." *Tropical Ecology* 46.2 .2005. pp. 241-252.

[41] Mishra, B. P., and R. C. Laloo."A comparative analysis of vegetation and soil characteristics of montane broad-leaved, mixed pine and pine forests of northeast India."*Advances in Plant Physiology.IK International Publishing House, New Delhi* 2006.pp. 185-197.

[42] Tripathi, O. P., H. N. Pandey, and R. S. Tripathi."Distribution, community characteristics and tree population structure of subtropical pine forest of Meghalaya, northeast India."*International Journal of Ecology and Environmental Sciences* 29.2004. pp. 207-214

[43] Strasberg, Dominique. "Diversity, size composition and spatial aggregation among trees on a 1-ha rain forest plot at La Réunion." *Biodiversity and Conservation* 5.7. 1996. pp. 825-840.

[44] Thapa, Namita, et al. "Effect of plantation on plant diversity and soil status of tropical forest ecosystems in Meghalaya, northeast India."*International Journal of Ecology and Environmental Sciences* 37.1. 2011. pp. 61-73.

[45] Bhuyan, Putul, M. L. Khan, and R. S. Tripathi. "Tree diversity and population structure in undisturbed and human-impacted stands of tropical wet evergreen forest in Arunachal Pradesh, Eastern Himalayas, India." *Biodiversity and Conservation* 12.8. 2003. pp. 1753-1773.

[46] Baishya, Ratul, SarojKantaBarik, and Krishna Upadhaya."Distribution pattern of aboveground biomass in natural and plantation forests of humid tropics in northeast India."*Tropical Ecology* 50. 2. 2009.pp. 295

[47] Parthasarathy, N. "Tree diversity and distribution in undisturbed and human-impacted sites of tropical wet evergreen forest in southern Western Ghats, India." *Biodiversity & Conservation* 8.10. 1999. pp. 1365-1381.

[48] Sarma, K., and S. K. Barik."Coal mining impact on vegetation of the Nokrek Biosphere Reserve, Meghalaya, India."*Biodiversity* 12.3. 2011.pp. 154-164.

[49] Sahu, S. C., N. K. Dhal, and R. C. Mohanty. "Tree species diversity, distribution and population structure in a tropical dry deciduous forest of Malyagiri hill ranges, Eastern Ghats, India." *Tropical Ecology* 53.2. 2012. pp. 163-168.

[50] DebnathPalit, Sudin Pal, Soma Chanda. "Diversity and Richness of Plants in Darjeeling Himalaya with an eye on Gaddhikhana Forest Beat, Senchal East Zone Forest Range,Darjeeling" Indian Journal of Forestry. 35.1. 2012. pp.39-44