NBU Journal of
Plant Sciences

Vol. 3, March 2009
ISSN No. 0974 6927

Change of vegetation structure in Gorumara National Park due to anthropogenic interferences

A Sarkar, S Sarkar[1] and AP Das*
Taxonomy and Environmental Biology Laboratory, Department of Botany, University of North Bengal, Siliguri 734013, WB. [1]DAV Public School, NHPC, Rangit Nagar, Sikkim (S)

Abstract
The impact of Human intervention on species composition, biomass and soil structure in the exploited and unexploited areas of *Shorea robusta* forest in a part of Gorumara National Park has been evaluated. The areas are adjacent to the Bichhabhanga-Saraswati Eco-Development Committee. The tree species are identical to both areas but differ in their density, frequency and IVI. Tree biomass is smaller in disturbed areas as compared to non-disturbed areas. Due to over exploitation changes occurred in the physical characters of soil. Crown cover also varies significantly within the two sites.

Keywords: Species composition, Human intervention, IVI, Crown cover, Soil, JFM

Tropical Moist Deciduous Forest in Terai and Dooars of West Bengal (Champion & Seth 1968), India is now facing threat from the uncontrolled urbanization in near or distant places and severe poverty in forest villages (Chakrabarti *et al.* 2002). This pressure is changing the structural characteristics such as species composition, density, crown cover, Importance Value Index (IVI) and biomass. Soil structure also changes due to opening of forest cover. Detailed information is necessary for understanding the relative extent of plant diversity across the area and its implication for conservation and management (Parthasarathy & Sethi 1997). It is very crucial to understand the distribution of individual species and their various girth class, association and dispersion pattern (Longman & Jenik 1987).

To understand the analytical perspective, the extent of plant diversity in the exploited and unexploited forest areas, their population density and distribution pattern, tree population structure, regeneration status are to be observed very closely. Present paper has scrutinized the status (qualitative and quantitative) of two patches of forest under different use type and the role of local Joint Forest Management Committee (JFMC)).

Loss of biological diversity due to deforestation and habitat destruction needs greater attention (Metcalfe 2005; Natural Resource Committee 2006). Human interference has almost completely destroyed *Myristica* swamp forest of Southern Western Ghats in Kerala by transforming it into paddy fields (Varghese & Menon 1999). Anthropogenic factors such as grazing, harvesting and man induced fire disclimax grasslands at many places in India (Singh 1976, 1978; Singh *et al.* 1979). Every year almost 97 million people are being added to the total population of the world (Moore 1995) fastening the process of deforestation. However, it is observed that change condition is not significantly associated with population growth, rather, change in forest conditions is strongly associated with local forms of collective action (Varughese 2000). This is true for this region as well. But, only limited studies focused this complex issue (Chakrabarti *et al.* 2002). Interestingly, no effort has been taken over to understand the differences between two types of forest (*exploited* and *unexploited*) in this are. This paper has tried to highlight that issue.

*Corresponding author:
E-mail: apdas.nbu@gmail.com

Forest structure

The forest under this study is basically dominated by semi-deciduous trees interspersed with evergreen ones. The unexploited part of forest under this study is dominated by *Schima wallichii* and exploited part by *Shorea robusta* mixed with other species of plants as discussed below.

Unexploited Forest

The unexploited forest study is dominated by *Schima wallichii* (64) followed by *Shorea robusta* (62). Other prominent species include *Lagerstroemia regine* (22), *Neolamarckia cadamba* (6) and *Turpinia pomifera* (9). Saplings of different species recorded are *S. robusta* (6), *Chisocheton paniculatus* (5), *Butia monosperma* (5), *Meliosma simplicifolia* (4), etc and those are almost equally represented.

Exploited Forest

Here it is dominated by *S. robusta* (65) along with *Michelia kingii* (11), *Turpinia pomifera* (6) and *Careya arborea* (6). The dominant species of saplings is *L. parviflora* (30) followed by *S. robusta* (15), *Syzygium operculatum* (14), *S. wallichii* (12) and *Casearia glomerata* (11).

Location

The study area is a part of Gorumara South Range of Gorumara National Park and is lying around 26°43'29" N latitude and 88°46'45" E longitude. Bichhabhanga-Saraswati Eco Development Committee is giving protection to this forest as part of their agreement with

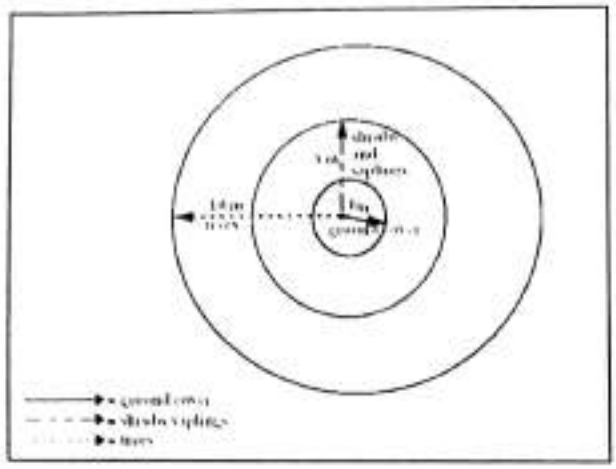

Fig. 1: Concentric Circles for Vegetation Study of a Forest Plot

the Government Forest Department (FD) during the implementation of Joint Forest management (JFM) program. It is primarily a natural forest except a small patch planted during 1947 – 1968. The area is on the plains and is well connected with Jalpaiguri town by roads. Local population is heterogeneous and is a combination of *Kora*, *Santal*, and *Nepalese*.

Average elevation of the site is 90 m and chiefly covered with alluvium soil. Average annual rainfall is 375 cm and the monthly average temperature ranges between 15.5° to 32° C. In order to examine the impact of exploitation, a piece of 1395.01 ha (Bichhabhanga - 1 & 2, Central - 2 & 3 and Sursuti - 5 blocks) forest in exploited area and 765.65 ha (Central - 1, Medla Jhora - 2 and Barahati - 1 blocks) forest in unexploited area were demarcated for detailed study.

Methodology

IFRI dataset (Wertime *et al*, 1999) has been used for collection of information from the site. Information about User Group (UG) was collected by one to one household surveys. Most of the discussions were held in the houses of individuals, fields, shops, tea stalls, common courtyards, etc. Degree of biotic interferences, produces harvested, cattle grazing and institutional information were collected by canvassing the IFRI data set. A self structured questionnaire was canvassed to capture the trend of ethnobotanical use pattern, which was prepared following Jain (1981, 1987, 1991).

To evaluate the Importance Value Index (IVI), 30 circular plots (Becker, 1995) were laid down (Fig. 1) on each study sampling area to determine the density, frequency and basal area for the calculation of Relative Density (RD), Relative Frequency (RF) and Relative Dominance (RDm) as described Misra (1966), Shimwell (1971), Das and Lahiri (1997), Kadir (2001), Rai (2006) and Ghosh (2006). For trees (>10 cm DBH) diameter of plots were 10 m and for seedlings (> 2.5 to < 10 cm DBH) this was 3 m in diameter placed at the centre of the 10 m plots were demarcated. Plant specimens were identified in the Department of Botany, St. Joseph's College, Darjeeling and at the Department of Botany, North Bengal University. All these specimens will be deposited in the NBU- Herbarium. Ground soils in unexploited and over exploited areas were assessed through feel method suggested by Thien (1979).

Table 1: Species richness, Simpson's index and Shannon's index of trees in the study area

Variables	Non- exploited		Exploited	
	Tree	Saplings	Tree	Saplings
Study area	765.65 ha		1395.01 ha	
Number of trees	258	84	132	136
Simpson's Index	7.82	41.51	4.03	11.02
Shannon's Index	2.833	3.496	2.228	2.722

Results and Discussion

In 773.3 ha of unexploited forest 50 species of trees (>10 cm of DBH) and 39 species of saplings (> 2.5 to < 10 cm of DBH) and in 1321 ha of exploited tropical wet mixed deciduous forests 28 species of trees (>10 cm of DBH) and 28 species of saplings (> 2.5 to < 10 cm of DBH) were found. Total 258 tree trunks are recorded in unexploited plots. However, the number of tree trunks in exploited plots is 132. This count is quite high in unexploited area. Most of the species are deciduous or semideciduous. Species richness, diversity indices and evenness indices has been shown in Table 1 and Fig. 1.

The density of trees varies between two areas (Table 1 and Fig. 2). In unexploited and exploited areas, 5 dominant species are covering 64.01% and 71.11% of total stem count respectively. In unexploited area the dominant trees are *Schima wallichii*, *Shorea robusta*, *Turpinia pomifera*, *Lagerstroemia regine* and *Neolamarckia cadamba* and in exploited area the dominant trees are *Shorea robusta*, *Michelia kingii*, *Schima wallichii*, *Turpinia pomifera* and *Dillenia pentagyna* (Table 2). Total biomass in unexploited and exploited areas is 2993977.4 cubic meter and 2840071.88 cubic meter respectively. In unexploited area the dominant 5 species occupy 16.06% of the total biomass and in exploited area they occupy 27.67% of the total biomass.

Tree diversity & density according to girth class

The interesting finding in this study that increase in DBH is inversely proportional with species richness and diversity. However, there is an exception in 20 – 30 cm girth class, where the density is less than 30 – 40 cm girth class in unexploited area. This trend is also followed in exploited area except 20 – 30 cm and 30 – 40 cm girth class is showing less density than 40 – 50 cm girth class (Table 3; Fig. 3 & 4).

Crown cover

Both the areas showing the unanimity of the crown cover with the number of stem per plot. In unexploited area per plot average percentage of crown cover is 51.33% and in exploited area it is 9.47%. The average crown cover per species in unexploited and exploited areas is 5.83% and 2.10% respectively (Fig. 5). In unexploited area high crown cover is recorded in plot no 7, 11, 13 and 27. On an average crown cover in these plots is 80%. It is low in plot no 6 and 22 and it is 15%

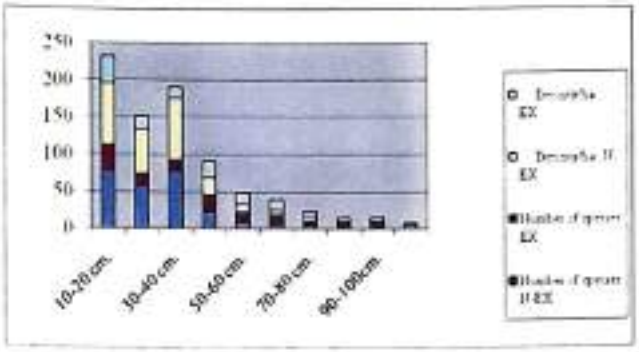

Fig.2: Distribution pattern of tree species richness, Shannon-Weiner's Index and density/ha of unexploited and exploited areas

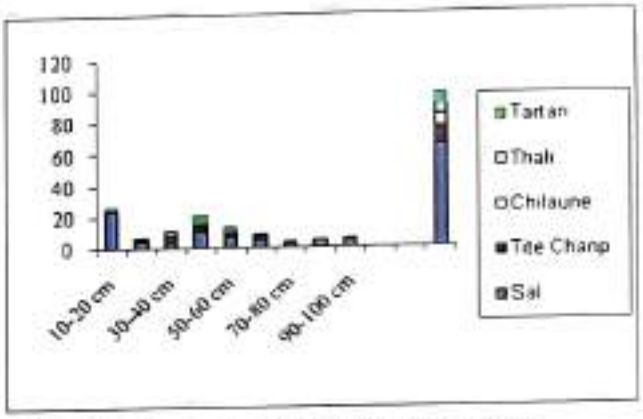

Fig.3: DBH wise stem distribution (exploited)

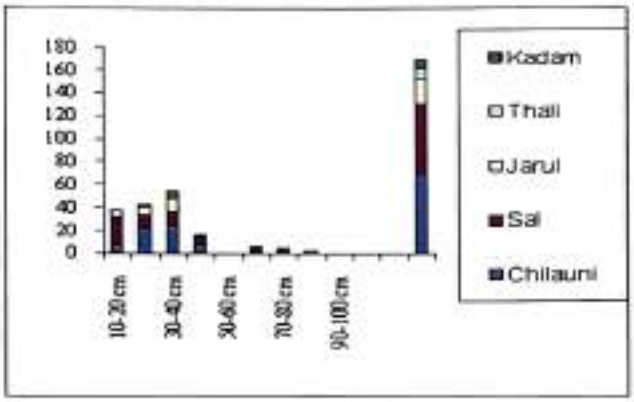

Fig.4: DBH wise stem distribution (unexploited)

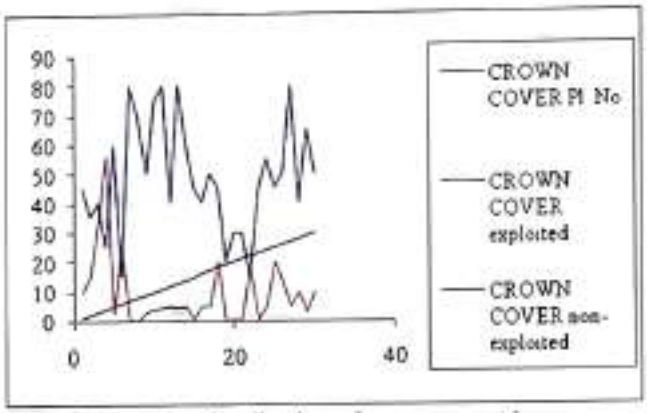

Fig.5: Plot wise distribution of crown cover in unexploited and exploited areas

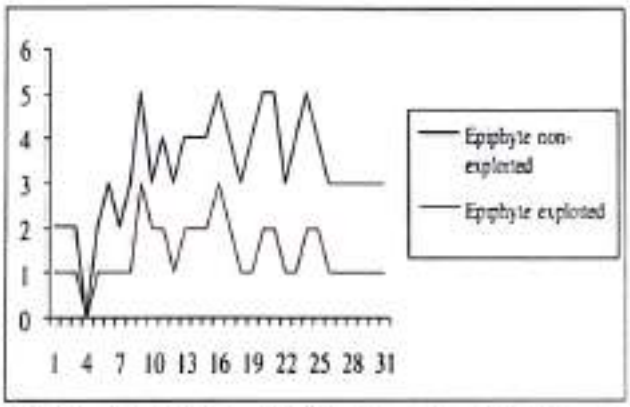

Fig.6: Plot wise distribution of epiphytes in unexploited and exploited areas

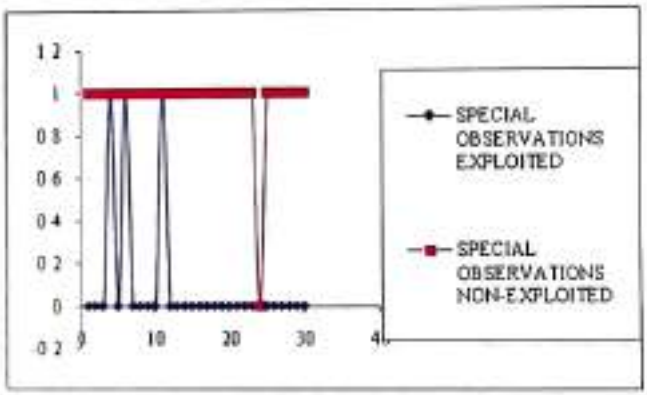

Fig.7: Plot wise physical soil character and percentage

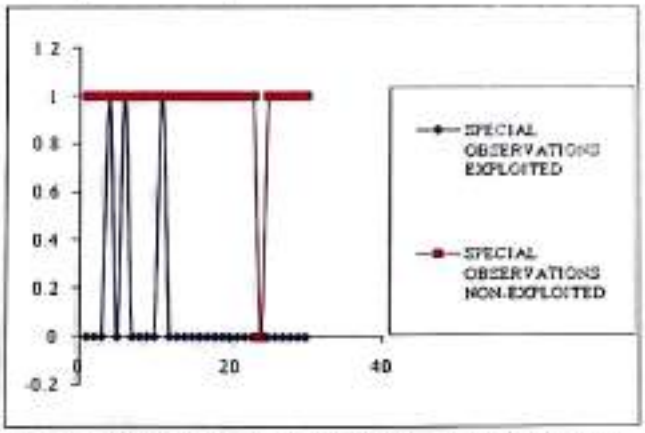

Fig.8: Plot wise special observations in exploited and unexploited areas

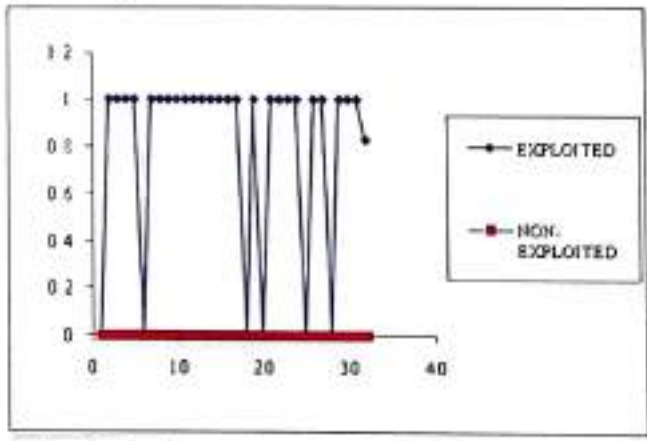

Fig.9: Plot wise grazing scenario in exploited and unexploited areas

Table 2: Dominant 5 tree species with stem count, density/ha, basal area/ha and IVI of exploited and unexploited areas

Name of plants	Unexploited					Exploited				
	Total Stem	%	Density /ha	Basal area/ ha in sq m	IVI	Total Stem	%	Density /ha	Basal area /ha in sq m	IVI
Schima wallichii	64	24.81	68	254947.7	110.17	7	5.30	8.49	5508.5	35.87
Lagerstroemia regine	22	8.53	23	22103.9	32.94	0	0	0	0	0
Neolamarckia cadamba	6	2.32	6	2947.1	25.45	0	0	0	0	0
Shorea robusta	62	24.03	66	198858.3	113.69	65	49.24	67.94	241999.2	173.29
Turpinia pomifera	9	3.49	10	2123.41	22.81	6	4.54	7.43	1545.43	31.82
Dillenia pentagyna	0	0	0	0	0	6	4.54	6.36	2151	21.78
Michelia kingii	0	0	0	0	0	11	8.33	11.67	9129.8	42.22

Table 3: Girth class wise species richness, diversity and density of woody species of plants

Girth class (in cm)	No. of sp.		SWI		Density/ha	
	N-EX	EX	N-EX	EX	N-EX	EX
10-20	78	35	0.360	0.350	83	37
20-30	57	17	0.331	0.261	60	18
30-40	78	15	0.360	0.244	83	16
40-50	23	22	0.213	0.296	24	23
50-60	9	14	0.115	0.235	10	15
60-70	7	12	0.096	0.215	7	13
70-80	6	6	0.086	0.138	6	6
80-90	3	5	0.051	0.122	3	5
90-100	2	6	0.037	0.138	2	6
> 100	1	3	0.021	0.084	1	3

* N-EX= Non- exploited area, EX= Exploited area, SWI=Shannon-Weiner's Index

only. In exploited area crown cover is highest in plot no. 4 (56%) and there is no crown cover in plot no 8 and 19.

Occurrence of Epiphytes

Prevalence of epiphytes is an indicator of the forest stand condition and helps to approximate the age of the forest. In unexploited area there are 20% plots with abundant epiphytes, 63.33% plots with a few epiphytes and 16.66% plots without any epiphyte as has been observed. In exploited area, 60% plots with abundant epiphytes, 33.33% plots with a few epiphytes and the remaining 6.66% are with no epiphytic association (Fig. 6).

Soil character (physical)

Predominant soil texture in both the areas is sandy loam and followed by sandy clay loam (*Unexploited:* sandy loam 46.7% and sandy clay loam is 20%; *Exploited:* sandy loam 60% and sandy clay loam 23.3%). In unexploited area clay loam is 13.3% and sandy clay loam is 3.3% and these types of soil are absent in exploited area. While in exploited area clay is 10% but it is absent in unexploited area (Fig: 7).

Biotic intervention

Unexploited plots showing least biotic intervention whereas exploited plots showing tremendous biotic pressure. During present study, 83% of the plots showed evidence of grazing; 30% are degraded due to fuel wood and timber collection. 26.66% and are also lopped for fodder; 26.66% are burnt to facilitate new sprouting for better grazing of livestock. Evidences on presence of wild animals in exploited and unexploited areas are 16.66% and 13.33% respectively (Fig: 8 & 9).

Social information

There are only 324 persons living in Bichhabhanga and Saraswati villages (Chakrabarti *et al.* 2002). The population density of the survey area is 0.033/ha of the forest. The activities coordinated by this UG are forest improvement, maintenance, monitoring and interaction with higher authorities. The UG has also passed rules in relation to harvest of forest products and appropriate technology for harvesting these products.

Shorea robusta, Meliosoma simplicifolia and *Lagerstroemia parviflora* are the main species which they harvest to meet their need for fuel wood. Mostly they harvest dry and small fallen tree parts. They use 98% of their collection for subsistence and sale the rest (2%) in the nearby market (Lataguri). The local unit to measure the collection is *Bojha* (1 *bojha* = 15 kg and 18 *bojhas* = 1 *pile*). Last year the total harvest of this product was 666 *piles* with an estimated cost of Rs.86580/-. To construct and to repair their houses they collect mostly tree trunk/big branches of *Shorea robusta*. The local unit to measure this product is *Khutti*. One *khutti* is equal to 0.037 cubic meters. Last year the total harvest of this product was 256 *khuttis*. No account of fodder was found during discussion with the people.

After implementation of JFM in this area the member of this UG are trying to protect the forest and as a result, extractions has been drastically decreased (70%). Present field observations (Table 1) have proved that the vegetation in unexploited area is quite better than that of the exploited area.

In unexploited area trees of 48 species and saplings of

Table 4: DBH wise distribution of 5 dominant tree species in Exploited area

	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	>100
Shorea robusta	24	4	3	10	8	5	2	4	4	1
Michelia kingii	0	1	5	2	1	2	0	0	0	0
Schima wallichii	1	0	0	2	2	1	0	0	1	0
Turpinia pomifera	0	0	3	2	1	0	0	0	0	0
Dillenia pentagyna	1	0	0	4	1	0	0	0	0	0

Table 5: DBH wise distribution of 5 dominant tree species in Unexploited area

	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	>100
Schima wallichii	8	21	20	8	1	3	2	0	1	0
Shorea robusta	22	12	13	6	1	3	3	2	0	0
Lagerstroemia regine	2	7	11	2	0	0	0	0	0	0
Turpinia pomifera	6	1	1	0	0	0	0	1	0	0
Neolamarckia cadamba	0	1	4	1	0	0	0	0	0	0

45 species are recorded. However, it is only 28 species of tree and 35 species of sapling in exploited area. In unexploited area, there are 28 (>10cm DBH) different species not found in exploited area. Where as in exploited area there are 13 (>10cm DBH) different species, which are not present in unexploited area. In case of species >2.5 cm DBH, unexploited area has 39 different species which are not present in exploited area whereas 22 unmatched species are present in exploited area. Some species are lost from over-exploited fields and occurred only in unexploited field. A considerable number of species have been occurred in exploited fields due to natural succession. According to the villagers, species, which are not present in unexploited area, and found in exploited area, came latter. Although the stand count of seedling in exploited area is narrowly higher than unexploited area but is low in species richness.

In both the areas *Shorea robusta* and *Schima wallichii* are playing a great role in species association (Table 4 & 5). All the 5 dominant species from both the study areas show this dependency. If the *Shorea robusta* population increases, *Schima wallichii* will decrease. With the increase of *S. robusta*, the population of *Lagerstroemia regine* will decrease but *Turpinia pomifera* will increase. Where *S. wallichii* increases, the population of *S. robusta* and *T. pomifera* found decreasing.

Crown cover influences the growth of other species. Negative co-relation is found between crown cover and occurrence of seedling in unexploited area and positive co-relation in exploited area. This is facilitating some species to grow alarmingly in exploited area. Succession of sun loving plant is removing medium light and moister loving plants.

Epiphytic growth in unexploited area is very poor as the plants are mostly young. However, this is better in exploited area. This result is proving extent of effort the local community invested to protect their assigned forest which was earlier severely degraded by human exploitation. We know any intervention in a plant association leads to change in vegetation structure and in long term it changes the environment of the area and that is evident from the result of the present study

Conclusion

The vegetational association in this tropical moist mixed -deciduous forest is closely related to the density of *Shorea robusta* and *Schima wallichii*. Increasing population of one species decreases the population of other species and brings changes in associated species composition. Opening of the canopy deteriorate the humus structure and that initiate the change of soil character. Change in soil condition brings change in species composition. Dry and sun-loving species are replacing shed and moist loving species. So, the changes of species composition, along with vegetation structure as the result of un-controlled biotic intervention in the forest. However, the initiative taken by UG proved to be positive to reverse this trend.

Acknowledgement

We are grateful to the people of Bichhabhanga and Saraswati villages for their cooperation and for providing help to the team members to the fullest possible extent. Above all we acknowledge the help rendered by the officials of Forest Department. Thanks to Dr. Sarala Suzana Khaling, Dr. Joydeep Bhattacharya, Late Mr. Sudhangshu Ranjan Ghosh, Mr. Atanu Sarkar and Mr. Rajdeep Bhattacharya for their unstinted support during field study.

References

Ascher W. 1995. *Communities and Sustainable Forestry in Developing Countries*. International Centre for Self-Governance, 720 Market Street, San Francisco.

Bagchi S. 2001. Unnayan Bonam Prakritik O Manobik Abonayan (in Bengali). *Yojona* (Bengali Edition), June-2001, Kolkata.

Brundtland G. 1987. *Our Common Future*. Oxford University Press, New York.

Chakrabarti M, Datta SK, Sarkar A. 2004. How Governance isuues influence Joint Forest Management in India: A perspective from Sub-Himalayan West Bengal. *Proceedings of Silver Jubilee Symposium on Governance in Development*. Institute of Rural Management Anand, pp. 76-101.

Chakrabarti M, Sarkar A, Ghosh SR, Sarkar A. 2002. Forest structure, resource use and institutions: site report from Bichhabhanga, Gorumara National Park, Jalpaiguri, India. Centre for Rural Economy Appropriate Technology and Environment, St. Joseph's College, Darjeeling.

Champion HG, Seth SK. 1968. *A Revised Survey of the forest types of India*, Manager of Publications, Govt. of India, Delhi.

Das AP, Lahiri AK.1997. Phytosociological studies of the ground covering flora in different types of vegetation in Tiger Hill, Darjeeling District, West Bengal (India). *Indian Forester* 123 (12): 1176-1187.

Dattagupta D. 1999. *Biswayaner Banvojon* (in Bengali), National Book Agency, Kolkata.

Ghosh C. 2006. *Biology of Tea Garden Weeds in Darjeeling District of West Bengal (India)*. Ph.D. Thesis, University of North Bengal.

Jain SK. 1981. *Glimpses of Indian Ethnobotany*, Oxford & IBH Publishing Co., New Delhi.

Jain SK. 1987. *A Manual of Ethno-Botany* (Ed.), Scientific Publishers, Jodhpur.

Jain SK. 1991. *Dictionary of Indian Folk Medicine and*

Ethnobotany, Deep Publications, New Delhi.

Kadir A.K.M.M. 2001. *Ecology of subhimalayan herblands in Darjeeling with special emphasis on Streptocaulon sylvestre Wight — an endangered and endemic plant*. Ph. D. Thesis, University of North Bengal.

Longman KA, Jenik J. 1987. *Tropical forest and its environment*, Second edition. Longman Scientific and Technical, Harlow (copublished in US with John Wiley and Sons, New York).

Metcalfe S. 2005. *Transboundary Protected Area Impacts on Communities: Case Study of Three Southern African Transboundary Conservation Initiatives*, African Wildlife Foundation Working Papers.

Misra R. 1966. *Ecology Work Book*. Oxford & IBH, Cal.

Moore R. 1995. Economic Growth, Ecology and Sustainable Development: Theory and Policy with Reference to Australia (Moore R, Ryan J, Eds.). *Sustainable Development- Policy and Practice*, New Age International Publishers, New Delhi, pp. 2-15.

Myers N. 1992. Tropical Deforestation and Climatic Change. *The Endangered Rain Forest and The fight for Survival*,World Rain Forest Movement, Penag.

Natural Resource Committee 2006. *Technical Approach to Define Highlands Forest Integrity*, Draft for consideration at the meeting of Natural Resource Committee of the Highlands Council.

Ostrom E. 1990. *Governing the Commons*, Cambridge University Press, Cambridge.

Ostrom E. 1992. *Crafting Institutions for Self-Governing Irrigation System*, Institute for Contemporary Studies, San Francisco, California.

Parthasarathy N, Karthikeyan R. 1997. Plant Biodiversity inventory and conservation of two tropical dry evergreen forests on the coromandel coast, South India. *Biodiversity and Conservation* 6: 1063–1083.

Rai U. 2006. *Characterisation of Plant Biodiversity in Darjiling Hills using Remote Sensing Techniques*. Ph.D Thesis, University of North Bengal.

Shimwell DW. 1971. *Description and classification of vegetation*. Sidgwick and Jackson, London.

Singh J S. 1976. Structure and function of tropical grassland vegetation of India. *Pol. Eco. Stud* 2: 17-34.

Singh JS. 1978. Effect of short term protection against herbage removal on the grassland vegetation at Varanasi. *Glimpses of Ecology* (Sing JS, Gopal B, Eds) International Scientific Publication, Jaipur, pp. 97 - 108.

Singh VP, Dagar JC, Upadhyay SD. 1979. Analysis of structure, production dynamics and successional trends of tropical grassland communities at Ujjain (India). *Sylvatrop Philipp for Res* 4: 231 - 254.

Thein SJ. 1979. A flow diagram for teaching texture by feel analysis. *Journal of Agronomy Education* 8, pp. 54-55.

Varghese AO, Menon ARR. 1999. Floristic Composition, Dynamics and Diversity of *Myristica* swamp Forests of Southern-Western Ghats, Kerala. *Indian Forester* p. 775.

Varughese G. 2000. Population and Forest Dynamics in the Hills of Nepal: Institutional Remedies by Rural Communities, Institutions and Governance. *People and Forest: Communities, Institutions and Governance* (Gibson CC, Mackean MA, Ostrom E, Eds). Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, Pp.- 168-197.

Wertime MB, Ostrom E, Gibson C, Lehoucq F. 1999. *Field Manual*, International Forestry Resources and Institutions (IFRI) Research Programme, Version 9.5, Center for the Study of Institutions, Population, and Environmental Change, Indiana University, Bloomington, USA.