1

Natural Resources Management in and around Namdapha National Park in Arunachal Pradesh: An Integrated Ecological and Socio-Economic Study

A. Arunachalam, R. Sarmah
D. Adhikari and M. Majumder

Introduction

The National Parks are aimed for public recreation, research and study of wildlife in natural conditions and conservation of the natural resources. Arunachal Pradesh encompasses two national parks. One is the Namdapha National Park (1985 km^2) and the other is the Mouling National Park (483 km^2). The Namdapha National Park is rich and diverse in both floral and faunal composition. As per Botanical Survey of India (BSI, 1990), many taxa reported rare and endemic are found here (e.g. *Aeschynanthes superba, Angiopteris evecta, Bruinsmia polysperma, Cheirestylis pusilla, Gnetum ula, Glycosmis cymosa* and *Magnolia griffithi*). Sharma et al (1990) reported a number of rare, endangered and threatened taxa, two new genera, four new species, three new records for India and fourteen new distributional records from Namdapha. Apart from its botanical benevolence, a total 75 out of 135 genus of land mammals in India have been reported in the Namdapha National Park (Singh et al, 2000). Thus, it was worth upgrading a reserve forest to a wildlife sanctuary (on 2nd October 1972) and then to National Park in the year 1983.

However, the transition in the status of the park area has also resulted in resettlement of humans who were living inside the protected area. Eventually the land use practices of the local inhabitants have also been transformed. Primarily they were forest farmers practicing shifting agriculture, but when they were resettled outside the park area they ventured in to settled agriculture, however continuing to use the forests in the park area.

The people residing adjacent to the national park mainly belong to Chakma and Lama Community. Although there are no definite land tenure or ownership rights in the state, strict enforcement of allotted areas in respect of these communities has led to more a settled form of agriculture. Shifting agriculture (locally called 'jhum') with shorter fallow period (3-5 years) is being practised by a portion of these people on a smaller scale, however.

Over all, the land use practices of the humans settled in the adjacent area of the park seem to be regulating the forest dynamics on a large scale, at least in the buffer zone of the Namdapha National Park. We undertook a study on linking ecological issues with socio-biological aspects (**Box 1**) of the shifting agriculture affected buffer zone of the Namdapha National Park. This is a part-project of a pilot study as "People-Centred Land Use Development in Shifting Agriculture Affected Buffer Zone of Namdapha National Park". In this paper, we are presenting our preliminary observations highlighting the significance of such a study in this part of the north-eastern India.

Study area

The geographical position of Namdapha National Park is in between latitude $27^0 23' 30''$N to $27^0 39' 40''$N and longitude $96^0 15' 2''$E to $96^0 58' 33''$E. The altitude varies from 200m to 4571m asl. The declared buffer zone occupies 177 km^2, which is about 9% of the total park area. The study has been carried in and around Namdapha National Park (**Table 1**).

Box 1

Objectives of the study

1. Study on primary and secondary forests with reference to biodiversity and biophysical factors in and around buffer zone of Namdapha National Park.
2. Study on the relationship of forest ecosystem with village agro-ecosystems, agro-biodiversity potential and related socio-economic survey.
3. Analysis of social, economic, cultural and religious as well as institutional aspects of indigenous resource management system.

Table 1. Study Sites in and around Park area

Site number	Location	Site name	Forests being studied	Name of villages
I	Buffer zone	*Haldibari***, *Hornbill***	Secondary forest, Primary forest	———
II	Adjacent area*	M.V. Road side***	Secondary forest*	M'Pen I & II
III	Adjacent area*	Anchal Reserve Forest***	Secondary forest	Deban, Budhisatta Anandapur I & II

* The area is adjacent to the park boundary.

** Located 10 kms away from the villages.

*** Located within the vicinity of 1-4 kms from the forest sites.

The area experiences three seasons: winter (November to February), spring (March to May) and monsoon (June to October). The annual rainfall varies from 1400mm to 2500mm. The mean annual minimum and maximum temperatures are 13°C and 29°C respectively. The relative humidity varies between 47% and 93%.

The varying topography, rainfall, temperature, humidity and soil conditions have resulted in different types of forest vegetations. Champion and Seth (1968) classified the forest types in the area as follows:

1. Upper Assam Valley Tropical Wet Evergreen Forests (IB/CI)
2. Upper Assam Valley Tropical Evergreen Forests (IB/C2a)
3. Upper Assam Valley Tropical Evergreen Forests (IB/C2b)
4. Assam Valley Tropical Semi-Evergreen Forests (2B/C-1)
5. Sub-Himalayan light alluvial Semi-Evergreen Forests (2B/C1/S1)

6. Secondary Moist Bamboo brakes (2/251)
7. Eastern Hollock Forests (3/1526)
8. East Himalayan Moist Temperate Forests (12/C-3)
9. Moist Alpine Scrub Forest (15/C-1)

Plant Biodiversity in the Forest Ecosystem

The unique geographical position, varied topography, high annual precipitation spreading throughout the year have made the forest very rich in floral diversity where in not a single species can be termed as dominant species of the area. On the basis of a survey carried out in parts of the Park. Sharma et al (1990) reported 73 species of lichens, 59 species of Bryophytes, 112 species of Pteridophytes, 5 species of Gymnosperms and around 801 species of Angiosperms. This does not include the floral elements of temperate and alpine regions, which has not been explored due to greater inaccessibility and other environmental factors. From our preliminary studies we, so far, have listed 44 tree species, 12 species of shrubs and 6 species of herbs (**Table 2**) from primary forest plot and 29 species of trees, 18 species of shrubs and about 50 species of herbs from a secondary forest in the buffer zone. More than 60 plant species (trees, shrubs, herbs and bamboos) of secondary forest are used by the local people for different purposes (**Table 3**). The plant biodiversity we found in our plots may not even represent a half of the total plant diversity of the Namdapha National Park.

Agricultural Systems

Agriculture is the primary source of livelihood of the local people of this area. Different typologies of agricultural systems have been identified so far (**Table 4**). These can be broadly categorised into wetland rice cultivation, unirrigated valley cultivation, jhum, rotational bush fallow, homegarden and animal husbandry. Sixty-one plant species have been documented so far from different agricultural systems (**Table 5**). Among these two were cereals, two millets, thirty vegetables and pulses, sixteen fruits, two oil yielding, five condiments and spices, three narcotics and mastectomies and two others.

Wetland Rice Cultivation

Wetland rice cultivation is done in low-lying areas (villages M'Pen-I, M'Pen-II and Anandapur-I). For this, people bring down the runoff water from hill slopes into their agricultural fields by narrow channels, which bring decomposed nutrients from the hill. Hence no fertilizer is applied to these fields except a small quantity of cow-dung during land preparation. Firstly, the seeds are broadcasted in nursery plots during June and after 30-40 days the seedlings are transplanted into the prepared field. Harvesting is done in September after which the land is left fallow until the following May. This type of agricultural system is however, absent in Deban, Budhisatta and Anandapur-II.

Table 2. Plant species of the primary forest

Botanical name	Family
Trees	
Alstonia scholaris	Apocynaceae
Altingia excelsa	Hamamelidaceae
Mangifera sylvatica	Anacardiaceae
Artocarpus lakoocha	Moraceae
Baccaurea sapida	Euphorbiaceae
Dysoxylum sp.	Meliaceae
Melia azadirachta	Meliaceae
Canarium strictum.	Burseraceae
Castanopsis sp.	Fagaceae
Chukrasia tabularis	Meliaceae
Cinnamomum glanduliferum	Lauraceae
Cinnamomum sp.	Lauraceae
Dysoxylum procerum	Meliaceae
Dysoxylum sp.	Meliaceae
Pterospermum acerifolium	Sterculiaceae
Dysoxylum sp.	Meliaceae
Toona ciliata	Meliaceae
Duabanga sonnetiroides	Lythraceae
Azadirachta sp.	Meliaceae
Litsea sp.	Lauraceae
Magnolia griffithi	Magnoliaceae
Chisocheton paniculatus	Meliaceae
Mesua ferrea	Clusiaceae

Michelia oblonga.	Magnoliaceae
Erythrina indica	Papilionaceae
Ostodes paniculata	Euphorbiaceae
Saprosoma tarnatum	Rubiaceae
Albizzia sp.	Mimosaceae
Stereospermum chelonoides	Bignoniaceae
Syzizium kurzii	Myrtaceae
Talauma hodgsonii	Magnoliaceae
Terminalia citrina	Combretaceae
Terminalia myriocarpa	Combretaceae
Michelia champaca	Magnoliaceae
Walsura robusta	Meliaceae
Spondias axillaris	Anacardiaceae
Kayea assamica	Clusiaceae
Shorea assamica	Dipterocarpaceae
Dalbergia pinnata	Fabaceae
Eurya acuminata	Theaceae
Endospermum chinense	Euphorbiaceae
Garcinia sp.	Clusiaceae
Sapium baccatum	Euphorbiaceae
Spondias pinnata	Anacardiaceae
Shrubs	
Baliospermum micranthum	Euphorbiaceae
Begonia roxburghii	Begoniaceae
Chasalia assamica	Rubiaceae

Table 3. Plants of Secondary Forest and their Uses

Local name	Botanical name	Parts used	Purpose
Trees			
Udal	*Sterculia villosa*	Trunk, Bark	T & R
Gahorisopa	*Elaeocarpus aristatus*	Trunk	T
Boromthuri	*Talauma hodgsonii*	Trunk	T
Korom	*Dalbergia latifolia*	Trunk & brunches	FW & FE
Bandardima	*Dysoxylum binectariferum*	Trunk & Branches	FW & FE
Tezpatta	*Cinnamomum tamala*	Leaves & Branches	Con & FW
Jutuli	*Altingia excelsa*	Trunk, Branches	T & FW
Nahor	*Mesua ferrea*	Trunk, Branches	T & FW
ND	*Macaranga* sp.	Trunk, Branches	FW
Sirish	*Albizzia* sp.	Trunk, Branches	Ho & FW
Paroli	*Stereospermum chelonoides*	Trunk, Branches	FW
Hollock	*Terminalia myriocarpa*	Trunk, Branches	T & FW
Hatipat	*Pterospermum acerifolium*	Trunk, Branches	T & FW
ND	*Aesculus assamicus*	Leaves & Flowers	FP
Asu gach	*Morinda angustifolia*	ND	ND
Bischgoch	*Aesculus assamicus*	ND	ND
Nagphena	*Sterculia roxburghii*	ND	ND
Bandardima	*Dysoxylum procerum*	ND	ND
Chikamurolia	*Allangium chinense*	ND	ND
Satiana	*Alstonia scholaris*	ND	ND
Bogori	*Zizyphus mauritiana*	ND	ND
Ritha	*Sapindus mukorossi*	ND	ND
Simolu	*Bombax ceiba*	ND	ND
Ghora neem	*Melia dubia*	ND	ND
Modar	*Erythrina indica*	ND	ND
Panjihuta	*Actinodaphne obovata*	ND	ND
Outenga	*Dillenia indica*	Fruits	Fo & M
Dewachali	*Artocarpus lakoocha*	Leaves, seeds, trunk	Fod, Fo & T
Bokom	*Melia azadirachta*	Leaves, trunk	Fod & FW
Shrubs, herbs and bamboos			
Tengi kata	*Rubus moluccanus*	Fruits	Fo
Churat pat	*Leportia sp*	Leaves	V
Chokola tenga	*Citrus medica*	Fruits	M & Fo
Bet	*Calamus sp*	Stem, young shoot, fruits	Fr, Ho, R & V
Jeng	*Calamus erectus*	Leaves, young shoot	Rf & V
Nepaphu	*Clerodendron colebrookianum*	Leaves	M & V
ND	*C. viscosum*	ND	ND
ND	*Lantana camara*	ND	ND
Titabhekuri	*Solanum nigrum*	Fruits	V
ND	*S. torvum*	ND	ND
ND	*S. xanthocarpum*	ND	ND
Basak	*Adhatoda vasica*	Leaves	M
ND	*Cassia sp.*	Leaves	Fod
Gos dhekia	*Cyathea sp.*	Young stem and leaves	V
ND	*Leportea* sp.	ND	ND

Fr= Furniture, **T**=Timber, **M**= Medicine, **V**= Vegetable, **S**= Spice, **TM**= Thatching material, **Pl**= Plates, **R**= Ropes, **Fo**= Food, **FP**= Fish poison, **Rf**=Roofing, **FW**= Fuelwood, **FE**= Fencing, **Ho**= Housing, **Fod**= Fodder, **Br**= Broom making, **Con**= Condiments. *ND= **Not documented**

Unirrigated Valley Cultivation

This is the most common agricultural system in this area. Here double cropping is done. The first cropping is from May to August using paddy and maize. The second cropping is from October to January with mono cropping of mustard. In both the cases instead of plantation, seeds are directly broadcasted in the field.

Jhum Cultivation

The major crop components of jhum in this area are paddy, maize and chillies along with different vegetables. In this area jhuming is not so much prominent as in other parts of Arunachal Pradesh. The jhum cycle is also very short (3-5 years). The jhum plots in this area are generally over gentle slopes. So the people prefer ploughing instead of drilling in the jhum field wherever it is possible.

Table 4. Topologies of agro-ecosystems

Name of the villages	Typologies of agricultural system	Major crops grown
Deban	Unirrigated valley	Paddy+ Maize → Mustard/Winter vegetables.
	Rotational bush fallow	Paddy+ Maize+ Chillies. → Winter vegetables
	Jhum	Paddy + Maize + Chillies + vegetables.
	Home garden	Fruit trees + Zinger + vegetables
Budhisatta	Unirrigated valley	Paddy+ Maize → Mustard/Winter vegetables.
	Rotational bush fallow	Paddy+ Maize+ Chillies. → Winter vegetables
	Jhum	Paddy + Maize + Chillies + vegetables.
	Homegarden	Fruit trees + Zinger + vegetables
Anandapur-I	Unirrigated valley	Paddy+ Maize → Mustard/ Winter vegetables.
	Wet land rice	Paddy
	Home garden	Fruit trees + Zinger + vegetables/ Mustard
Anandapur-II	Unirrigated valley	Paddy+ Maize → Mustard/Winter vegetables.
	Rotational bush fallow	Paddy+ Maize+ Chillies → Winter vegetables
	Home garden	Fruit trees + Zinger + vegetables/ Mustard
M'Pen-I	Unirrigated valley	Paddy+ Maize → Mustard/ Winter vegetables
	Wet land rice	Paddy
M'Pen-II	Unirrigated valley	Paddy+ Maize → Mustard/Winter vegetables.
	Wet land rice	Paddy

Rotational Bush Fallow

This system is followed in the plain areas. As there is no irrigation system, some people leave their agricultural plots fallow for two to three years after one or two cropping. Here also mixed cropping system is followed as in jhum. The shrubs and herbs whatever comes up during the fallow are harvested before cropping and burnt after drying. Occasionally, instead of burning the harvested materials are left as such for decomposition in the field.

Homegarden

The homegarden systems are not well developed, but the plants are grown haphazardly around the houses, where mainly ginger is cultivated with some vegetables (**Table 5**). They mainly cultivate potato, radish, brinjal, cabbage, cauliflower and different types of beans on a commercial scale. Some people also cultivate tobacco and pigeon pea in their homegardens. Besides vegetables, fruits and some other economically important plants are also grown in the homegardens (**Photo 1**).

Table 5. Plants cultivated in different agricultural systems

Type	Common name/ Local name	Botanical name
Cereals	Paddy (Dhan)	*Oryza sativa* L
	Maize (Makai)	*Zea mays* L
Millets	Finger millets (Marwa)	*Elusine coracana* (L.) Gaertn
	Pearl millet (Bajra)	*Pennisetum typhoides* (Burm.f.) Staf &Hubb
Vegetables and Pulses	Potato (Aalu)	*Solanum tuberosum* L
	Brinjal (Begun)	*Solanum melongena* L
	Tomato (Tamattar)	*Lycopersicum esculantum* Mill
	Raddish (Mula)	*Raphnus sativus* L
	Cabbage (Patta kabi)	*Brassica oleraceae* L
	Cauliflower (Phool kabi)	*Brassica oleraceae* L
	(Lai)	*Brassica juncea*
	Turnip (Shalgam)	*Brassica rapa* L
	Bottle gourd (Lau)	*Lagenaria siceraria* Standl
	Bitter gourd (Karala)	*Momordica charantia* L
	Cucumber (Khera)	*Cucumis sativa* L
	Red pumpkin (Kumra)	*Cucurbita maxima* Duch
	Ridge gourd (Jhinga)	*Luffa acutangula* (L.) Roxb
	Smooth gourd (Dhundul)	*L. cylindrica* (L.) Reem
	White gourd (Chalkumra)	*Benincasa hispida* Cogn
	(Bhat karala)	*Momordica cochinchinensis* Spreng
	Lady's finger (Bhendi)	*Abelmoschus esculentus* Moen
	Cassava (Simal alu)	*Manihot esculata* Crantz

	(Kauthekera)	*Garcinia cowa*
	Yam (Kath alu)	*Dioscoria alata* L
	Sweet potato (Mitha alu)	*Ipomea batatas* Poir
	Quash	*Sechium edule* Sw
	(Lal sag)	*Amaramthus* sp
	Cowpea (Barbati)	*Vigna sinensis* (L.) Savi ex Hassk
	Pigeon pea (Arahar)	*Cajanas cajan* (L.) Milsp
	Broad bean (Shim)	*Vicea faba* L
	French bean (Shim)	*Phaseolus vulgaris* L
	Hyacinth bean (Shim)	*Dolichos lablab* L
	Drumstick (Sajina)	*Moringa oleifera* Lamk
Fruits	Banana (Kela)	*Musa paradisiaca* L
	Elephant apple (Outenga)	*Dillenia indica* L
	Guava	*Pisidium guajava* L
	Jack fruit (Kathal)	*Artocarpus heterophyllus* Lamk
	Jujube (Bogori)	*Zizyphus jujuba*
	Lemon (Lebu)	*Citrus limon* Burm. f.
	Orange (Kamala)	*C. reticulata* Blanco
	(Rabat tenga)	*C. maxima*
	Mango (Am)	*Mangifera indica* L
	Papaya (Amita)	*Carica papaya* L
	Pears (Naspati)	*Pyrus communis* L
	Pineapple (Anaras)	*Ananas comosus* Merr
	Tamarind (Tentul)	*Tamarindus indica* L
	Embelic (Amlakhi)	*Emblica officinalis* Gaertn
	Hog-plum (Amra)	*Spondias pinnata* Kurz
	Custard apple (Ata)	*Annona squamosa* L
Oil yielding	Mustard (Sariha)	*Brassica campestris* K
Narcotics and Masticatories	Betel nut (Supari)	*Areca catechu* L
	Tobacco (Tamak)	*Nicotiana tabacum* L
	Hemp (Bhang)	*Canabis sativa* L
Condiments and spices	Chillies (Lanka)	*Capsicum frutescens* L
	Ginger (Ada)	*Zingiber officinale* Rose
	Turmeric (Haldi)	*Curcuma longa* L
	Coriander (Dhania)	*Coriandrum sativum* L
Others	Cotton (Tula)	*Gossypium hirsutum* L

Animal Husbandry

Animal husbandry is one of the important sources of economy of the people of this area. The different components animal husbandry is cattle, pig, goat, buffalo and poultry birds. The average number of animal per household varies from 17 to 25 (**Table 6**).

Efficiency of different Agricultural Systems

A detailed study on the efficiency pattern of three different agricultural systems viz. wetland rice cultivation, unirrigated valley and in jhum was done. The monetary efficiency was 2.04 from wetland rice cultivation, 1.42 (mixed cropping) and 1.65 (mono-

cropping) from unirrigated valley and 1.56 from jhum (**Table 7**). Though these systems are not so much efficient as compared to the values reported for similar systems of Meghalaya by Ramakrishnan (1984), Maikhuri and Ramakrishnan (1990) and Ramakrishnan (1992), still these systems can provide subsistence livelihood for the local people. In all the systems the maximum portion of input has been in the form of human labour, which is provided free by the farmers' family. Out of total input 77.72% in wetland rice, 82.01% (mixed cropping) and 83.83% (monocropping) in unirrigated valley and 84.94% in jhum systems are invested in the form of human labour. The remaining portion is invested as animal labour and seeds. There has been negligible quantity of external input as manure. In wetland rice cultivation, the total output was Rs. 13194 in return of total input of Rs. 6473. In unirrigated valley the output was Rs. 10017 (mixed cropping) and Rs. 5376 (monocropping) in return of input Rs. 7061 and 3259 respectively. In jhum system, the output was found to be Rs. 16604 in return of input of Rs. 10671. The double cropping in unirrigated valley makes the system most efficient. So the people prefer this system. The modes of input in different systems are given in **Table 7**.

Socio-ecological Setting

The historical information regarding human settlement around the adjacent areas of the Namdapha National Park is that the area of present villages namely Deban, Bhudhisatta, Anandapur I & II are under Anchal Reserve Forest within the Diyun Forest Range. These villages were settled during 1964-65, when the area was covered by dense forest and dominated wild animals like elephant, buffalos, wild pig, tiger, etc. There were no roads. Surplus land facilitated shifting cultivation. However, in due curse of time, some of them settled near the bank of the river and practiced wetland cultivation. This subsistence farming turned into intensive farming with increasing population and land shortage. The houses are built on a platform made up of bamboo and wood (**Photo 2**). The roofing material is

the Jeng leaves (*Calamus erectus*). Drinking water is mainly collected from the river except Deban village where drinking water is supplied by government agencies. Sanitary system is poor. The unsurfaced road connecting the villages remains closed during monsoon.

The number of household residing in the villages (Deban, Budhisatta, Anandapur-I, Anandapur-II, M'Pen-I and M'Pen-II) is 353, of which 322 households belong to Chakma, 28 Lama and 3 Wancho communities. The average family size of these people is in between 5.23 to 6.15 person. The average land holding of a family ranges in between 0.59 ha to 1.29 ha (**Table 6**).

Table 6: Structure of the villages adjacent to Namdapha National Park

Parameters	Deban	Budhisatta	Anandapur-I	Anandapur-II	M'Pen-I	M'Pen-II
Community	Lama/ Wancho	Chakma	Chakma	Chakma	Chakma	Chakma
No. of household	31	56	55	38	95	78
Total human population	172	293	315	216	584	457
Average family size	5.55	5.23	5.73	5.68	6.15	5.86
Male population	94	152	157	114	288	235
Female population	78	141	158	102	296	222
Total area (ha) (excluding Jhum field)	18.43	61.53	52.89	49.08	108.14	100.79
Area under wetland valley (ha)	-	-	36.28	-	40.67	40.07
Un-irrigated valley (ha)	13.45	54.08	11.49	47.2	65.11	58.9
Settlement (ha)	4.98	7.45	5.12	1.88	2.36	1.82
Land holding per household (ha)	0.59	1.1	0.96	1.29	1.14	1.29
Total animal population	615	1390	759	648	1588	1691
Cattle	149	341	215	160	453	650
Pig	18	163	157	123	185	152
Goat	35	210	32	117	170	175
Buffalo	-	-	-	-	-	150
Poultry	413	676	355	248	780	564
Animal population per household	19.839	24.821	13.800	17.053	16.716	21.679

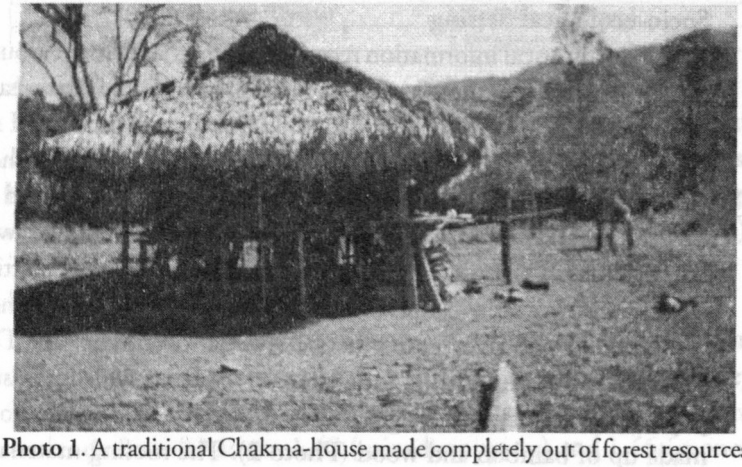

Photo 1. A traditional Chakma-house made completely out of forest resources

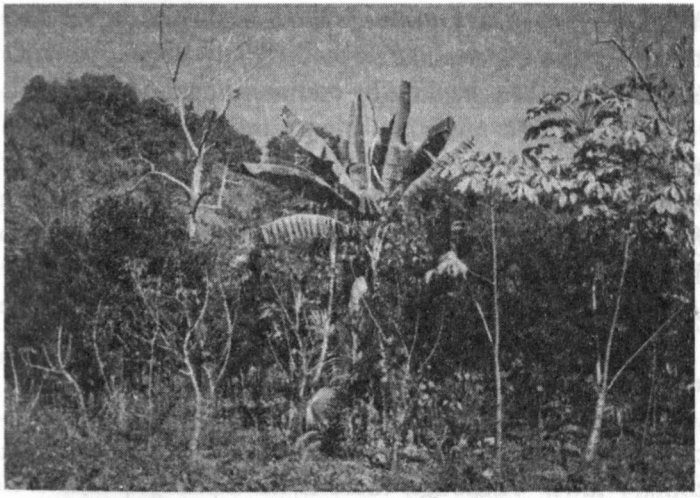

Photo 2. Structure of a homegarden system practiced by Chakmas.

Table 7. Mode of input (Rs ha^{-1}) and monetary efficiencies of different agricultural systems

Agricultural systems	Land preparation		Harvesting	Post harvesting	Seeds	Total input	Output	Efficiency
Wetland rice	2192± 497	1542±425	1077± 268	1124± 167	539± 78	6473±1434	13194±4092	2.04
Unirrigated valley								
1st Mixed cropping	2203± 156	1338± 340	1155± 157	2130± 350	235±19	7061±1129	10017±1033	1.42
2nd Mustard	1002± 140	73±7	816± 115	1283± 257	85±5	3259±511	5376±1100	1.65
Jhum	3478± 391	2130± 177	2241± 274	2102± 263	720± 59	10671±1163	16604±629	1.56

Traditional Knowledge of Plant Resource Utilization and Biodiversity Conservation

Indigenous people have been continually using forest and land resources to ensure better living conditions. Traditionally, the indigenous people seem to have better knowledge on forest resource utilization. Most of such resources are obtained from the Namdapha National park areas as well as from neighbouring Anchal Reserve Forests. Our preliminary survey reported about 60 plant species that are used for various purposes (**Table 3**). Some

of the villagers have rich knowledge about medicinal plants. The treatments of the diseases like fever, dysentery, cough, cut and sores and many others are done by traditional methods. Some of the commonly used medicinal plants are *Achyranthes aspera* (urinary disorders, skin diseases, in boil and wet piles), *Ageratum conyzoides* (cut & sores), *Clerodendrum colebrookianum* (fever), *Hedychium* sp (bone-ache), *Dillenia indica* (cough, fever and weakness), *Euphorbia hirta* (dysentery and in worms) and *Centella asiatica* (skin diseases and dysentery).

The influence of modernity on traditional activities is less appeared among the communities of the areas under study. In some cases traditional institutional arrangements play a vital role in conservation of natural resources also through stringent customary laws. Although there is no definite traditional institution system among the Chakma's yet, they follow some rules that to some extent play a little role over the natural resource utilization. For instance, depending upon the settlement areas and distance from the forest there are some specific points for collection of forest resources for a particular village. In case of any controversy, the village committee imposes a fine. The imposed fine is however, utilized for the village developmental activities. The three zones viz., Happy valley, Haldibari and M.V.Roadside are known for extraction of canes, bamboos and jeng (roofing leaves) respectively, which are in the buffer zone of the Namdapha National Park. They also visit to Diyun Anchal Reserve forest for collecting housing materials and fuelwood along with some other minor products (NTFP's) like vegetables, medicinal plants, honey, mushroom, etc.

Institutional Dimension of Land Use and Land Cover Change

The land use and land cover change in the study sites has been significantly affected by both informal and formal institutional arrangements. The informal institutional arrangements (**Box 2**) are such that are designed and enforced by the community leadership. These arrangements are reflected in the peculiar settlement patterns of indigenous as well migrant

communities, distribution of land among individual households, inheritance rules for family controlled land, and disputes resolution norms mainly centring around the use of common property resources. The formal institutional arrangement (**Box 3**) on the other hand exist in the form of many policy statements, various regulations and acts regarding forest and wildlife management in and around the national park, departmental notifications based on the executive decisions, and the corresponding enforcement mechanism.

Box 2

The informal institutional arrangements in the study area are related with the following developments:

Migration and settlement patterns: The first incidence of the change due to anthropogenic pressures started occurring due to the influx of Chakma immigrants in the Miao circle of erstwhile Tirap district of Arunachal Pradesh. The Chakma people, who currently inhabit adjacent areas of the park in five village settlements, are originally from the Chittagaon Hill Tract (CHT) of the Bangladesh. They started coming to this area in mid-sixties in small groups and stayed in clustered settlements to protect themselves from abundant wildlife in the dense natural forest of Namdapha. In the initial days when the population was small, the Chakmas lived the life of forest dwellers as *jhum* farmers, hunters, poachers, and wood collectors. However, with the increase in population of the area due to the continued influx of Chakma immigrants till the early seventies, the dispersed village settlements started appearing in the form of dwellings located on the cleared land, which is mainly used for subsistence agriculture and homestead gardens. Though there is no formal land tenure system in Arunachal Pradesh, the family controlled plots of land were allotted to household heads by an executive order (The exact revenue records of allotted land as well as the copy of the executive order regarding the allotment are not available in the sub-divisional office at Miao). A few Chakma settlers still practice swidden farming in the neighbouring Anchal Reserve Forest under Diyun forest rang. The Shingpho people who are indigenous inhabitants of the area and are politically and economically well off as compared to the immigrant communities vehemently oppose any attempt to clear the hilly plots in the Reserve Forest on in the Unclassed State Forest (USF) areas. Within a family, all the sons inherit the alloted land in equal

proportion. The girls have no right to inherit the family controlled land. However, there are number of cases where the son-in-laws who decide to construct their dwelling in their spouse's village, have been given a share in the plots of land possessed by the family. The incidence of nuclear family is common among the Chakmas, but the common bond of being a first of second-generation immigrant Chakma keeps the community as highly organised. The community solidarity is also strengthened by the common religious faith in Buddhist ethics in their everyday life.

The Lama population in Deban village is another immigrant community, which came to this area after the Chakma people. Their adherence to Buddhism is perhaps the dominant factor for their migration to this area. A few Wangchoo households are also located in the same village. The Wangchoo community is an indigenous tribe of Arunachal Pradesh, but are originally from Tirap district. Therefore, they also fall in the category of settelers. Whereas Lama people are enterprising farmers, the Wangchoo are swidden farmers. Being an indigenous community they act as village leaders and exercise the power of enforcing community rules regarding allocating jhum fields to needy families.

Emergence of new land-based occupations: The emergence of agro-pastoral form of land use in one of the most populated Chakma village M'Pen II in collaboration with a group of persons from Bihar who own a large herd of cattle consisting of about 250 cows as milch cattle. The grazing rights have been extended to the cattle owners.

Market linkages promoting commercialisation of agriculture: From the very beginning of Chakma influx in the adjacent areas of the Namdapaha forest, there were socio-religious linkages of immigrants with Buddhist organisations located in Diyun. These linkages later gave way to the creation of economic ties among the grain merchants, pity traders, middle men who served as a link between farmers and market forces. The development of Miao town as a sub-divisional headquarters also facilitated the market linkages of farmers. This brought about a reorientation in the land use activities of the farmers and they invariably became intensive agriculturists with an aim to generate marketable surplus for earning higher incomes. The additional income that is generated through sale of agriculture products goes towards financing the education of the younger generation and there is a preference to send youth for higher studies in Assam, Meghalaya, Delhi and even abroad.

Several social disputes are resolved at local level. A few cases are given below:

If the dispute is inter-village or inter-communities, the Village

Headman(s) and the members of the each village or community sit together and take the final decision accordingly to the nature and degree of the offence. The punishment to the accused on many occasions is in the form of a monetary fine or materials.

In case of theft, the accused have to return the stolen articles or its equivalent amount along with some fine that is fixed by the headman and the members.

When crops of a person are damaged by the cattle or other domestic animals of others the cattle owner has to pay the fine to the first party. The amount of the fine is fixed depending upon the degree of damage. In cases of seduction of girls, both the parties have to pay fine to the society.

Box 3

The formal institutional arrangements that noticeably had significant impact on the land use and land cover change in the study sites are the following:

Declaration of Namdapha forest as a tiger reserve and then as a national park: This executive decision for implementing a management strategy of creating protected areas brought about major change in land use activities of the settlers.

Resettlement and resettlement policies: The executive decision to allow Chakma people to settle in the adjacent areas of the Park boundary was perhaps related with the human rights question the related UN Convention. There was to foresight about its future consequences on the land use changes. However, the recognition of the adverse impacts of anthropogenic pressures in the form of increasing demand of agricultural land, and forest use with rising population became evident to Park authorities quite early. There was a settlement of Chakma farmers who used to practice swidden farming at Haldibari, was resettled in a new settlement called Budhisatta which in mid-seventies was like a degraded forest land outside the Park boundary. This decision to resettle the Haldibari population was taken essentially to enforce the norm of no human interference in the buffer zone of the Park. The present day Chakma farmers are the most enterprising vegetable growers of the area and continue to extract forest products from Haldibari as per their needs.

Forest zoning: The Park authorities have carries out an extensive survey of the area and have identified specific zone both inside and outside the Park boundary. The impact of zoning on land use and land cove change is significantly felt in such zones which under the occupation of settlers. Most Chakma and Lama farmers make fullest use of the available land

under their possession, which is evident from the cropping intensity and cropping pattern. In the buffer zone as well as in the adjacent areas between M'Pen I & II, there are several cases of illegal extraction of forest products. The situation in the M.V. Road extraction zone is particularly alarming in view of the Park authorities.

Forest use rules: There are different formal institutional regimes in the form of access rights in for community-based forest management practices. For example, there are areas classified as state reserve forests, anchal reserve forest, unclassed state forest (i.e. open access degraded forest lands, and community lands under the ownership of indigenous people of Arunachal Pradesh who have the traditional rights over the land.

Patrolling and rule enforcement: There are specific operational procedures and rules that are followed by the Park authorities for carrying patrolling of the area to monitor and enforce any violation of the formal institutional arrangements. The assessment of the effectiveness of these rules would be challenge for institutional analysts.

Formation of Village Forest Management Committees: This is a very recent institutional innovation after a notification was issued based on an executive decision for implementing JFM model of community-based natural resource management in Arunachal Pradesh.

Honey Extraction as a Source of Income

Carne (1979) refers to honey as one of the oldest food used by people. In this region the bees (*Apis dorsata* locally called "Bor modhu") make their nest in a number of tree species (*Bombax ceiba, Terminalia myriocarpa, Stereospermum chelonoides,* etc). The Chakma people have adequate techniques to harvest the honey (**Box 4**). They generally slash the surrounding trees and other vegetation around the tree. This practice makes honey tree distinguishable as single standing specimen, and also they put permanent bamboo nails on the tree trunk, which remain for two to three seasons. But whether the technique they are using for honey extraction is sustainable or not is a question of great concern. Applying torch on the hives or burn a fire below the tree are some of the strategies to avoid bee population to be around the tree during honey extraction. However, these practices reduce the chances of the bees nesting on the same tree in the next season. Nonetheless, extraction of natural honey gives the local people an alternative source of income and that also without any major input. So, efforts should be taken to make this practice more sustainable. In this regard, apiculture could be a strategy in these villages.

Box 4

The method and techniques of harvesting honey is very difficult and risky. First they start work for construction of a stairway to the tree. The stairs are made with bamboo stalks. Small pieces of bamboo (40-50cm long and 2-3cm wide) are sharpened, so that the stalks can be driven into the wood of the tree and inserted in the tree about 30-40cm apart. Long bamboo poles are used to connect the bamboo pins. Holes are made on the long pole in such a way that can be fitted the bamboo pins (**Photo 3**). This stairway generally left intact after harvesting of honey so that it can be used in the next year. Honey is collected during night and dark period. When the above set up is ready, one or two persons climb the tree with a bucket, long rope, big knife and splitted bamboo bundles (used for burning to get smoke). There they use a torch of smoke on the nest until most of the bees turn insensitive. The collector uses the burning torch to brush the bees from the nest. When most bees go away from the nest, the collector put a bucket underneath the nest and plucks the honeycomb. They leave a few smaller nests on the tree, so that the bees can again resettle. They collect 10-12 litres of honey from a mature nest.

Photo 3. The bamboo stairway used for honey extraction from *Bombax ceiba*.

Conservation Aptitude

A few plants are used by the people from cultural as well as spiritual viewpoint. Some selected plant species are chosen for the shelter of honeybees and so they are preserved. Some plants are not cut, as they believe that if humans cut these plants some misfortune will hail on them. Although superstitious, these activities lead to the conservation of a few plant species. The 'Nahar' (*Mesua ferrea*) is a sacred tree for the Chakmas; they don't cut the tree for any purpose, but to build temples. Some examples have been given in **Table 8**. They also leave some tree

species in their agricultural field (jhum as well as in unirrigated valley). Among these maximum are *Albizzia* sp, which are atmospheric nitrogen fixers. These trees are also used as support for different species of beans and other climber crops. Besides, the villagers (Chakmas, in particular) harvest the forest products mostly during the winter and none or a little during summer. This process of harvesting indicates the rich traditional knowledge on the ecological issues pertaining to the regeneration of the plant species in nature and also conservation aptitude behind it.

Table 8. Reason of Importance towards Conservation by the Indigenous People

Name of species	Reason of importance	Measures taken to protect
Bombax ceiba	Harbour honeybees	Trees are not cut
Terminalia myriocarpa	Harbour honeybees	Trees are not cut
Stereospermum chelonoides	Harbour honeybees, fuel wood	Harvested but only branches are cut
Albizzia sp.	Fuel wood	Only branches are lopped off
Sterculia villosa	Rope making	Bark is taken but in a controlled way
Citrus medica	Medicinal	Planted in the homegardens
Livistonia jenkinsiana	Roofing	Planted in the homegardens
Alstonia scholaris	Religious beliefs	Cut rarely due to some taboos

Conservation through Joint Forest Management (JFM)

A JFM scheme has been implemented in about 40 ha in the Diyun Anchal Reserve Forest zone since 2002. The village forest management committee (VFMC) has been formed and is registered under society registration act 1860, modified by the societies registration (extension to Arunachal Pradesh) Act 1978. The committee is formed for protection, regeneration, and scientific management of degraded community forest, jointly with the department of environment and forest to ensure equitable distribution of forest products including the NTFP's for villagers' domestic consumption and marketing the surplus yield for the

economic development of the society. Thus it is anticipated that JFM may help to conserve the natural resources and reduce the pressure over the national park.

Conclusion

Community-based conservation and/or land use development have been widely accepted for the very ideological reasons or instrumental ones that the involvement of local community living in and around the park/protected areas is critical to the success of the conservation effort. The process in itself is multi-dimensional involving social-cultural, economic and ecological issues pertaining land use and its consequences. While, economists look into the increasing the economic incentives to the local people who are around the park area, ecologists would believe in protection of the natural resources. These two are, however, linked through basic socio-cultural activities establishing a sustainable livelihood style. Our preliminary study basically shows that the people who have been resettled outside the Namdapha National Park were diverse with different socio-cultural activities. Nonetheless, one thing was common to see is that they were all using the natural resources to the fullest extend, however tending not to be commercial, although there is potential for that. So, enterprise-based biodiversity conservation and integrated watershed development and management could be possible strategies for the sustainable development of the resettlers. This study is still underway and a lot more to be studied in these directions, however.

Summary

The Namdapha National Park is rich in biodiversity due to its unique geographical position, varied topography and high annual precipitation. Human settlement was there inside the protected area twenty-five years back who had resettled in the adjacent areas after the declaration of the national park in 1983. Though the people have been resettled outside the park boundary still they are largely dependent on the natural resources of the park for their subsistence livelihood. Apart from different forest

products like timber, vegetables, medicine, fuel wood, thatching materials and others honey is also providing a greater source of income of the local people. Besides forest resources agriculture is one major source of living of the people of this area. They are practicing both shifting as well as settled agricultural systems. The settled agriculture can be categorized as wetland rice and unirrigated valley. The monetary efficiency of wetland rice cultivation was more than the unirrigated valley and jhum cultivation systems. People are conserving the rich biodiversity of the area through their traditional- knowledge and traditional-institutional rules. Government has also taken initiatives for conservation and decreasing pressure on the protected area by implementing joint forest management scheme recently.

Bibliography

Champion, H.G. and S.K. Seth (1968) A Revised Survey of the Forest Types of India, Delhi.

Crane, E. (1979) Honey: A comprehensive survey. Heinemon, London, UK.

Maikhuri, R.K. & P.S. Ramakrishnan, (1990) Ecological Analysis of a Cluster of Villages Emphasising Land Use of Different Tribes in Meghalaya in North-east India; Agriculture, Ecosystems and Environment 31: 17-37.

Ramakrishnan, P.S. (1984) The science behind rotational bush fallow agriculture system (jhum); Proceeding of the Indian National Academy of Sciences (Plant Sci.), 1984: 379-400

Ramakrishnan, P.S. (1990) Agricultural Systems of the North-Eastern Hill Region of India. Pp 251-274, *In S.R. Gliessman (ed.) Agro-ecology Researching the Ecological Basis for Sustainable Agriculture.* Springer-Verlag, New York.

Ramakrishnan, P.S. (1992) Shifting Agriculture and Sustainable Development, (Man and Biosphere Series. Volume.10). UNESCO-Parthenon Publishing Group, Paris.

Singh, D.N., S.S. Chandiramani and A. Gupta Choudhury (2000) Biodiversity of Namdapha, A Profile. Project Tiger Namdapha Tiger Reserve, Department of Environment and Forest, Govt. of Arunachal Pradesh.

Sharma, B.D., A.S. Chauhan and B.N. Wadhwa, (1990) Study and Conservation of the Plant Resources of the Proposed Namdapha Biosphere Reserve, Arunachal Pradesh Botanical Survey of India, Kolkata.