

Anthropogenic threats and biodiversity conservation in Namdapha nature reserve in the Indian Eastern Himalayas

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*The Namdapha nature reserve is one of the largest protected areas for biological conservation in the Indian Eastern Himalayas – a global biodiversity hot spot. The reserve supports rich floral and faunal species diversity. The virgin forest cover of this nature reserve has been considerably reduced, degraded and fragmented by clear-felling for human settlements, shifting agriculture and massive extraction of non-timber forest products (NTFPs), particularly *Zalacca secunda*, an endemic stemless rattan palm. There are 12 villages with a population of 4191 in the northwestern periphery and 13 villages with a population of 5147 in the southeastern periphery of the park. The core zone of the park has two major Lisu local settlements with a total of 43 households. The local people totally depend on the nature reserve for their livelihood. This article focuses on the human-generated threats (due to immigration pressure and its consequences manifesting as clear-felling for settlements and agriculture, overharvesting of NTFPs, hunting and poaching of rare and endangered fauna, uncontrolled fishing in the river, etc.) to biological diversity in the nature reserve. For better management of Namdapha nature reserve, approaches like formation of biodiversity management committees in the fringe villages, creation of a buffer zone in the southeastern boundary of the park, resettlement of encroached communities in the core zone, provision of alternative conservation options (substitutes for roofing and fuelwood) and deployment of more field staff for better patrolling are recommended.*

BIOLOGICAL resources are the basis of life in the tropical world. The process of industrialization and urbanization tends to damage this vital resource base that could be disastrous to the human race. In view of biological conservation and to minimize degradation of natural ecosystems, protected areas have been established that cover about 5% of the world's land area^{1,2}. Twenty-five biodiversity hot spots have been identified³ worldwide as areas of greater biological endemism in the biosphere. Two of these are present in the Indian subcontinent, viz. the Eastern Himalayas and the Western Ghats. The latter has been studied widely due to its easy accessibility. However, the Eastern Himalayas are inaccessible mountain terrains with rich biodiversity, where chances of getting newer species have been predicted⁴.

Arunachal Pradesh (83,784 km²) in northeastern India occupies a major portion of the Indian Eastern Himalayas and has about 82% forest cover⁵. About 26 major tribes and over 110 sub-tribes of human societies⁶ inhabit different parts of the State, with an intricate lifestyle totally

dependent on the forest resources. The traditional livelihood system of the people consisted of shifting cultivation, settled cultivation, and hunting and gathering of forest produces. Namdapha nature reserve in Arunachal Pradesh enjoys a dual status of a national park as well as a tiger reserve (lat 27°23'30" to 27°39'40"N and long 96°15'2" to 96°58'33"E). This is one of the largest protected areas (1985 km² with 177 km² buffer zone) in the State, but has also been affected by severe anthropogenic disturbances (Figure 1). This article describes the problems and issues relating to the human interaction with natural resources for effective biodiversity management in Namdapha nature reserve.

For the study extensive field surveys were made (by R. S., D. A. and M. M.) from September 2001 to March 2003. About 160 km distance (from Miao to Vijaynagar) was trekked along the Namdapha hill trails covering both buffer and core zones. Detailed household surveys using a semi-structured questionnaire was conducted involving 450 households located in northwestern and southeastern periphery of Namdapha nature reserve. Personal interviews with the village headman and other villagers of different age groups and sex were conducted. Official information was recorded from the forest department as

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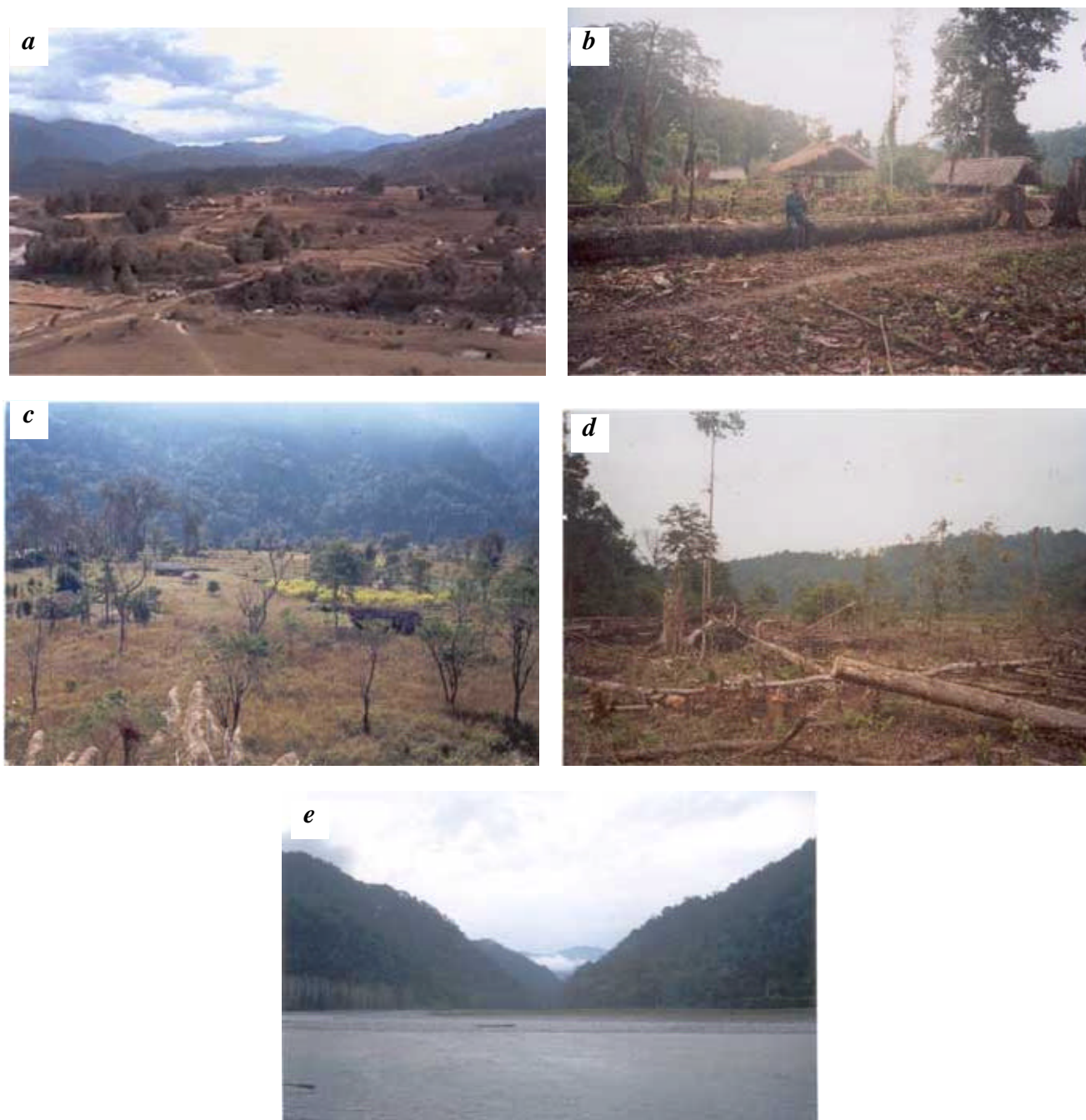


Figure 1. Human disturbances in Namdapha nature reserve. Settlements in southeastern boundary (a), core zone (b) and northwestern boundary (c). d, Clear-felling in core zone. e, Overview of Namdapha.

well as from civil administration. Quantification of the extracted forest products was done by weighing the head load and quantity consumed per household per day in the sample households.

Status of biodiversity

The Namdapha is a species-rich protected area consisting of tropical, subtropical, temperate and alpine formations. Tropical wet evergreen forests occur in the lower reaches and alpine vegetation higher up, near Daphabum. The low-

land tropical evergreen forest is perhaps the largest *Dipterocarpus* forest in the region. *Dipterocarpus macrocarpus* (hollong) dominated well-drained areas and *Shorea assamica* (mekai), an endemic and locally threatened species dominated drier, gravelly soil in Namdapha⁷. The area is a treasure house of endangered, wild relatives of cultivated, and rare and interesting plants (e.g. *Camellia caudata* (wild tea), *Coffea benghalensis* (wild coffee), *Mangifera sylvatica* (wild mango). *Gnetum ula* and *Pentasacme wallichii* are extremely rare species reported from this protected area. *Psilotum nudum*, the rare primitive plant has

also been reported from 40-mile area of the park⁸. Different species of root parasites (*Sapria himalayana*, *Balanophora* spp.) are yet another set of rare species in the park^{9,10}. Overall, about 73 species of lichens, 59 species of bryophytes, 112 species of pteridophytes, 5 species of gymnosperms and 870 species of angiosperms have been recorded so far in the protected area⁹. A summary of the flora (species, genera and families) is given in Table 1. However, the recorded biodiversity may contribute only a portion of the total biodiversity in the park, as this area is bound to have rich biodiversity due to the confluence of Indo-Myanmar biota.

The faunal diversity is also high in Namdapha. Ninety-six species of mammals were listed¹¹. The park is an important refuge for *Hylobates hoolock* (hoolock gibbon)¹², the only ape of northeast India. Recently, a new species of deer has been reported from around this area¹³. The carnivores present are *Panthera pardus* (leopard), *P. tigris* (tiger), *P. uncia* (snow leopard) and *Neofelis nebulosa* (clouded leopard), an assemblage that is globally unique to Namdapha. A variety of other threatened mammals are present including *Cuon alpinus* (dhole), *Ailurus fulgens* (red panda), *Felis temmincki* (Asian golden cat), *Elephas maximus* (Asian elephant), *Moschus chrysogaster* (Himalayan musk deer), *Bos gaurus* (gaur) and *Bubalus bubalis* (wild Asiatic buffalo). A total 233 species of birds, 76 species of fishes (*Danio horae*, *Barilius jayarami*, *Garra tirapensis*, *Aborichthys tikadari* and *Kryptoterus indicus* were new), 25 species of amphibians (*Rhacophorus namdaphaensis*, *Philautus namdaphaensis* and *P. shyamprupus* were new), 28 species of reptile (*Cyclemys mouhati*, *Elaphe mandarina* and *Trimeresurus macrosquamatus* were considered rare) were reported. Invertebrates include 188 species of beetles, 102 butterflies, 35 moths, 24 Hemiptera and 115 Mantodea¹¹. Although documentation of floral and faunal diversity has been done by the Botanical and Zoological Surveys of India, intensive studies on quantification of biodiversity is warranted for better management of the park.

Threats to biological diversity

Human influx

In recent years, human migration confounded by population increase *vis-à-vis* human developmental activities

has posed increasing threats to the biodiversity of forest zones all over the world¹⁴. Although Namdapha nature reserve is in a remote corner of the country, it could not escape from human interference¹⁵. Several ethnic human societies have been living in and around the park (Figure 2) that fully depend on nature reserve for their day-to-day life. There are 12 (9 Chakma, 1 Lama, 1 Singpho and 1 Mishmi) villages with a total of 704 households and a population of 4191 in the northwestern periphery, of which six villages are closer (within 5 km from the park boundary) to the park. Another 13 (4 Lisu and 9 Nepali) villages with 673 households and a population of 5147 are found in the southeastern periphery (Vijayanagar) of the park. Besides the side-line settlements, there are two unauthorized settlements in the core zone with 43 households and a population of 280 (Table 2).

The Chakmas, originally belong to the Chittagong Hill Tracts (CHTs) of Bangladesh, have settled down in different parts of the State as refugees¹⁶ (mainly in Changlang and Lohit districts) during 1964–65. Prior to the declaration of Namdapha as a National Park and tiger reserve, the Chakmas were living in Haldibari, Zero camp and Farmbase (present buffer zone). After declaration as a national park in 1983, they were resettled outside the park boundary in the adjacent Anchal reserve forests (the present settlements). However, they continue to use the park resources for their livelihood. The Lama is another migrant community from Bhutan that came during 1963–64. The Singpho and Mishmi are native tribes. The original homeland of the Singphos was in the Hukang Valley, lying towards the northeast corner of the Patkai range in the Eastern Himalaya, they migrated to the present settlements¹⁷ during 1780–95. On the other hand, Mishimis migrated from Lohit district of Arunachal Pradesh.

Lisus and Nepalese occupy the southeastern periphery of the park. The Lisus originally belong to Myanmar, and migrated to Arunachal Pradesh before 1947. According to available records, only thirteen families migrated mainly from Putao area of Myanmar¹⁸ during 1947–48. The Nepalese (ex-servicemen of Assam Rifles) had settled down during 1963–64. Increasing population pressures developed a pushing effect towards the jungle for land and food, which led to encroachment in different areas of the park. There are two unauthorized Lisu settlements in the core zone (38 and 52 mile) of the park, damaging the virgin forest. Immigration of Lisu tribes from Vijayanagar and

Table 1. Recorded floristic diversity of Namdapha nature reserve

Category (total no.)	Dicots	Monocots	Lichens	Bryophytes	Pteridophytes	Gymnosperms
Families (215)	119 (55.35)	19 (8.84)	17 (7.90)	21 (9.77)	36 (16.74)	3 (1.4)
Genera (639)	403 (63)	111 (17.37)	34 (5.32)	33 (5.16)	54 (8.45)	4 (0.63)
Species (1119)	674 (60.25)	196 (17.5)	73 (6.53)	59 (5.27)	112 (10)	5 (0.45)

*Values in parentheses are percentage of total number.
Source: Chauhan *et al.*⁷.

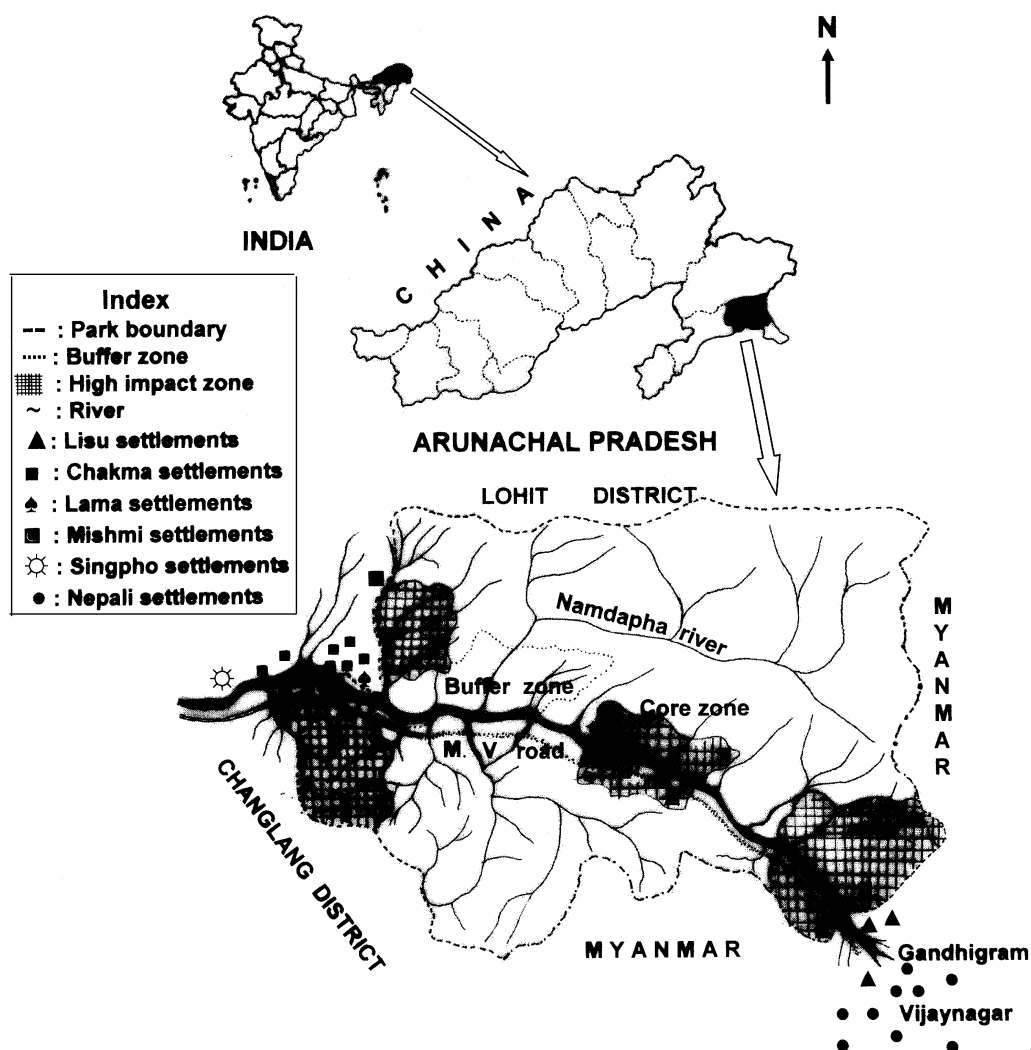


Figure 2. Map of Namdapha National Park, showing human settlements in and around the park boundary.

Gandhigram to the park area is a regular phenomenon. About 170 ha of forestland (in the core zone) has already been cleared within the last five years for agriculture (excluding *jhum*) and settlement (pers. obs.). Further, there is illegal felling of trees and collection of non-timber forest products (NTFPs).

Extraction of forest products

People depend on the park for timber, bamboo, roofing materials¹⁹, medicinal plants²⁰ and other NTFPs²¹. Happy Valley, Haldibari and M. V. Roadside areas (in the buffer zone) have been identified as extraction zones in the park (pers. obs.). Maximum and minimum extraction of roofing materials (leaves of *Zalacca secunda*; an endemic, stemless rattan palm) has been recorded in M'Pen-I and Lama basti, which accounted for 12.5 tonnes yr⁻¹ and 3.0 tonnes yr⁻¹ respectively. It is also estimated that about

975 tonnes of bamboos and posts, and 45.5 tonnes of wild vegetables and medicinal plants are harvested annually in the eight studied villages (Table 3) in and around the national park, of which the villagers of M'Pen-I harvest a major chunk (237.5 tonnes of bamboos and posts, and 13.0 tonnes of wild vegetables and medicinal plants). This can be attributed to demographic pressure and easy accessibility to the forest as well as to the local market demand. Overall, the biomass extraction and/or consumption as estimated in this study is only an underestimate, as we have not taken into account the total biomass used by the settlers as a ratio of the total primary production of the tropical rainforest and also the losses due to natural disturbances. Nevertheless, over-exploitation of certain resources, including *Z. secunda*, bamboos, etc. may, over a period of time, cause damage to the overall biodiversity of the park. For instance, we could not find traces of *S. himalayana* (a rare root parasitic plant) population reported earlier in the 42-mile core zone area⁷. Incidentally, there

Table 2. Population pressure in the northwestern and southeastern periphery of Namdapha nature reserve

Village	Community	Migrated from	Total no. of households	Total population
Northwestern periphery				
Lama basti	Lama	Bhutan	23	122
Bhudhisatta	Chakma	Bangladesh	56	293
Anandapur-I	Chakma	Bangladesh	55	315
Anandapur-II	Chakma	Bangladesh	38	216
M'Pen- I	Chakma	Bangladesh	95	585
M'Pen-II	Chakma	Bangladesh	78	457
Kamalapuri	Chakma	Bangladesh	59	319
Nandankanon	Chakma	Bangladesh	49	289
Devapuri	Chakma	Bangladesh	125	726
Punyabhumi	Chakma	Bangladesh	103	751
Pisi basti	Singohoo	Patkai range	12	68
Kathan	Mishmi	Lohit district	11	50
	Sub total (A)		704	4191
Core zone*				
38 mile	Lisu	Myanmar	23	130
52 mile	Lisu	Myanmar	20	150
	Sub total (B)		43	280
Southeastern periphery				
Gandhigram	Lisu	Myanmar	300	2000
Sidikhu	Lisu	Myanmar	25	183
Hozolo	Lisu	Myanmar	32	280
Daudi	Lisu	Myanmar	28	279
Buddhamandir	Nepali	Assam Rifle, India	23	280
Tophill	Nepali	Assam Rifle, India	32	270
Twohut	Nepali	Assam Rifle, India	43	297
Mazgaon	Nepali	Assam Rifle, India	48	346
Chidudi	Nepali	Assam Rifle, India	28	200
Ramnagar	Nepali	Assam Rifle, India	22	180
Gaurigaon	Nepali	Assam Rifle, India	11	82
Phaparbari	Nepali	Assam Rifle, India	43	450
Daragaon	Nepali	Assam Rifle, India	38	300
	Sub total (C)		673	5147
Total		(A + B + C)	1420	9618

Population according to 2001 census.

*Pers. obs.

were a few remnant populations in one of the secondary forests in (Haldibari, Zero camp) the buffer zone of the park⁹, which is 20 miles away from the earlier reported area.

Fuelwood is the major source of energy in these areas. No alternative energy sources like electricity and cooking gas are available. The consumption of firewood is higher during winter (1239.11 tonnes) in comparison to summer (908.36 tonnes) for processing (boiling) of agricultural products (chillies and turmeric) for their value-addition. Also, more firewood is required for warmth during winter season (Table 3). In this case, the ratio of extraction to consumption is 1:0.99, which implies that the people collect according to their needs. Illegal felling and traf-

ficking of trees have been noticed several times inside the park area (pers. obs.), although the Supreme Court has banned such activities in the Northeastern States since 12 December 1996.

Hunting and poaching

Hunting, illegal fishing and trapping of wild fauna like tiger, barking deer, leaf deer, sambhar, wild boar, bear, wildcat and a variety of birds by local inhabitants (Lisu, Chakma and Mishmi) for bush meat and hide, is a severe concern for the management of Namdapha. *Pyxidea mouhotii* (Kachho, a terrestrial turtle) is common in Nam-

Table 3. Extraction of forest produces in selected villages in and around Namdapha nature reserve

Demography			Extraction of forest products (tonnes village ⁻¹ yr ⁻¹)					Average season-wise fuelwood consumption (tonnes village ⁻¹ season ⁻¹)	
Village	Community	Total no. of households	Human population	Bamboo and posts (dry wt)	Roofing materials (<i>Zalacca secunda</i>) (dry wt)	Fire wood (dry wt)	Wild vegetables and medicinal plants (fresh wt)	Summer*	Winter**
Lama basti	Lama	23	122	57.5	3.0	100.2	0.2	46.05	54.72
Budhisatta	Chakma	56	293	140.0	7.4	320.8	5.5	132.50	186.48
Anandapur-I	Chakma	55	315	137.5	7.3	287.4	5.6	115.02	171.11
Anandapur-II	Chakma	38	216	95.0	5.0	236.5	7.0	96.82	139.08
M'Pen- I	Chakma	95	585	237.5	12.5	480.4	13.0	214.40	269.38
M'Pen-II	Chakma	78	457	195.0	10.3	417.0	9.0	170.35	242.66
38th mile	Lisu	25	165	62.5	2.6	165.6	2.6	74.98	91.50
52nd mile	Lisu	20	130	50.0	3.3	142.3	2.6	58.24	84.18
Total		390	2283	975.0	51.4	2150.2	45.5	908.36	1239.11

*Summer (April–September); **Winter (October–March).

dapha²² and is being poached for food²³. Habitat destruction poses further threat²⁴ to wildlife. Hunting of *Muntiacus putaoensis* (leaf deer), a rare species, was also encountered during field survey. Although the Wildlife (Protection) Act 1972 was extended to Arunachal Pradesh in May 1973, and prohibits picking, poaching and hunting of wild animals and plants, its enforcement is not be of much use in this area.

The great Indian hornbill (*Buceros bicornis*), the State bird of Arunachal Pradesh, has played an important role in the traditional lifestyle and dressing habits of many tribes in the State. The tribal people use the beak of the bird as a headgear to be worn as a traditional knot on the forehead. Thus, the world's most colourful bird is heading towards extinction in the northeastern States of India. Moreover, there are ample game hunters around Namdapha who frequently hunt birds for fun and food. The Apatani tribe residing in higher elevations (Ziro) of Arunachal Pradesh now use artificial beaks of the hornbill, as reiterated by the WWF-India in the State. Such acceptability remains to be tested with other tribes in the State.

Buffer zone

The buffer zone concept of Namdapha nature reserve is somewhat different from the IUCN concept. The buffer area (177 km²) is confined only to the northwest corner of the park (Figure 2). This area had human settlements earlier (Haldibari, Farmbase and Zero camp) and was later added to the park in 1986. Currently, in the buffer zone (demarcated by the forest authorities), there is no human settlement, but the resettled communities frequently visit the zone for various forest produces (Table 3). The southeastern periphery of the park was earlier considered as a core area and human interference was supposed to be negligible there. However, decadal increase of human popula-

tion in the fringes of this nature reserve (Gandhigram and Sidikuh) has coerced people to encroach the park area. Further, immigration from a neighbouring country (Myanmar) is also adding to demographic pressure over the natural resources in the park. Consequently this is disturbing the pristine forest vegetation and the resident wild fauna in the protected area. Thus, it is evident that the buffer-zone concept failed with respect of Namdapha nature reserve.

Suggestions for conservation of biodiversity

Conservation of biological diversity through protected-area networking in this less-explored Eastern Himalayan zone is a distant dream due to several constrains, viz. inadequate data on biodiversity potential, village-to-village and community-to-community variations in dialects and culture, site inaccessibility, natural disasters, ineffective legal enforcement mechanisms, and lack of adequate infrastructural facilities and of well-trained, well-equipped and motivated personnel. The age-old practice of shifting agriculture has been one of the factors affecting the virgin forest cover in the region. Moreover, people are forest-dependent and any external intervention or monitoring of biodiversity or natural resources without peoples' participation will not be successful, even if it is well intended. In order to effectively manage biodiversity, the communities should be consulted through a functional participatory mode of community mobilization.

Nevertheless for conservation purposes, the Namdapha nature reserve needs meticulous monitoring that is rational and at the same time useful for management, rather than what is ideally required for in-depth studies of how community structure and species richness are affected by anthropogenic stress and changing environmental conditions. Therefore, a simple and cost-effective biodiversity monitor-

ing system as below is advised for effective management of the Namdapha nature reserve.

- (i) Extensive exploration and quantification of the biodiversity potential of the nature reserve. Such quantification should also take into consideration the local peoples' knowledge on natural resources utilization and management thereof.
- (ii) Deploying adequate number of staff for reserve management and also equipping them with minimum training and education.
- (iii) Providing monitoring equipments and financial resources, and
- (iv) Encouraging participation of local communities in protected-area management. Perhaps, people should be rewarded/given incentives for conservation efforts or sustainable use of bioresources.

However, with settlements in the core zone of the reserve, developing such a field-level biodiversity monitoring system must involve protected-area staff and representatives from park communities, without compromising biophysical, socio-biological, and socio-economic factors.

The Biological Diversity Act passed by the Indian Parliament in December 2002 mentions about formation of self-governed Biodiversity Management Committees (BMC) at village levels in biodiversity-rich areas; the main purpose of which would be to promote conservation and to ensure sustainable use and documentation of biological diversity (e.g. local biodiversity register). Nevertheless, personal interviews with people residing in the study villages (Chakma, Lama and Lisu) reveal that they are ignorant about the futuristic requirements of forest resources given the chance to continue with similar livelihood strategies as of now. Eventually, instituting BMCs would be difficult in the immediate future, as people have no legal rights; they are mostly immigrant populations, particularly in and around the park area. Perhaps, such resettlement status together with abundant forest resource availability is a bottleneck for biodiversity conservation per se. Thus, there is an urgent need for environmental education and awareness regarding biodiversity conservation amongst these communities. Overall, the land-use development schemes in and around Namdapha National Park should be oriented towards (i) environmental education to local people, (ii) managing abandoned shifting agricultural lands or providing suitable alternatives to shifting cultivation through community consultation and (iii) strengthening linkage between peoples' institution and other government agencies for sustainable development.

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MEETINGS/SYMPOSIA/SEMINARS

5th All India Peoples' Technology Congress

Date: 19–20 February 2005
Venue: Kolkata

Objectives include: A get together of scientists, engineers, scientific workers and policy makers with their latest activities/inventions/models/working experience in the Peoples' Technology field, disaster prevention through socio-technical approach, animal husbandry as an alternate of income generation.

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International School on EPR Spectroscopy and Free Radical Research

Date: 17–20 November 2004
Venue: Bhabha Atomic Research Center, Mumbai

Themes include: Applications of EPR Spectroscopy and the scope of Free Radical Research in the thrust areas of Biology, Biotechnology, Medicine, Chemistry, Physics, Material Science, Food Science, Radiation Biology and other multi-disciplinary sciences.

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