

CRITICAL ECOSYSTEM
PARTNERSHIP FUND


Ashoka Trust for Research in
Ecology and the Environment
www.atree.org


Department of Environment & Forests
Government of Assam



MAINTAIN AND RESTORE HABITAT CONNECTIVITY AND REDUCE HUMAN ANIMAL CONFLICT IN NORTH BANK LANDSCAPE

Project No 51498

Project implemented by

**North Bank Landscape Conservation Programme
WWF India
Tezpur, Assam, India
2007-2010**

TABLE OF CONTENT

i.	The Project team	5
ii.	Acknowledgement	6
1.	North Bank Landscape conservation Programme – The background	7
2.	The study area and the conservation issues	10
3.	Strategic direction	17
3.1.	Project purpose and expected output	19
4.	Status of the elephant corridors	21
4.1.	Tipi elephant corridor	21
4.1.1	Land cover change dynamics of the area	23
4.1.1.i	Growth of human settlements in the area	26
4.1.1.i.a.	Objective	26
4.1.1.i.b.	Methodology and database	26
4.1.1.i.c.	Findings and discussion	26
4.1.1.i.c.1.	Settlement pattern	26
4.1.1.i.c.2.	Settlement types	27
4.1.1.i.c.3.	Settlement growth	30
4.1.1.i.d.	Conclusion	31
4.1.2.	Status of elephant movement across Tipi Corridor	32
4.1.2.i.	Methodology	32
4.1.2.ii.	Status of elephant movement during 2005-2006	32
4.1.2.iii.	Current status of elephant movement (2007 to 2009)	34
4.1.3.	Status of human elephant conflict	36
4.1.4.	Socio economic profiling of the area	37
4.1.4.i.	Methodology	37
4.1.4.ii.	Social structure	37
4.1.4.iii.	Economy and Livelihood	38
4.1.4.iv.	Problems and plans	38
4.1.4.v.	Human nature interface	38
4.1.4.vi.	Suggestion for intervention	39
4.1.4.vi.a.	Livelihood and economy	39
4.1.4.vi.b.	Man nature interface	39
4.1.4.vi.c.	Future plans	40
4.2.1.	Bornadi Khalingduar complex	41
4.2.2.	Land cover change dynamics of the area	43
4.2.2.i.	Bornadi WLS	43
4.2.2.ii.	Neoli PRF	43
4.2.2.iii.	Khalingduar RF	44
4.2.3.	Status of elephant use of the area	47
4.2.3.i	Introduction	47
4.2.3.ii	Methodology	48
4.2.3.ii.a	Data analysis	48
4.2.3.ii.a.i.	Covariates used in models	49

4.2.3.iii.	Results	49
4.2.3.iv.	Discussions	51
4.2.4.	Status of other important biological component	52
4.2.5.1.	Review of Scio-Economic Scenario of the fringe villages of Bornadi WLS, Neoli PRF and Khalingduar RF, Udalguri District, Assam	52
4.2.5.1.a.	Some of the salient observation	55
4.2.6.	Status of human elephant conflict	59
4.2.6.i.	Human elephant conflict in BK Complex	59
4.2.6.i.a.	Introduction	59
4.2.6.i.b.	Methodology	59
4.2.6.i.c.	Result and discussion	60
4.2.6.i.d	Conclusion	63
5	Conservation action plan	64
5.1	Conservation action plan for Tipi corridor complex	64
5.2	Conservation action plan for Bornadi Khalingduar complex	67
	Reference	73

List of abbreviation

AC	Alternate Current
AREAS	Asian Rhino and Elephant Action Strategy
AT	Assam Type
ATREE	Ashoka Trust For Research in Ecology And The Environment
BK	Bornadi-Khalingduar
BTAD	Bodoland Territorial Autonomous District
BTC	Bodoland Territorial Council
CEE	Centre for Environment Education
CEPF	Critical Ecosystem Partnership Fund
CPR	Common Property Resources
ER	Elephant Reserve
ESD	Environmentally Sustainable Development
FGD	Focus Group Discussion
GIS	Geographical Information System
GPS	Global Positioning System
GRAF	General Reserved Engineering Force
HEC	Human Elephant Conflict
IEK	Indigenous Ecological Knowledge
IRS(LISSIII)	Indian Remote Sensing Satellite
IRV	Indian Rhino Vision
LPG	Liquid Petroleum Gas
NBL	North Bank Landscape
NEEPCO	North Eastern Electric Power Corporation
NGO	Non Government Organization
NP	National Park
NREGA	National Rural Employment Guarantee Act
NTFP	Non Timber Forest Produce
OBC	Other Backward Class
ORC	Orchid Research Centre
ORDC	Orchid Research Development Centre
PHC	Public Health Centre
PRF	Proposed Reserved Forest
RCC	Reinforced Cement Concrete
RF	Reserved Forest
SBGL	Sub Group
SRI	Systematic Rice intensification
SRTM	Sustainable resource and Technology Management
SSB	Sasastra Seema Bal
SWOT	Strength Weakness Opportunity and Threat
TR	Tiger Reserve
UNDP	United Nations Development Program
VCDC	Village Council Development Committee
VDP	Village defense party
WS	Wildlife Sanctuary
WT	Watch Tower
WWF	World Wide Fund for Nature

THE NORTH BANK LANDSCAPE TEAM

Project Management

Dr. Dipankar Ghose,
Head, Eastern Himalaya and Terai, WWF India

Landscape Coordinator

Dr. Anupam Sarmah

GIS Team

Mr. Amit Sharma
Mr. Gopala Areendran (IGCMC)

Field Team

Mr. Hiten Kumar Baishya
Mr. Soumen Dey
Dr. Jimmy Bora
Mr. Sanjay Gogoi
Mr. Tridip Sarma
Ms. Sushila Basumatari

Team Assistants

Mr. Ananta Das
Mr. Indrakanta Bharali

ACKNOWLEDGEMENT

We wish to thank the following individuals and institutions for their support and guidance during implementation of this exercise:

Mr. Ravi Singh, Secretary General & CEO, Dr. Sejal Worah, Program Director, Mr. Sujoy Banerjee, former Director (Species Conservation), Mr. Tariq Aziz, former Head, AREAS Programme, Dr. Dipankar Ghose, Head, Eastern Himalayas and Terai, Dr. G. Areendran, Head IGCMC, and Ms. Vishaish Uppal, Sr. Coordinator (Livelihoods) of WWF India, Dr. A. Christy Williams, AREAS Coordinator of WWF International, Mr. K. Borgoyari, Dy. Chief of Bodoland & EM, Forests (BTC), Mr. G.C. Basumatari, CHD, Forests (BTC), Mr. B. Sarmah (DFO, Dhansiri), Mr. Minakshi Sundaram IAS DC Udalguri, Late. A. Bodo (RO, Bornadi), Mr. H. Kalita (RO, Nonai), of Assam Forest Department, Mr. D. Hazarika, CO, Harisinga Circle of Assam civil administration, Mr. Temeswar Deori, Sub Divisional Agriculture officer, Mr. Nedo (DFO, Bhalukpong), Mr. T. Tapi (DFO, Pakke TR, Seijosa), Mr. Y. Gibi (RO, Tipi) of Arunachal Forest Department, Mr. G. Tseering (EAC, Bhalukpong), of Arunachal civil administration, Department of Geography, Gauhati University, NGO partners like Kameng Angling Association, Tipi and Help Tourism, Siliguri, for their unconditional support and guidance during the work. The project implementation would not have been possible without the support from individuals like Jayanta Sarma of Society for Socio-Economic Awareness and Environmental Protection (SSEAEP); Debanga Mahalia and Monsoon Jyoti Gogoi for their help in documenting the bird and butterfly diversity in Bornadi and Khalingduar area; Nerkhang Khaklari, Raithai Basumatari, Bimal Basumatari, Sanjay Basumatary, Dipak Boro Satya Boro, Binod Doimari and all other members of Dimakusi, Paneeri, and Udalguri ABSU units; Ananta Bag and Golap Behera of local NGO Green Valley Forest and Wildlife Protection Society; Mr. Bordoloi, Manager, Dimakusi TE; Mr. Jayanta Das, local wildlife activist; members of all Dong committee, all village headmen of the area, VCDC members, and local community. We profusely thank all of them for their kind support and guidance.

Special thanks to CEPF for extending their technical as well as financial support for undertaking this work.

These wider area's biodiversity values have been internationally recognised by WWF in the form of being a Global 200 Ecoregion (Eastern Himalayas). Conservation International identified the same region as a Biodiversity Hot Spot (Himalaya)³ and is expected to launch its Critical Ecosystem Partnership Fund (CEPF) in the near future.

In 1998, WWF selected the North Bank area as one of its priority Landscapes for the conservation of Asian Elephants (WWF, 1998). Under coordination of the WWF Asian Elephant and Rhino Action Strategy (AREAS), WWF-India established a field presence in the Landscape in August 2001. After surveys into the status and distribution of elephants, several issues critical to the survival of the species were identified and a start was made to address these. Especially in countering conflict between elephants and humans in one of its focal areas, the programme achieved considerable success in terms of reducing losses (both in terms of elephants, people and livelihoods) and gaining acceptance by local communities and Government agencies.

During biological surveys, some information on tiger presence and conflicts with tiger has been collected as well. A detailed understanding of the status of the species is however lacking and an attempt to secure funding for work on tiger has failed.

An alliance of the Assam Government, the Forest Department, the International Rhino Foundation (IRF) and WWF is currently implementing an Indian rhino translocation plan (Indian Rhino Vision 2020). Rhinos will be moved from Kaziranga NP and Pabitora WS to other protected areas (especially Manas NP) in a bid to take pressure of the two high-density rhino populations and thus achieve a further expansion of the population and its range. The WWF contribution of this programme is managed from the Delhi office. Preparatory work in Manas NP however is captured in this document as Manas NP is part of the North Bank Landscape. Likewise, Indian Rhino Vision 2020 work in Kaziranga is captured under the Kaziranga Karbi Anglong Landscape Programme.

The North Bank Landscape Programme (NBLP) has been funded mainly through the AREAS seed-funding facility (using WWF-NL and WWF-US funds) and through a grant made available by the US Fish and Wildlife Service. The current phase of the programme comes to an end by June 2006.

The Government of India runs Programme Elephant and Programme Tiger. Apart from supporting protected areas, these programmes also provide for human-wildlife conflict mitigation (including compensation). Gaps in coordination of this work and administrative obstacles prompted WWF to engage with the Government to achieve a better coordinated effort to mitigate conflicts which can in the case of elephants be labelled as serious.

³ CEPF (2005)

This document outlines a programme of interventions required to safeguard the future survival of elephants, rhinos and tigers in the North Bank Landscape and thus contributing to the survival of wider biodiversity values and ecosystem functions. By doing so, important poverty alleviation gains will be made. Scope and direction of the proposed interventions builds on the experience the WWF North Bank Landscape Programme team gained over the last four years. A lot of information and many of these experiences have been captured in various reports produced by the team.

2. THE STUDY AREA AND THE CONSERVATION ISSUES

The North Bank Landscape is the area between the northern bank of the river Brahmaputra (south), the foothills of the eastern Himalayas (north), Sonkosh River (west) and the Dibang River (east). It is ca. 750 km long with largely continuous forests along the foothills of the Himalayan mountains, situated in the states of Assam and Arunachal Pradesh (Map 1). The total size of the landscape is ~40,000 km² of which about 16,000 km² is believed to be used by elephants effectively.

High species diversity has been noted for the Landscape (WWF-AREAS, 2003). Table 1 presents a summary of the number of faunal species per threat status. A floral study revealed that the forests of the North Bank Landscape are amongst the world's most richest (Gillison, 2004).

Table 1: Number of globally threatened mammal, bird, reptile, amphibian and invertebrate species in the North Bank Landscape (possibly present)

Taxa	Global Threat Category according to the 2002 IUCN Red List		
	Critically Endangered	Endangered	Vulnerable
Mammals	1	11	17
Birds	2	3	24
Reptiles	0	2 (1)	3 (3)
Amphibians	1 (1)	0 (2)	0 (2)
Invertebrates	1	0	0
Total	4 (1)	16 (3)	44 (5)

Source: modified after CEPF 2005

An excellent profile of the faunal diversity of the wider Eastern Himalayas hot spot is provided by CEPF (2005):

The mammalian fauna in the lowlands is typically Indo-Malayan, consisting of langurs (Semenopithicus spp.), wild dogs (Cuon alpinus), sloth bear (Melursus ursinus), gaur, and several species of deer, such as muntjacs (Muntiacus muntjak) and sambar (Cervus unicolor). Further up the mountains, the Indo-Malayan fauna transitions into a Palearctic fauna, consisting of snow leopards, Asiatic black bear (Ursus thibetinus) and a diverse ungulate assemblage that includes the blue sheep (Pseudois nayur), takin (Budorcas taxicolor) and Himalayas thar (Hemitragus jemlahicus). The red panda (Ailurus fulgens) is a Himalayan species that lives in old growth subalpine conifer and mixed forests with a bamboo understory.

Because the Himalayas have a relatively recent origin, endemism is low, especially among the better-known higher taxonomic groups. The golden langur (Trachypithecus geei) is restricted to the patch of semi-evergreen and temperate forest on the north bank of the Brahmaputra River, between the Sankosh and Manas rivers that flow south from the mountains. The pygmy hog (Sus salvinus) and hispid hare (Caprolagus hispidus) are restricted to the alluvial grasslands

and the Namdapha flying squirrel (*Biswamoyopterus biswasi*) is restricted to the temperate broadleaf forests of the Eastern Himalayas Region.

Endemism among birds in the region is higher than among mammals. Some species restricted to the region include the Manipur bush quail (*Perdica manipurensis*), chestnut-breasted partridge (*Arborophila mandelli*), Blyth's tragopan (*Tragopan blythii*), Temminck's tragopan (*Tragopan temminckii*), Sclater's monal (*Lophophorus sclateri*), Tibetan eared pheasant (*Crossoptilon harmani*) and rusty-bellied shortwing (*Brachypteryx hyperythra*).

But, despite the low overall endemism, the region harbors several species that are represented by globally significant populations. The foothill grasslands and broadleaf forests harbor important populations of the largest carnivore and herbivores in Asia, notably the tiger (*Panthera tigris*), Asian elephant, greater one-horned rhinoceros (*Rhinoceros unicornis*), and wild water buffalo. The elephant population in the remaining habitat patches along the north bank of the Brahmaputra River in Assam is one of India's largest and most important (Sukumar 1992). The greater one-horned rhinoceros, one of three species found in Asia, is restricted to several small, isolated populations contained within protected areas (Dinerstein, 2003).

The Eastern Himalayas Region is the last bastion for this charismatic mega-herbivore, which once ranged along the length of the Himalayas foothills, from Pakistan to Myanmar. Many other refuge populations of large herbivores—wild water buffalo, swamp deer (*Cervus duvaucelii*)—restricted to protected areas in southern Nepal and northeastern India—also represent some of the last remaining in the world, and are considered to be of global significance. The Brahmaputra and Ganges rivers that flow along the Himalayas foothills also support globally important populations of the Gangetic dolphin (*Platanista gangetica*).

The populations of vultures, greater and lesser adjutants—some of Asia's largest birds—in the foothill grasslands and broadleaf forests are globally significant, as are the populations of several of the hornbill species and pheasants, white-winged duck (*Cairina scutulata*), white-bellied heron (*Ardea insignis*), black-necked stork (*Grus nigricollis*) and the Bengal florican (*Houbaropsis bengalensis*).

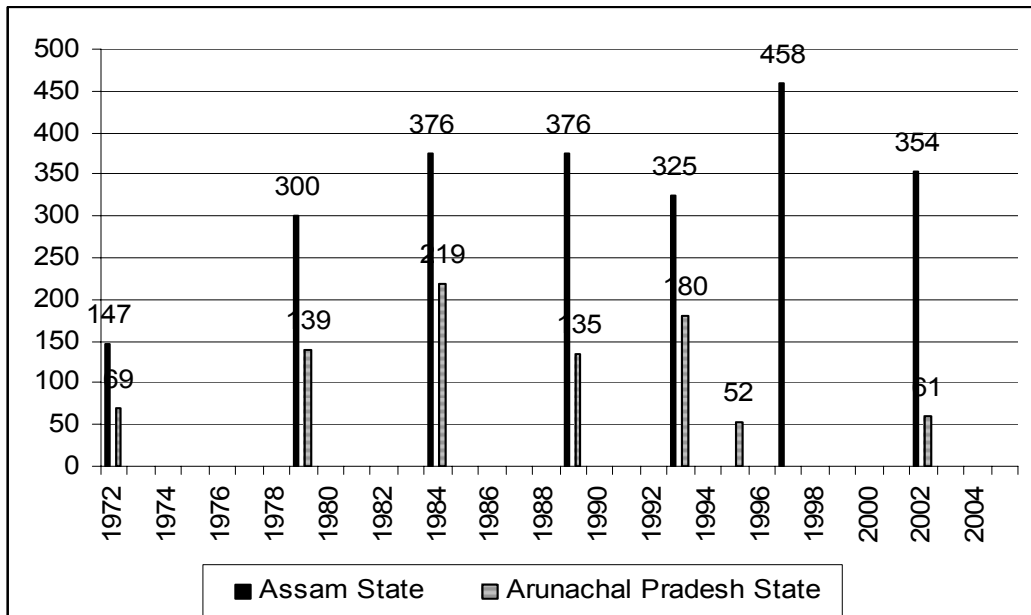
The North Bank Landscape has an estimated population of 1,800 elephants (2002/03)⁴ and ~150 tigers (2002; Figure 1: 415 total in the two States)⁵. As can be seen from Figure // and in Table //, tiger numbers are falling in the Landscape and in the States as a whole. A nucleus population of about 40 Indian rhinos are present in Orang NP. Translocation of at least 20 Indian rhinos into Manas NP is scheduled to take place in 2007.

⁴ Data from Government - Project Elephant

⁵ Data from Government - Project Tiger

These very large mammals are wide-ranging and their well being is probably an expression of the well being of the wider ecosystem. Biodiversity in the area is very high. This biological richness has been recognised by WWF which gave the area a priority status as being one of the Global 200 ecoregions of importance. Also Conservation International regards the area's richness highly and recognises the wider Eastern Himalayans as one of the 18 global biodiversity Hot Spots. The area lies on the interaction zone of the Indo-Malayan and Palearctic biogeographical realms and species typical of both zones can be found in the area. The steep topographical variation in the terrain also contributes to species-richness as different organisms specialise to survive at different altitudes. A distinct dry season (November – April) probably suppresses species richness somewhat.

Figure 1: Tiger numbers in Assam State and Arunachal Pradesh State



Source: data from Government Project Tiger

About a quarter of the Landscape (~10,719 km² out of ~40,000 km²) bears the status of Elephant Reserve (3) or Tiger Reserve (3). These entities are mainly a reflection of the central Governmental Project Elephant and Project Tiger. Parts of these reserves consist of protected areas (National Parks (NP) and Wildlife Sanctuaries (WS)) and unprotected reserved forests (all these categories fall under *notified* forests - Map 2). By far the largest acreage of the reserves is under nominal protection of notified Reserved Forests. Elephant and Tiger Reserves overlap in most cases.

The fertile alluvial plains along the Brahmaputra river are cultivated ever since humans settled here centuries ago. Assamese are the dominant ethnicity and live mainly in the alluvial plains. A diverse mix of ethnic and linguistic groups can be found throughout the region, especially in the hills: Bodo, Bengali, Hindi, Nepali, Mishing, Rabha, Karbi and many so called tea-tribes (workers on tea estates who

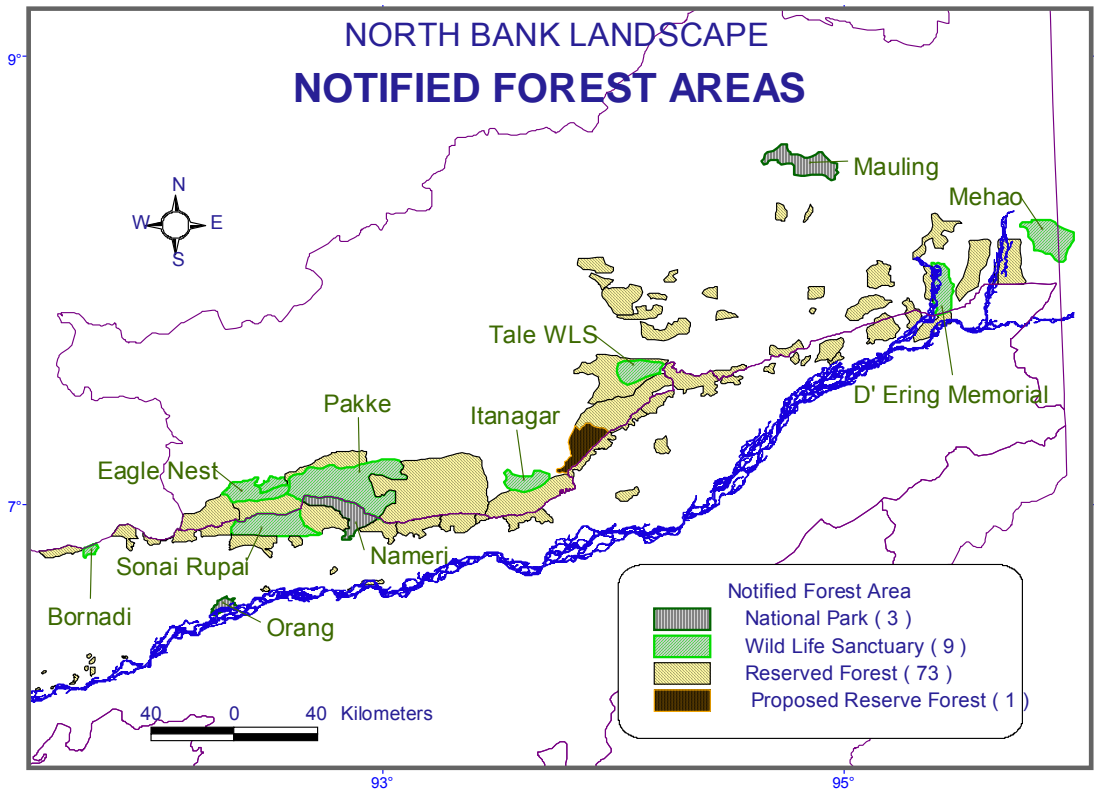
arrived from different parts of the country when the estates were formed, some 150 years ago).

Table 2: Elephant and Tiger Numbers in the Reserves in the Landscape

Reserve	1993		1997		2000	
	Elephants	Tigers	Elephants	Tigers	Elephants	Tigers
Ripu Chirang Elephant Reserve		9		1		0
Sonitpur Elephant Reserve		38		44		25
Kameng Elephant Reserve		?		?		?
Manas Tiger Reserve		81		125		65
Nameri Tiger Reserve		25		29		32
Pakke Tiger Reserve		?		?		?
Animals outside reserves		24		33		27
Total Known		177		232		149

Source: Government Project Elephant and Project Tiger

Map 2: Notified forests in eastern North Bank Landscape



In recent history, almost all land in the alluvial plains has been occupied by agricultural fields, supporting a population of about eight million people. In the Assam State part of the Landscape, 7,878,058 people reside (383 / km²); in the Arunachal Pradesh State part of the Landscape, 722,418 reside (11 / km²) (2001 census data). Presently the annual population growth rate in Assam is 1.8% (Government of Assam, 2003). The main crop is rice (one harvest / year).

Currently, elephants and tigers are found in the northern sections of the Landscape, along and in the foothills of the Himalayas. Over time, historical elephant routes accessing the Brahmaputra River have been converted and access to the river through natural vegetation is now an impossibility for elephants. But elephants leave the forest and come onto the alluvial plains in search of food during the wet season. At the far eastern side of the Landscape, north-south movement of elephants across the river into the Myanmar area is still possible. The northern half of the Landscape consists of the foothills (up to an altitude of 3,000 m) of the Himalayan mountain range, which abruptly spring out of the alluvial plane. This area with steep topography is largely covered by forest. It is mainly in these forests where tigers are found.

Situated along the foothills, teagardens have been set-up during colonial times.

Table 3 shows changes in land-use in the Landscape, derived from LANDSAT satellite imagery data.

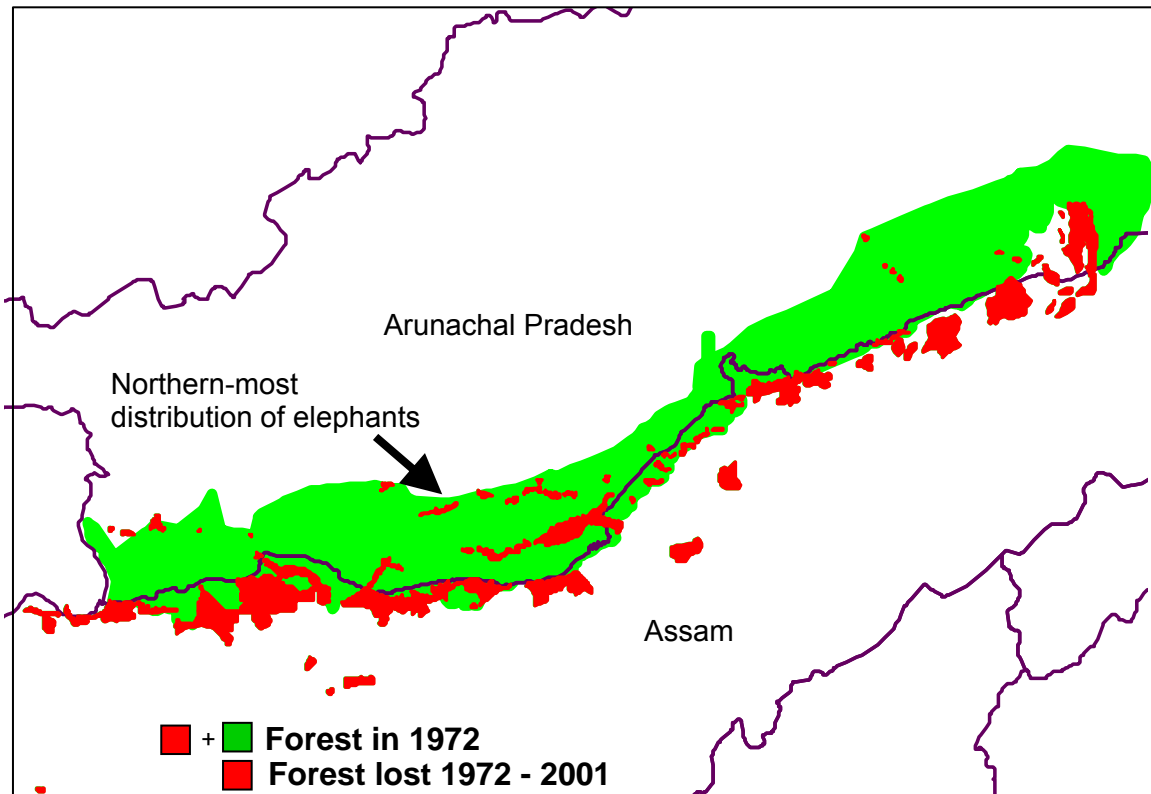
Table 3: Land Use Changes in North Bank Landscape (1991 – 2001)

Land Use Class	1991 (km ²)	2001 (km ²)	Change in Landscape (%)	Change in Elephant range only (%)
Forest	n.a.	n.a.	-2.38	-5.31
Degraded Forest	n.a.	n.a.	1.56	3.19
Agriculture	n.a.	n.a.	8.58	3.20
Tea Garden	n.a.	n.a.	0.35	0.08
Waste & Fallow Land	n.a.	n.a.	-6.66	-0.65
Water Bodies	n.a.	n.a.	-1.70	-0.94
Settlements	n.a.	n.a.	0.08	0.06
Snow & Cloud cover	n.a.	n.a.	0.16	0.37

Source: AREAS North Bank Landscape Programme, 2006

In the past 10 – 15 years, agriculture has expanded in the Landscape at the expense of waste lands and in a lesser extent, forests. Within the elephant range, forest loss is however a relatively more important factor than elsewhere. Especially the lowland forests in Assam State have been converted (65% loss between 1972 and 2001), and at the moment, very little lowland forest is left. It are the lowland forests however, on which elephants depend for their shelter and food supply; elephants hardly use forests on steep terrain.

Map 3: Forest loss in the Kameng and Sonitpur Elephant Reserves in the North Bank Landscape, 1972 – 2001



Towards the eastern part of the Landscape, several large infrastructural works can be found. Large hydroelectric dams are coming up in the Subansiri and Kameng Rivers which is going to be a major threat for east-west movement of elephant and tigers across the landscape.

In India, the forests and wildlife are constitutionally vested as state subjects. Thus, the respective state Forest Departments are primarily accountable for managing forests and the Wildlife Wings of the Forest Departments manage the protected areas. The Chief Wildlife Warden is responsible for the implementation of Wildlife Act, and has to report to the central Ministry on select wildlife matters. The Ministry of Environment and Forests has overall responsibility for forests and protected areas in India. But, unlike in the rest of India, about 54 percent of the forests in the northeast hill states are categorized as unclassed state forests. These are largely under the control of private individuals, clans, village councils, district councils and other traditional community institutions. In Assam, two district councils manage 3,589 square kilometers (1 percent) of Reserve Forests and Proposed Reserve Forests, the rest being under the state Forest Department. In comparison, the neighboring hill states Meghalaya (97 percent), Nagaland (97 percent) and Tripura (84 percent) have much greater proportions of their forests managed by autonomous district councils as well as clans, village councils and individual families. Arunachal Pradesh has about 52 percent of community managed and controlled forests (Down to Earth 2002). Utilization of

unclassified state forests includes traditional usufruct rights. Thus, in these hill states the District Councils are an important part of the governance structure, and forest management comes under the purview of the Council Forest Departments. Despite the devolution of management rights to the states and districts, the central Ministry of Environment and Forests, in Delhi, retains responsibility for sourcing funds to the state departments, formulating legislation and amendments, and providing direction to state Forest Departments on major policy decisions in forest and biodiversity protection. Acceptance of central-level directives by the state departments is, however, discretionary.

Even at the village level, there are institutions such as the village durbars and Village Development Councils that play a very important role in conservation of biodiversity and ecological services. These councils run the day-to-day village administration, including the management of village or community forests where fuelwood extraction, thatch grass collection, and gathering materials for house construction are permitted and regulated.

Certain village durbars are also the custodians of sacred groves and community forests. Like the rest of the country, Assam and Arunachal Pradesh follow the Panchayati Raj system, which governs a substantial portion of the common property resources, and is also an important decentralized institution in biodiversity conservation.

In Arunachal Pradesh, the Anchal Samitis are the panchayat equivalents, and comprise of village clusters. A substantial portion of undisturbed natural community forests in Arunachal Pradesh is under the control of Anchal Samitis, which makes them important stakeholders of biodiversity conservation and management.

There are more than 150 conservation-related nongovernmental organizations in northeast India. Most are organized at local and grassroots level, but several are regional, national, and international NGOs that have been working in the region for more than two decades. The activities of the grassroots NGOs vary from poverty alleviation through community development, education and awareness, community mobilization, advocacy and action projects, to ex situ and in situ conservation and biological inventory and surveys. Many were established by dedicated groups of individuals motivated to conserve species, biodiversity, or the environment where they live. For example, the Green Guards and Green Manas are two local NGOs based in Assam engaged in small-scale ex situ conservation projects; the former rescues, rehabilitates, and releases greater and lesser adjutant storks, and the latter has a captive breeding program for Pygmy hogs. In Assam, Nature's Beckon is a small activist group striving to save the last few patches diverse rainforest in the remote Jaipur, Upper Dihing and Dirak districts of eastern Assam from industrialization.

Some of the regional and national NGOs active in northeast India include ATREE, a NGO that promotes biodiversity conservation and sustainable resource use in the eastern Himalayas and the Western Ghats. Aaranyak is a regional NGO dedicated to biodiversity conservation and other environmental issues in Northeast India and coordinates activities of smaller, grassroots NGOs such as Nature's Foster, Green Heart Nature Club, Green Forest Conservation, New Horizon, Green Manas, and Green Guard. Because many of these grassroots NGOs are unable to receive and convert foreign-currency grants from international donors, the larger NGOs function as "nodal agencies" to receive, disburse and coordinate activities of the former.

CEE is a national NGO active in northeastern India. CEE is primarily engaged in environmental education programs, and is also the National Host Institution for the UNDP Small Grant Programme in India. The northeast regional cell of CEE in Guwahati (CEE NE) facilitates the program in the eight northeastern states where it implements 11 ongoing projects, of which five are in Assam. Other national NGOs active in the region include Wildlife Trust, India and the Bombay Natural History Society. Other NGOs include Inner Asia Foundation in Arunachal Pradesh, which is striving to create a reserve to the north of, and contiguous to, Kamlang Wildlife Sanctuary and Namdapha National Park, and the World Pheasant Association which is active in Arunachal Pradesh. (Culled from CEPF, 2005)

After having executed Landscape wide (field) investigations, the programme has so far concentrated its interventions in the Kameng and Sonitpur Elephant Reserves, near the town of Tezpur where the main programme office is located. This limitation was needed because of the limited resources available when compared with the enormity of the area, the long (750 km) extended shape of the Landscape and the enormity of the conservation issues at play in the Landscape. Recently the Programme has become more active in the Manas Tiger Reserve area after social unrest in the area started to subside. Some of these activities are linked with the on going project **Indian Rhinos Vision 2020 (IRV 2020)**.

3. STRATEGIC DIRECTION

Relationship to eco system profile:

This project seeks to build on existing landscape conservation initiatives to maintain and restore connectivity and protect wide ranging threaten species in priority corridors with a particular emphasis on the North Bank Landscape.

Specifically it relates to the CEPFs strategic direction number one –

1. Build on existing Landscape conservation initiatives to maintain and restore connectivity and to protect wide ranging threatened species in priority corridors with a particular emphasis on the North Bank Landscape in Assam, India. [1.1 Identify important habitat linkage between side outcomes in the priority corridors. 1.2 Engage civil society in developing and implementing management plans for key habitat linkages.]

The project addresses CEPF priority site and corridor outcome: North Bank Landscape and CEPF priority species outcome: Asian elephant and Indian tiger.

The Tipi corridor in the North Bank is the major link between the CEPF priority sites – Nameri NP (126), Pakke WLS (134), Sonai Rupai WLS (158) – and other large elephant and tiger habitats in the North Bank.

The Bornadi-Khalingduar corridor connects several CEPF priority sites in Bhutan as well as India. CEPF priority sites through this corridor to Bornadi WLS (58) and Manas NP (117) in India.

In both the corridors in the North Bank Landscape, a priority CEPF landscape, the project seeks to engage the civil society in active conservation work, specially in its objective of maintaining/restoring habitat linkages (CEPF priority corridor North Bank) for wide ranging threatened species (CEPF priority species Asian elephant and Indian tiger) by promoting management practices that favour conservation and livelihood as well. The project aims to enhance targeted awareness programmes seeking to build public opinion in favour of conservation.

3.1. PROJECT PURPOSE AND EXPECTED OUTPUT:

3.1.1. Purpose

Reduced human intervention in the two corridors through civil society action securing free use of these two corridors by elephants.

3.1.1.a. Purpose Indicator 1.

Conservation Alliances for each corridor established.

3.1.1.b. Purpose Indicator 2.

Conflict free movement of elephants through the two corridors.

3.1.2. Output 1.

Community dynamics, land use and elephant movements in Tipi-Dedjling corridor complex understood.

3.1.2.a. Output Indicator 1.1.

Document on over all Socio economics of local communities in Tipi-Dedjling corridor complex.

3.1.2.b. Output Indicator 1.2.

Document on Land use by people and elephants in Tipi-Dedjling corridor complex.

3.1.3. Output 2.

Civil society engaged for development of conservation action plan for Tipi-Dedjling corridor complex.

3.1.3.a. Output Indicator 2.1.

Conservation Action Plan for securing Tipi-Dedjling corridor complex ready.

3.1.3.b. Output Indicator 2.2.

Stakeholder Alliance for securing Tipi-Dedjling corridor complex in place.

3.1.4. Output 3.

Community dynamics, land use and elephant movements in Bornadi-Khalingduar corridor understood.

3.1.4.a. Output Indicator 3.1.

Document on over all Socio economics of local communities in Bornadi-Khalingduar corridor.

3.1.4.b. Output Indicator 3.2.

Document on Land use by people and elephants in Bornadi-Khalingduar corridor.

3.1.5. Output 4.

Civil society engaged for development of conservation action plan for Bornadi-Khalingduar corridor.

3.1.5.a. Output Indicator 4.1.

Conservation Action Plan for securing Bornadi-Khalingduar corridor.

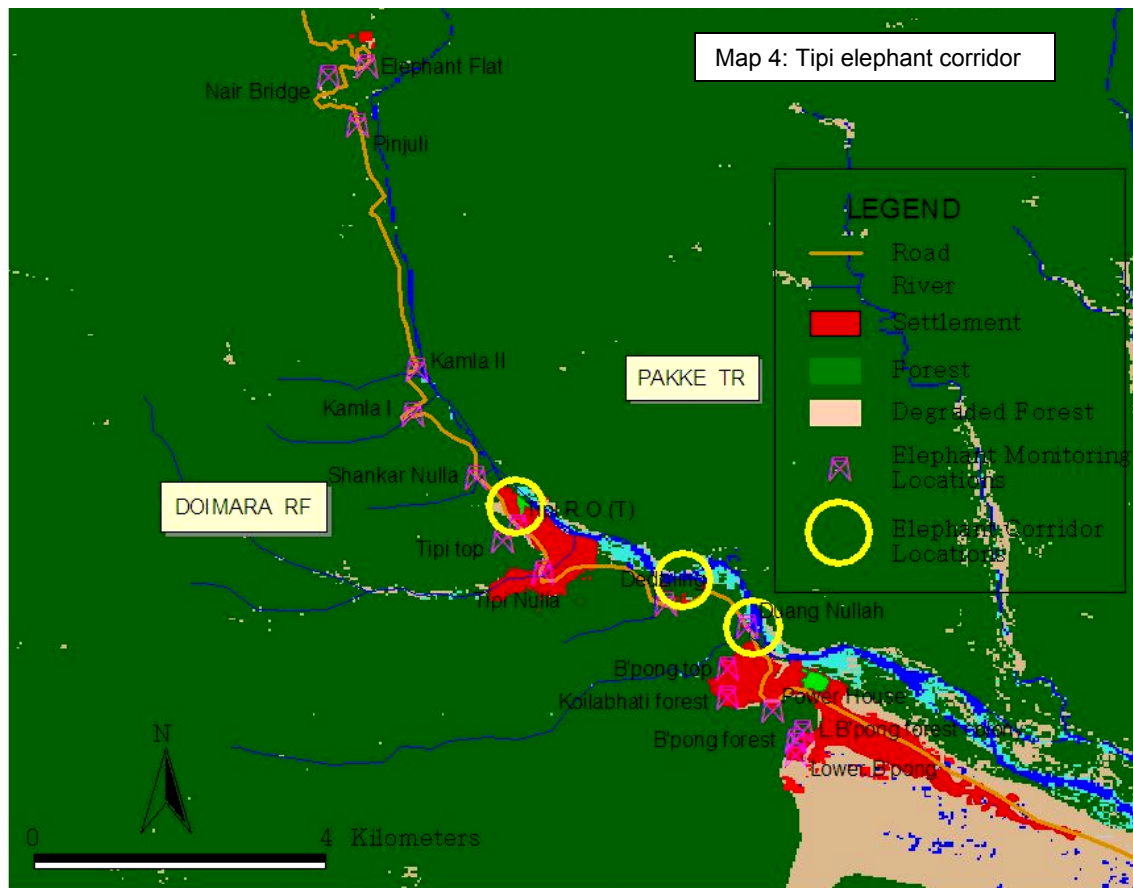
3.1.5.b. Output Indicator 4.2.

Stakeholder Alliance for securing Bornadi-Khalingduar corridor.

4. STATUS OF THE ELEPHANT CORRIDORS

4.1. TIPI ELEPHANT CORRIDOR

Tipi the small township in the West Kameng district of Arunachal Pradesh and is situated on the bank of River Kameng. It lies at a distance of six Kms in the north of Bhalukpong on the Assam Arunachal border. Tipi is a part of the three important forest reserves in that area namely, Pakke Tiger Reserve, Doimara Reserve Forest and Kameng Elephant Reserve. The Kameng River separates the Pakke Tiger reserve from Doimara RF. This small township, with a few hamlets in the early seventies is believed to have derived its name from the word



AREAS NBL Program, WWF India

Boundaries and alignments are subject to correction

T.P. or *Transit Permit*, as vehicles and commuters used to stop in the check gate to obtain clearance for further movement and trade. This area has grown centered around the forest offices and people came in to settle here mainly as labourers and traders. This area of late has experienced a rapid growth in terms of settlement expansion as well as the population expansion as this is the entry point to three districts of Arunachal Pradesh viz. – Tawang, East Kameng and West Kameng. The area is also gaining importance as one of the potential trade route between India, Bhutan and China. People from far flung areas have started settling here considering the future prospects. Mega hydro electric project on River Kameng has also contributed significantly to the recent escalation of population and various collateral developments in the area.

The Tipi area is very important for its biodiversity. The area with rich green cover ranks third in terms of biodiversity as per the study conducted by WWF (2004)⁶. Historically, the area between Orchid Research Centre (ORC) to Tipi Nala was extensively used by the elephants to cross from the Pakke Tiger Reserve to Doimara Reserve Forest. But even though at present, this movement exists, it has gone down drastically which can be attributed to the rapid expansion of settlements in that stretch. The information obtained through monitoring reveal the importance of Dedjling as a corridor in the Tipi area. All these information highlights the importance of Dedjling and Tipi in ensuring connectivity between Pakke and Doimara forests which is an essential for providing the elephants a bigger space in Kameng Elephant Reserve (WWF 2006)⁷.

The most important feature of Tipi is that it has some flat lands. These lands are favorable for human settlement as well as other developmental activities. The area has therefore lured people from its nearby hilly districts. As it is a part of the three forest reserves Pakke TR, Doimara RF and Kameng ER, the flat lands are also preferred by the wildlife in these forests. Mainly the Asian elephants and other animals prefer the gentle slopes ($> 15^{\circ}$) to cross the River Kameng to reach the Pakke Tiger Reserve. Therefore, this area is important for both wildlife and human. The fast and unplanned growth of settlement in the area is disturbing the wildlife movement. As a consequence, the elephant movements through this corridor are gradually decreasing. The elephant herds are found to explore new areas for crossing the River Kameng from either side. Consequently human elephant conflict has been found to have increased considerable in and around Seijosa area on the other bank of the River Kameng.

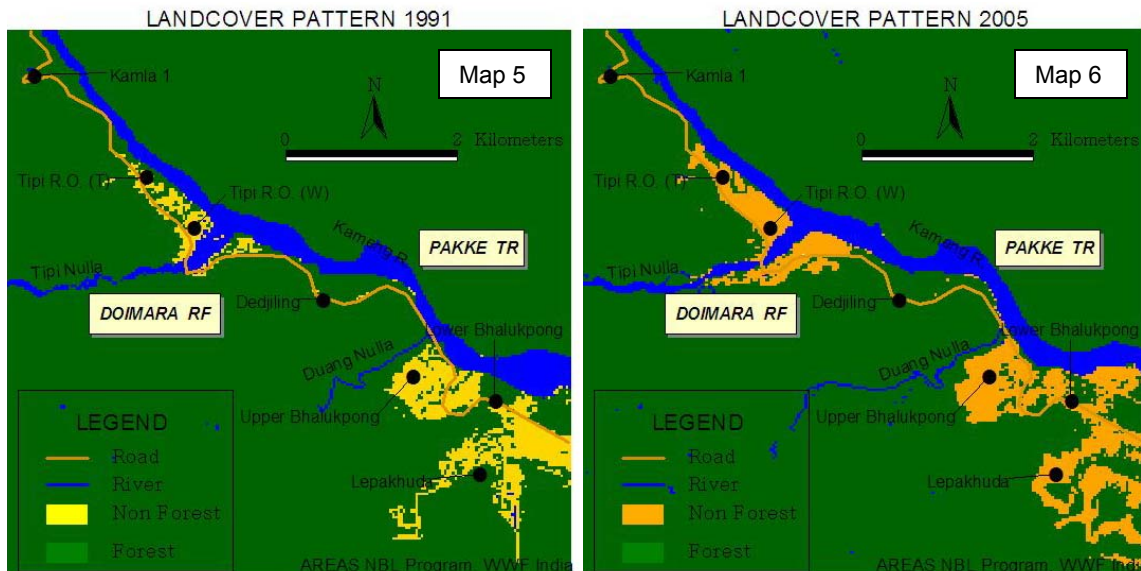
The Tipi area is regarded as an important corridor for the movement of Asian elephants and the other wild animals. From the perspective of conservation, it is very essential to maintain this corridor for elephant movement. On the other hand, this place is growing at a faster rate which can be the major cause for the disturbance in the elephant corridors. Because of the increasing flow of people to this area the settlements are seen in the remote parts also. Some parts of the dense forest areas are also becoming populated. The area is declared as industrial area by the government of Arunachal Pradesh. Developmental activities by NEEPCO and Kameng Hydro Electric Project have also contributed towards the growth of the area. Though the area is developing and getting modern facilities, the environment is affected to some extent. The industries are growing and causing inconvenience for the wildlife. The elephants are facing great difficulties in crossing one forest block to another as the corridor is getting threatened. Unless a proper land use plan is implemented, this vital wildlife corridor is soon going to be a history resulting in fragmentation of one of the best elephant habitat in the globe.

⁶ Biodiversity of North Bank Landscape, North East India, WWF, 2004

⁷ Corridor Report (unpublished), WWF, 2006

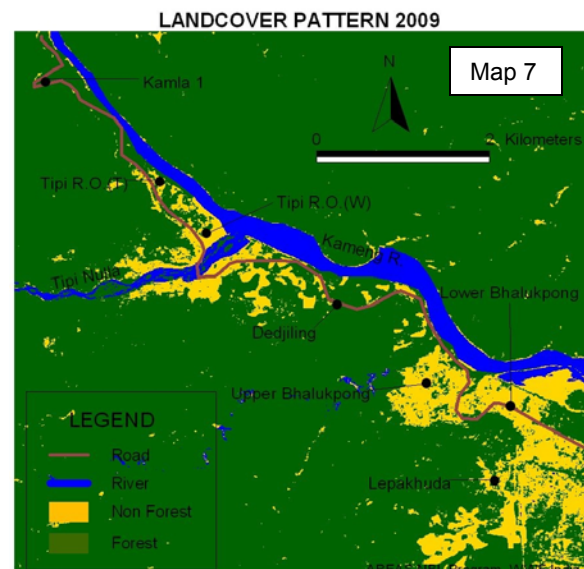
4.1.1. LANDCOVER CHANGE DYNAMICS OF THE AREA

The Tipi area has experienced rapid changes in terms of land cover during the last eighteen years. Settlement area has increased significantly during the period at the expense of the forest cover in the small section of about ten kilometers between Bhalukpong and Tipi (Map 5, Map 6 and Map 7). The land cover status in the said section encompassing an area of about 41 km² has been mapped and analyzed to understand the changes between 1991, 2005 and 2008. Most of the area under consideration is in Arunachal Pradesh barring a small area south and east of Lepakhuda accounting for about four percent of the total falling in adjoining Assam. As per the LANDSAT records of 1991, of the total about 3.83 percent of the area was under human activity mainly settlement. Again in 2005,



as per the IRS (LISS III) data about 6.29 percent has gone under the non forest category mainly into settlements. This figure has gone up to 8.44 percent as per IRS (LISS VI) 2008 data. This indicates a forest loss of about 2.5 percent or about 1 sq. km. during 1991 to 2005 and another 2.1 percent during 2005 to 2008. This change in land cover has primarily taken place in the comparatively plain areas that are critical for elephant movement.

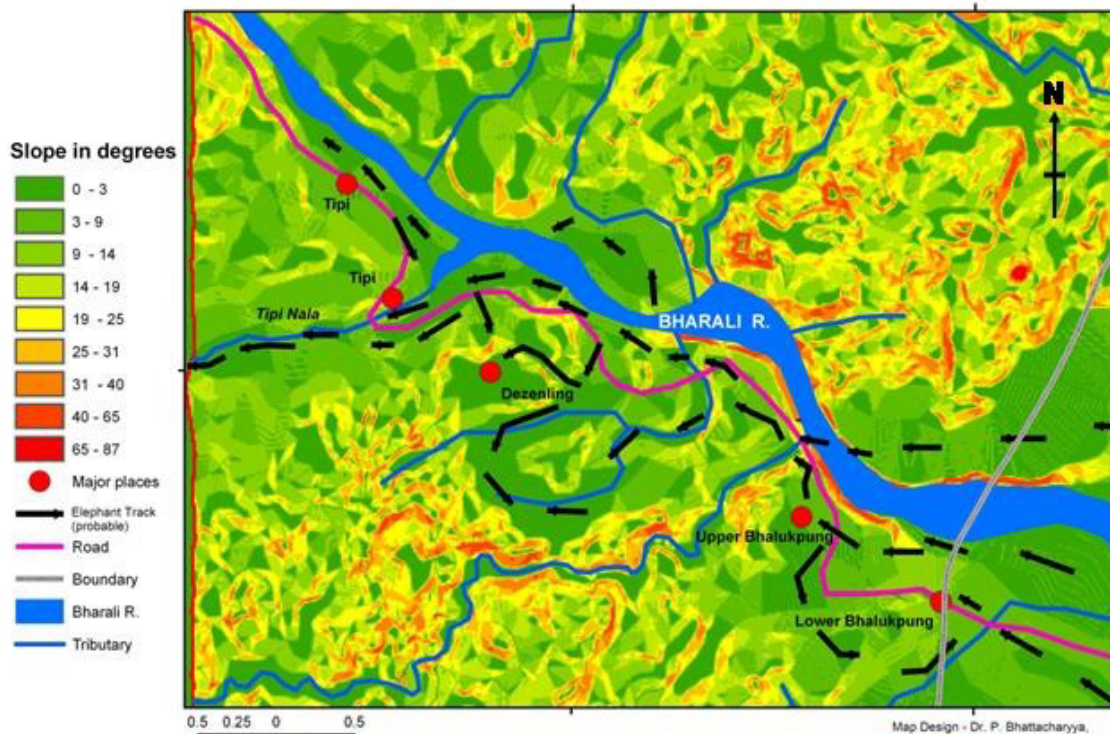
In the section mentioned, the Bhalukpong-Bomdila road passes almost through the middle for a distance of 9.8 Kms. The change in land cover, mainly as a result of growth of settlements has taken along the road disturbing the activity of wildlife. As per the 1991 data about 4.6 Kms were affected by settlement



growth i.e. – in about 47 percent of the section. As per the 2005 data, in the same section the affected length has gone up to 5.3 Kms i.e. about 54 percent marking an increase of 7 percent. The increase broadly is not very significant but it becomes very significant keeping in view that the changes has taken place in the sections preferred by elephants for their movement, primarily in the Tipi area. The topography in general in the whole section is undulating with very few stretches of inter mountain valleys and plains.

From the slope generated for the section (Map 8), it is seen that only about 30 percent of the areas in the section possess a slope of less than 20°. On the assumption that elephants prefer a slope of less than 15° for their regular activities, a model has been generated to find the best possible movement areas.

SLOPE CATEGORY BASED ELEPHANT TRACKS

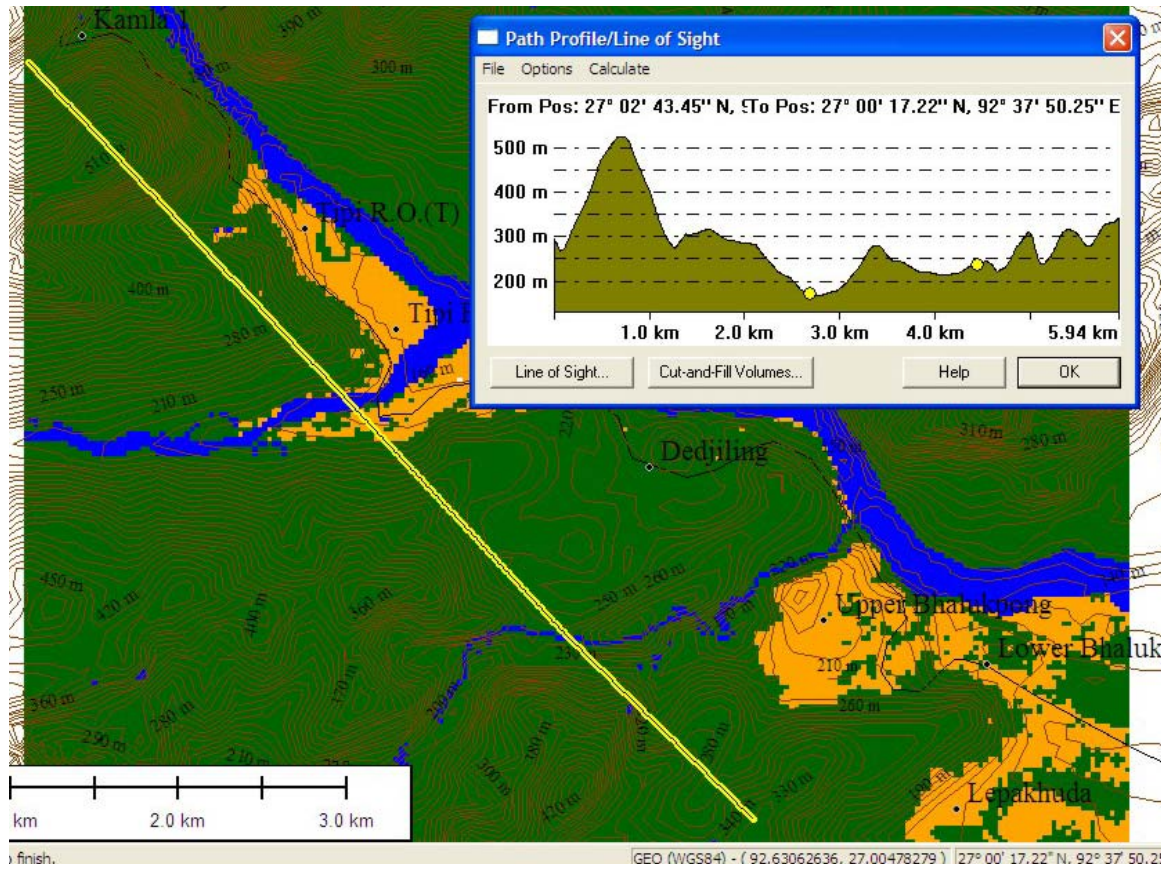


Map 8: Slope map of Tipi-Bhalukpong

The findings as seen Map 9 very much match with the ground realities and so the assumption regarding the preferred slope zone holds true for the section. From the analysis it is seen that the sections along both side of the Tipi nala is the only easy possibility for the elephants for moving in between the two sides. Even though crossing is possible in the Dedjling section, the trend further west is to move closer to the Tipi nala. The same areas are also seen to be preferred by the humans for their activities in the area.

Analyzing the topographic profile along the north south alignment from near Kamla 1 to Lepakhuda in Lower Bhalukpong it is seen that very few sections can support any easy east west movement in the area (Map 9). It is seen that the

section is dominantly undulating with slopes of varying degree, the area near Tipi nala offers the broadest plain section with a comparatively less slope followed by the Dedjling area which is the second best option.



Map 9: Movement possibility of elephants along various stretches of Tipi corridor

4.1.1.i. GROWTH OF HUMAN SETTLEMENTS IN THE AREA

4.1.1.i.a. Objective:

The basic objective for undertaking this study was -

1. To analyze the settlement pattern of an area, and
2. To understand the impact of the growth of settlement on the elephant corridor.

4.1.1.i.b. Methodology and database:

This survey was conducted to understand the settlement pattern of this township and also to assess its impact on the elephant corridor. The survey was carried out on both the north and south bank of the Tipi Nala.

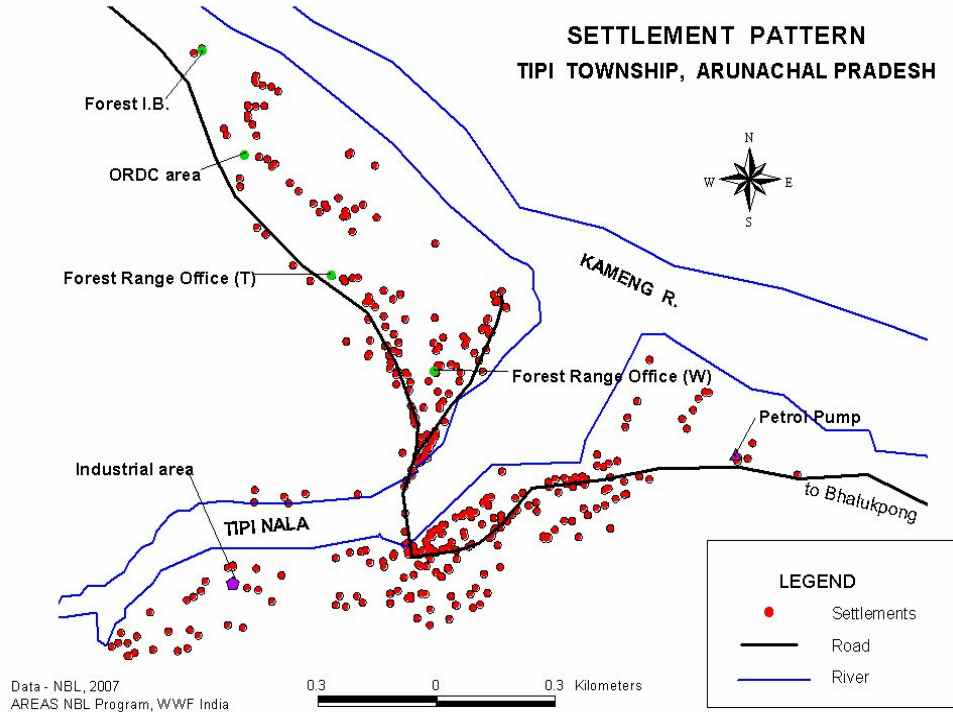
Relevant data (both spatial and temporal) on the settlements were collected on pre designed data format. Most of the data were collected from primary sources, that is, by physically visiting each of the household and interviewing people therein. Certain information were however, collected from secondary sources like Govt records etc.

The findings and outputs are primarily based on data generated from the field. The data collected from the field has been entered, processed and analyzed using MS Excel using simple statistical methods. The data generated is geo-referenced using handheld Garmin GPS system (etrex, model Venture) and the database generated has also been built into a GIS engine for outputs. Mapping is done using ArcView GIS; Image works has been done on IRS LISS III image (2005).

4.1.1.i.c. Findings and discussion:

The settlement study of an area is very significant for various reasons. It can give a picture of human relationship with the natural environment. It also implies the human dependency on natural environment.

4.1.1.i.c.1. Settlement pattern



Map 10: Settlement pattern of Tipi

The Tipi area is a very small area with dense settlements. Though it is recently developed, the settlements have grown very rapidly. The settlements are located on both sides hilly side and near the river bank. The settlements are comparatively high near the river bank i.e. plain area. The Settlement of Tipi is distributed both the north and south bank of Tipi Nala. The settlements are situated on both sides of the main road. Because of dense settlements these are compact type of settlement. The river side settlements are mainly compact type. In some parts, the settlements are dispersed. On the hilly side, this type of settlements is found. It is also found that south bank has more settlements than north bank of Tipi River. The settlements are spread over the both of the river bank. On the main road of Tipi the settlements are developed. The settlements pattern shows the density of the settlements in the area. The density is reasonably high.

4.1.1.i.c.2. Settlement types

The recently developed township of Tipi is located in the hill slopes of Arunachal Pradesh. During the earlier phase of settlement, the houses were mainly huts and typical North Eastern type like *Changhor*. But as the development started, the house types also changed. The old types are also there. But the newly built houses are Assam type. From the survey it is found that the houses are of mixed type. The area has different types of houses i.e. mainly Assam Type (AT), RCC and Hut (H).

Assam type: Following the great earthquake of 1897, Assam, situated in a seismic zone, fostered the development of a unique architectural style - the 'Assam type' architectural style, low level, bamboo-elevated, which is eminently suitable for an earthquake-prone region with a prolonged rainy season. The 1950 earthquake levelled several large structures but left the Assam type ones mostly untouched.

RCC: It means Reinforced Cement Concrete. It is a house structure which can be of two or more storied.

Hut: A small house, hovel, or cabin; a mean lodge or dwelling; a slightly built or temporary structure.

The whole area of Tipi comprises both private and government sectors. Most of the land is used for the purpose of settlement, a limited amount for agricultural purposes and a negligible amount is left fallow. Out of the settlements 76 % is private structure and 24 % is government structure.

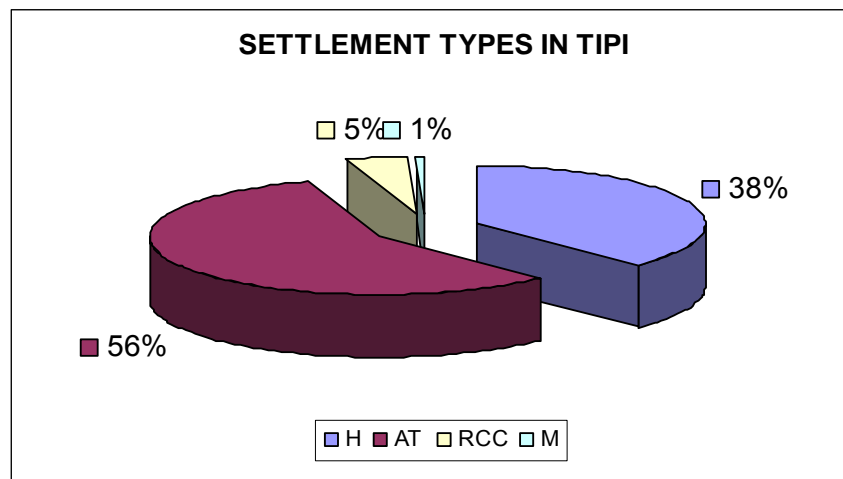


Fig. 2: Settlement types in Tipi

As per the study, there are different types of settlement structures, such as Assam type, hut, RCC and mixed. Among them 56 % is of Assam type (AT), 38 % is of hut (H), 5 % is of RCC. Therefore Assam type is more dominant in Tipi area. 1 % represents mixed (M) type of settlement structure, which are not exactly fall under Assam type, RCC or Hut but somehow represent structures other than AT, RCC or hut such as Big Water Tank and some other type of structure.

This analysis shows that there is variation in the ownership of settlements. About 76 % of household are under Private sector & 24 % household is under Government Sector.

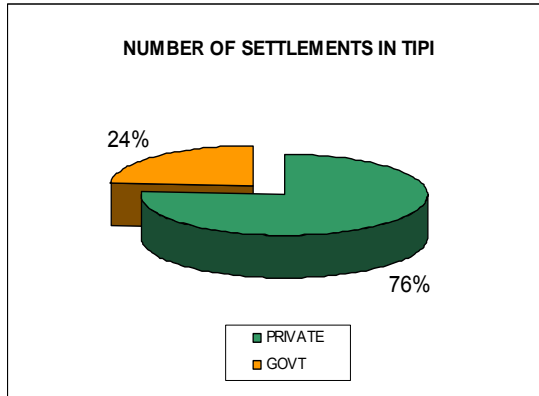


Fig: 3 Land ownership in Tipi

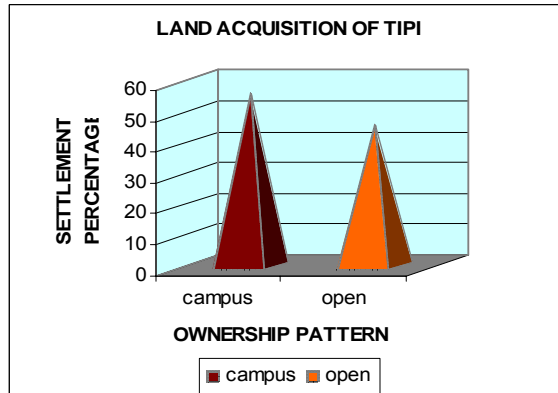


Fig: 4 Land acquisition pattern of Tipi

The above figure shows the land ownership pattern open and campus. The term “campus” indicates land with house in a definite boundary and term “open” indicates land with a house without a boundary. In the Tipi area about 55 % has campus and 45 % has open land. Therefore it is not very clear about the actual ownership of lands whether they are their own land or occupied land. Because about 50 % of lands are open, have no boundary wall or fencing. And from another point of view, the government ownership is less than half of the private ownership. The government has land for some important offices like Forest Department office and the quarters of the staff members and institutions like Orchid Research Development Centre (ORDC) and the quarters for the staff members. The other government departments like Electricity department, General Reserve Engineering Force (GREF) have their land. The government house types are basically Assam type and the private houses are of Assam type (AT), RCC and also Hut (H).

Because of the hilly terrain, the houses are made in different patterns. The houses which are mainly located in the hill slopes area are made up of bamboo generally called ‘*Changhor*’, a house which is an ‘Elevated House’. These are built 3-4 meter above the surface. On the flat lands, the Assam type and also RCC type are found. From the survey it is found that the recently built houses are Assam type and RCC type.

The Tipi area is basically depended on forest based products. But because of the fast growth of the township there are also developing some important industrial estates. People from the area, work in the industries which have lessened their direct dependency on forests goods. The industrial estate area is situated on the hill slopes. The major industries there are coal factory, raisin factory, wine factory, saw mill etc. The saw mills are depended on the forest woods. The Raisin factory is depended on the pine trees. A large amount of pine trees are used for the raisin factory.

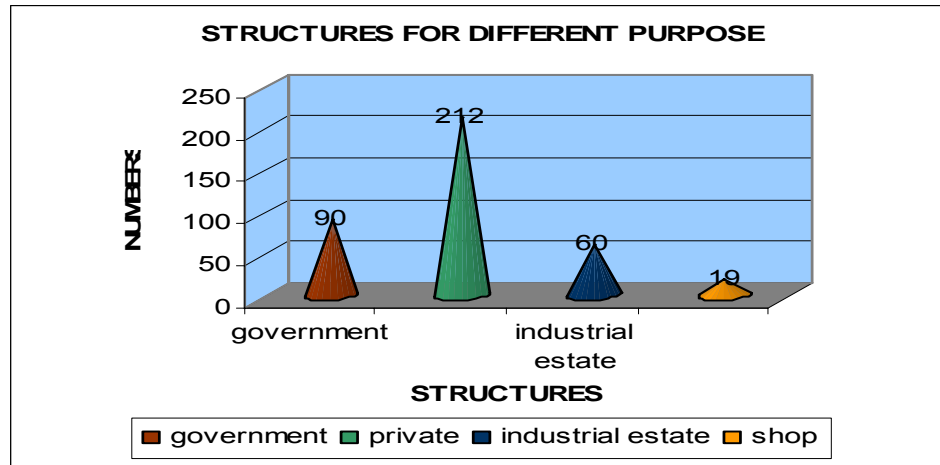


Fig 5: Structures for different purpose

The figure shows that industrial structures are also important. They comprise almost 1/4th of the structures. The industrial estate covers large portion of land both open and campus. It is also noteworthy that the industries are developed in the hill slopes after clearing the forest areas. The forest richness is declining because of these developmental activities.

4.1.1.i.c.3. Settlement growth

The Tipi township is recently developed and the settlement is spread very rapidly in the area. When the industry set up in that area the people belong to various places came and further they had settled over there between the late 60s and early 70s.

As the industries were set up on both of the banks of the Tipi Nala, the settlement mostly increased after 1990. This survey establishes the fact that most of the people deal with the industrial sector. Rest of the people deal with lumbering and road construction. As this area is the transit point of two major states of North-East India viz: Assam & Arunachal Pradesh, most of the people settled here belong to both of these states. People came to this place in different period of time, in search of various reasons. Economic purpose is the major cause of the settlement of Tipi. People basically came from the different parts of Assam & Arunachal Pradesh, mainly from Nalbari, Tezpur, Behali, Balipara, Doimara, Lower Bhalukpong (as lower Bhalukpong is a part of Assam) & people belong to Arunachal Pradesh basically came from Tawang, Dirang etc. The settlement growth is in increasing direction. From the survey, it is found that the settlement there started in the 60's. The survey indicated that the settlement of this area highly increased during the phase of 1990 to 2000.

4.1.1.i.d. Conclusion

The Tipi area is regarded as an important corridor for the movement of Asian elephants and the other wild animals. From the perspective of conservation, it is very essential to maintain the corridor for elephant movement. On the other hand, the Tipi area is growing at a faster rate which can be the major cause for the disturbance in the elephant corridors. Because of the increasing flow of people to this area the settlements are seen in the remote parts also. Some parts of the dense forest areas are also becoming populated. The area is declared as industrial area by the government of Arunachal Pradesh. Developmental activities by NEEPCO and Kameng Hydro Electric Project have also contributed significantly towards the growth of the area. Though the area is developing and getting modern facilities, the environment is affected to some extent. The industries are growing and causing inconvenience for the wildlife. The elephants are facing great difficulties in crossing one forest block to another as the corridor is getting threatened. Unless a proper landuse plan is implemented, this vital wildlife corridor is soon going to be a history resulting in fragmentation of one of the best elephant habitat in the globe.

4.1.2. STATUS OF ELEPHANT MOVEMENT ACROSS THE TIPI CORRIDOR

Tipi elephant corridor is a long stretch (2km x 2 km) of land along the river Kameng and elephant can cross only through some very specific point due to geographical and anthropogenic limitations. WWF India has been monitoring the elephant use in this corridor very intensively since March 2005 and all the probable entry/exit points throughout the entire stretch of the corridor had already been identified before the initiation of this particular project. From the year 2007 monitoring was started on the western end of the corridor, in Lepakhuda area close to Assam-Arunachal interstate border.

4.1.2.i. Methodology:

The elephant monitoring has been going on in daily basis. One person has been engaged to collect information on elephant use from all the 12 selected crossing points. The person physically visits all the locations every day and collects all direct and indirect evidence of elephant crossing. The information thus collected is entered in a pre designed data format (Annexure 1 – data format). This data has been uploaded in a GIS domain to get spatial and temporal analytical output.

4.1.2.ii. Status of elephant movement during 2005-2006

Use of the habitats by elephants in NBL were monitored since 2000 and since March 2005 more intensive monitoring of elephants and their movements were undertaken in the Tipi-Bhalukpong section to develop a better understanding of the present status. It has been found that elephant visits/presence the area were highly seasonal in nature. The movement of elephants across the river from Pakke to Doimara and vice versa was recorded only during December to April. There was a distinct peak in the usage of the corridor between the months of December to February, this may be due to the fact that this is the comparatively dry period and the velocity of the river water is at its minimum.

One year of monitoring shows (Fig. 6) that during this period, for 40 percent of the days elephants were found to be using the areas in and around Tipi and they move to other areas during the rest. The presence of the elephants is seen round the year in the year with a peak during December to February. Elephant Flat, Tipi top, Dedjling and Tipi are the most favoured spots for the elephants. This means that elephants spend a considerable time in and around Tipi and the finding re-establishes the importance of the forests in Tipi area for elephants even though at present there is enormous growth of human activities in the same area.

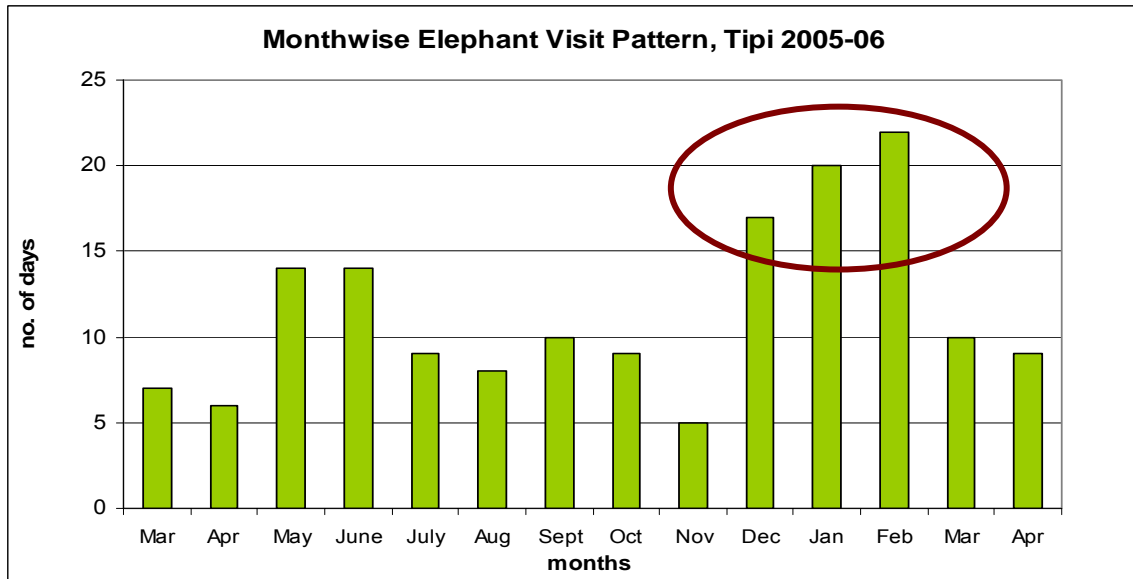


Fig. 6: Elephant visit pattern – Tipi

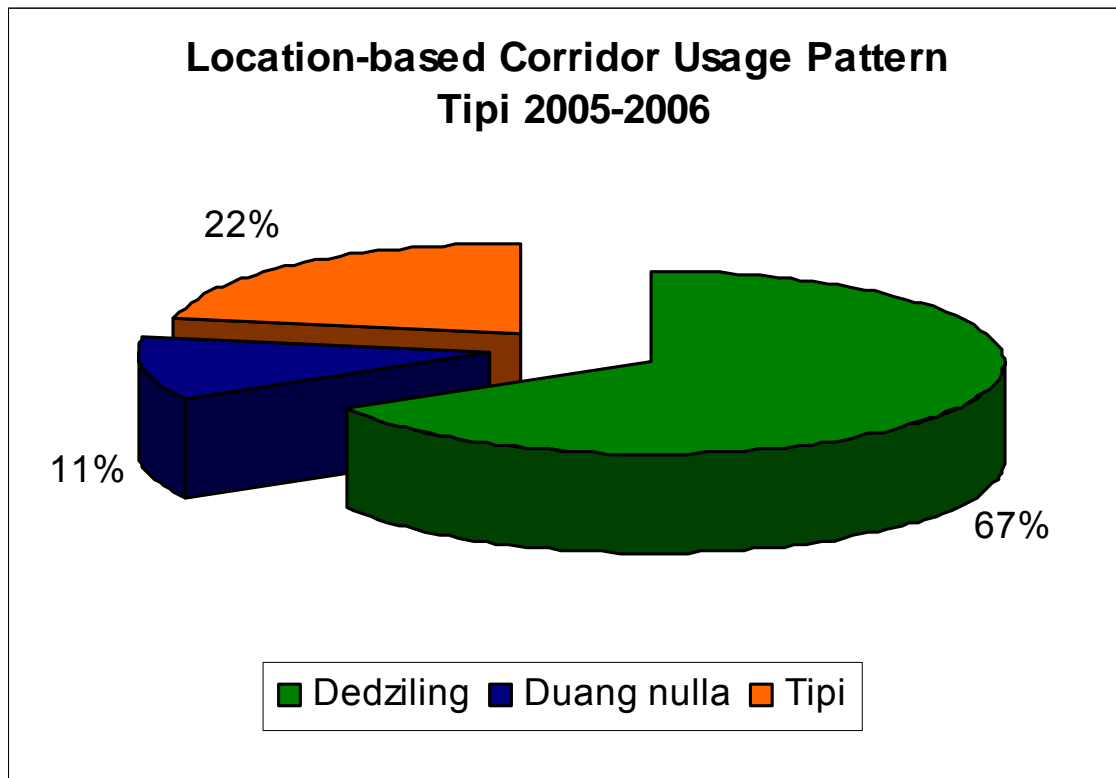
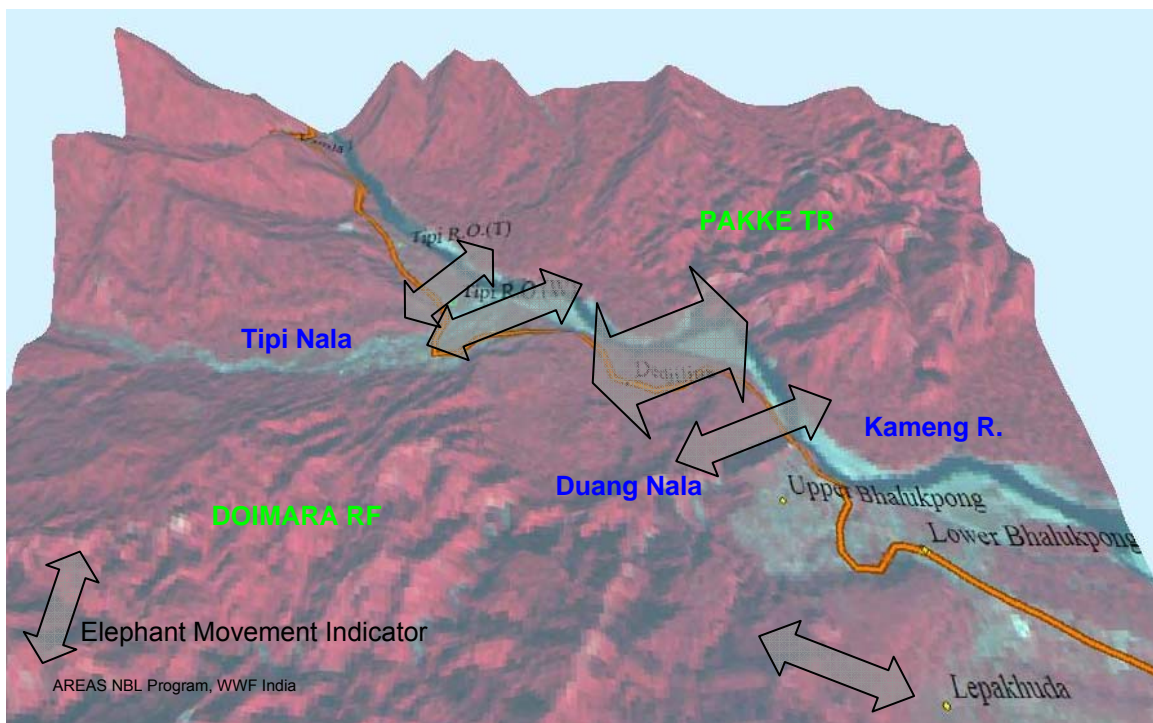


Fig. 7: Corridor use pattern – Tipi

Historically, from secondary sources it is learnt that in Tipi, the area between ORDC to Tipi Nala was extensively used by the elephants to cross over from the Pakke to the Doimara side. But even though at present, this movement exists it has gone down drastically at present which can be attributed to the rapid growth

of settlements/population in that stretch. Duang nala although came out to be a less frequented area is recognized to be of great importance due to the fact that elephants have used this area to move from Doimara side to the Pakke side. The data/ information obtained through monitoring reveal the undoubted importance of Dedjling as a corridor in the Tipi area (Fig. 7 & Map 11). All these information highlights further the importance of Dedjling, Tipi and Duang nala in maintaining the forest connectivity for elephants between Pakke and Doimara forests and essentially in providing the elephants a bigger forest area in Kameng ER.

Analyzing the field data it is seen that the elephants prefer to use the low slopes (up to 10 degrees) for their movement. The same area is also preferred by the humans for their settlements as a result there is intense competition among the two groups over the very limited friendly topography that is available in the area.



Map 11: Corridor use pattern - Tipi

Further, the data obtained from the field validates the modelling (slope and topography) done to derive the probable areas used by elephants in the area. This indicates that the results obtained through GIS modelling can be taken as the basis for planning for conservation and development in the area.

4.1.2.iii. Current status of elephant movement (2007 to 2009)

- Bhalukpong-Tipi corridor is currently not under active elephant use. During 2009, elephants have not crossed from Pakke to Doimara even in a single occasion (Fig. 8).
- Dedjling, despite under heavy pressure seems potential as elephant corridor (Fig. 8).

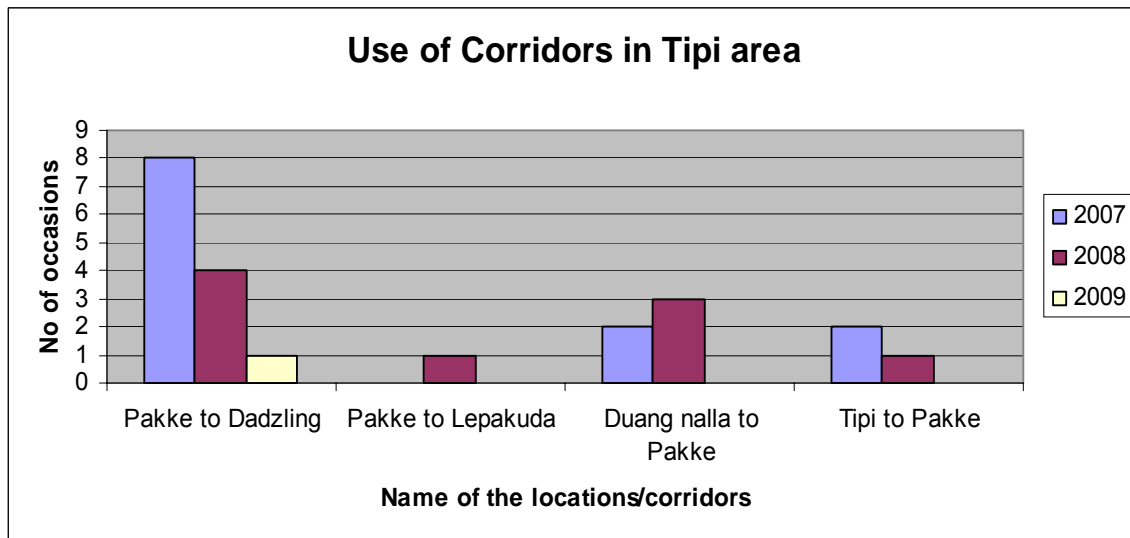


Fig. 8: Corridor use pattern by elephants along the Tipi-Bhalukpong stretch (2007-2009)

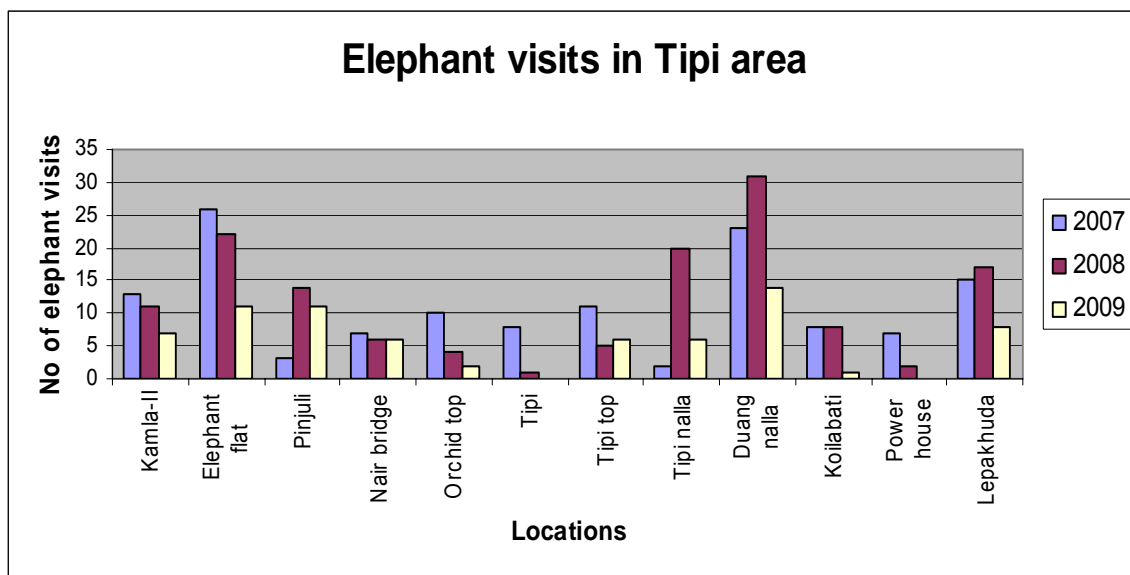
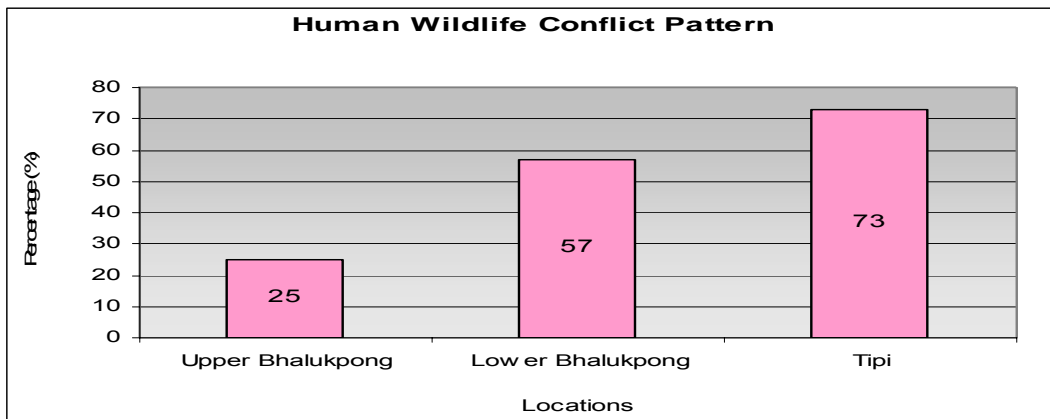


Fig. 9: Elephant visits in different locations along the Tipi-Bhalukpong stretch (2007-2009)

- Along the western bank of the Kameng River elephants are roaming around in small herd (2-6 individuals in each). Their presence has been recorded from Lepakhuda to Elephant flat (Fig. 9).
- They are found more frequently in Lepakhuda, Duang nalla, and Elephant flat.

4.1.3. STATUS OF HUMAN ELEPHANT CONFLICT

Tipi and Lower Bhalukpong has a rich history of wildlife activity and Tipi area is documented to be one of the most active elephant corridors (WWF & WTI) in this stretch and this results in an intense competition for space between the animals and humans. Considering human elephant conflict as a major problem, it seen that (Fig. 22) 73% of the households in Tipi recognises the elephants in the area to be problem and this substantiates the earlier finding of Tipi being an important area for wildlife activity. In the other two stretches the problem is not very widespread and can be regarded as almost negligible in the case of upper Bhalukpong. But in lower Bhalukpong, although HEC has so far not a major problem but is potential as new forest areas are being cleared constantly for settlement expansion along the Assam-Arunachal state boundary. This is very prominent in the area north of the Bhalukpong railway station and people has started to pour into this area as they have heard that some new developments are planned by the government in that area which may strengthen their economy in the near future.



4.1.4. SOCIO ECONOMIC PROFILING OF THE AREA

4.1.4.i. Methodology

The participatory discussion was employed at the first level to identify the major habitations and understand the broad issues of the area. Three broad discussions were done in the three main areas of concern viz.- Tipi, lower Bhalukpong and upper Bhalukpong. The discussions were done involving mainly the elders of the society, teachers and community leaders from each of the area.

A household survey was done with a pre designed question format (Annexure - 2 questionnaire format) to understand the community and the dynamics involved in details. A systematic random sampling method was employed to cover at least 30 percent of the households in the three major settlement areas. Hundred and sixteen households were surveyed in the entire area with maximum coverage from the Tipi area followed by the lower Bhalukpong area.

The findings and outputs are primarily based on data generated in the field. The data collected has been processed and analysed using MS Excel using simple statistical methods. The data generated is geo-referenced using handheld Garmin GPS systems and the database generated has also been built into a GIS engine for outputs. Mapping has been done using ArcView GIS; Image works has been done on IRS LISS III image (2005) using ERDAS Imagine and 3D model has been built from SRTM data using Global Mapper.

4.1.4.ii. Social structure:

The Tipi – Bhalukpong sector like any other hill area is dominated by the community identified as the Scheduled Caste group, meaning primarily the tribals. The area as a whole is dominated by the scheduled tribe population accounting for 80 percent of the population, the general community comes next with a share of 15percent and the rest 5 percent is comprised by the other Backward Caste (OBC) The Major population is comprised by Tribes like Aka, Miji, Nisi, Mompá, Apatani, Sulung and a remarkable Nepali population along with people from rest of India. . Lower Bhalukpong has the largest chunk of original settlers (mainly from the Adi community) followed by upper Bhalukpong and Tipi. Mizi is the most dominant group in the Tipi area and is a major group in upper Bhalukpong but has negligible presence in lower Bhalukpong area. In upper Bhalukpong the scene is a complex mixture of a number of groups ,no group is found to be as dominant . The Nepali's is a well distributed group with a good presence in all the three settlement areas.

Population Structure: The area has a very healthy population structure unlike many other Indian scenario which normally has a big proportion of dependent population. The area has 49% of the male population in the working group and 55% of female population in the working group. There are 904 females for every 1000 males on average in the area which is quite healthy as compared to the National figure of 933 and average figure for Arunachal Pradesh 893 as per the

2001 census figures. In the working group (in between 15-60 years) there are about 1004 females for every 1000 males and which forms the most active / dynamic group in any society. The area has a literacy rate of 70.7% which is higher than the national average of 64.8% (2001) and is also much better than the average Arunachal figure of 54.3%.

4.1.4.iii. Economy and Livelihood:

The crude average income estimated for the whole area is Rs. 6370/month/family where in about 28% of the total population are engaged in economic activities. Looking into the ownership pattern of necessary household amenities it is seen that the status is moderately healthy and developed. About 83% of the households possess electricity and about 40% of the population use gas stove (LPG) for the purpose of cooking. The amount of production is almost negligible in the households; yam, potato, maize and rice are the popular produce but at very low levels. A very small portion also rears livestock and produces poultry products as source of meat specially in the Tipi area. Chicken is the most popular produce followed by cow and pig. Meat of wild species are also quite popular among the community specially in lower Bhalukpong and Tipi and the adjoining forest area is the prime source for many (about 30%), deer and wild bird meat seems to be most popular among the people.

Fuel used for general and cooking purpose by the households is a strong indicators of the people's livelihood and lifestyle. In the area it is seen that firewood is the most common type of fuel used, The use of firewood is found to be highest in the Tipi area, where more than 74% households using it followed by lower Bhalukpong where about 66% of the households use the wood as fuel.

4.1.4.iv. Problems and Plans:

From the study it has been found that Electricity supply, water supply, disease, and HEC are few most prominent problem of the area. . The problem of conflict with wildlife specially elephants seems to be more in Tipi and lower Bhalukpong area because the settlements have come up in the narrow stretches of flat land in between the river and the hills, which are also preferred by the wild animals. The problem of HEC is more prominent in Tipi followed by upper and lower Bhalukpong. Although HEC has so far not a major problem but is potential as new forest areas are being cleared constantly for settlement expansion along the Assam-Arunachal state boundary. The majority of people of the area are ready to move out of the critical elephant corridor area if necessary assistance is provided by the concern authority.

4.1.4.v. Human Nature interface:

The community in the area are also dependent on the forest produce both timber and nontimber. The local population is also dependent on the forest for meeting requirement of fire wood and timber used in the construction of the houses. Comparing the dependency level on the adjoining forests for fuelwood in all three

sites, it is found that residents of Tipi are more dependent on the forest produce followed by those in lower Bhalukpong. According to the local population the major cause of deforestation in the area are logging by the local people and outsider and encroachment of the forest land. From the study it was found that the availability of wild life is decreasing due to growing settlement and developmental activity.

4.1.4.vi.Suggestion for intervention:

4.1.4.vi.a. Livelihood & economy:

- a. The entry and settlement process in the area should be closely monitored to check the rate of growth so that the livelihood and economic system in the area remains sustainable.
- b. People involved in the tourism sector are almost negligible and this needs to be promoted as in the long run tourism can become the best option of revenue generation for the state.
- c. Youths can be trained to guide the tourist of the Bhalukpong – Tawang section. They should also be trained in the various facets of nature and trekking can be introduced in the area. Necessary support should also be made available for the same.
- d. Areas should be identified and developed as tourist spots within a distance of thirty kilometers radius from Bhalukpong which will have minimum negative impact on the natural setting.
- e. The resident population has very limited skill in weaving/knitting, poultry rearing and the like. Training and supporting a few households in the above skills can add value to the tourism sector.
- f. Local forms of art and culture should also be promoted to add value to the tourism sector.
- g. Use of alternative energy sources should be promoted in the area as this can bring down the dependency of the people on forest for fuel wood.
- h. Easy availability of LPG and kerosene at government rates should be ensured.

4.1.4.vi.b. Man nature interface

- a. The process of development should be carefully planned by the government involving all concerned departments, researchers and conservationists for the area so that the present unplanned growth do not lead to a catastrophe in the future.
- b. Logging by locals for firewood and construction activity should be effectively monitored and regulated by the concerned authority.
- c. Trade in illegal timber should be immediately stopped.
- d. The local population should be made aware about the biodiversity richness of the area as well as the global importance.
- e. People should be made aware about the importance of certain stretches (corridor & habitat) of land for wildlife.

- f. People's support should be generated to ensure protection of this critical wildlife corridor.
- g. The community should be encouraged to use non-conventional energy sources so that the pressure on the forests are minimised.
- h. Traditional customs should be given proper share of importance to extract maximum community co-operation for conservation and development.
- i. The forest, police and administrative department should enforce the law in the best possible way.
- j. The forest department should work closely with the community leaders.

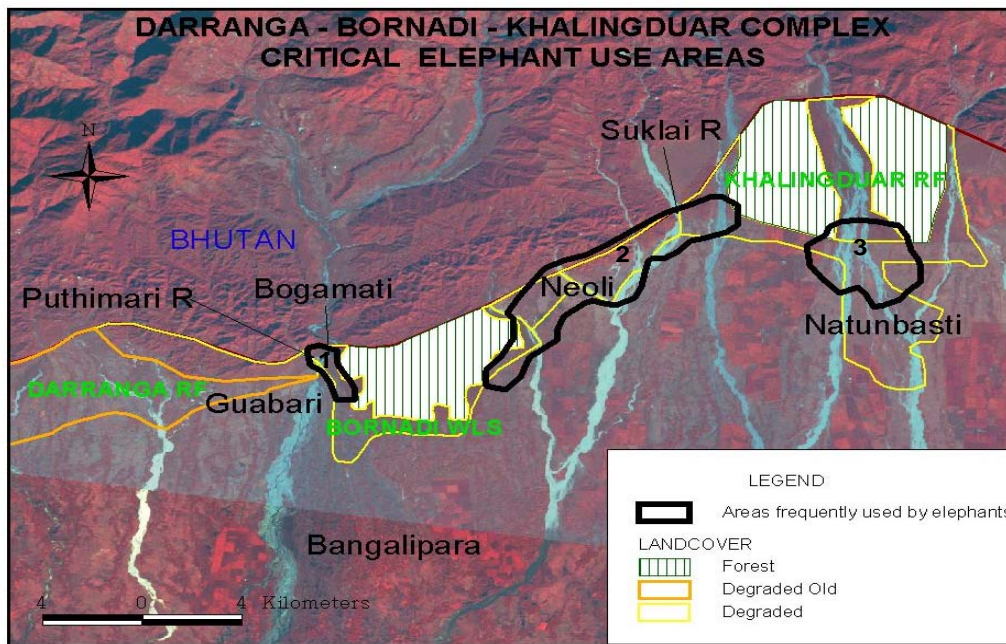
4.1.4.vi.c. Future plans:

- a. A land use zonation map should be prepared involving all concerned experts for the area for promotion of sustainable development and nature conservation.
- b. The settlements should be preferably allowed only in selected areas which are found to be least disturbing to the nature and wildlife. The settlements should be concentrated to small pockets only.
- c. A model settlement plan should be prepared which should also include drainage, water supply, sewage and waste management design so that it is nature friendly.
- d. Certain pockets of settlement should be preferable removed to keep down the levels of man animal conflict and also to provide a safe passage for the wildlife.
- e. Settlements and developments have taken place mainly inside the notified forest areas and the authorities and government should abide by the law in the strictest terms for the long term benefit of the community of the area.

Detailed report: Annexure 3

4.2. BORNADI-KHALINGDUAR COMPLEX

This area comprises of the Khalingduar RF, Daranga RF and Bornadi WLS along with the Neoli PRF and adjoining foothill areas along the international boundary bordering Bhutan. This complex forms the disjunct eastern part of the Ripu-Chirang Elephant Reserve in Assam. The whole complex has an estimated elephant population of about 170-200 elephants in an area of about 120 sq. kms. The area has a good tiger population too (Map 12).



Map 12: Bornadi-Khalingduar complex

This is the only remaining portion of lowland forest along the Bhutan border which is still quite undisturbed and favored by elephants. The Neoli PRF and adjoining foothill forests forms the vital link between Bornadi WLS and Khalingduar RF adjoining the Khaling forests in Bhutan. The whole complex provides excellent habitat space in the Assam plains in this part of the landscape and also provides opportunity for east-west movement of elephants up to Manas NP.

A major portion of the area is owned by the state forest department and government of Assam. A portion of the connecting stretch is also under private ownership. Administratively, the area is under the control of the Bodo Territorial Council (BTC).

The demographic pattern is quite complex with people from different backgrounds settling in the area, the main identified groups are the Bodo, Nepali and Adibasi. The area is not very densely populated and the rural economy is largely dependent on agriculture.

The spread and growth of human activities, especially expansion of agriculture, settlement and illegal extraction of forest products is the most important factor threatening the mere existence of this forest complex. Another important limiting factor is the law enforcement by the concerned Govt agencies. Inadequate protection infrastructure with the forest department like camps, vehicles, communication net works, boats etc., has also been a major problem.

However, active movements of elephants are still recorded. But due to expansion of human activities, this movement is facing a tremendous threat. Attempts of elephant herds to move from one part to the other are disturbed by human population which has grown remarkably and that too along the foothill areas, which is very much preferred for the purpose of movement. It has also been observed that human activities have gained momentum in the Bhutan hills which is very much limiting the scope of elephant movement in this stretch.

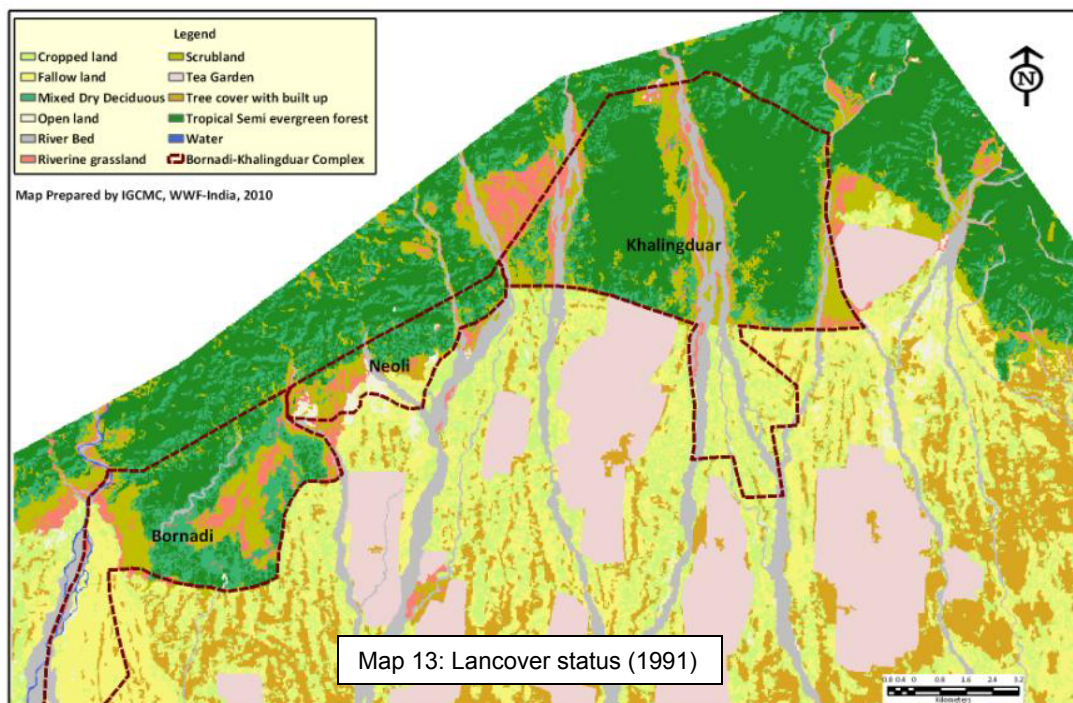
4.2.2. LANDCOVER CHANGE DYNAMICS OF THE AREA

The Bornadi-Khalingduar area experienced remarkable landcover change during the last eighteen years. To understand the landcover change in the area over the period of last eighteen years, satellite images of the year 1991, 2001 and 2008 were analyzed. The area covered for the study is Bornadi WLS, Neoli PRF and Khalingduar RF. All these area are sharing boundary with the neighboring country of Bhutan. Out of 545.75 Sq KM of analysed area in the complex it is found that the grass land area in the Bornadi WLS is converting gradually to mixed dry deciduous forest, the semi evergreen forest area of the Neoli PRF is also decreased o a large extent. One of the most remarkable change is noticed in the southern extension of the khalingduar RF. The reverine grass land and scrubland area in that portion has completely changed to settlement and crop land.

Salient features of LCLU change in Bornadi_ Khalingduar complex:

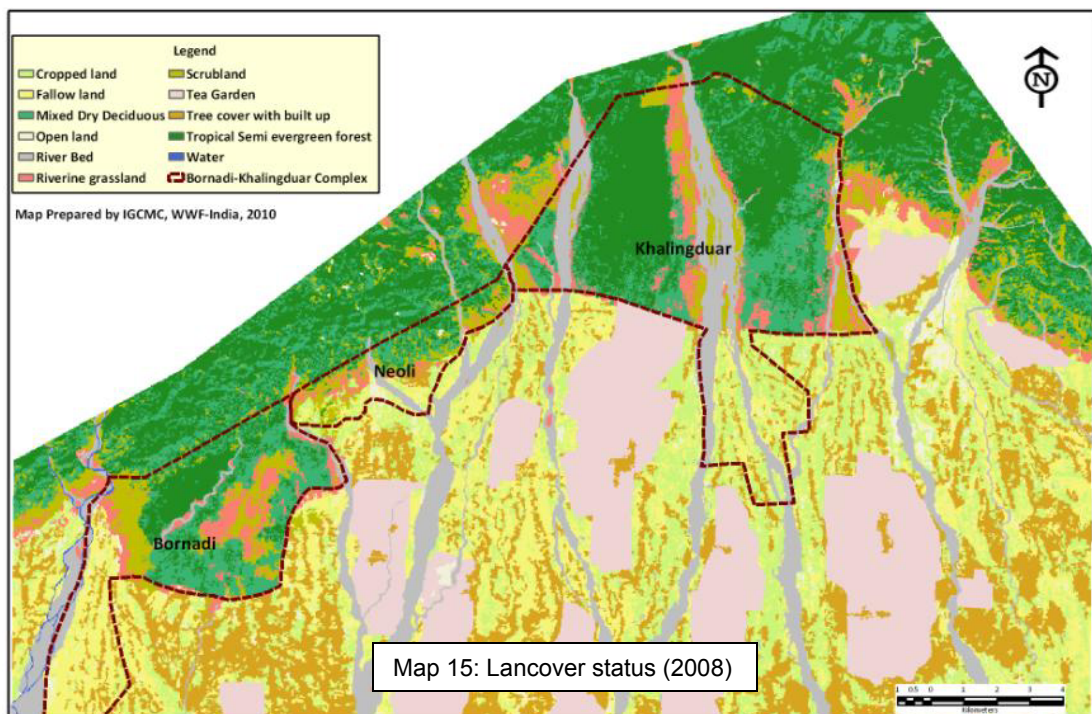
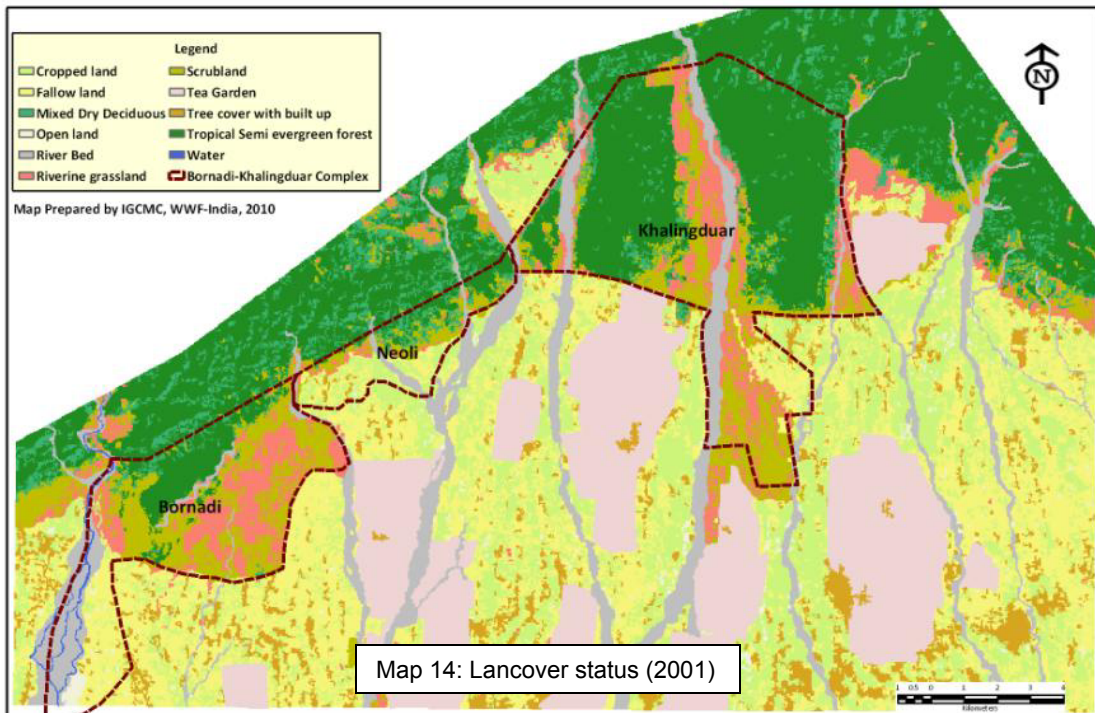
4.2.2.i. Bornadi WLS (26.22 Sq.Km.)

- 49% of the grassland area converted in to dry deciduous forest during 1991-2008.



4.2.2.ii. Neoli PRF (11.48 Sq.Km.)

- 30% of the tropical semi evergreen forest converted mostly in to mixed dry deciduous forest during this period



4.2.2.iii. Khalingduar RF (70.90 Sq.Km.)

- Almost 30% of tropical semievergreen forest and riverine grassland has got converted in to mixed dry deciduous forest.

- Scrubland has also got significantly (more than 60%) decreased due to change of river course
- The reverine grass land and scrublands in the southern extension of the reserved forest has completely got converted in to human settlements and crop fields.

Area (Sq km) under different LULC categories in Bornadi			
LULC Classes	1991	2001	2008
Water	0.59	0.35	0.15
Tropical semi evergreen forest	5.36	6.95	6.31
Mixed dry deciduous	1.03	8.72	9.30
Scrabland	11.32	7.15	5.30
Revarine grass land	8.21	2.86	4.14
River bed	4.43	1.77	1.90
Cropped land	0.67	0.62	0.56
Fallow land	3.93	7.43	6.46
Open land	0.66	0.24	0.63
Tea garden	0.00	0.00	0.00
Tree cover with build up	0.27	0.38	1.72
Total	36.47	36.47	36.47

Table 4: Landuse change matrix in Bornadi WLS during 1991 to 2008

Area (Sq km) under different LULC categories in Neoli			
LULC Classes	1991	2001	2008
Water	0.00	0.00	0.00
Tropical semi evergreen forest	2.08	2.63	1.46
Mixed dry deciduous	1.41	2.39	2.06
Scrabland	2.21	2.19	2.94
Revarine grass land	0.54	1.00	1.05
River bed	0.95	0.77	0.89
Cropped land	2.38	0.35	1.36
Fallow land	1.65	0.77	1.08
Open land	0.04	1.10	0.30
Tea garden	0.00	0.00	0.00
Tree cover with build up	0.23	0.29	0.34
Total	11.48	11.48	11.48

Table 5: Landuse change matrix in Neoli PRF during 1991 to 2008

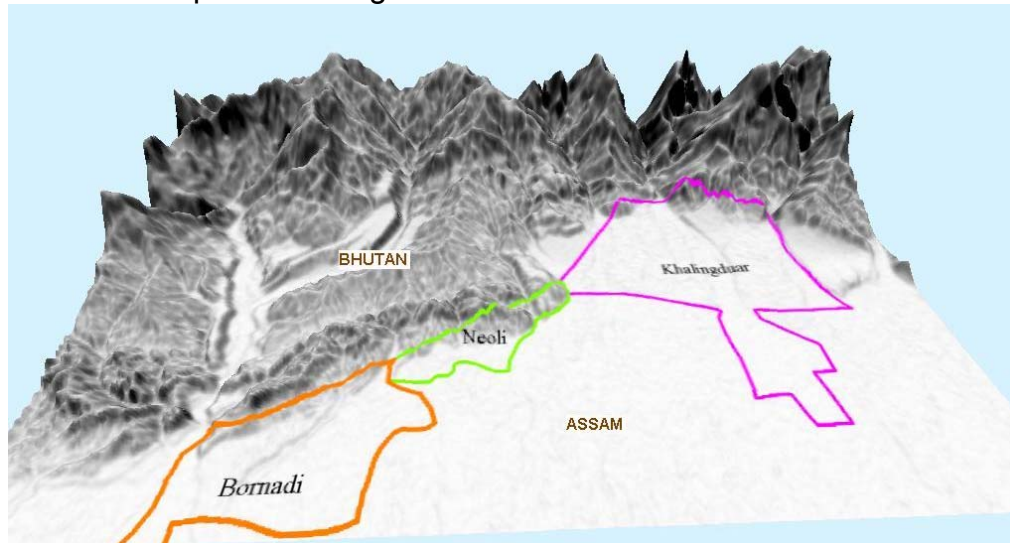
Area (Sq km) under different LULC categories in Khalingduar			
LULC Classes	1991	2001	2008
Water	0.00	0.00	0.00
Tropical semi evergreen forest	33.83	31.84	24.34
Mixed dry deciduous	4.76	6.92	14.21
Scrabland	12.93	11.31	5.42
Revarine grass land	9.80	3.55	6.26
River bed	6.72	9.03	12.04
Cropped land	0.76	4.42	4.63
Fallow land	2.24	3.95	2.91
Open land	0.02	0.16	0.22
Tea garden	0.06	0.01	0.01
Tree cover with build up	0.50	0.43	1.60
Total	71.63	71.63	71.63

Table 6: Landuse change matrix in Khalingduar RF during 1991 to 2008

4.2.3. STATUS OF HABITAT USE BY ELEPHANTS

4.2.3.i. Introduction:

The Bornadi-Khalingduar (BK) complex is situated in the north of Udalguri District under Bodoland Territorial Autonomous District (BTAD) Council of Assam. The area comprise of Bornadi Wildlife Sanctuary (26.22 Km²) in the east and Khalingduar Reserve Forests (70.90 Km²) on the west. In between there is a Proposed Reserve Forest named Neoli PRF (11.48 Km²). The entire area falls under bhabhar zone of eastern Himalayan foothill. This complex is connected with the forest of neighboring country Bhutan. The Bornadi area is famous for the critically endangered species like Pigmy hog, Hispid hare etc. Bornadi is having flat land with small hillock on the north and forest type is predominantly semi evergreen type with extensive patches of grassland in between. Neoli patch is primarily low hills with bamboo (secondary vegetation) and semi evergreen forests. Khalingduar is a flatland with hills on the north and forest is mainly tropical semi evergreen type. The Neoli area was well-known as an elephant corridor since long back (Choudhury, 1999). This area is preferred by elephants to move from east to west and vice versa may be because of the comparatively easy terrain for elephants to negotiate.



Map 16: 3D model of Bornadi-Khalingduar complex

Habitat wise the Bornadi Khalingduar complex is not very significant as an elephant habitat but it is very important as a buffer area to the large forest tracts of Bhutan and act as a corridor for east west movement through these Himalayan foot hills. The complex faced massive deforestation during the period of 1991 to 2001 when a significant proportion of valuable timber species were selectively logged illegally by forest mafia and surrendered extremist group. Along the southern stretches of Bornadi Khalingduar complex the illegal trafficking is still going on but after the establishment of SSB camps along the forest fringe, the forest the rate of deforestation is decreasing gradually.

As the Neoli PRF part of the Bornadi-Khalingduar complex has no protection infrastructure so far, people from other parts of the district as well as from the locality has started occupying the flat land and foot hills for settlements and Tea garden establishment. More than hundreds of small tea gardens have been set up in this area in the last 4-5 years which is posing serious threat to the movement of elephant herds through their territory, resulting in increasing human elephant conflict. Unsustainable collection of bamboo and other NTFP is also going to aggravate this problem.

Evaluating population status for species that are mobile, cryptic and occur at low densities is challenging, particularly at the largest spatial scales (MacKenzie, 2005). Occupancy estimation has been proposed as a robust and cost-effective alternative to estimation of more data-intensive state variables such as abundance or demographic parameters (MacKenzie *et al.*, 2002; Manley *et al.*, 2004). The value of any surveys can be enhanced if multiple surveys are conducted so that the probability that a species occurs at a site can be estimated while compensating for the fact that the probability of detecting it during an individual survey is <1 (Gu and Swihart, 2004; MacKenzie *et al.*, 2002, 2006). Because a simple record of detection or non-detection of a species during an individual survey is the only data requirement, occupancy estimation has been suggested as an efficient approach for assessing population status and habitat associations for cryptic, low-density species over large spatial scales (Bailey *et al.*, 2004; MacKenzie *et al.*, 2002; Manley *et al.*, 2004; O'Connell *et al.*, 2006) and can therefore be used to determine elephant occupancy also over large areas.

4.2.3.ii. Methodology:

We estimated dung detection probability for elephants by observing sampling sites independently allowing estimation of detection probability. Different models have been developed by MacKenzie *et al.* 2006 to occupancy rates when detection probabilities vary due to site characteristics, time or environmental variables. Elephant dung was recorded on the trails within each of the grids of 2km x 2km size. Dung piles were classified as 1) Fresh dung: shine on outer surface of the bolus; odour present; moist pile 2) Dry dung: No shine on surface; odour absent even at close range. Each of the grids was surveyed twice within a single year for detecting elephant signs in form of dung's.

4.2.3.ii.a. Data analysis:

We used program PRESENCE (version 3.0, Hines and MacKenzie, 2008) to estimate probabilities of occupancy and detection, using single season analysis. We included habitat and distance from human settlement/activities from the sampling area as covariates because we predicted dry season occupancy to be positively related to habitat cover and distance from human activities.

4.2.3.ii.a.i. Covariates used in models:

Distance of human settlement: Distance to the nearest human settlement was determined using ArcView (ESRI Inc., 2002). Linear distance was calculated from the centre of a grid or sampling site to the edge of the nearest human settlement (village/ human activities). Human activities mostly involve agriculture, tea gardens and timber business.

Habitat: Each observer recorded the broad habitat types in each of the sampling units. Habitat was mainly classified as 1) Mixed Forest 2) Bamboo 3) Grassland.

We attempted to fit different models which incorporated habitat categories and distance from human settlements as covariates that may affect probabilities of occupancy and detection. The models were composed of the complete set of combinations that result from considering occupancy and detection constant across all sample units. We ranked models using the small-sample correction to Akaike's Information Criterion (AICc) and used Akaike weights to compare weight of evidence among models in the candidate set (Burnham and Anderson, 2002).

4.2.3.iii. Results:

The best fitting model with respect to AIC values (Table 7) for the dung data set was $\psi(\text{distan})$, $p(t)$. Distance to human settlements was the most important determinant of elephant occupancy based on the a priori single-covariate models. We also investigated the possibility that after this effect was accounted for covariates such as habitat might prove to be important. These exploratory models received little support (Table 7), as they were >7 Delta AIC units from the top model. Under the best fit models, AIC model weights for $p(\cdot)$ and $p(t)$ models are all $>1\%$, indicating support for models in which detection probabilities varied with relation to habitat and distance from human settlements. Estimated detection probability under the top model was about 0.75 and the probability of observing elephant dung given that it was present (p^{\wedge}) ranged from 0.75 to 1.00. Model-averaged occupancy estimates ($\Psi(\text{SE})$) ranged from 0.9524 (0.0465) to 1.000 (0.000), which indicates proportion of area occupied by elephants is quite high in the study sites.

The top models (i.e., the 11 a priori models with AIC weights $> 1\%$) also suggest that dry season occupancy was positively related to distance to the nearest human settlement. Six top models indicated elephants avoid human settlements in the dry season.

Model	AIC	Delta AIC	AIC wgt	Model Likelihood	No.Par.	-2*LogLike
psi(disthuman),p(t)	30.49	0	0.2671	1.0000	4	22.49
psi(disthuman),p(thabitat)	30.75	0.26	0.2345	0.8781	6	18.75
psi(disthuman),p(tdisthuman)	30.91	0.42	0.2165	0.8106	5	20.91
psi(disthuman),p(tdisthuman+habitat)	31.66	1.17	0.1488	0.5571	7	17.66
psi(disthuman+habitat),p(t)	34.49	4	0.0361	0.1353	6	22.49
psi(disthuman),p(.)	36.14	5.65	0.0158	0.0593	3	30.14
psi(.),p(t)	36.53	6.04	0.013	0.0488	3	30.53
psi(disthuman),p(disthuman)	36.76	6.27	0.0116	0.0435	4	28.76
psi(.),p(thabitat)	36.79	6.3	0.0114	0.0429	5	26.79
psi(disthuman),p(habitat)	36.9	6.41	0.0108	0.0406	5	26.9
psi(.),p(tdisthuman)	36.95	6.46	0.0106	0.0396	4	28.95
psi(.),p(tdisthuman+habitat)	37.71	7.22	0.0072	0.0271	6	25.71
psi(disthuman),p(disthuman+habitat)	38.02	7.53	0.0062	0.0232	6	26.02
psi(habitat),p(thabitat)	39.63	9.14	0.0028	0.0104	7	25.63
psi(disthuman+habitat),p(.)	40.14	9.65	0.0021	0.008	5	30.14
psi(habitat),p(tdisthuman+habitat)	40.55	10.06	0.0017	0.0065	8	24.55
psi(.),p(.)	41.47	10.98	0.0011	0.0041	2	37.47
psi(.),p(habitat)	42.54	12.05	0.0006	0.0024	4	34.54
psi(.),p(disthuman)	42.79	12.3	0.0006	0.0021	3	36.79
psi(habitat),p(t)	43.17	12.68	0.0005	0.0018	5	33.17
psi(.),p(disthuman+habitat)	44.05	13.56	0.0003	0.0011	5	34.05
psi(habitat),p(.)	44.66	14.17	0.0002	0.0008	4	36.66
psi(habitat),p(habitat)	45.58	15.09	0.0001	0.0005	6	33.58

Table 7: Summary of model selection results.

4.2.3.iv. Discussions:

Human activities are one of the major determinants of Asian forest elephant distribution in the Bornadi-Neoli-Khalingduar area. Occupancy models for dung reveal continued avoidance of human settlements, features which apparently direct elephant seasonal distribution more than ecological factors, such as the presence of good habitat. Further, studies have shown that noise can influence the behaviour of some wildlife (Bowles, 1995), and elephants may specifically avoid noise if it negatively impacts their infrasound communication (Payne *et al.*, 1986; Poole *et al.*, 1988). Also, Blake (2002) and Douglas-Hamilton *et al.* (2005) found that elephants habitually and rapidly vacate areas where people are perceived as hostile. These observations therefore, support our conclusion that human activities may determine elephant distribution in the larger landscape, and may seriously inhibit the long-term survival of elephant populations in such areas. Since forest elephants are regarded as one of the flagship species, their continued existence in the Bornadi-Neoli-Khalingduar areas will contribute to the future of the entire ecosystem. Continuous monitoring of the elephant population in different seasons would aid in determining the greater dynamics of colonization and extinction processes which can be helpful for the managers to establish proper managemental strategies in the area.

4.2.4. STATUS OF OTHER IMPORTANT BIOLOGICAL COMPONENT

Under the current project an initiative was taken to record the important components of this biological complex. Accordingly studies were undertaken to document the bird and butterfly diversity of Bornadi-Khalingduar complex. Mr. Debanga Mahalia and Mr. Monsoon Jyoti Gogoi, extended their technical support to us for doing this work.

4.2.4.i. BUTTERFLY DIVERSITY OF THE AREA - Annexure 4

4.2.4.ii. BIRD DIVERSITY OF THE AREA – Annexure 5

4.2.5. SOCIO ECONOMIC PROFILING OF THE AREA

4.2.5.i. Review of Scio-Economic Scenario of the fringe villages of Bornadi WLS, Neoli PRF and Khalingduar RF, Udalguri District, Assam

The fringe villages of the Bornadi WLS, Khalingduar RF and Neoli PRF represents a land areas border to the international border of Bhutan and Interstate Border of Arunachal Pradesh on north bank of Brahmaputra Valley on the intersection of 26° 48' N to 26°53' N to 91°44' E to 91°51' E.

The study was carried out in the area in exploratory nature, based on FGD followed by sample survey and collected in from the 27 villages out of 57 villages, where village selection are stratified on the basis of forest fringe cluster i.e. Bornadi (WLS), Neoli (PRF) and Khalingduar (RF) and distance based cluster (i.e. on the basis of distance from the forest) and identified as SBGI (located less than 3 km from forest), SBGII (located between the distance of 3 to 6 km), SBGIII (located more than 9km from forest)I. All the information collected from 339 household of 27 villages are the data base of this study. This summery note is prepared on the observation of interpretation exercise of primary data and FGD.

Physical make up of the region represents foot hills and piedmont plains, with soil types of *Typic Udorthents*, *Typic Fluvaquents*, *Typic Paleudalfs* and *Dystric Eutrochrepts*. This physical make up particularly unconsolidated fragmented sedimentary formation of the foot hills and low lying piedmont plains are the critical aspects of physical environment of the area. There is emmense possibility of land degradation on the foothills part due to weathering and erosion followed by landslide in the absence of adequate vegetation covers over the area. On the other hand the extensive Piedmont plain is composed with silt and stone with loamy material which encourages high rate of water percolation leading to crisis of surface water retention. In totality, the physical situation of the area creates hurdles to the socio-economic life of the people.

The social make up of the region is controlled by the diversity of ethnic composition with high population belongs to Bodo, Nepali and Adivashi

communities. Other important group living in the area are Garo, Rabha, Orang, and Munda. Cultural practices of these ethnic groups knit the cultural mosaic of the area.

From demographic perspectives it is observed that more population is concentrated in the potential working population age group than the dependent population age group. But the sex ratio represents a gloomy picture of gender development where the sex ratio is lower than the district (943), state and national (932) average. Similarly the literacy level is also below the district (55.92) and state average (64.8). On the other hand educational attainment at different level of education reveals that numbers of achievers from primary level gradually decline. It is strikingly decline after the Middle School Level. The inaccessibility to proper educational facilities is one of the important factors behind the drop out situation. The information of working population indicates that, there is a discrete situation of male and female working population, where male working population is higher than the female. This situation is may be related with the facts of declination of Sex Ratio from lower age group to higher one, e.g. Sex ratio in all the cluster of observation are low in the age group of 18 to 60 years and above 60 years age group than the age group of below 18 years. Such variation may have significant difference in male and female work participation and their role in economy. In addition, there is distinct difference of demographic potential working population and actual working population; it indicates there is more population of lower and higher age group also participates in the work force of the area. It is linked with possibility of existence of Child labour and old age labour in the area.

The economic scenario of the area represents a subsistence agricultural economy, where winter paddy is cultivated as main crops. There are secondary crop produced in the area which includes summer paddy mainly. A significantly numbers of farming families practice horticulture instead of other crops. There is significant numbers of families having their homestead gardens, product of this garden are also their secondary source of earning. Animal rearing is also one of their source of livelihood. But comparison of cattle and goat population with the existing grazing land within the village indicates that to support the fodder of these animals they are compelled to depend on neighboring forest.

The occupation wise population belongs to different families indicates that larger numbers of working population are as engaged as cultivators and wage labour. If the agricultural and contractual labours are added with wage labour the labour population is significantly high in all the clusters of observation. Therefore in case family's average annual income higher share is from wage earning in all the cluster of observations. This situation indicates that majority of the people's livelihood is based on wage earning. It is a dismal aspect of livelihood security of the people living in the area. Because, in case of wage earning people don't achieve any accesses and right on the resources, they only provide labour on the directives of owners. These unwholesome situations of livelihood are profoundly

clarified by the land use related information. The land related information indicates that comparatively a larger section families living in the area without agricultural land (it is significantly 30% of families living in SBGII cluster do not having agricultural land). Such situation in many cases compelled the respective families to rely on wage earning as source of livelihood.

In case of fallow land, comparatively higher percentage of families having both the categories of permanent and temporary fallow land. The poor moisture retention of soil over piedmont plains, increasing trend of silt and stone deposition by the course of rivers, anomalies of summer rainfall are the important reason of this existence of more fallow land. It may also compelled a section of farmers go for wage earning as labourer.

Moreover, poor productivity of agriculture and increasing trend of land degradation is associated with situation of lease out agricultural land. The trend of lease out indicates how potentials framing families lease out their agricultural land out of hardship. Equally the lease in information indicates the pattern have and have not divide in the area. Most of the lease in land is used by the smaller tea grower. Basically the sloppy land near to the foothills is attraction of the tea growers and they take the opportunities. Over the time more and more people will become wage labour in the small tea gardens. This is an undesired trend of development copping up recently in the area, which promote mono culture and many areas to near to the forest (even wildlife sanctuary) are used for the purpose. The used of pesticides and fungicides in such gardens may creates some distressing situation to forest and its associated wildlife.

There is a positive initiatives observed in the area. To overcome the constrains of surface water crisis people developed a indigenous practices water harvesting system locally called as 'Dong'. Dong practice in the area from time immemorial to collect water from the streams and river in the neighbourhood through man made conduit, using the principles of watershed. Through this practice people able to get water to fulfill their requirement for agriculture and domestic purposes. Over the period institutions are buildup to manage this harvesting system as Dong Management Committees involving all the water user of an watershed, which some time covers numbers of villages and its inhabiting families. All these committees are strongest community institution available in the area till date. Scientific intervention through contour banding, gully plugging, and riparian vegetation covers development etc possible in this aspects to harness more significant results from this practices.

Interestingly people attitude about nature conservation is not absolutely negative, still they believes that more vegetation cover in the surroundings may links with more water yield and better practices of agriculture. But their arduous liabilities of livelihood requirements in short term may not allow them to focuses on such practices. Many a cases some local people are involved in illegal activities which creates detrimental situation of neighbourhood forest. But such practices are

patronized by the outsider, not by immediate forest villagers; such villagers are involved only for wage earning. Still they have a mind if they get opportunity along with their livelihood security they will extend their helping hand for forest conservation in the area. But their exposure to Joint Forest Management is hazy which represents improper implementation mechanism and lack of people involvement in the processes.

4.2.5.i.a. Some of the salient observation:

- High population in dependent age group, low average sex ratio and low sex ratio in the age group of below 12 years, 12 to 18 years, above 60 years, low literacy, low female work participation, low agricultural labour, high numbers of cultivators, high average income from agriculture, high rate of land lease out and lease in, more families having permanent fallow land, more numbers of families involved in NTFP collection, are common in the cluster located near to the forest area, i.e. SBGI.
- Low working population, higher numbers of families without agricultural land, high numbers of wage labour, more dependency on wage, high annual average expenditure are common in the intermediate distance cluster from forest, i.e. SBGII.
- There is high dependency ratio, more working population concentration, high work participation of male working population, more earning from sales of agri-product and from salaries, more families rely on homestead gardening, more annual savings at family level, higher numbers of families practicing small Tea Gardening observed in far distance cluster from forest, i.e. SBGIII.

The overall observation and FGD in the field reveals following important aspects problems and prospects in the area, which is placed here in the manner of **SWOT**.

Pieces of Strength:

Kind of strength	Portrayal of strength
Socio-cultural	High ethnic diversity leading to cultural diversity.
Demographic	High population in the potential working age group.
Knowledge system	Strong ethnic and indigenous knowledge system related with ethno-botany and resource management.
Skill	Skill of handloom and handicraft; Traditional Knowledge of Agriculture Animal rearing and water harvesting and management
Capital	High social capital on the basis of community base social practices. Existence of grain bank concept and its

	practices in some villages, Acceptance and popularization of modern concept of SHG
Agricultural	Existence of practices of homestead gardening, horticulture

Pieces of weakness:

Kind of weakness	Portrayal of weakness
Gender related	Low sex ratio and low work participation female in working force
Knowledge and skill related	Low literacy, lower educational attainment
Infrastructural	Lower accesses and unequal distribution of educational and health facilities, Low transport and communication facilities and connectivity, Low service facilities in the areas of vocational development, skill up gradation
Agricultural	Low crop diversity in existing practices, Absolute dependency on winter paddy
Handloom and handicraft	Less modernization, Less interest for pursuing by the younger generation
Market	Lower accesses to market

Pieces of opportunity:

Kind of opportunity	Portrayal of opportunity
Environmental	Near to the forest, particularly one WLS, Existence of four major rivers, Extensive plain land.
Cultural	Diversity of culture and society through ethnic diversity, Existing trend of cultural assimilation through marital relationship, cultural participation and mutual sharing
Knowledge	Traditional Knowledge of Natural Resources, Nature Worshiping
Skill	Skills on cultural practices, agriculture, traditional water harvesting
Institution	Dong Management Committees and community participation there in, Modern institution of student organization at different level
Socialization	Existing popular socialization means through Sports for the younger generation

Pieces of threats

Kind of threats	Portrayal of threats
Physical Environment related	Surface water deficiency leading to crisis of water for agriculture, drinking and other domestic uses.

	Anomalies of rainfall for last 5 to 6 years increases the problem
	Soil wash in the hilly terrain and gully erosion along the river and streams during the rainy seasons
	Declination of soil moisture retention capacity
	Infestation weeds like Ipomoea in agricultural field in the valley part and Lantana in the foothills
	Degradation of neighbourhood forest and copping up of anthropogenic pressure
Natural resource related	Water scarcity
	Declination of rice productivity,
	Declination of availability of fodder, fuel wood, building material
	Rampant pressure of land use change and conversion of agricultural and hills area for Tea Plantation
Wildlife threat	From Elephant, peacock , monkey
Heath related problems	High rate of infestation of malaria
	Water related disorder like Hepatitis, stomach disorder
Employment related	High rate of unemployment
	Lack of avenues for employment
	More pressure on agriculture
Mono cropping	Single cropping in majority of agricultural field
	Sprawling of small tea garden activities
Social	Lossing the knot of social assimilation through belief and trust,

On the basis of the SWOT statement mentioned above it is felt that, there is urgent need of targeted intervention in the areas of livelihood security and quality of life. In the perspectives of NBL philosophy and rationale of operation following are some of the area where some interventional initiatives can be under take:

1. **Development of knowledge and skill:**

In this aspects to achieves the community initiatives for nature conservation there is some requirement of educational interventions in the

line of ESD for children and youth, along with community education and capacity building through awareness campaign followed by need based skill development training.

2. Intervention in the areas of NRM:

Intervention for betterment of the village CPR and individually owned natural resources can be under take in the areas mentioned below:

- a. Water harvesting: initializing the capital of IEK of Dong management adopting watershed principle.
- b. Agricultural development: through introducing ideas of crop diversification, systematic cropping by the method of SRI, adopting measures for weeds control, etc.

Detailed report: Annexure 6.

4.2.6. STATUS OF HUMAN ELEPHANT CONFLICT

4.2.6.i. Human elephant conflict in Bornadi Khalingduar (BK) Complex

4.2.6.i.a. Introduction:

Human elephant conflict (HEC) is now a very common term used by the wildlife conservationist as well the common people. In simple language, it can be define as competition to acquire food, shelter and space (Chong *et al.* 2005). The focal points of HEC are usually the edge of protected areas (and Hart O'Connell, 1998 in Nelson *et al.*,2003). Now the situation has reached a stage that, wherever there are elephants there is conflict. The major cause of HEC is the destruction of habitat followed by conversion of land for other purposes, blockage of corridors, collection of NTFP, human disturbance inside the forest area, etc. HEC has now become a social problem and involvement of all sections of the society and political willingness combined with willingness of the decision maker has become imperative for solving the problem.

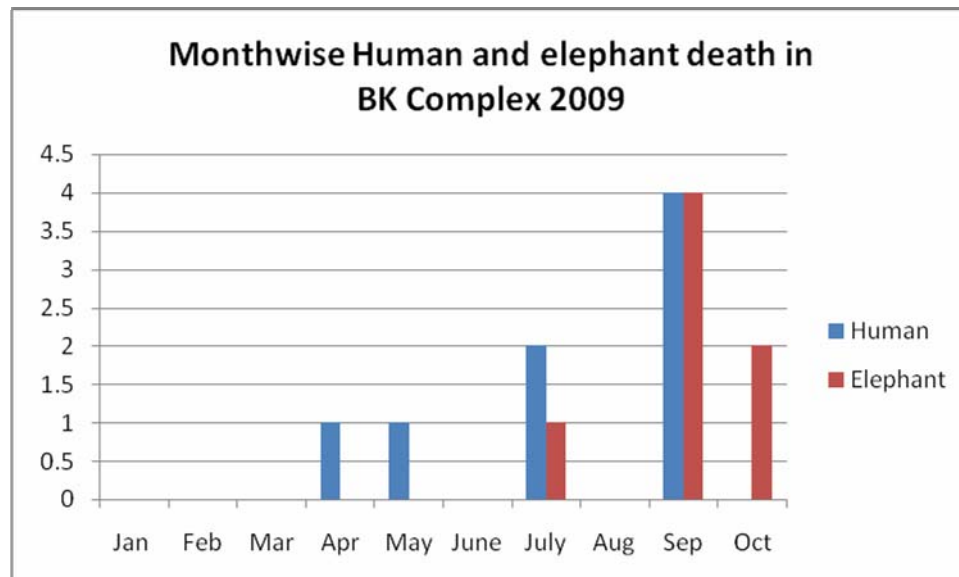


Fig 10: Human elephant death during 2009 in the fringe of Bornadi-Khalingduar

4.2.6.i.b. Methodology:

Information on Human elephant conflict was collected by rapid survey method and by visiting the forest range offices and beat offices. During the survey period information on conflict prone villages was collected from different forest offices. GPS location of all the conflict prone villages was taken. Information on human and elephant death was also collected from the local range offices. To know the conflict situation in the fringe villages, 43 villages were selected in three clusters viz. a. Bornadi b. Neoli and c. Khalingduar, in the fringe of Bornadi-Khalingduar complex forest area.

A simple questioner was designed to know the following facts:

1. Beginning of human elephant conflict Year,
2. Maximum and minimum no of raiding herds,
3. Probable cause of HEC,
4. Trend of HEC in the particular village,
5. Months when HEC is most frequent,
6. Time of elephant visit,
7. Mitigation method used,
8. Suggestion to minimize the HEC,
9. Historic records of elephant visits to the area,
10. Threat to the elephant population,
11. Conflict incident per year,
13. No. of days spent by the elephant to or near the village etc.

The information from the villagers was extracted by focussed group discussion involving different category of people like the farmer, teacher, youth, students, women, elderly person of the village, village council development committee (VCDC) members, Gaon burah, Village Defence Party (VDP) members etc.

4.2.6.i.b. Result and discussion:

Conflict start season: HEC started in most of these places more than forty years ago and in some places it is started in the last decade. This may be because of the large scale deforestation and conversion of forest land for other purpose like settlement and cultivation (mostly tea). From our study we found that the prime cause of HEC in the whole Bornadi Khalingduar (BK) complex is deforestation and blockage of elephant movement due to different human activity. The Bornadi area of the complex is a wildlife sanctuary (WLS) so there is not much recent encroachment but the adjoining area of the Bornadi WLS is already occupied by the people and converted to tea garden. So there is no buffer of the sanctuary left. In these places the incidents of confrontation of elephant with human being is increasing gradually. On the other hand, the Neoli Proposed Reserve Forest (PRF) part of the complex is not having any legal entity. Taking the advantage of the legal status of the area many people started settling there and some people from other place have also started setting up tea gardens in the flat spaces of the area. This is obstructing the free east - west movement of elephants through the area. Recently the SSB (Sasastra Seema Bal) a paramilitary force, is also constructing their camps in a vital elephant corridor. In Khalingduar area during the last decade massive tree felling took place when all the timber tree were felled illegally by the timber mafia. After that the vegetation pattern of the area changed and unpalatable species of herbs emerged and covered several area of the RF resulting in the scarcity of food for elephants inside the RF.

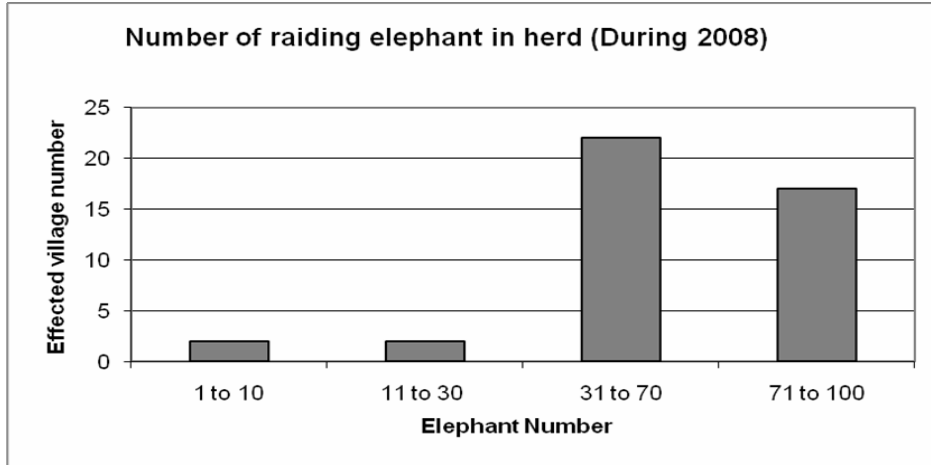


Fig 11: Herd size in surveyed villages

The villagers informed that the raiding herd size is between 5+ to 100+ in different places and at different times. During the crop plantation period(May to July) and harvesting period(November to December) the herd size is large and in the other period it is in small group. The big herd of elephants attacks the crop field and the smaller herds raids the kitchen and granary. Most of the surveyed villages experienced big herd (more than thirty elephants) during the peak raiding season.They also informed about few loner elephants both tusker and *makhna* (tusk less male elephant). In the area they estimate 5-6 such elephants. According to the villagers these elephants are responsible for the human casualties in the area.

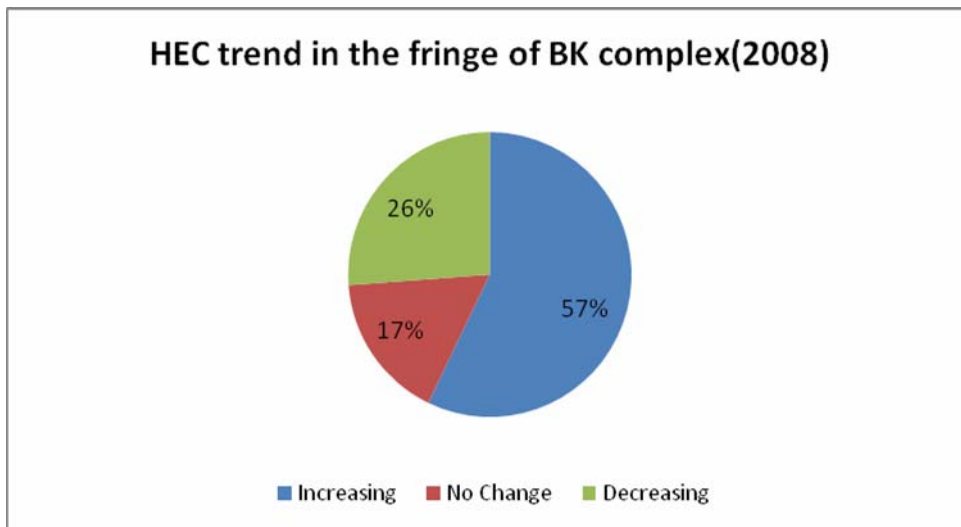


Fig 12: HEC trend in the fringe villages of Bornadi-Khalingduar complex

Although HEC problem was there in some villages even forty years back but the intensity was not very high. At that time elephants used to visit the crop fields during the crop harvesting period, but now-a-days the intensity of HEC is going up in some places and elephant have started raiding the crop fields in two seasons. The human and elephant death incidents are also on the rise especially

in the fringe of Khalingduar and Neoli area. Cultivation of paddy in the fringe of the Khalingduar and Neoli area is also a factor for rise in HEC. In the study it is found that in the fringe of Khalingduar RF, the HEC trend is increasing and in the fringe of Neoli it has remained constant or marginally increased. But in eastern fringe of Bornadi, HEC trend is decreasing. This may be because of change of cropping pattern in the fringe of Bornadi. Most of the crop land where paddy was cultivated earlier have given way to tea cultivation. Tea is not favored as feed by the elephant so although the elephants keep visiting the area but the elephant caused crop damage has decreased in these areas. People in the fringe of Bornadi feel that the HEC is in decreasing trend in their area because of change in land use. In the western part of the Bornadi WLS, HEC shows an increasing trend. It was seen that sometimes the elephants follow the river Bornadi towards south and create problem in the area like Bangalipara, Suagpur, Maharipara etc situated on the south western part of the sanctuary.

In most of the surveyed area the common month of HEC is July to November. In some villages it starts a little early and in some places it may end a little late. There are two distinct peak period of HEC, June to August and September to November. Apart from this, the loner elephants and small herds keep creating trouble by destroying house, injuring or killing human being, raiding granaries, etc. throughout the year. The villagers informed that the elephants generally attack the crop field in the evening, the usual raiding time being 5 pm to 8 pm.

The people were asked whether they are getting any help from any agencies - government or non government to mitigate HEC, they simply answered that till date they have not got any support from forest department or any NGO to minimize the HEC problem. They also informed that they are not even getting the ex-gratia for human death or injury or crop damage compensation from government.

During the survey villagers were asked to suggest ways to minimize HEC in their area. Most of them were unable to give any suggestion, only a few villagers suggested eviction of illegal settlers from the forest area.

Regarding the short and long term method of HEC mitigation, the people stated that they use various techniques to keep the wild elephant herds away from their crop field and village. Some of them are - making noise, lighting fire, using torch light, using spear and catapult and electric fence. During our field visit we have noticed that electric fence is very popular as a HEC mitigation method. The local people use it during the paddy cultivation period, but unfortunately to minimize the cost most of them use AC current from domestic source, due to which many elephants and even human being got killed previously, During the period January to October 2009 seven elephant got killed. Six of them are suspected to have been killed by electrocution. For long term mitigation of HEC every villagers give their opinion in favor of restoration of the habitat.

The survey shows that the most effected crop is paddy in all the study area. Even the HEC season is also directly related to the paddy cultivation season. The elephants attack the crop field during the summer and also in winter. The other cultivation like maize, betel nut, coconut, potato, tea, vegetable is also damaged during the elephant raids.

Conflict incidents and time spent by elephants near the village showed that the elephant spend more time in the fringe of Khalingduar RF and the average conflict incident is also more in that area. The fringe of Neoli area comes next. In the fringe of Bornadi, the elephants spend comparatively less time than the other two areas, but in the western part of Bornadi WLS, in the recent years elephant presence period and HEC have become more prominent.

4.2.6.i.d. Conclusion:

For last three-four decades most of the fringe villagers of Khalingduar-Bornadi complex were living in harmony with the elephants and the situation had not reached the level of conflict. But during the next two decades the problem of HEC increased. The cause can be directly attributed to clearing of forest and blocking of corridors. The problem of HEC has become more serious in recent years which is because of massive logging and conversion of forest areas to tea gardens, human settlements, bamboo and other NTFP collection, and increased human disturbance inside the forest.

To solve the problem, a proper land use plan and its implementation is very important. Involvement in land-use planning is typically a long term process that requires government support, often legislative and/or policy changes, and can be extremely expensive to implement. But it has long-term benefits for mitigating human-elephant conflict (Nelson *et.al.* 2003). which will help to restore the elephant habitat and corridors. Apart from this, short term methods like formation of well equipped anti depredation squad, use of domestic elephant to drive the wild herds, proper electric fencing, cultivation of elephant deterrent crop species in the forest fringe, implementation of government scheme and awareness programmes among the villagers regarding the HEC problem will help to minimize the HEC problem in this area.

5. CONSERVATION ACTION PLAN

5.1. Conservation action plan for Tipi corridor complex

The section identified as the Bhalukpong-Tipi area is a very critical one for maintaining the habitat connectivity and continued survival of elephants and other wildlife in North Bank Landscape. For the purpose of conservation of elephants and their habitats in the area the following action plans are suggested based on a few broad results obtained through a scientific analysis.

1. Land cover change in the section has gained momentum during the last few years and that too in areas identified as vital for the animals.
2. The growth of human habitations is totally unplanned and all of these have taken place inside Doimara Reserved Forest and so can be identified as encroachments.
3. Elephant presence is quite abundant in the area but the movements have become limited due to obstructions and disturbances resulting out of human activities.
4. There is no popular identified elephant movement sections north of Tipi as the topography becomes more rugged and steep sloped.

5.1.1. General

Action a: Constitute a co-ordination committee for the area and work closely in all matters.

Partnership: Government departments, NGO's & Community representatives

Current status: Committee Constituted (The Tipi Core Group)

Action b: Monitor land cover changes and settlement growth in the area.

Partnership: Forest dept, & Gauhati University

Current status: Documentation ongoing

Action c: Monitor elephant / tiger population in the area.

Partnership: Forest dept, Community representatives

Current status: Documentation ongoing

Action d: Organize community level awareness programs in the area.

Partnership: Government departments, & NGO's

Current status: Ongoing

Action e: Prepare a Landuse zonation Plan for the area.

Partnership: Government departments, Gauhati University & NGO's

Current status: Initiated

Action f: Promote use of biogas & solar power

Partnership: Government departments, NGO's & Community representatives

Current status: To be initiated

Action g: Prepare and implement a tourism plan
Partnership: Government departments, NGO's & Community representatives
Current status: To be initiated

Action h: Train local youths in nature trekking and tourism activities
Partnership: Government departments, & NGO's
Current status: To be initiated

Action i: Government at the highest level to accept the plans prepared for implementation and support NGO's & Community representatives
Partnership:
Current status: To be initiated

Action k: Arrange training for forest department ground staff in anti-poaching and wildlife monitoring activities
Partnership: Govt. dept.
Current status: To be initiated

5.1.2. Lower Bhalukpong

Action a: Declaration of a no-development zone (through Govt. notification) in the area to arrest further expansion of human habitations.
Partnership: Government departments, & NGO's
Current status: To be initiated

Action b: Clear recently developed human settlements (about 15 households) in Lepakhuda to facilitate easy north south movement of elephants.
Partnership: Government departments.
Current status: To be initiated

Action c: Work out a rehabilitation / relocation package for the critical areas.
Partnership: Government departments, & NGO's
Current status: To be initiated

5.1.3. Upper Bhalukpong

Action a: Declare no development zone (through Govt. notification) up to a distance of 100 mts. on either side of the Duang Nala.
Partnership: Government departments.

Current status: To be initiated

Action b: Declare no development zone (through Govt. notification) further north of the Duang Nala bridge point along the Bomdila road.

Partnership: Government departments.

Current status: To be initiated

Action c: Prevent all types of earth cutting activities.

Partnership: Government departments.

Current status: To be initiated

5.1.4. Dedjling

Action a: Declare the area as a no development zone (through Govt. notification)

Partnership: Government departments, NGO's & Community representatives

Current status: To be initiated

Action b: Promote the archeological importance of the area

Partnership: Government departments, NGO's & Community representatives

Current status: To be initiated

Action c: Erect road signage for the vehicular traffic and tourists

Partnership: Government departments NGO's & Community representatives

Current status: To be initiated

Action d: Support one well equipped anti poaching camp (WT type)

Partnership: Forest department.

Current status: To be initiated

5.1.5. Tipi

Action a: All forms of further development and construction should be arrested in the area.

Partnership: Government departments. & community representatives

Current status: To be initiated

Action b: Declare no development zone (through Govt. notification) up to a distance of 100 mts. on either side of the high bank of the Tipi Nala. All existing structures in this zone should be immediately cleared.

Partnership: Government departments & community representatives

Current status: To be initiated

Action c: Erect Power fence on both sides of the Tipi Nala (at 100 mts distance) for safety of both animals and humans (for approx. 3 kms.)

- Partnership:** Government departments.
Current status: To be initiated.
- Action d:** Clear the area in between Forest Range office (T) and Forest Range office (WL)
Partnership: Government departments, & community representatives
Current status: To be initiated.
- Action e:** Work out a rehabilitation / relocation package for the identified critical area with about 15 households.
Partnership: Government departments, NGO's.
Current status: To be initiated
- Action f:** Erect power fencing on either side of this critical area for safe passage of the animals as well as humans (for approx. 1.5 kms.)
Partnership: Government departments, & community representatives
Current status: To be initiated.
- Action g:** Support one well equipped anti poaching camp (WT type)
Partnership: Government departments.
Current status: To be initiated.
- Action h:** Erect road signage for the vehicular traffic and tourists
Partnership: Government departments, NGO's & Community representatives
Current status: To be initiated.

5.2. Conservation action plan for Bornadi-Khalingduar complex

5.2.1. General

- Action a:** Constitute a co-ordination committee for the area and work closely in all matters.
Partnership: Government departments, NGO's & Community representatives
Current status: In Place but need formalization
- Action b:** Monitor land cover changes, Tea plantation and settlement growth in the area.
Partnership: Forest dept, WWF and other NGO.
Current status: Documentation ongoing.
- Action c:** Emerging issues of Human Elephant Conflict (**HEC**) need to be addressed properly and immediately to prevent further loss of human and elephant life and also to minimize elephant related household and crop damage.
Partnership: Forest dept, Administration, and NGO's.
Current status: Documentation ongoing.
- Action d:** Study the impact of tradition dong water harvesting system and its impact on the livelihood of the fringe villagers.

- Partnership:** NGO, forest and agriculture department.
Current status: WWF start the initial survey for mapping.
- Action e:** Dong system need to be made more scientific to serve the people efficiently
Partnership: Agriculture department, District administration, and Forest department, NGO's & Community representatives.
Current status: Running on traditional methods.
- Action f:** Study the change in ground water level in Udalguri district in the last decade.
Partnership: PHC department.
Current status: Not done.
- Action g:** Series of awareness programme to be held covering all section of society like the students, villagers etc.
Partnership: Forest department, District administration, Local NGO, and student organization.
Current status: Going on.
- Action h:** Land use zonation map needs to prepare for streamlining the human activity taking place in and around the B-K complex.
Partnership: Forest department and District administration
Current status: Yet to be initiated
- Action i:** Map and documentation of present status of forest, encroachment, elephant use and HEC in the Bornadi-Khalingduar complex.
Partnership: Government department and NGO.
Current status: Partially done
- Action j:** Declare the Bornadi-Khalingduar complex as a protected area, excluding the stone collection sites for revenue generation and including the present forest area and few critical deforested areas.
Partnership: Forest department.
Current status: Bornadi is a wildlife sanctuary, Khalingduar is a RF and Neoli is a PRF.
- Action k:** Problem of flood and erosion in the rivers of the area should be addressed
Partnership: Forest, soil conservation, flood and irrigation departments.
Current status: very low attention in this field.
- Action L:** A rapid action force need to be form to prevent the illegal timber trade in the Udalguri district.
Partnership: Forest department and administration
Current status: Not in place.
- Action m:** Capacity of forest department need to enhance by providing them sufficient man power, logistic resource, training to deal with the situation.
Partnership: Government, WWF and other NGO.
Current status: not in place.

- Action n:** Habitat improvement activity need to be initiate including grassland management, plantation, water hole creation, elimination of weed and exotic species etc
Partnership: Forest department, NGO and local community
Current status: Not started.
- Action o:** Tourism
Partnership: Local organization, tourism and forest department and community.
Current status: Not started.
- Action p:** Alternative energy source
Partnership: Concerned Govt Dept and NGOs.
Current status: Not yet started
- Action Q:** GIS Mapping of the whole complex showing the land cover change during the last two decade.
Partnership: Forest department and WWF or other Organization.
Current status: Done by WWF India.
- Action R:** Monitor elephant / tiger population in the area.
Partnership: Forest department, Community representatives
Current status: Documentation ongoing.

5.2.2. Neoli area:

- Action a:** Define and demarked the forest boundary and existing forest.
Partnership: Forest department, administration and NGO.
Current status: Not yet started.
- Action b:** Land ownership status of the rising tea gardens in the fringe area.
Partnership: Forest department and district administration.
Current status: Not started.
- Action c:** Shift the SSB camp of Chamrang to south bank of Chamrang river to facilitate the easy and free movement of elephant from Khalingduar RF to the Neoli PRF and vice versa.
Partnership: SSB, District Administration and Forest department.
Current status: Yet to initiated
- Action d:** Stop the deforestation activity in the Chamrang part of Neoli PRF in the name of religious activity.
Partnership: Forest department, district administration, SSB.
Current status: Initial steps started.
- Action e:** Stop the collection bamboo and other NTFP from the PRF
Partnership: Forest department, district administration, SSB.
Current status: Going on without any restriction.
- Action f:** Remove/relocate illegal settler from the Neoli PRF
Partnership: Forest department, district administration, SSB.
Current status: No action till date.
- Action g:** Verify land ownership of a tea garden on the eastern side of Neoli river and take necessary action.

- Partnership:** Forest department, district administration.
Current status: Initial discussion held with concern authority.
- Action f:** Map the water harvesting system of the Chamrang and Neoli River
Partnership: Forest department, Local NGO, WWF India, Agriculture department.
Current status: Started.
- Action g:** Plantation activity of indigenous tree should be done to regain the lost green cover of the area.
Partnership: Forest department.
Current status: Not yet started.
- Action h:** Forest camp need to construct at Khoirani area.
Partnership: Forest department.
Current status: Not yet started.

5.2.3. Khalingduar area:

- Action a: Construction of forest camp at Satgharia and Kundarbill area
Partnership: Forest department.
Current status: Not yet started.
- Action b: Electric fence in the fringe
Partnership: Forest department, WWF and other NGO.
Current status: Not yet started.
- Action c: Study/removal of weed and exotic species of plant
Partnership: Forest department WWF and other NGO.
Current status: Not yet started.
- Action d: Construct new staff quarter and renovation of existing quarters including power and water supply.
Partnership: Forest department.
Current status: Already started in Bornadi WLS.
- Action E: Staff strength need to enhance with adequate infrastructure.
Partnership: Forest department.
Current status: Not yet started.
- Action F: Wireless network need to install
Partnership: Forest department and WWF.
Current status: To started by January 2011
- Action g: JFMC committees need to be activated
Partnership: Forest department.
Current status: Not yet started.
- Action h: Need one more vehicle for patrolling
Partnership: Forest department WWF and other NGO.
Current status: Likely to be done in 1st part of January 2011.
- Action I: Road from range head quarter to Chamrang beat should reconstruct
Partnership: Forest department.
Current status: Not yet started.

- Action j: Road from range office to Jalimukh need to repair including the bridge
Partnership: Forest department.
Current status: Partially sone.
- Action h: New patrolling path should be constructed to patrol the Chamrang and Coramore area.
Partnership: Forest department.
Current status: Not yet started.

5.2.4. Bornadi area:

- Action A: Manpower of the Sanctuary should be enhanced.
Partnership: Forest department and Government.
Current status: Manpower is not sufficient and most of the present staff are not physically fit to perform their duty.
- Action B: Demarked the boundary by constructing a trance which will also help in further encroachment of the forest land.
Partnership: Forest department and district administration may take the help of NREGA scheme.
Current status: Small trance is present
- Action C: Grassland management practice should be done with proper fire line, which will also act as a patrolling path for the sanctuary authority.
Partnership: Forest department, district administration, and NGO like WWF
Current status: No management practice.
- Action D: Removal of weed species from the grassland and improvement of habitat.
Partnership: Forest department and WWF.
Current status: Not done.
- Action E: Water hole inside the forest need to maintain.
Partnership: Forest department, district administration, WWF and other NGO.
Current status: Not yet started
- Action F: Drinking water facility for the forest staff need to need to create.
Partnership: Forest department and NGO.
Current status: Very poor condition of drinking water. Only source is a very old and deep well, which is not able to supply 50% of the total requirement.
- Action G: Forest staff quarters should be repaired.
Partnership: Forest department
Current status: Very poor condition.
- Action H: All patrolling paths need to maintain to cover the whole sanctuary.
Partnership: Forest department and district administration.
Current status: No maintenance.
- Action I: Document biodiversity richness of the sanctuary.

Partnership: Forest department, Local NGO and WWF
Current Status: Partly done
Action J: Habitat improvement activity
Partnership: Forest department and WWF
Current status: Going to be initiated by January 2011.

REFERENCES:

- Bailey, L.L., Simons, T.R., Pollock, K.H., 2004. Estimating site occupancy and species detection probability parameters for terrestrial salamanders. *Ecological Applications* 14, 692–702.
- Blake, S., 2002. The ecology of forest elephant distribution and its implications for conservation. Ph. D. Thesis. University of Edinburgh, Edinburgh, Scotland.
- Bowles, A.E., 1995. Responses of wildlife to noise. In: Knight, R., Gutzwiller, K. (Eds.), *Wildlife and recreationists: coexistence through management and research*. Island Press, Washington, DC, USA, pp. 109–156.
- Burnham, K.P., Anderson, D.R., 2002. *Model Selection and Multimodel Inference: A Practical Information-Theoretic approach*, second ed. Springer-Verlag, New York, NY, USA.
- Choudhury, A. U. (1999). *Status and Conservation of the Asian Elephant (Elephas maximus) in north-eastern India*. *Mammal Review* 29(3):141-173.
- Chong, D. K. F. and Dayang Norwana, A. A. B. 2005. Guidelines on the Better Management Practices for the Mitigation and Management of Human-Elephant Conflict in and around Oil-Palm Plantations in Indonesia and Malaysia. Working Draft 2. WWF-Malaysia, Petaling Jaya.
- Douglas-Hamilton, I., Krink, T., Vollrath, F., 2005. Movements and corridors of African elephants in relation to protected areas. *Naturwissenschaften* 92, 158–163.
- Gu, W., Swihart, R.K., 2004. Absent or undetected? Effects of nondetection of species occurrence on wildlife-habitat models. *Biological Conservation* 116, 195–203.
- Hart, L. A. and O'Connell, C. E. 1998. Human Conflict with African and Asian Elephants and Associated Conservation Dilemmas. Workshop on Co-operative Regional Wildlife Management in Southern Africa.
- MacKenzie, D.I., 2005. What are the issues with presence–absence data for wildlife managers? *Journal of Wildlife Management* 69, 849–860.
- MacKenzie, D.I., Nichols, J.D., Lachman, G.B., Droege, S., Royle, J.A., Langtimm, C.A., 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83, 2248–2255.
- MacKenzie, D.I., Nichols, J.D., Royle, J.A., Pollock, K.H., Hines, J.E., Bailey, L.L., 2006. *Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence*. Elsevier Academic Press, London, UK.
- Manley, P.N., Zielinski, W.J., Schlesinger, M.D., Mori, S.R., 2004. Evaluation of a multiple-species approach to monitoring species at the ecoregional scale. *Ecological Applications* 14, 296–310.
- Nelson, A., Bidwell, P., and Sillero-Zubiri, C. 2003. *A Review of Human-Elephant Conflict Management Strategies*. People and Wildlife Initiative, Wildlife Conservation Research Unit,
- O'Connell, A.F. Jr., Talancy, N.W., Bailey, L.L., Sauer, J.R., Cook, R., Gilbert, A.T., 2006. Estimating site occupancy and detection probability

- parameters for meso- and large mammals in a coastal ecosystem. *Journal of Wildlife Management* 70, 1625-1633.
- Payne, K.B., Langbauer, W.R., Thomas, E.M., 1986. Infrasonic calls of the Asian elephant (*Elaphas maximus*). *Behavioral Ecology and Sociobiology* 18, 297–301.
- Poole, J.H., Payne, K.B., Langbauer Jr., W.R., Moss, C.J., 1988. The social contexts of some very low frequency calls of African elephants. *Behavioral Ecology and Sociobiology* 22, 385-392.