Understanding Biodiversity Conservation and Buffer zone Vegetation in Manahari Buffer Zone Village Development Committee, Chitwan National Park

A dissertation submitted for the partial fulfillment of the requirements for the Master's Degree in Environmental Science

Submitted by

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LETTER OF RECOMMENDATION

This is to certify that Mr. Anil K. C. has prepared this dissertation entitled, *"Understanding Biodiversity Conservation and Buffer Zone Vegetation, in Manahari Buffer Zone Village Development Committee, Chitwan National Park."* as partial fulfillment of the requirement for the degree of Masters of Science in Environmental Science under my supervision and guidance.

This dissertation bears the candidates own work and has not been submitted for other purposes.

I therefore recommend this dissertation for approval and acceptance.

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Declaration

I, Anil K.C., hereby declare that the work presented herein is genuine work done originally by me and has not been published or submitted elsewhere for the requirement of a degree program. Any literature data works done by others and cited within this dissertation has been given due acknowledgement and listed in the reference section.

…….

Anil K.C.

Date: 6 August, 2007

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LETTER OF APPROVAL

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Degree	Master of Science in Environmental Science: Majoring in Wildlife Management.
Title of Thesis	*Understanding Biodiversity Conservation and Buffer Zone Vegetation, in Manahari Buffer Zone Village Development Committee, Chitwan National Park*

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ABBREVIATIONS AND ACRONYMS

NTNC	Nepal Trust for Nature Conservation (Formerly, King Mahendra Trust for Nature Conservation KMTNC)
APU	Anti Poaching Unit
BZ	Buffer zone
BZCF	Buffer Zone Community Forest
BZMC	Buffer Zone Management Committee
BZUC	Buffer Zone User Committee
CF	Community Forest
CNP	Chitwan National Park (Formerly Royal Chitwan National Park, RCNP)
DNPWC	Department of National Park and Wildlife Reserve
Dbh	Diameter at Breast Height
FSSD	Forest Survey and Statistics Division
GN	Government of Nepal (Formerly, His Majesty's Government)
ICDP	Integrated Conservation and Development Programme
IUCN	International Union for Conservation of Nature
LRMP	Land Resource Mapping Project
MPFSN	Master Plan for Forestry Sector Nepal
NPWCA	National Park and Wildlife Conservation Act
NTFPs	Non timber forest products
PA	Protected Areas
PPP	Park People Programme
PCP	Participatory Conservation Programme
UC	User Committee
UG	User Group
UNDP	United Nations Development Program
UNEP	United Nations Environmental Programme
VDC	Village Development committee
WRI	World Resource Institute

Abstracts

This study entitled **"Understanding Biodiversity Conservation and Buffer Zone Vegetation, in Manahari Buffer Zone Village Development Committee, Chitwan National Park."** was carried out in the Buffer Zone (BZ) of the Chitwan National park. It includes two wards (ward no 1 and 2) of Manahari VDC, Makawanpur district. The study aims to find out the dependency of the local people in the park resources and the income generation activities in relations to rhino status.

Vegetation analysis of the community forests in the buffer zone, socioeconomic survey in 62 households and GIS analysis of land use change were done. About 11 tree species, 40 shrub species and 18 herb species were recorded in 222.47 ha. The fuelwood and fodder resources of the buffer zone were insufficient and the harvest practice was not sustainable. The total demand of fuelwood and fodder was 2002.03 t/ha and 3099 t/ha respectively where only 23 percent and 27 percent were supplied from the BZ forest. Unpalatable species like *Lantana sp* and *Mikania sp* had high density (7880/ha and 7240/ha) and frequency (80 percent and 70 percent) of these species are higher too. There were no timbers available.

Poaching and killing of the wildlife species were not reported. The economic status was relatively poor in compared to the other areas and crop production was not sufficient. The illegal harvest of the park resources and encroachment in the Buffer zone forest was ongoing. The migration in this area was ongoing and this could increase more pressure on park resources and also forest of the BZ. In addition, the 1992 land use map of Manahari VDC shows 4.6 percent decrease in forest coverage.

Keywords: Biodiversity conservations, Buffer Zone, Vegetation, GIS analysis, Land use, Chitwan, Manahari VDC, Rhino

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Chapter 1

1.1. Introduction

Buffer zone (BZ) in the Chitwan national park (CNP) was designated in the year 1997. It was established to involve/participate the local people finding the goal of long term conservation of biodiversity (CNP and Buffer Zone Management plan 2001-2005). The BZ of CNP consists of 35 Village Development committees and 2 Municipalities. Manahari BZ VDC is located on the eastern sector of the BZ of CNP in Makawanpur District along with other 5 VDC and 1 Municipality of Chitwan District.

Despite its several successes in biodiversity conservation, threats to sustainable biodiversity conservation in Chitwan continue to exist in many forms and at different scales (Budhathoki, 2005). Both biological as well as anthropogenic induced threats have been observed in Chitwan. Like in many world heritage sites of developing countries, Chitwan has on going illegal hunting/poaching and cattle grazing. These are the biggest human induced threats to park management (Pine, 1992). However, social capital has been rapidly gaining its ground in long term conservation (Kremen et al. 1999). Social capital involves ecology, economic forecast and social strata (Bajimaya, 2006). Unless these three fundamentals can be synthesized as one, forecasting scenarios and sustaining development activities to safeguard biodiversity will remain difficult task.

The master plan for the forestry sector, 1998 has identified the conservation of ecosystem and genetic resources as one of the long-term objectives. Nepal' s network of protected areas (PA) including the Buffer zone which covers 28998.67 sq Km (19.70 percent) of the land (DNPWC, 2006), is to accomplish this objective. The landmark legislation, the National Park and Wildlife Conservation Act (1973), felicitated the establishment of 9 National parks, 3 Wildlife Reserves, 3 Conservation Areas and 1 Hunting Reserve. These network of PA developed in three decades has remained vital for conservation of biodiversity as to the network represents most of the major ecosystems of Nepal.

In recent past, traditional protective philosophy was unable to find the root cause of the problems and has led to failure of many national parks, since it was aimed mainly at protection by law enforcement (Sharma, 1991).

The effort to diffuse human antagonism against the National park Chitwan have only "bought some time" because the conflict will increase with the disappearance of the few remaining patches of the forest outside the National Park that have fulfilled the needs for fuelwood and grazing land. Once these are lost, the pressure of the growing population will be directed towards the National park. The relation between the wildlife, tourists, national park and the local people symbiotic rather than antagonistic: the benefits must be natural in the form of jobs, markets, prestige sentiment or even thatch grass. The timely task for the park planner is to explore and foster means of co existence beyond the park boundary and into local communities. If this is not achieved, National park and reserve system in the developing world will perish as sand castles on the beach and the insight of naturalist like Aldo Leopold will have been for nothing (Mishra, 1984).

Community wildlife management is an increasingly widespread as an approach for conserving biodiversity through sustainable exploitation by indigenous peoples (Western and Wright, 1994; Campos et al., 1996; Oritz and Mazzuchelli 1997; Robinson and Bennett, 2000). According to the context, the approach can benifit from cultural tradition with respect to stewardship and conservation ethic (Kleymeyer, 1994; colchester, 2000; Schwratzman et al., 2000a).

Bioresources, which are essential for maintaining the ecological process and life support system, and to sustain and improve agricultural, forestry, and fisheries production, are depleting very fast. Many species are threatened of extinction due to habitat destruction, over exploitation and the introduction of inappropriate technologies. Scientist anticipate that if present trends continue, by the year 2015, some 25% if species present in the mid-1980s will be lost (WRI, IUCN & UNEP, 1989). The situation, especially in many developing countries like Nepal, is alarming. Hence, biodiversity conservation is now a global issue with significant implication and is receiving attention.

Chitwan National Park is the first National Park of Nepal. It was gazetted in 1973 and UNESCO declared CNP as the World Heritage site in 1984. Earlier Parts of the today' s National Park was separately preserved and protected. The greater one horned rhinoceros (*Rhinoceros unicornis)* listed in the CITES Appendix 1and as endangered species in IUCN Red data book is widely poached as they are known for their horns with exceptional values in the oriental medicine (Adhikari, 2002). With the establishment of the Chitwan National Park in 1973 (Area 932km^2) rhinos have dramatically turned around from the brink of extinction because of stringent protective measures. Rhinos have increased from 147 animals in 1972 to 544 in 2000 (Pellink and Uperety, 1972). CNP has an area of 932 sq Km and is surrounded by 750 sq Km as buffer zone declared in 1996.

1.2. Literature review

Sharma (1999) studied park people interaction in CNP and found that without proper support from the locals conservation efforts cannot sustain. Bhuju (1984) studied the conservation strategy of Nepal and found that the legal provision had clearly demarcated the protected areas for conservation but the co operation with the locals is still lacking. Bhatta (1994) studied the buffer zone aspects and the local participation in the conservation of biodiversity and found that the problems of the locals are yet to be addressed.

Paudyal (2000) found local people to be supportive in conservation issues but their compulsion to use forest products has made it difficult to stay away from the National park. The study has come up with suggestion to reduce locals' dependence on the parks, apart from its findings. Further research is required to analyse the ways of uplifting economic conditions of the local people, as the economic condition has been found to be directly related to park dependency. Joshi (1999) detailed the socio-economic characteristics of CNP buffer zone residents and concluded that buffer zone residents heavily rely on national park and surrounding forests to meet their basic needs. Upadhaya (1989), found rural dependence in forest resources is aggregated by rises in human and livestock population, makes wildlife conservation a difficult task. Methods which could

reduce or shift such dependence would have positive implication for wildlife conservation.

Nepal and Weber (1995) explored five major causes, i.e. illegal transaction of forest products from the park, livestock grazing in the park, illegal hunting and fishing, crop damage and threats to human and animal life, of park people conflict in the CNP. Shrestha (1994) studied on the resource conflict between park conservation and adjoining settlements and found serious threat to the survival of endangered animals and plants because of poaching and illegal use of park resource. Crop damage, livestock toll and harassment to the people were other major problems.

Rijal and Meilby (2006) suggested that lack of knowledge of forest structure, composition and magnitude of human impacts on various components of the ecosystem remain a major limitation for the development of the appropriate participatory management programmes for conservation and sustainable utilization of the forests in Nepal.

Pradhan (1995) studied the sustainable use of fuelwood and timber resources in the buffer zone VDC' s of Bardia National Park and found that the timber and fuelwood supply was surplus but the problem was quality rather than quantity. Straede and Hells (2000) considered annual grass cutting programme as a park people conflict resolution in CNP. He presented that 50,000 tones of biomass were removed from the park where as illegally removed fuelwood account to about half of the resources. And they also concluded that BZCF has not been able to substitute fuelwood from National park and suggested that alternative should be provided. Pandit (1995), studied the vegetation composition, biomass production and park resources consumption pattern by ethnic groups of adjoining villages of Chitwan National Park. He found that 32 species from grassland were used as fodder but have not detailed studies about shrubs and trees. Poudyal (2000) found that strict conservation principle is not suited for sustainability of the corridor to maintain the connectivity and landscape linkages and to achieve long term conservation goal.

1.3. Objectives

Broad objectives:

To contribute more knowledge about biodiversity conservation with emphasis on socio-economic structure, community activities and vegetation ecology in the Manahari Village Development Committee from the buffer zone,

Specific objectives:

- Determine the quantity of resource need in buffer zone households (Manahari VDC).
- Study the vegetation of the Manahari VDC including assessment of timber, fuelwood and fodder needs, annual yield and energy consumption pattern.
- Study changes in land use pattern in the Manahari VDC, of the buffer zone of the Chitwan National Park.
- Study incidence of rhino occurrence and poaching activities in the Manahari VDC, of the buffer zone of the Chitwan National Park

1.4. Justification of study

Volume of study had carried out in socio-economic, vegetation and in the numerous conflicting issues of CNP and buffer zone. These researches largely ignored the interrelationship and interdependency that influences the biodiversity conservation. Site specific studies on the local level addressing the ground truth were lacking. To incorporate different factors into one for better insights of influences, my study will avail the information on the way of livelihood of the people, vegetation ecology of the community forest, resource need and supply and the land use pattern within the VDC. Information thus produce will help to understand the conservation threats, subsequently guides to develop the program according to stakeholders' aspiration.

The research had focused on root cause of poaching, household economy and status of community managed forest. It is important to interface the well being of the communities for long term survival of the rhinos in Chitwan. Often it is argued that poor and professional castes (marginalized households) are under represented in the decision

making body of the Buffer Zone Management Committee. My study argues that not only marginalized households are susceptible to poaching earnings but also well to do households. Therefore, this study was designed to look at social status, habitat conservation, land allocation, education and employment opportunities.

This study is different from many other studies in the past. Resources Himalaya Foundation initiated a mentorship research conservation programme in 2006. Under this programme all 35 VDCs and 2 Municipalities under the buffer zone of CNP would be studied looking at population growth, socioeconomic structure and overall natural resources for sustenance such as labour, fuelwood and fodder in each VDC. By doing so, accurate information would be available for the management because all VDC areas and their forest patches are different. In addition, investigators would have an opportunity to prepare master' s dissertations.

1.5. Site Description

Manahari VDC lies in the eastern boundary of CNP in Makwanpur District. Section (46) number 33 Nepal gazette part 3 date 2053/8/17 designated the boundary of buffer zone of the CNP. According to the gazette the area West of Hasta khola of ward no 2 and Rapti confluence upto the Highway to the bridge of Lothar River is the boundary of buffer zone of Manahari VDC. Two wards of Manahari VDC were combined with Lothar user committee of Chitwan District, under the buffer zone of CNP (Fig: 1). The area is mostly the flood plain of Rapti river and has face flood occasionally. Wild beasts (Rhino, tiger, bear and cervids) frequently visit the area (as told by the villagers).The total populations in Manahari VDC was 13835 and total households was 2620 (CBS, 2001). The total Land area in the buffer zone of the VDC is 757 ha.

Box 1
General Information of Manahari VDC

Area (ha): 757.0
VDC: Manahari
No of wards included in the BZ: 2
No. of settlements: 15
No of Household: 439
Total population: 2396
No of user group: 27

Source: DNPWC/ PPP 2000

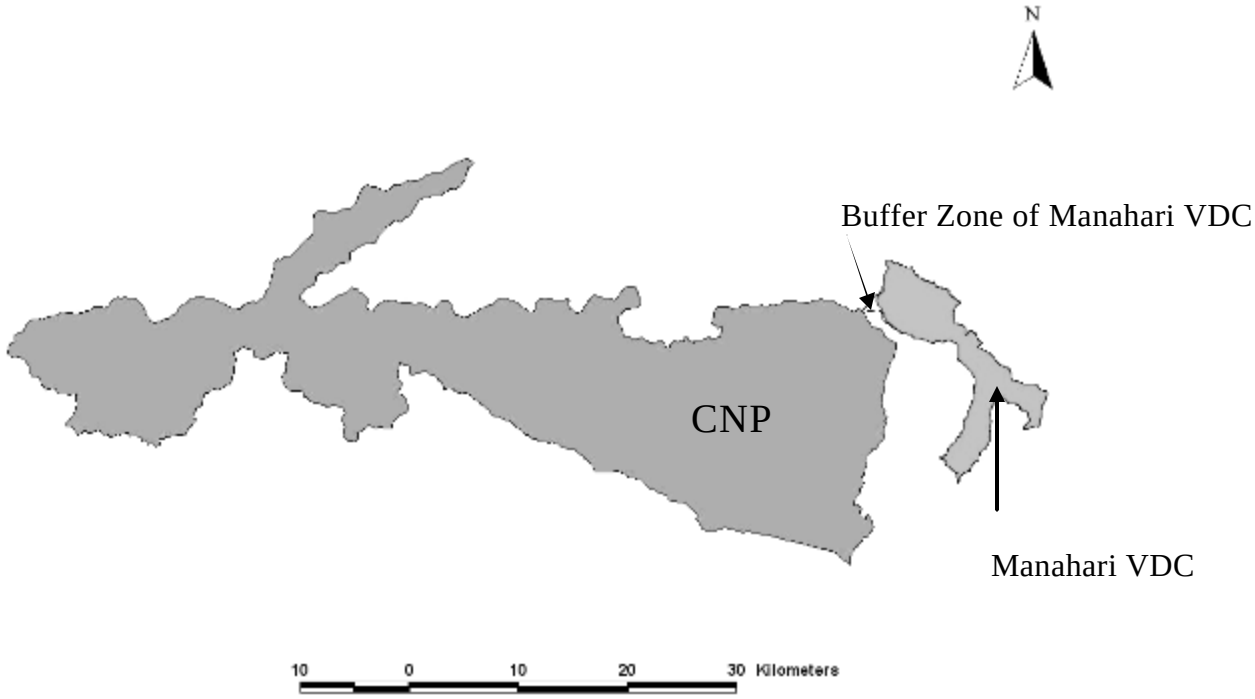

Fig: 1: Site map of CNP with study area

Table 1: Population of Manahari VDC

Census year	Average HH	Total no of HH	Total Population	Male Population	Female Population
2001 Census	5.28	2620	13835	6986	6849
2005 Projection	5.1	2861	11105	7627	7478

Source: PCP 200

Table 2: Land use category in BZ

Category	Total Land area (Ha)
Cultivated Land	103.00
Forest Land	147.10
Shrub Land	76.12
Grass Land	0.00
Cultivated Land (per Person)	0.04
Forest Land (per Person)	0.06

Source: DNPWC, PPP and UNDP, 2000.

The study area was dominated by Tamang. The literacy rate of the village in total was 44.7(Districts Village Development Profile 2002), but the studied area seems at more dreadful condition. The two BZ wards, (ward no 1 and 2) with 757 ha of land with 439 household and a total population 2396 (PCP 2000).

1.6. Limitation of study

The study was conducted during an academic session of the Masters' degree in environmental sciences hence it is not free from limitation. I spent only two months in the field (March- April, 2006).

The study was conducted during the insurgency period, so compromise had to be made. The plots were designed from the LRMP 1992 map which needed further corrections and no new land use maps were available. The points generated from the maps were missing from the actual field so latitudinal extensions were made.

Vegetation survey was carried out in the dry spring seasons so all the species including annual herbs could not be identified. Moreover the forest area was dry and burnt.

Chapter 2

Methodology

2.1. Household Socio economic survey

2.1.1. Survey design and Sample size

The household socioeconomic survey covered two wards of Manahari VDC. Stratified random sampling method was applied for the survey on the basis of settlement size which was based on population size (DNPWC/PPP, 2000), and land holding of household which was classified into five classes.

Table 3: Distribution of settlement by population size

Symbol	Settlement	Population
S1	Lothar	101-300
S2	Campa Tole	Up to 100**
S3	Sunachauri	>300
S4	Sunachauri post	100-300*
M1	Khair Ghari	>300*
M2	Jogi Tole	Up to 100

* indicates not included in the source data ** indicates the settlements do not exist

Source: DNPWC/PPP, 2000

Table 4: Land holding categories

Symbol	Land holding
1	Landless
2	0-10 Kattha
3	10-20 Kattha
4	1- 4 Bigha
5	>5 Bigha

(1 Bigha= 20 kattha= 0.68 ha)

The sample size (n) of the household in the study area was determined by using formula (Arkin and Colton, 1963; cited in Sharma, 2000) at 95 % confidence level.

$$n = \frac{N Z^2 P(1-P)}{Nd^2 + Z^2 P(1-P)}$$

Where, n = sample size

N= total number of households

Z= confidence level (at 95% level z=1.96)

P=estimated population proportion (0.05, this maximize the sample size)

d=error limit of 5% (0.05)

The sample size was found to be 62 households. These 62 households were chosen on the basis of settlement size and land holding. Random sampling method with replacement was used for equal number of sample size distribution in each settlement and land holding categories. Each sample was drawn through lottery method.

A village settlement map with total no of households prepared by a local organization (NGO count the total settlements. According to the map there were 6 settlements patches, namely Lothar, Sunachauri A (Post), Sunachauri B, Khairghari and Jogital. Regular discussion between team members was made on subject matter of questionnaires to make similar and equal understanding level and to help each other in sorting out problems. Interview was made with the family head as far as possible, if such was not possible interview was taken from the next knowledgeable member of the household.

2.1.2. Questionnaire survey

Sixty two households representing from two wards and different five land holding categories (Table 4) were interviewed and filled in semi structured questionnaire.

Questionnaire with three parts was developed (For detail see annex 7) including information of household, Buffer zone community forest and buffer zone management issues and rhino/ wildlife related issues.

2.1.2.1. Household information

This part mainly focused on the household information to identify the livelihood support mechanism through occupation of respondent and family members, land holding, crop types and its production, livestock holding (including feeding types), resources need (Fuelwood and fodder) and their access, energy use and consumption pattern and annual income and expenditure analysis.

2.1.2.2. Buffer zone related issues

This part is related with Buffer zone community forest and buffer zone management issues. It was designed to obtain the information about condition of buffer zone forest, types of resources extraction, pressure on community forest, resources allocation system, land categorization within community forest, problems within the community forest, suggestions/ recommendation for better management and resources utilization of community forest., budget transparency and household level participation in Buffer zone management.

2.1.2.2. Rhino/Wildlife related issues

This part was designed to obtain the information on crop and livestock depredation by Rhino and other wildlife, compensation mechanisms, trend of Rhino movement, reason for rhino decline, rhino poaching events, poachers identity, current ongoing programs to conserve Rhino by authorities (Buffer Zone Management Committee / Buffer Zone Community Forest/ National Park) and their effectiveness and suggestions/ recommendations for future initiatives to protect/ conserve Rhinos.

2.1.3. Data Analysis

2.1.3.1. Household Income

Net household income was determined by subtracting overall expenditure from total income. Income from agriculture production noted in local unit (Muri) was converted into standard projection unit (Kg), by using following conversion.

Table 5: Conversion for local unit into standard unit

	Un milled (Muri)	Kg
Paddy	1 =	50
Maize	1 =	60
Wheat	1 =	69
Oil seed	1 =	57

Source: Nepal and Weber, 1993

Agriculture and livestock production was converted into monetary value by multiplying the local market price. Income from other sources like business, service, wage labor, remittance and others was directly obtained in monetary value. Expenditure was also noted on different topics (Education, livestock, Agriculture, livestock maintenance, food and others) in monetary value.

2.1.3.2 Estimation of Annual Resource (Fuelwood and Fodder) Need.

Annual resources of the respondent and amount resources from different sources (Buffer zone community forest, National Park, Own land and other community forest outside Buffer zone) was noted in local unit (Bhari). And weight of the Bhari was converted into Kilogram (Kg) according to respondent perception and experience as possible. Those who could not convert Bhari into Kg following equivalents were used.

Table 6: Conversion unit for local resource unit into standard unit

Local unit			Standard unit (Kg)
1 Bhari	Fodder	=	50
1 Bhari	Fuelwood	=	40

Source: Nepal and Weber, 1993

Data were analyzed using different statistical tools. Data from questionnaire were first entered into the MS Excel program in database form. Some necessary calculations were completed with this program. Qualitative form of data and information were also coded and entered for analysis. Once the basic calculation and modification were completed variables were categorized according to needs of analysis.

2.2. Vegetation Survey

2.2.1 Survey Design

FINNIDA land use map (1992) scaled at 1:25000 was used for vegetation survey which was digitized using Arc View. Random points were fixed on the digitized map of Manahari VDC by using GIS software. These random points were located in the field with the help of GPS. Vegetation survey was conducted only on the points that were inside the forested area on buffer zone community forest.

2.2.2. Sample size

Random points were generated using GIS software by creating gridlines in each 30' ' difference on the Manahari VDC digital map of FINNIDA land use map (1992) and in each such gird, random numbers were plugged.

A transect line of 30 seconds interval which was developed. At each sampling point' s quadrate plots of 20x20 m^2 square shaped quadrate laid to study tree species. At two opposite corners in South-East and North-West corner within tree plots nested quadrates of 5x5 m^2 were laid to study shrub species. Similarly at two opposite corners within shrub plots 1x1m^2 were to study herbs species.

All tree species having diameter at breast height (Dbh) greater than 10 cm were studied within 20x20 m^2 plot. The dbh and height of each tree were measured with the help of dbh tape and clinometer respectively. Crown coverage, no of cut stumps, lopping and grazing intensity was also recorded.

Height, number and coverage of all species with height greater than 10 cm, and dbh less than 10 cm were recorded. Similarly, the number height and coverage of all herb species, including seedlings of trees and shrubs species with less than 10 cm height, were recorded in 1x1 m^2 nested plot. (Rizal and Mailby, 2006)

Number of cut stump of tree species with height and circumference, ocular estimation of lopping percentage of tree species, grazing percentage and evidence of burning and human interference were noted.

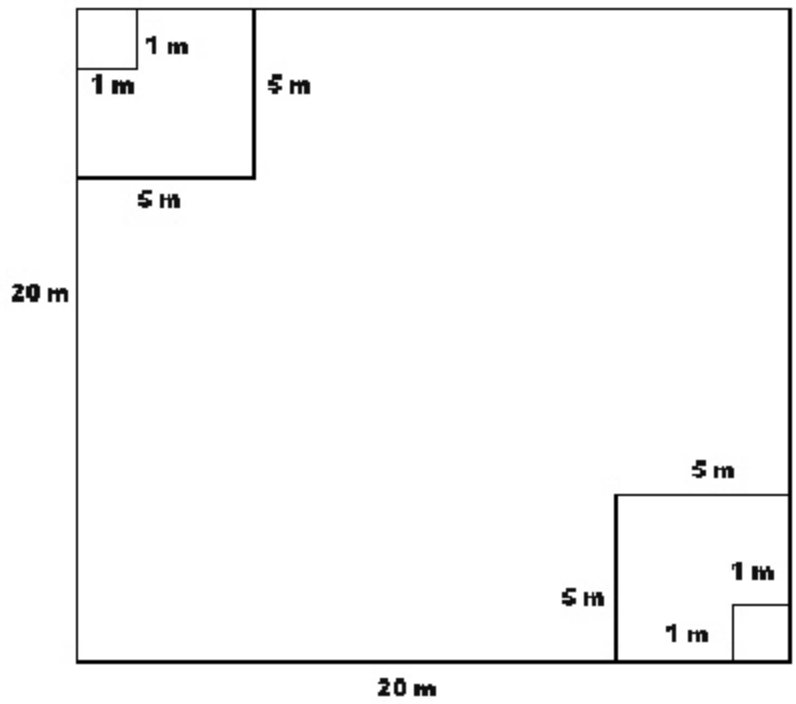

Fig: 2: Plot Design (Nested quadrate plot)

2.2.4. Classification of Forest

2.2.4.1. Forest Types

The buffer zone forest of Manahari VDC was found to be Riverine forest and Mixed hardwood forest (CNP and buffer zone management plan 2000-2005).

1. Terai Mixed Hardwood (TMH)
2. Riverine Forest
3. Terai Sal forest

2.2.4.2. Stand size

The following stand size classes as used by Forest Inventory Division (FSSD 1988 a/b .Chitwan) were adopted in this study area for stand size classification.

Table 7: Stand size classification

Symbol	Stand Size	DBH (cm)
1	Sapling	<12.5
2	Poles	12.5 – 25
3	Small saw timber	25 – 50
4	Large saw timber	> 50

2.2.5. Calculation

Density, frequency, relative density and relative frequency of the species were calculated. Similarly basal area, Importance value index and species diversity of tree species were also calculated. Density, Relative Density, Frequency, Relative Frequency, Basal Area, Relative Basal Area and Importance Value Index (IVI) were calculated for tree species. The formulae used for the analysis of vegetation were given in the annex 7. For regeneration of tree species, height classes were made based on Rijal & Meilby (1995) and the lopping intensity was classified based on Silori (2001).

2.2.5.1. Tree Volume

The computerize calculation system called inventory (INV) developed by the Forest Inventory Section, Ministry of Forest and Soil Conservation, Nepal (FSSD, 1988 Chitwan) was used for the calculation of resources of the Manahari Buffer zone community forest. INV was used to estimate the volume of each individual tree. The system estimates for computing the total volume of the whole stem is

Ln (V) = a + b x Ln(d) + c x Ln (h)s

Where, Ln refers to logarithm

V = total stem volume with bark

d = Diameter at breast height

h = Total height

a, b and c are the volume parameters, which are constant for each species but different between species. The volume parameters were obtained from the study carried out by Forest Survey and Statistical Division (FSSD, 1991).

2.2.5.2. Biomass of stems, branches and foliage

INV can also compute the biomass of stem, branches, foliage and whole tree. Stem biomass is obtained by multiplying the stem volume by wood density. Wood density was obtained from Forestry Sector Master Plan, 1988 (HMG, 1988 a). For obtaining the biomass of branches (fuelwood) and foliage (fodder), ratio of branch to stem biomass and foliage to stem biomass were applied for various species (HMG, 1988 a).

2.2.5.3. Estimates of Annual Yield

The Master Plan for the forestry sector of Nepal (MPFSN) has estimated the annual yield of different forest types of Terai for the Central Development Region. The percent annual yield estimated by Master Plan in similar forest types of Central Development Region were applied to estimate the annual yields of Buffer zone forest in the study area.

The annual yield of the Terai mixed hardwood forest was used for the annual yield of tree species like, Alibizia *julibrissin, Bombax ceiba, Trewia nudiflora, Holarrhena pubescens* etc. Although MPFSN had classified the Siwaliks, of which Chitwan valley is a part, as an area having little fuelwood deficit, the situation for villages adjoining the park should be no different than the Terai region which suffers from a major shortage (Sharma, 1991). And the major thing is that almost all Siwaliks area has been protected as National Park and the study area lies in the inner Terai having almost similar type of climatic condition, so the annual yield was calculated on the basis of similar forest types of Terai of the Central Development region.

Defining sustainable wood harvest as the sum of stem and branch growth, and stem and branch mortality with only 15 % of stem growth allocated for timber and rest (85 %) for fuelwood assuming recovery factor for Terai is 90 % (HMG, 1988 a). The annual accumulation of dead wood is 4.9 % of the annual yield (HMG, 1988 a). Hence, for the

calculation of fuelwood from dead wood, 4.9 % of total wood was considered as fuelwood.

Table 8 : Growing stock and annual yield (tons/ha) in the natural forest of Terai regions of Central Development Region, Nepal (Source: HMG, 1988)

Forest Type	Forest Biomass			Annual Yield			Percentage Yield		
	Stem	Branch	Leaf	Stem	Branch	Leaf	Stem	Branch	Leaf
TMH	86.1	59	3.7	4.2	2.9	0.2	4.88	4.92	5.41
KS	74.1	50.7	7.4	3.8	2.6	0.4	5.13	5.13	5.41

TMH = Terai Mixed Hardwood forest, KS= Khair Sissoo Forest

The yield from leaf biomass can be used as fodder if the tree is fodder species. Similarly, fodder yield from buffer zone forest was calculated on the basin on Total Digestible Nutrient (TDN) yields for various categories of land as follows (HMG, 1988 b).

Table 9: Fodder yield from various land category (Source: HMG, 1988 b)

Land Category	TDN Yield (t/ha/yr)
Hardwood forest, grazing	0.34
Conifer forest, grazing	0.1
Mixed forest, grazing	0.15 - 0.2
Forest plantation/hand cutting	1.44
Shrubs/ burnt forest grazing	0.77
Waste land/ over grazed land, grazing	0.24
Flat land, grazing	0.58

2.3. Land use change pattern

To study of land use change pattern of Manahari Buffer zone VDC, LRMP-data (1978) and FINNIDA maps (1992) were used. The data was analyzed using ESRI' s software' s, Arc info 3.5.2 and Arc view 3.2. From the overlay map of land use between 178-1992, comparison of areas and rates of change of the different land use was made. And also the overview of land cover changes (percent) in the six categories, including land cover gained and lost from each category for the period between 1978 and 1992 was calculated.

2.3.1 Flow chart for GIS interpretations

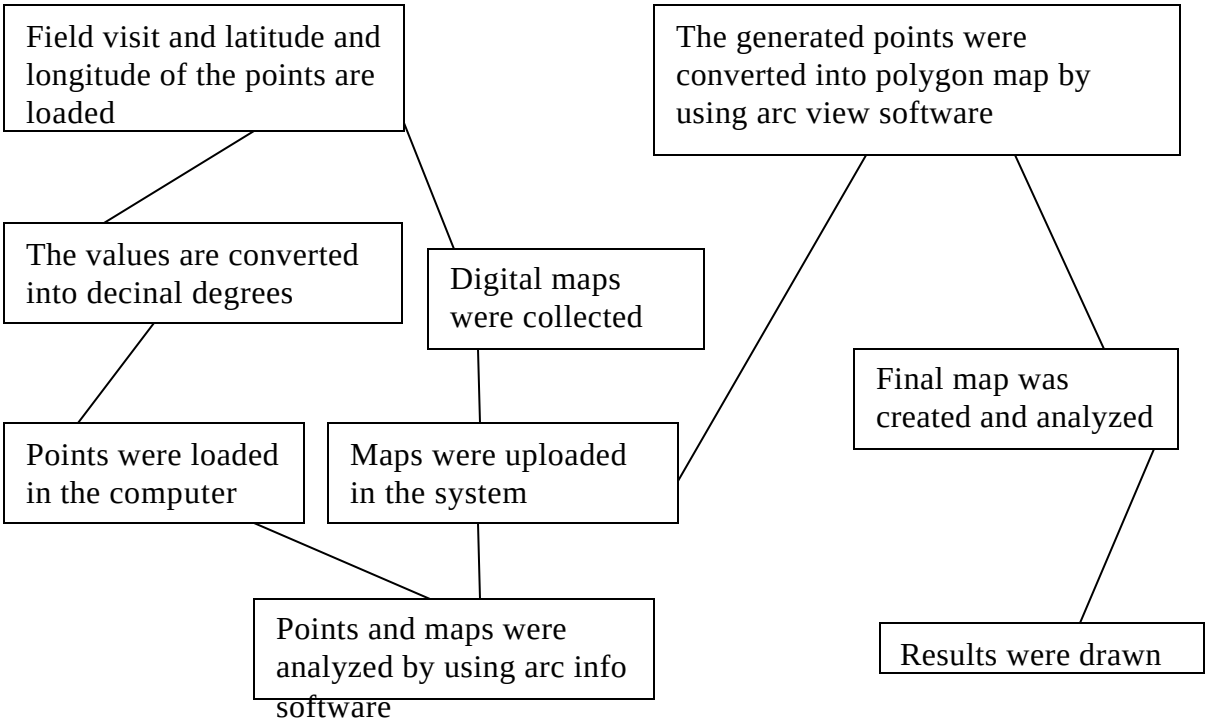

Fig 3: Flow chart for the GIS interpretations

Chapter 3

Results

General information:

3.1. Household Socio economic survey

3.1.1. Family structure, size and Residence period

In the study area, 45 nuclear families and only 17 joint families were interviewed. The average family size was 6 and the male and female ratio was equal (Table 10). Of the total population, 37 percent were of age below 15 years, 6 percent of age above 60 years and rest 57 percent of the productive age groups between 15 to 60 years (Table 11). The settlements were new and recently formed. About 16 percent respondents lived there only for less than 10 years, 20 percent were there from 20 years and only 10 percent were living there for more than 50 years. The trend of migration from the hills of Makawanpur District was common and continuous.

Table 10: Household (hh) characteristics

Total no of hh in the BZ	488
Sampled hh	62
No of singular family	45
No of joint family	17
Average family size	6
Male: female	3: 3

Table 11: Sampled population with respect to age group

Age group	Individuals	%share
Below 15	138	37
15-60	211	57
Above 60	23	6
Total	372	100

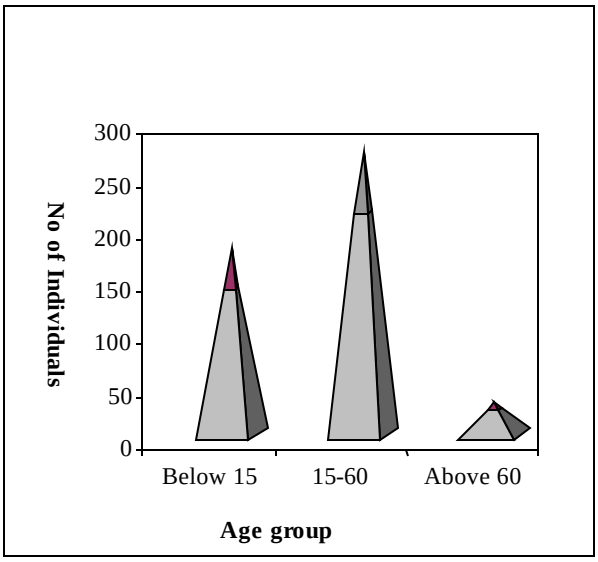

Fig 4: Age pyramid of sampled population

3.1.2. Level of education and profession

The education status was poor with 48 percent of the total respondents' family were uneducated and only 2 percent had education above S.L.C. (Table 12). The total share of the dependent population, below 15 and above 60 is 43 percent and the productive population share is 57 percent. (Fig 5) Only 4 percent of the total were skilled manpower including all employed/job holders and 27 percent are students, 1 percent of population were dependent upon remittance and 5 percent were involved in self business.

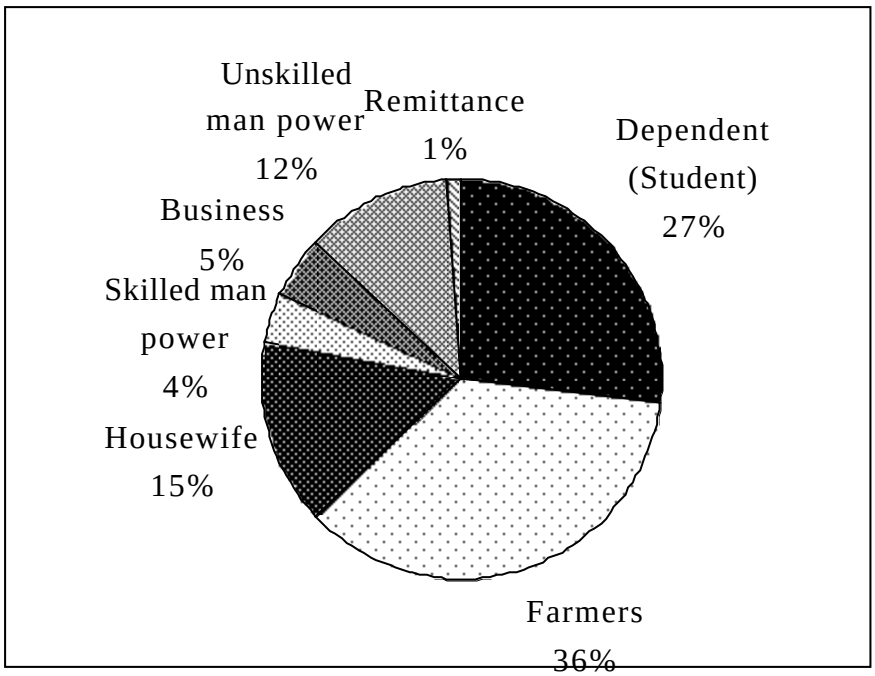

Fig 5: Professional structure

Table 12: Educational status of the respondent families

Educative status	No of Individuals	% share
NE	178	48
HE	186	50
CE	8	2
Total	372	100

3.1.3. Land holdings

The average land holding of the household was 0.51 hectare (ha). The land ownership study indicated that of the total land of each household, 0.24 ha was government land (encroached land) and 0.26 ha private land (Table 13). However, about 6 percent of the people were landless and they did not have even government land. If the government land or 'Aileni' (land of which they do not have ownership papers) are not considered then 60 percent will be landless, 54 percent landless were using government land. Those who have private land makes a share of 40 percent and of these 11 percent have only private land and rest 29 percent have both types of land. The average land holding of such households was 0.47 ha and 1.05 ha respectively (Table 14).

Though some individuals had land but it was unproductive. In total 14 hh do not produce food at all and 7 of the studied households have balanced and surplus (Table 15).

Table 13: Land category

Land holding Category	No of HH	No of Hh*
1	4	36
2	33	12
3	10	9
4	13	5
5	2	0

***** Government land was also considered as owned land

Table 14: Land holding type

S.N.	Land holding	No of Hh	% Share	Average LH (ha)
(i)	100% Landless	4	6	0
(ii)	Only government land	33	54	0.26
(iii)	Only private land	7	11	0.47
(iv)	Both (ii and iii)	18	29	1.05
	Total	62	100	

Table 15: Crop production and sustainability

Crop productions and food sufficiency	No of HH	% Share
Not at all	14	23
Less than a month	6	10
Less than six months	22	35
More than six months	13	21
Sufficient and surplus	7	11
Total	62	100

3.1.4. Buffer zone related issues

Every household were the member of the Buffer Zone Management system but the approach to information and member status was unknown to most of them. About 25 percent of the sampled households were unknown about the buffer zone and its functioning. 68 percent have buffer zone membership and rests did not know about it. Cases of double memberships i.e. also member of adjoining buffer zone community forest of Piple VDC were also found.

Table 16: Buffer zone membership and Status

Buffer zone status	No of HH	% Share
No	21	34
Member	34	55
Executive	7	11
Total	62	100

3.1.4.1. Community forest

The people in the study area were using four patches of forest (Table 18). More over a small patch was also designed as the Leasehold forest which was not included in my study. Respondents told that the community forest was degraded. About 27 respondents told that it is satisfactory, 8 of them said it is good, 6 did not know about the buffer zone community forest and 1 told that it is very good now.

All of household use fuelwood, as the primary source of energy, and of them 74 percent said that the available resources, (fuelwood and fodder) is not enough and 26 percent agreed that it is enough.

Table 17: Condition of the Community forest

Condition	No of HH	% Share
Don' t Know	6	14
very good	1	2
Good	8	19
Satisfactory	27	65

Table 18: Forest used by the locals

Community forests	No of HH	% Share
Bhramsthani Lamidamar BZF	45	57
Sunadevi	25	32
Lothar	8	10
Bhramsthani Simara, Piple BZF	1	1

The forest of the study area did not seem enough for the villagers demand. They had suggested different alternatives for better management of the existing forest. They mostly suggested for further plantations and management of forest, community involvement in conservation works and need of dykes and fence to protect forest from recurring flood events.

Table 19: Suggestions and Recommendations for Better Management of Community Forest

Suggestions	No of respondents
Alternative Energy Source	1
Awareness Education and Skill Development trainings	4
Budget Transparency	2
Community Involvement	11
Conflict Solutions	1
Forest management and plantations Needed	12
Dyke and Fencing	9
Government Should provide protection and conservation	3
No Answers	15
Rules Regulation and Work Plans need and should be improved	4
Forest Security, firing and grazing control	23
Time Table to Harvest Fuelwood and Fodder Twice a Month	1
Workers Needed in CF	3

3.1.5. Rhino/Wildlife related issues

Wildlife was common. Incidences of livestock killed by wildlife were mostly inside the park and few in the BZ. No compensations provisions were made and the process of compensation was too lengthy.

Rhino visit was common in the adjoining settlements near the park boundary and movement decreases away from the park. Some respondent even replied that they have not seen rhino for a longtime. Locals believe that habitat loss and poaching were the main cause for declining rhino population. The rate of crop damage by rhino had decreased compared to the past. Most of the respondent told that they were not harmed but households hear the jungle reported damage from rhino for one to three months. The rate of damage probably was the cause of declining rate of rhino. No any casualties from rhino have been reported.

Table 20: Frequency of wildlife

Wildlife Occurrence	No of Respondent	% Share
Yes	18	29
Sometimes	44	71
Don' t Know	0	0
Total	62	100

Table 21: Frequency of Rhino

Rhino Frequency	No of Respondent	% Share
Occasional	29	47
Usually	15	24
Not Known	18	29
Total	62	100

Table 22: Cause of Rhino Decline

Cause of Decline	No of Respondent	% Share
Don' t Know	14	23
Habitat Loss	30	48
Poaching	17	27
Natural Loss	1	2
Total	62	100

Table 23: Rhino Damage Months

Months	No of Respondent	% Share
Don' t Damage	21	34
1 Month	13	21
2 Months	13	21
≥3 Months	15	24
Total	62	100

Table 24: Rhino status

Rhino Status	No of Respondent	% Share
Increasing	0	0
Decreasing	61	98
Same	1	2
Total	62	100

During this study the respondents have suggested habitat management; better security, awareness and education were the most to achieve the goal of conservation.

Table 25: Locals' Suggestion and recommendation to conserve rhino

Responses	No.
Habitat management	15
Tight security fencing and monitoring	14
Good governance, discipline, duty and law	9
Community involvement and coordination	6
Stop poaching killing and human encroachment	3
Awareness education and skill development	13
Religious belief	1

3.1.6. Household Income

The economic status of each hh was not calculated but the income expenditure in terms of surplus and deficit was estimated. Among the 45 respondents 11 did not have enough to eat, 1 had balanced situation and rest had savings (surplus). They do posses land and animals, rarely they buy food items, vegetables and others from the market. Land less people were the ones buying. People in the area were also found relying on the NTFP's collected from the NP. Besides they were also founds trapping wild boar cubs and selling for NR 500-2000 each. The average livestock per household was found 4.7 units but 19 percent of the household had no animals and only 8 percent were stall fed. Rests were grazing in the community forest and/or inside the park. None of the animals were reported of improved variety.

Table 26: Livestock

Feeding type	No of HH	% share
0=No animals	12	19
1= Stall feeding	5	8
2= Grazing	26	42
3= Both (1 and 2)	19	31

3.1.7. Estimation of Annual Resources (fuelwood and fodder) Need.

The total estimated fodder and fuelwood demand were 2971.8 tons and 172.4 tons respectively. But this does not include the demand for the grazing livestock and the agricultural byproducts, like hay and straw. The average livestock unit per household was 4.7.

Table 27: Meeting demands for fuelwood and fodder

Source	No of hh	% share
Park	25	40
Buy	3	5
Others	34	55

3.1.7.1. Energy use:

Every household in the study area were using fuelwood as the primary source of energy. 80 percent also using Kerosene for lighting purpose, 51 percent had electricity lines 9 percent also had biogas, 8 percent had LPG and 30 percent among them were also using other sources like battery, wax candle etc.

Table 28: Energy consumption pattern

Energy consumption pattern	HH	%Share
Fuelwood	62	100
Kerosene	50	80.65
Electricity	32	51.61
Biogas	9	14.52
LPG	5	8.06
Others	30	48.39

3.2. Vegetation Analysis

The study was carried out in the BZCF (Brahmasthani Lamidamar CF) of the Manahari VDC. The VDC had a small patch of Sal (*Shorea robusta*) forest (Campa tole forest) too but it was inside the army camp so studies can not be conducted in them.

3.2.1. Herbs

The total of 18 species of herbs was recorded in the study area. The density and relative density was found to be highest of *Saccarum spontaneum* and *Solanum xanthocarpum* i.e. 237500/ha, 39166/ha, and 53.88percents and 8.88percents respectively. Similarly highest frequency and relative frequency was recorded of *Arundinella nepalensis* and *Solanum xanthocarpum* i.e. 33.3percents and 9.30percents respectively. The lowest frequency and relative frequency was 16 percents and 4.6 percents and was common for 13 species.

Table 29: Analysis of the Herbs

SN	Name of the species	D/ha	RD	F	RF
1	*Arundinella nepalensis*	16666.67	3.78	33.33	9.30
2	*Aschyranthes aspera*	5000.00	1.13	25.00	6.98
3	*Cynodon sp*	5000.00	1.13	16.67	4.65
4	*Cyperaceae sp.*	5000.00	1.13	16.67	4.65
5	*Dalbergia sissoo*	833.33	0.19	16.67	4.65
6	Unidentified 1 (Dhukure ghans)	4166.67	0.95	16.67	4.65
7	Unindentified 2 (Dhukure jhar)	23333.33	5.29	16.67	4.65
8	*Euphorbia hirta*	11666.67	2.65	16.67	4.65
9	*Impereta cylindrica*	30000.00	6.81	16.67	4.65
10	Unindentified 3 (Jhar)	1666.67	0.38	16.67	4.65
11	Unindentified 4 (Jhinge/jushe jhar)	24166.67	5.48	16.67	4.65
12	Unindentified 5 (khursani jhar)	25833.33	5.86	16.67	4.65
13	*Lantena camera*	1666.67	0.38	16.67	4.65
14	Unindentified 6	833.33	0.19	16.67	4.65
15	*Mikania micarantha*	7500.00	1.70	25.00	6.98
16	*Pilea sp.*	833.33	0.19	16.67	4.65
17	*Saccarum spontaneum*	237500.00	53.88	25.00	6.98
18	*Solanum xanthocarpum*	39166.67	8.88	33.33	9.30
	Total	440833.33		358.33	

3.2.2. Shrubs

A total of 40 shrub species were recorded from the study area. The total calculated density was 51720/ha. The density and relative density was found to be highest of *Lantena camera* and *Mikania micarantha* i.e. 7880/ha, 7240/ha and 15.2 percent, 14 percent respectively. Similarly highest frequency and relative frequency was recorded of *Murrya koenigii* i.e*100* and 8.47 respectively. The lowest frequency and relative frequency is 10 and 0.85 percent shared among 20 species. The potential fuelwood and fodder values for shrubs and herbs were not calculated, though the shrubs were used.

Table 30: Analysis of the Shrubs

SN	Name of the species	D/ha	RD	F	RF
1	*Achyranthes aspera*	360	0.70	20	1.69
2	*Albezia lucida*	680	1.31	80	6.78
3	*Clerodendron viscosum*	2600	5.03	90	7.63
4	*Caliocarpa macrophylla*	560	1.08	20	1.69
5	*Cassia fistula*	40	0.08	10	0.85
6	*Chenopodium sp*	40	0.08	10	0.85
7	*Cissampelos pareira*	720	1.39	50	4.24
8	*Clemantis grata*	800	1.55	20	1.69
9	*Clemantis sp.*	40	0.08	10	0.85
10	*Coffia bengalensis*	80	0.15	10	0.85
11	*Colebrookea oppisitifolia*	2920	5.65	60	5.08
12	*Dalbergia sisso*	120	0.23	10	0.85
13	*Ehertia levis*	160	0.31	10	0.85
14	*Eupatorium adenophorum*	1360	2.63	10	0.85
15	*Ipomea sp*	240	0.46	10	0.85
16	*Lantena kamera*	7880	15.24	80	6.78
17	*Mallotus philippenis*	40	0.08	10	0.85
18	*Marrdenia koenigii*	800	1.55	10	0.85
19	*Marrdenia royalei*	3080	5.96	80	6.78
20	*Mikania micarantha*	7240	14.00	70	5.93
21	*Murrya koenigii*	6960	13.46	100	8.47
22	*Mytragyana parviflora*	280	0.54	10	0.85
23	Unidentified 1	40	0.08	10	0.85
24	*Pilea sp.*	80	0.15	10	0.85
25	*Pogestomon glaber*	5120	9.90	80	6.78
26	*Porona sp.*	400	0.77	10	0.85
27	*Premna sp.*	680	1.31	30	2.54
28	*Eupatorium glandolusum*	2920	5.65	40	3.39
29	*Sida sp.*	240	0.46	20	1.69
30	*Solanum erianthum*	240	0.46	10	0.85
31	*Solanum torvum*	40	0.08	10	0.85
32	*Solanum verbascifolium*	600	1.16	20	1.69
33	*Solanum xanthocarpum*	1280	2.47	40	3.39
34	*Syzigium sp*	240	0.46	10	0.85
35	*Syzigium operculata*	120	0.23	10	0.85
36	*Trewia nodiflora*	800	1.55	50	4.24
37	*Uncaria sp.*	240	0.46	10	0.85
38	*Urtica dioca*	1480	2.86	20	1.69
39	*Vellaris stanacca*	40	0.08	10	0.85
40	*Wetlandia sp.*	160	0.31	10	0.85
	Total	51720		1180	100.00

3.2.3. Trees

A total of 11 species of grown up trees were recorded. The total tree density was 385/ha. The calculated density and relative density was found to be highest of *Trewa nodiflora* and *Albezia lucida* i.e. 240/ha, 50/ha and 62.34 percents, 12.99 percent respectively. Similarly highest frequency and relative frequency was recorded of *Trewa nodiflora* and *Albezia lucida* i.e.100, 60 and 25 percents and 15 percents respectively. The lowest frequency and relative frequency is 20 and 5 percent. The basal area and relative basal area was highest of *Trewia nodiflora* i.e. 6.54 m^2/ha and 31.26 percents. The IVI value of *Trewia nodiflora* was 118.60 which show that the species is more common in the study area. The calculate Shannon Weaver' s diversity index (H) for tree species is 0.81.

Table 31: Analysis of the Trees

SN	Name of the species	D/ha	RD	F	RF	BA (m^2/ha)	RBA	IVI
1	*Acacia catechu*	25	6.49	40	10	1.76	8.43	24.92
2	*Albizia lucida*	50	12.99	60	15	5.41	25.86	53.84
3	*Azadirachta indica*	5	1.3	20	5	0.05	0.25	6.55
4	*Caseria elleptica*	5	1.30	20	5	0.32	1.53	7.82
5	*Cassia fistula*	5	1.30	20	5	0.19	0.91	7.21
6	*Dalbergia sisso*	25	6.49	40	10	4.56	21.81	38.30
7	*Ehertia laevis*	15	3.90	40	10	0.49	2.34	16.24
8	*Glochidon* sp.	5	1.30	20	5	0.09	0.43	6.73
9	*Litsea monopetala*	5	1.30	20	5	0.11	0.51	6.81
10	*Albizia procera*	5	1.30	20	5	1.40	6.67	12.97
11	*Trewia nodiflora*	240	62.34	100	25	6.54	31.26	118.60
	Total	385		400		20.91		300.00

3.2.4. Dbh class of tree species

The dbh category of the total species were analyzed and found that maximum of 44.6 percents were of pole sized and minimum of 8.1 percents of large saw timber. Similarly, the dbh category of individual species was also calculated.

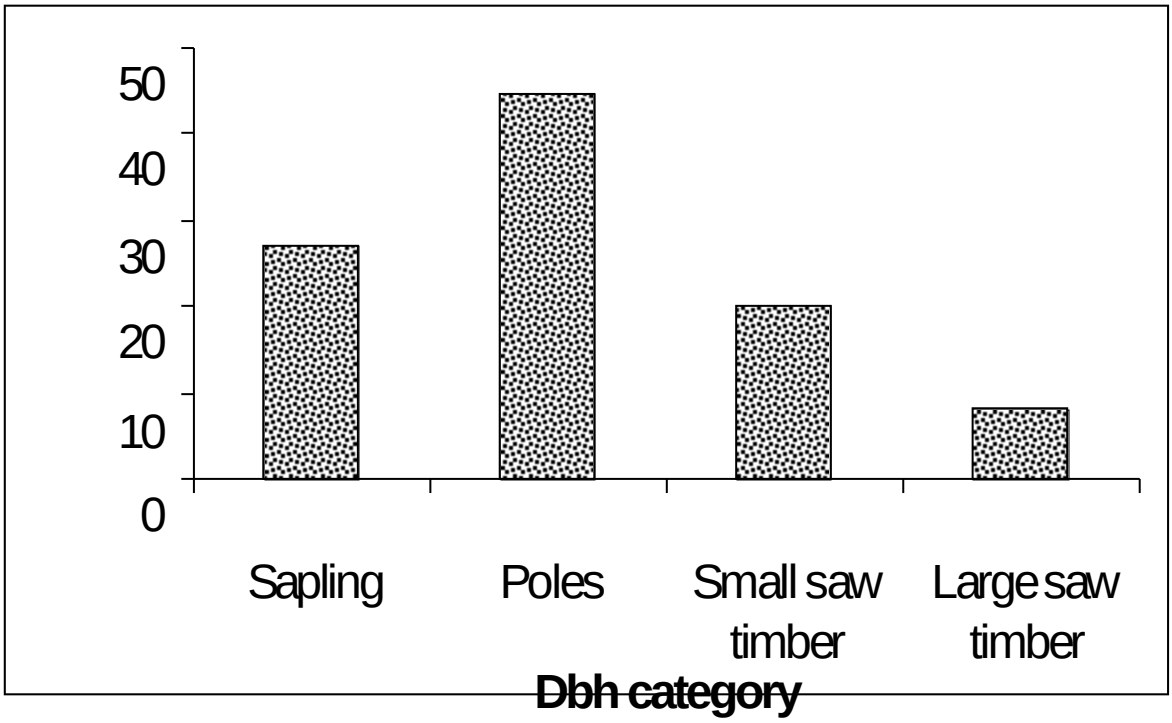

Fig 6: Dbh category of trees

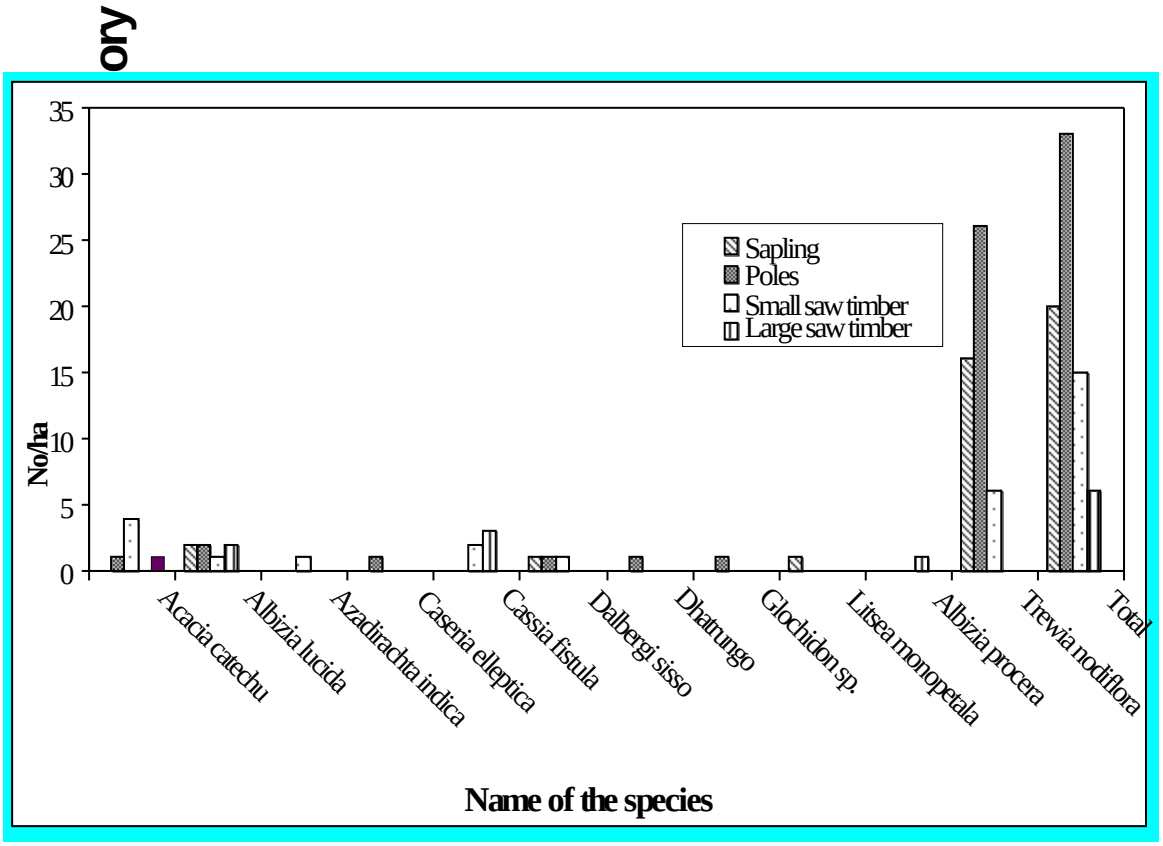

Fig 7: Dbh category of individual tree species

3.2.5. Regeneration of the tree species

There were 13 species of tree found under the regeneration category. *Trewia nodiflora* had the highest density of 16667/ha and lowest 833/ha among *Valaris stanacca* and *Syzigium* sps. The table is given in the annex 5.

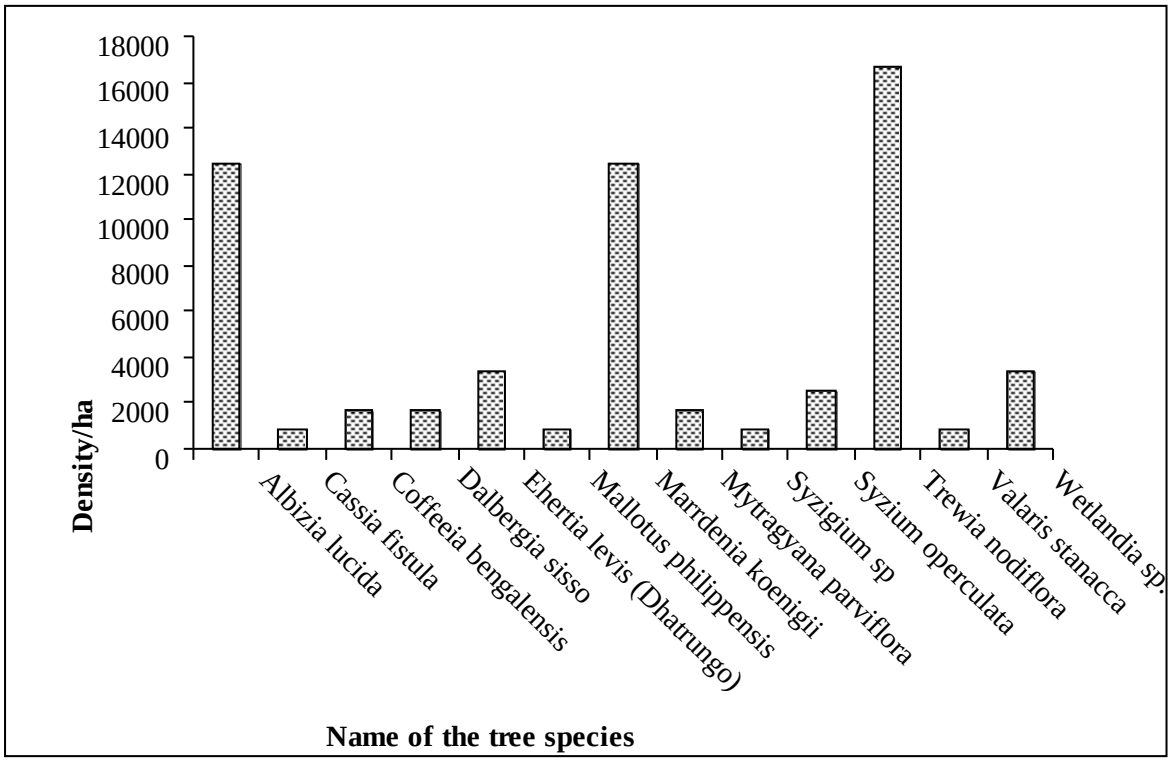

Fig 8: Regeneration of the tree species

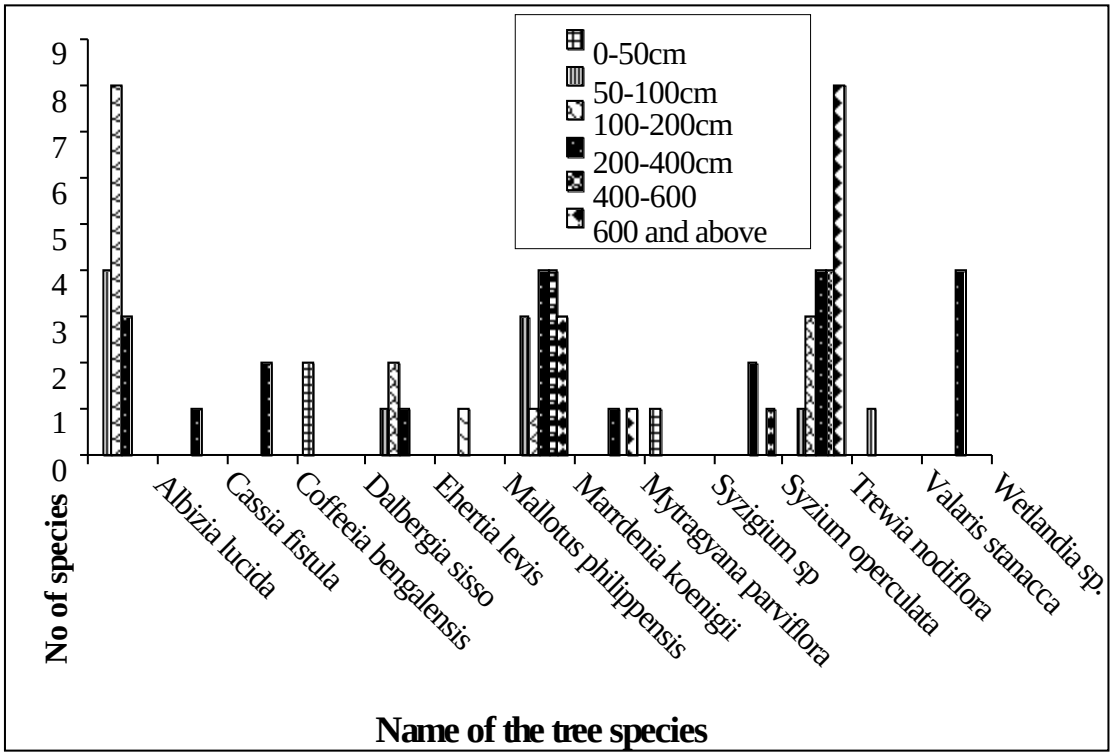

Fig 9: Regeneration of the tree species with respect to height class

3.2.6. Fuelwood and fodder

The total tree trunk volume was calculated to be 55m^3/ha.The total biomass production of the forest in terms of leaf, branch and stem was calculated to be 1.17/ha, 27.3t/ha and 41.7t/ha respectively. The potential fuelwood production of the forest is 2.09t/ha from stem and 1.4t/ha from branch and the fodder production is 0.06t/ha. Detailed calculation table is given in the annex (1/2). The demand and supply ratio of the fuelwood and fodder shows that the demand was higher than the supply amount from the buffer zone forest. There was a deficit of 1538.72 t/yr of fuelwood and 2261.87 t/yr of fodder.

Table 32: Demand and supply ratio of fuelwood and fodder

Total Forest area	222.47ha*
Total Estimated Fuelwood need	2002.03 t/yr
Total Estimated Green fodder need	3099.50 t/yr
Total Estimated sustainable fuelwood supply from BZCF	463.31t/yr
Total Estimated sustainable green fodder supply from BZCF	837.63t/yr
Deficit fuelwood	-1538.72t/yr
Deficit green fodder	-2261.87t/yr

**59.09ha of Sal forest is not accessible*

Table 33: Annual Fuelwood and Fodder Demand

Land holding	Total hh in BZ	No of HH	Average demand		Estimated fuelwood t/yr	Estimated green fodder t/yr
			Green fodder (Kg/day)	Fuelwood (Kg/day)		
Land less	104.43	4	13.75	8.75	333.53	524.12
Less than 10 kattha	155.18	10	22.3	15.5	877.95	1263.12
10 to 20 kattha	173.24	33	13.1	9.1	575.42	828.35
1 to 4 Bigha	51.73	13	25.3	10.8	203.91	477.68
above 4 bigha	3.42	2	5	9	11.22	6.23
Total	488	62	79.45	53.15	2002.03	3099.50

3.2.7. Cut Stump and Lopping

The total cut stump density was 115/ha where the highest cut stump was *Trewia nodiflora* 50/ha and *Acacia catechu* 30/ha.

Table 34: Cut stump density

Name of the species	density/ha
Accacia catechu	30
Albizia lucida	15
Jatropa quarcus	15
Mallotus philippensis	5
Trewia nodiflora	50

Among the studied tree species only 4 species were lopped which were fodder and fuelwood. The highest lopping was occurred in *Ehertia levis* and least in *Acacia catechu* i.e. 99 percent and 17.5 percent respectively. The highest lopping density occurred in *Trewia nodiflora* i.e. 55/ha and the lopping percent is 55.4 percent (annex 6).

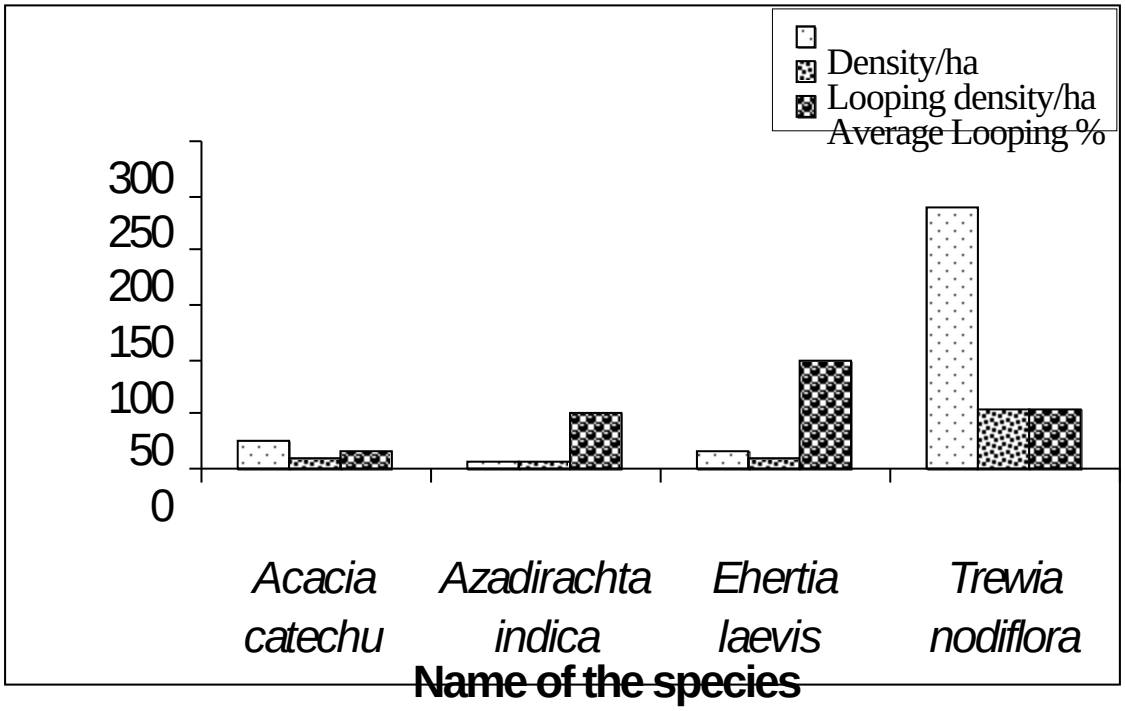

Fig 10: Lopping density of tree species

3.3. Land use change pattern

Land use change

A separate land use map of the buffer zone area of the Manahari VDC was not available. The BZ area demarcation in the map was missing. The forest area studied was not included in the map of PCP and DNPWC reports but the actual forest area was more than that reported. Two patches of forest in the Buffer Zone of Manahari VDC were mapped Brahmasthani Lamidamar community forest with area 163.4 hectare and Campatole forest 59 hectare. The later was within the security premises. From the average land holding of 0.73 ha the total cultivated land was estimated.

The buffer zone map acquired for the study was smaller than that seen in the field. The area studied also covered the land which was not earlier shown in the map as the BZ of Manahari VDC and is still considered to be under the Parsa Wildlife Reserve. The maps prepared were given in the annex 10 to 14.

Table 35: Studied forest area

Region	Area (ha)
Bramsthani Lamidamar	163.4
Campatole/ Morange dhap**	59
Cultivated area*	356.24

*Estimated from the Hh survey

** Vegetation study were not done

Table 36: General Pattern of Land use Change of Manahari VDC

Land 78	Land 92	Inference	Area (ha)
Agriculture land	Agriculture land	Unchanged Agriculture	502.29
Agriculture land	Forest	Agriculture to Forest	213.69
Agriculture land	Grassland	Agriculture to grassland	0.36
Agriculture land	Water bodies	Agriculture to Water bodies	19.06
Forest	Agriculture land	Forest to Agriculture	541.89
Forest	Forest	Unchanged Forest	7378.98
Forest	Grassland	Forest to Grassland	21.40
Forest	Shrub land	Forest to Shrub land	3.13
Forest	Water bodies	Forest to Water bodies	172.18
Grassland	Water bodies	Grassland to Water bodies	1.46
Water bodies	Agriculture land	Water bodies to Agriculture	54.02
Water bodies	Forest	Water bodies to Forest	100.36
Waterbodies	Shrub land	Water bodies to Shrub land	0.35
Waterbodies	Water bodies	unchanged Water bodies	314.05
		Total	9323.23

Table 37: Land use Change of Manahari VDC from 1978 to 1992

Land category	Area in land 78	Area in land 92	% Area in 78	% Area in 92	Change	% Change
Agriculture land	735.39	1098.21	7.89	11.8	362.82	3.9
Forest	8117.59	7693.02	87.07	82.5	-424.58	-4.6
Grassland	1.46	21.76	0.02	0.2	20.3	0.2
Shrub land	0	5.6	0.00	0.1	5.6	0.1
Water bodies	468.79	504.64	5.03	5.4	35.85	0.4
Total	9323.22	9323.23	100.00	100	0	0

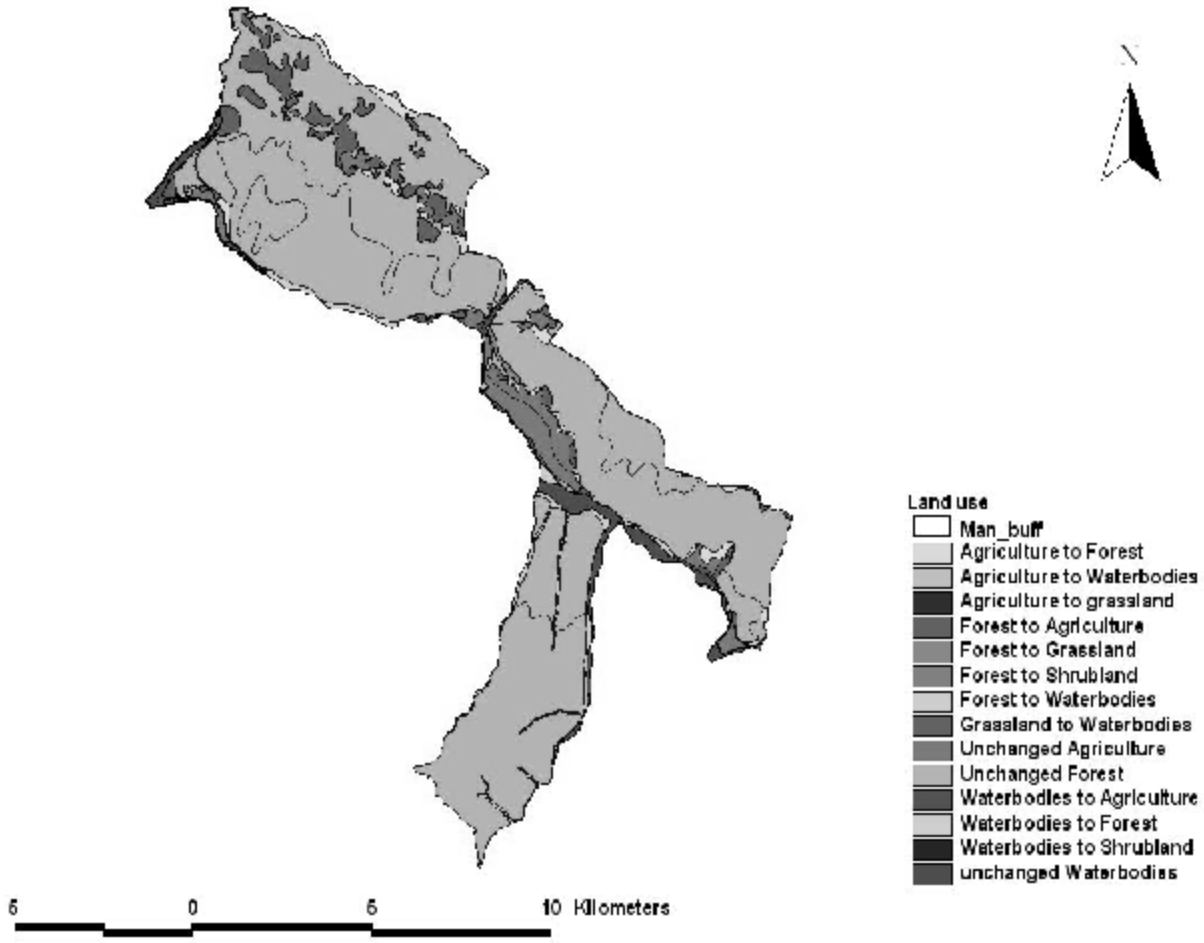

Fig 11: Land use change of Manahari VDC (1978-1992)

Chapter 4

Discussion

4.1: General information:

4.1.1: Household Socio economic survey

Though the questionnaire does not deal with the mode of interactions with the park resources, we found that almost all of the local peoples were dependent on forest products. In the spring season, lot many people enter to the Park forest, in the Churia range, to collect NTFP' s likeban-kurilo (*Asparagus*), bamboo shoots and were they also hunting small game animals like deers and boar, and also dependent upon fishing in Rapti river. For their collection they camp inside the park for about a fortnight. The people periodically use to harvest fish from the adjacent Rapti River too. Herds of cattle and buffaloes were seen entering into the park in the morning and returned only in the evening. There was no grassland or grazing land reported in the study area and the potential fodder yield from the various sources does not support the demand.

Straede et al. (2002) found that though officially villagers have been prohibited from using CNP for more than 30 years, their life still depends significantly on products from the park. Dependency on NTFPs among people within a village varies with economic and social class. Small farmers and landless households generally depend more on forest resources, than the large scale farmers. Large scale farmers' economic dependency on the forest is mostly for agriculture or related activities but small farmers or landless households depend upon commercial NTFPs that fetch greater returns than agriculture.(Murali et.al, 2006)

There were no improved breeds of animal and this was also the situation of the whole VDC (District profile of Makawanpur 2058 B.S.).The settlement area do posses land and livestock, rarely they buy agriculture and livestock products, only few landless people had to buy these products from their wage. The people were found relying on the NTFP's collected from the NP. Besides collection from forest, people also collect fuelwood and timber, brought by the flood of the Rapti river in the summer. Though river is inside the park, people activities were common through out the periphery of the NP. Illegal harvest

of fuelwood and collection of cubs of wild boar was common in the area. But it has substantial contribution in the local economy.

Chitwan valley is a very fertile land. The locals believe that a small family could survive with 10 Katthas (0.34 ha) of land. But in Manahara VDC the situation was quite different. The area was at little high elevation from the river and had no irrigation facilities. Moreover, the area was less fertile due to the dry sandy soil. Hence despite bigger land holdings they were not able to sustain their life. Most of the fields remain barren for longer time as only maize was cultivated once or sometimes twice a year.

The LRMP map and visual experiences showed that there was no managed grass land or any open land that can be used for grazing. But the average individual livestock holding is 5.8 and the fodder pressure was very high. The livestock in the area were of local variety. Since paddy was rarely grown due to irrigation problem the probability of feeding straw or husks to decrease fodder pressure was less. They were completely dependent on the forest land for their daily needs. The forest in VDC was very small so, they were forced to enter to the NP, both to collect grass and to graze the livestock. Live stocks killed were mostly inside the park and few were also killed in BZ. No compensations provisions were made and lengthy process of compensation discourage most of the people to apply for it.

The income included all sources while the expenditure calculated excluded expenses on the daily food and clothing. Hence though it seems saved, in reality they were always in scarcity. A household of the study area need about 27000 Kg food crop. But in the study area only 7 household produces that quantity. Besides, the village was dominated by the Tamang Community who use a lot of cereal to prepare domestic wine for their household consumption and this increases demand of cereal.

They do have big land to grow food crops but the land was not fertile. The soil in the area was mostly sandy soil and all the area was formerly covered by the flood deposits. It is then only not fertile otherwise sediments make land more fertile. Though the valley is

known for good rice harvest, the area was worthless in terms of cereal production. Some people grew maize twice and only a few households near the highway grow rice.

The average family size was approximately equal to VDC' s average family size of 5.77 and sex ratio is also equivalent. (District profile, Makawanpur district 2058 B.S.) Education level of the respondent was relatively lower. The literacy rate was lower than reported by DNPWC/ PPP (2000) but the percent average of above S.L.C. was satisfactory. The data showed that the level of education of the study area was lower than remaining part of the same VDC. (District profile, Makawanpur district 2058 B.S.)

The average land holding of the household in the studied area was 0.51 ha. In Chitwan valley generally 0.34 ha is enough for the sustenance of a family with average size of 5 regarding the production about 200Kg per kattha (0.034 ha) per year. In the studied area the average family size is 6 and average land holding is sustainable but due to various reasons like the soil structures, lack of irrigation facilities and repeated flood events it is much less productive. Percent landless people was much lower than the District profile, Makawanpur district 2058 B.S.)

4.1.2. Buffer Zone management and Community Forest

The buffer zone community forest was not well demarcated and managed by the community. Process of preparation of constitutional plan and work plan was going on. This portion of the buffer zone comes under the Lothar and there was confusion in demarcations. Most of the people were rampant settlers and those who owned land earlier were also residing in the public land after repeated hit by the flood.

The CNP Management Plan 2001 had envisioned that all the residents in the buffer zone area are the user member of the BZ but it did not seem so here. Less that 68 percent only had the membership which is much less. Local organizations such as DDCs, VDCs, and BUCs are largely controlled by local elites (Paudel, 2004). The members usually educated and high ranked people in the society. CNP and buffer zone management plan 2000-2005 had the goal to maintain the ecosystem of CNP for sustainable biodiversity

conservation and to conserve and enhance the unique and representative biodiversity of the area with the support of local global communities but yet no sign of the actual local community involvement was seen.

Wells and McShane (2004) found that the most important threats to biodiversity originate from protected area boundaries and involve issues and institution well outside the traditional realm of conservationists. While village visit for interview with the locals, most of the house are empty and most of them were inside the Park near the Chuiria range to collect Kurilo (*Asparagus*) root, bamboo shoot and other NTFPs. Moreover almost each and every household had a shed for the livestock but there were no animals during visits. The respondent lied saying that they do not own any livestock. But it was learned from the neighboring areas' people that their animals were sent to the Park Forest for grazing. Wildlife Conservation Regulation, 2034 B.S. / Environmental Protection Act and Environmental Protection rules, 1997 has prohibited illegal entry against any kind of collection of fuelwood, fodder, timber, NTFPs, or any animals. It has also prohibited grazing animals and camping inside the protected areas.

The forest patches in the buffer zone was very small and it is unlikely that it can meet all the demand of the local people. The committee had protected the forest the locals were deprived of regular use of the forest resources. This also forced the people to turn to the NP. Besides, the park vegetation was also under pressure from cattle and buffaloes. All the settlements near to the National park were on the Ailani land (or the government land) and almost all of them had every day hand to mouth problem and alternatives of living was lacking in the village and due to that they were dependent on NTFPs and other productions from the NP. The declaration of buffer zone and the strict rules of the community forest had affected livelihood of marginal people. The quarterly permit for collection fuelwood was not sufficient for them. They need collection permit for twice a month. Furthermore, they were not able to buy forest product even in the nominal prices due to poor economy. They were positive towards conservation of forest and they said forest collection or dependency was due to weak economy and lack of alternatives.

4.1.3: Rhino/Wildlife related issues

Wildlife movement to village is common in the area. In case of rhino it is common in the settlements adjoining the park movement decreases away from the park boundary. No accidents, neither loss or injuries of human or livestock from wildlife were recorded expect some poultry loss by fox and jackal, and there were no such records in the park also (DNPWC/ PPP 2000). Locals also told that such incidence had not occurred in recent past.

Adhikari (2002) told that all the households in the settlements of BZ are the potential shelter for rhino poachers and the entire rhino habitat lie adjacent to these settlements. There used to be a permanent shelter of rhino in the study area and the animal movement is frequent but no cases of rhino poaching were recorded. The older shelter of rhino was encroached and destroyed by the new rampant settlers.

Box 2

Rhino incidence

In case of rhino mortality within the last five years a respondent told that two dead rhinos were found nearby the Machan concessionary hotel but they don' t know the cause of death. There was one man involved in poaching and was already in jail. Similarly an individual from Sunachuri chaukitole was also nabbed and sent to jail. The incidents were all happened inside the park. Moreover the family of these individuals was also missing from the village. Therefore, we are unable to interview with the poachers. One of the local told that he had tasted the dried meat of rhino and have seen lots of meat left for sun dry inside the park near the hotel.

4.1.4: Annual Resources (Fuelwood and Fodder) Need.

A large no of households were dependent upon firewood for cooking energy and this was not only case of this VDC but entire district (District profile, Makawanpur district 2058 B.S.) The demand of firewood will increase with the increase in population. This will increase pressure on forest of the NP affecting the wildlife habitat.

Need of green fodder per livestock unit in the sampled household is very less compared to reported by Jnawali 1994 (9733.3 kg/LSU/yr). The fodder and fuelwood demand is in negative proportion, though the relative no. of hh in the buffer zone is lower than the actual dependent population. The average annual demand of fuelwood was 1.528 t/hh and fodder in terms of khar (*Imperata* sps.) and khadai (*Saccarhum* sps.) was 0.259 t/hh and0.20625 t/hh respectively (Pandit, 1995).

The annual per capita fuelwood consumption in sampled households is lower compared to NTNC, 1996 for VDC level (Sharma, 1991). To meet the demand of green fodder, users of BZCF and own cultivated land almost were equal. The BZCF users for green fodder are lower compared to DNPWC/PPP, 2000. The user of National park for fuelwood in the sample household have decreased than reported by DNPWC/PCP/UNP, 2001 for eastern sector but increased compared to Joshi (1999). For all buffer zone VDC level, DNPWC/PPP (2000) has reported nil while DNPWC/PCP/UNDP (2001) has reported 23 % households fulfill their fodder requirement from the National park in whole buffer zone area.

DNPWC/PPP/UNDP (2001) has mentioned 30.5% household entering into park from Eastern sector. The in entering into the park seems to be decreasing for fodder. The data show the entering into the park green fodder are almost landless or small farmers. Sharma (1991) has reported that 45 % respondents accepted their illegal entry for resources extraction in the park. Hence, pressures on the park have not decreased for fuelwood.

4.2. Vegetation Analysis

The total no of tree species found in study area was similar to Baghmara but higher than other forest studied by Steffen et al 2000. The number of species in under story vegetation was similar as reported by Steffen et al 2000. Shakya (2003) found that the under story vegetation of the Terai and Siwaliks consists the dominant species *Saccharum spontaneum* and *Imperata cylindrica* which is similar to our results. The calculated total density of tree species is 43100 / ha which was lower than of mixed broad leaved forest i.e. 221069 per ha and 162667 / ha (Rijal

1994). The basal area found was higher than that reported by different forest of Chitwan district by Steffen et al. (2000). Shakya, 2003 found that the under story vegetation of the Terai and Siwaliks consists the dominant species *Lantena camera* and *Murraya koenigii* respectively and calculated density of *Lantena kamera* and *Mickania micarantha* were highest in our study.. Similarly in the tropical forest *Coleobrokea oppositifolia* and *Callicarpa macrophylla* were most dominant (Shakya, 2003).

The calculated density was found to be highest of *Trewa nodiflora* and *Albizia species* which was higher than Rijal (1994). Similarly highest frequency and relative frequency was recorded of *Trewa nodiflora* and *Albizia lucida.*

13 regenerating tree species were found in the study area with density of 16667/ha, which is higher compared to tree density in the study area. *Acacia catechu* had no any sapling or seeding in the study area. Instead of this, *Mallotus phillippensis, Coffia bengalensis, Ehertia levis, Dalbergia sisso* and others were found in regenerating condition. Regeneration density of three species is higher compared to given for major species by BZCFUG (2061). *Trewia nodiflora, Marrdenia koenigii,and Albezia lucida* had higher density while *Dalbewrgia sisso* had lower density compared to BZCFUG (2061). Higher regeneration of *Trewia nodiflora* may be due to higher tree density and rhino movements. While looking at height categories, 18percent was under 1 m height and only 11percent above 4m. This may be due to the uncontrolled burning by locals as found in almost of total sampling area. Above six meter only 0.72 percent regenerating species were found out.

While looking at DBH category, there is poor representation of large saw timber in the study area. *T. nudiflora* was higher one species in this category. The number of pole sized tree was found higher. Looking on the stocking of tree in the study area, forest is medium to well stocked. Cut stump is also very less in the study area. Similarly lopping intensity was also least to medium. Low success of regenerating species, but good quality in terms of stocking, cut stump and lopping intensity shows the easy extraction of fuelwood and fodder through cutting regenerating species.

The average biomass for Khiar-sissoo and mixed hardwood forest of terai of CDR were higher (GN, 1988a) compared to my study. Average biomass per ha of *D. sissoo* and Mixed hardwood forest was only 6.45 percent and 2.92 percent respectively (GN, 1988a). The total tree trunk volume was calculated to be $55m^3$/ha.The total biomass production of the forest in terms of leaf, branch and stem was calculated to be 1.17/ha, 27.3t/ha and 41.7t/ha respectively. The potential fuelwood production of the forest per hectare is 2.09t/ha from stem and 1.4t/ha from branch tons and the fodder production is 0.06t/ha.

4.3. Land use change pattern

Land use change

The map of the Manahara VDC was quite missing. (DNPWCA Nepal Gazette for CNP 1981 and BZ 1997) Our GIS map shows that the area we studied was all out of the buffer zone and between the park and the buffer zone. The area was not well defined. Though we had worked on the buffer zone on field, the GIS map does not fit to the earlier map. The aerial map and GIS map shows that the area studied were under the Parsa Wildlife Reserve which seems quite contradictory. The area map as prepared by the DNPWC/PPP (2000) quite covers the study area.

The total forest land in the buffer zone was 200 ha (Banskota et al. 1997) but according to DNPWC/PPP (2000), CNP Management Plan (2001-2005), it was 147.1 ha. Field observations suggest that the total area was163.4 occupied by Brahmasthani Lamidamar community forest and 59.09 hectare of Campatole forest suggest that the total forest in the whole VDC was less than that of Banskota et. al. 2000 and was lower even added shrub land and grassland. There is no grassland (DNPWC/PPP2000, CNP management plan 2001-2005) but the results show that there are 21.404 ha of grass land in land 1992 map.

Box 3
Exciting facts of Manahari BZ

Only two wards of the VDC were considered as the buffer zone of the national Park (DNPWC, 1993). The area besides the older settlements where used to be the flood plain and grassland of the Manahari River had been cleared and changed into the new settlement called Nayabasti (Field Survey, 2006). These settlements were now clearing the adjoining forest massively.

The area east to the older settlements of the Manahari VDC, Sunachauri Chauli Tole used to be flood plain of the Mahahari River. Rhino birth had also been reported in the area. But after the political chaos in the nations, the area was encroached by the outsiders from the hills of Makawanpur district. There are many huts and temporary sheds built and left. According to the locals, the owners came only at night and by the early morning they left the area.

Only infants, small children and old aged people were residing there in the day time. They had encroached the area and converted it into farm land. The most amazing part was that being rampant settlers they used tractors and heavy equipments for farming. The huts and shed made there were using the highly valued timber, *Acacia catechu* (khair). It was repeated attempts by the park authority and the villagers to evacuate the area went in vain.

Chapter 5

5.1 Conclusions

The people in Manahari were dependent on the resources from the national park. The illegal entry and harvest of the park resources was continuous. The migration in this area was ongoing and this could increase more pressure on park resources and also forest of the BZ.

The fuelwood and fodder resources of the buffer zone are insufficient and the harvest practice was also not sustainable. As there was no timber in the community forest they depend on the park. The species like, *Accacia catechu* were seen used by the new settlers, this could generate conflict with old settlers and that could harm existing forest management.

The cases of poaching and killing of the wildlife species were not reported during the study period and within the last five years. The economic status was relatively poor and crop production was not sufficient to meet need of people. There is a need of alternative to forest products. Also income generation activities need to be developed so that people could afford for alternative living. Awareness need to be generated to make conservation sustainable.

5.2 Recommendation

Plantation on barren land and flooded area reduce the risk from annual flooding. Both plantation and alternative energy programs are suggested to make the Manahari settlements self reliant. Such programs must be initiated and implemented through BZUC and BZFUG.

To mitigate fodder demand, the unproductive herds of local varieties of livestock should be replaced by the high yielding hybrids so that the number of animals and grazing pressure on the buffer zone forest and adjoining National park will be reduced.

Beside conservation education, skill development trainings and alternative income sources should be promoted so that the dependency on the forest and NTFP can be reduced which will automatically minimize the illegal harvest of natural resources from the park.

Resettlement programs for the landless and evacuation of the encroachers should be done to reduce deforestation.

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Annex

Annex 1: Volume and Biomass

Species	Volume (m3/ha)	% Volume	Stem Biomass (t/ha)	Branch Biomass (t/ha)	Leaf Biomass (t/ha)	Total Biomass (t/ha)	% Biomass
Acacia catechu	2.24	4.07	2.15	1.47	0.02	3.64	5.2
Albizia lucida	17.62	32.06	12.69	8.55	0.58	21.82	31.13
Caseria elleptica	0.19	0.35	0.14	0.07	0.01	0.22	0.31
Cassia fistula	0.15	0.27	0.11	0.05	0	0.16	0.22
Dalbergia sisso	26.39	48.01	20.58	14.08	0.21	34.87	49.73
Ehertia levis (Dhatrungo	0.47	0.86	0.34	0.17	0.02	0.53	0.75
Glochidon sp.	0.09	0.17	0.07	0.03	0	0.1	0.14
Litsea monopetala	0.28	0.51	0.2	0.09	0.01	0.3	0.43
Azadirachta indica	0.07	0.13	0.05	0.02	0	0.08	0.11
siris(Baret)	1.26	2.29	0.91	0.64	0.04	1.59	2.26
Trewia nodiflora	6.2	11.28	4.47	2.07	0.27	6.81	9.71
	54.96	100	41.71	27.24	1.16	70.12	99.99

Annex 2: Annual Yield and Sustainable Supply

Species	Stem yield (t/ha/yr)	Branch yield (t/ha/yr)	Leaf yield (t/ha/yr)	Total biomass yield (t/ha/yr)	Sustainable Fuel wood supply from BZCF (t/ha/yr)	% of Sustainable fuel wood supply	Sustainable fodder supply from leaf (t/ha/yr)
Acacia catechu	0.1103	0.0754	0.0012	0.1869	0.1523	5.3700	0.0010
Albizia lucida	0.6191	0.4208	0.0316	1.0715	0.8523	30.0569	0.0284
Caseria elleptica	0.0068	0.0035	0.0003	0.0107	0.0084	0.2957	
Cassia fistula	0.0052	0.0023	0.0002	0.0077	0.0060	0.2131	
Dalbergia sisso	1.0559	0.7222	0.0111	1.7892	1.4577	51.4056	0.0100
Ehertia levis (Dhatrungo	0.0166	0.0082	0.0010	0.0258	0.0201	0.7094	0.0009
Glochidon sp.	0.0032	0.0014	0.0002	0.0049	0.0037	0.1321	0.0002
Litsea monopetala	0.0099	0.0044	0.0007	0.0150	0.0115	0.4055	0.0006
Azadirachta indica	0.0025	0.0011	0.0002	0.0037	0.0029	0.1009	
siris(Baret)	0.0442	0.0316	0.0021	0.0779	0.0623	2.1955	
Trewia nodiflora	0.2179	0.1020	0.0145	0.3344	0.2585	9.1153	0.0131

Annex 3: DBH class of each species (no/ha)

Name of the species	Sapling	Poles	Small saw timber	Large saw timber	Total
Acacia catechu		1	4		5
Albizia lucida	2	2	1	2	7
Azadirachta indica			1		1
Caseria elleptica		1			1
Cassia fistula			2	3	5
Dalbergi sisso	1	1	1		3
Dhatrungo		1			1
Glochidon sp.		1			1

Litsea monopetala	1					1
siris(Baret)					1	1
Trewia nodiflora	16	26	6			48
Total	20	33	15		6	74

Annex 4: DBH class of trees in the study area

DBH Category	%	No/Ha
Sapling	27.03	20
Poles	44.59	33
Small saw timber	20.27	15
Large saw timber	8.11	6

Annex 5: Regeneration pattern of the species

S. N.	*Name of the species*	0-50cm	50-100cm	100-200cm	200-400cm	400-600 cm	600 and above	total	D/ha
1	*Albizia lucida*		4	8	3			15	12500
2	*Cassia fistula*				1			1	833
3	*Coffeeia bengalensis*				2			2	1667
4	*Dalbergia sisso*	2						2	1667
5	*Ehertia levis (Dhatrungo)*		1	2	1			4	3333
6	*Mallotus philippensis*			1				1	833
7	*Marrdenia koenigii*		3	1	4	4	3	15	12500
8	*Mytragyana parviflora*				1		1	2	1667
9	*Syzigium sp*	1						1	833
10	*Syzium operculata*				2		1	3	2500
11	*Trewia nodiflora*		1	3	4	4	8	20	16667
12	*Valaris stanacca*		1					1	833
13	*Wetlandia sp.*				4			4	3333

Annex 6: Looping intensity

Name of the sps	Density/ha	Looping density/ha	Average Looping %
Acacia catechu	25	10	17.5
Azadirachta indica	5	5	50
Ehertia laevis	15	10	99
Trewia nodiflora	240	55	55.36

Annex 7

Questionnaires for the analysis of buffer zone community of RCNP

HOUSEHOLD SURVEY

Respondent Name: Date:
Caste/Ethnic Group: Lat:
Sex: Long:
Age:
Education:
Occupation:
Current Address (Village/VDC/Ward):
Residence Period (Year):
Family Structure: a) Nuclear b) Joint
Name of the data Collector:

Please provide some information in individuals who belong to this household (Begin with oldest person)

Individual ID (Full name)	Relation to respondent	Sex	Age	Marital Status	Occupation			Education
					I	II	III	

Farm Size/Production

Land type	Area		
	Bigha	Kattha	Dhur
Land Owned			
Shared Tenant			
Parti/Ailani			

1. What type of crop do you grow?

Crop type		Area			Production		Consumption (Kg)	Surplus (Kg)	Deficit (Kg)	Deficit period (Months)
		Bigha	Kattha	Dhur	Muri	Kg				
Food Crop										
Pulses										
Cash Crop	**Vegetables**									
	Oil seeds									
	Others									

2. How will you manage for the deficit months?
Business/Wage labor/ Buy/Borrow/ Barter/others……..

3. If surplus what do you do with the surplus crops?

Store/Sale/Others:…….

Livestock' s Types and Holding

Types of Animals	Numbers	Stall-feeding	Grazing	Both

Nutritional Status of Livestock' s (Observed) using**Rinney' s index**

Livestock	Observation	Status	Remarks
	Body Line Round		
	Body Line Angular		
	Body Line, Rib cage visible		

Fodder/Fuel Wood/ Timber

Season/Month	**Fodder**		
	Species	Quantity	Access

Fuel Wood

Species	Quantity	Access

Timber

Species	Quantity	Access

Alternative Energy

Fill in the information on use of fuel and how it is obtained (Record use for each month) (Liter for kerosene, No of Cylinder for gas/ Bhari for Firewood) (1 Bhari= ……..Kg)

Source	Amount	Expenditure	Season	Remark
Kerosene				
Electricity				
Solar				
LP Gas				
Battery				
Other				

Others Specify

…….

……

……

…… ……

4.Do you have Biogas plant in your home? Yes/ No.

……

….

5. If yes,

Installed Date	Biogas	
	Capacity	Expenditure

6. Have you installed Biogas plant on your own or did you get any support from others?

……

…… ……

7. How much livestock are needed to operate your Biogas plan?

……

…… ……

8. How much fodder is required for livestock?

……

….. ……

9. If no, why are you not having Biogas plan. Are there any constraints?

……

…… …… ……

10. Do you have any plans to install Biogas plant? Yes/No

……

…… ……

Buffer zone Community Forest, Household Participation and Issues

1. Have you involved in Buffer zone management? Yes/ No
2. If yes, what is your status (Position) in Buffer zone management council, UC, UG?

Date	Group	Status	If any other member of family (Relation with respondent)

3. Which community forest do you use?

……

……

4. What type of resources do you bring from the CF?

…… ……

5. What do you say about your community forest status?
   Very Good/ Good/ Satisfactory/ Bad
6. What was the condition of your Buffer zone DF in Past/Present?
   ……
   ……
   ……
7. Is available resources in our community forest fulfilling your demand? Yes/No

Resources	Demand (Bhari/Kg)	Supplied (Bhari /Kg)	Deficit (Bhari/Kg)

8. If no, how do you manage your demand?
   ……
   …… …….
9. Are there any kinds of resources allocation system in your CF? If Yes,on what basis Wellbeing/Population/No of livestock/Profession/Others.
   ……
   ……
10. Are there any land categorization for different purpose in your CF?
Pasture land/Recreation/Habitat management/Fodder/Fuel wood/Others ……..
……
……

11. What sort fof problem do you find in your CF?
……
……
……

What needs to be done fort the better management of your CF resources utilization and conservation? Any suggestions/ Recommendation
……
……
……
……
……

Rhino Related Issues

1. Have you ever face the problem of rhino? Yes/ No
2. Do rhino comes every around your area? Yes/ No

Season/Month	No of Rhino

4. What of problem Rhino brings to you?
   Cropdamage/Livestock damage/Physical Damage/ Human life loss/ Injury

4. Is there any kind of compensation measures for the loss? If yes what kinds?

……

…..

……

…..

5. Crop damaged caused by rhino

Crop	Time of Damage				Damages Amount/year in local unit	Compensation	
	Morning	Day time	Amount (Rs)	Amount (Rs)		Amount (Rs)	Substitute

6. Livestock loss by wild animals

Wildlife	Livestock	Number of loss	Time in year and month	Compensation	
				Amount (Rs)	Substitute

7. Frequency of human loss: injured/killed

Time	Killed	Injured	Compensations

8. How dop you defend against rhino movement into your area?

…….

…….

9. What do you know about Rhino movement in your area?

Increasing/Decreasing/Remains the same

10. If you think it is decreasing, what do you think why rhino is decreasing?

Natural death/ killing (poaching/Habitat loss/ others……...

…….

11. Do you know any house hold who have been accused of rhino poaching?

…….

…….

12. What do you think, why they are killing the rhino?

…….

…….

……

13. Do you have any idea, what kinds of people are found to be involved? (Poachers identity)

Name	Address	Involved date

14.What opportunity would stop them?

…….

…….

…….

15. What kind of activities are/ were doing by the BZCF management user groups to stop Rhino poaching? …….

…….

…….

…….

16. What activities needs to be done to conserve Rhino?

…… …..

……

…….

…….

Annual Income and Expenditure

1. How much is your is your annual income in terms of money?

Source	Amount (Rs.)	
	Calculated	Rectified
Agriculture		
Service		
Livestock		
Business		
Tourism		
Off-farm employment		
Others		
Total		

Remarks……

……

…… ……

2. How much is your is your annual expenditure in terms of money?

Item	Amount (Rs.)	
	Calculated	Rectified
Education		
Health		
Maintenance		
Agriculture		
Livestock Poultry Maintenance		
Loss of livestock		
Loss of crops		
Total		

Remarks…… ……

……

……

3. From the above two tables the saved amount becomes Rs……., Do you save this much annually? Yes/No

Annex 8

General formula used for vegetation analysis

2.2.5. 1. Density (D)

It is defined as the number of plant species per unit area. It is calculated as:

$$\text{Density/ ha} = \frac{\text{Total Number of Individuals of species in all sampling units}}{\text{Total number of sampling unit studied X Area (ha) of sampling unit}} \times 10{,}000$$

2.2.5.2. Relative Density (RD)

$$\text{Relative Density} = \frac{\text{Density of species}}{\text{Total density of all the species}} \times 100$$

2.2.5.3. Frequency (F)

$$\text{Frequency} = \frac{\text{Number of sampling unit in which species occurred}}{\text{Total Number of Sampling units studied}} \times 100$$

2.2.5.4. Relative Frequency (RF)

$$\text{Relative Frequency} = \frac{\text{Frequency of a Species}}{\text{Total Frequency of all the Species}} \times 100$$

2.2.5.5. Basal Area (BA)

$$\text{Basal Area} = \frac{\pi (\text{dbh})^2}{4}$$

Where, dbh = Diameter at Breast height of the tree

2.2.5.6. Relative Basal Area (RBA)

$$\text{Relative Basal Area Ratio(\%)} = \frac{\text{Basal Area of a species}}{\text{Sum of Basal Area of all species}} \times 100$$

2.2.5.7. Important Value Index (IVI)

$$\text{IVI} = RD + RF + RBA$$

Where,

RD = Relative density

RF = Relative frequency and

RBA = Relative basal area.

2.2.5.8. Diversity Index

Shannon Weaver (1949) had derived the formulae to find the level of species diversity of an area. An index is used to measure the species diversity

Diversity Index (H) = $-\sum ni/N \log_e ni/N$

Where,

H= Shannon index of species diversity

ni = Importance value index for each species

N= Sum total of importance values

Log_e= Natural log

The value of diversity index for real communities are often found to fall between 1.0 and 6.0 (Stilling, 1996).

Date: ……….
Plot No: ………
Plot Size: 20 ×20m^2

Annex 9 Data sheets for vegetation analysis
CNP BUFFER ZONE VEGETATION SURVEY
Data sheet for quantitative/qualitative study
TREE

Lat: ………..
Long: ……….
Altitude: ……m

Name of the Forest/CF/Buffer zone……………………………………
Forest Type…………… C o v e r a g e ……….% G r a z i n g ……….%
Interference…………..Aspect…………Slope…………….Soil
Type………….Status……………..

S/N	**Plant species**	**Dbh (cm)**	**Ht (m)**	**No**	**Lp (%)**	**CS (no)**	**No. of branch**	**Remarks**

Note:……………………………………………………………
………… ……………………………………………………
……………………………………………………………………
………………………………

Dbh: Diameter at breast height (1.3 m) **Ht=**Height, **No**=Number, **Lp**= looping, **Cs**= Cut stump **Tree** =Plant with diameter >10 cm

Plot No: ……
Plot Size: 5× 5m^2

CNP BUFFER ZONE VEGETATION SURVEY
Data sheet for quantitative/qualitative study
SHRUB

Name of the Forest/CF/Buffer zone……
Forest Type…… C o v e r a g e ….…..…% G r a z i n g ….…..…%
Interference…….Aspect ……Slope…….Soil Type…….Status……..

S/N	Plant species	Ht (m)	No	Remarks

Note:……
…… ……
……
……

Shrubs/Sapling =Plant with diameter <10 cm and height>10 cm

Plot No: ....
Plot Size: 1× 1m^2

CNP BUFFER ZONE VEGETATION SURVEY
Data sheet for quantitative/qualitative study
HERB

Name of the Forest/CF/Buffer zone……………………………………
Forest Type…………… C o v e r a g e ……….% G r a z i n g ……….%
Interference……………Aspect …………Slope……………..Soil
Type………….Status……………..

S/N	Plant species	Ht (m)	No	Remarks

Note:…………………………………………………………
…………………………………………………………………
…………………………………………………………… ………
……………………………….

Herbs/Sapling =Plant with height<10 cm

Annex: 10

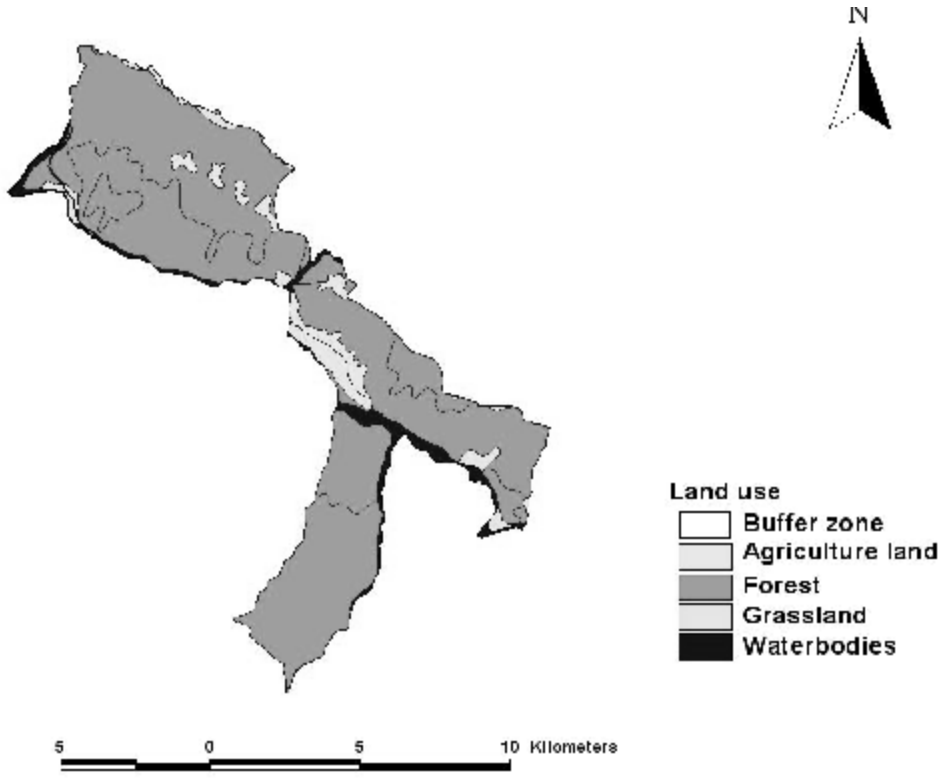


Fig 1978 Land use map of Manahari VDC

Annex: 11

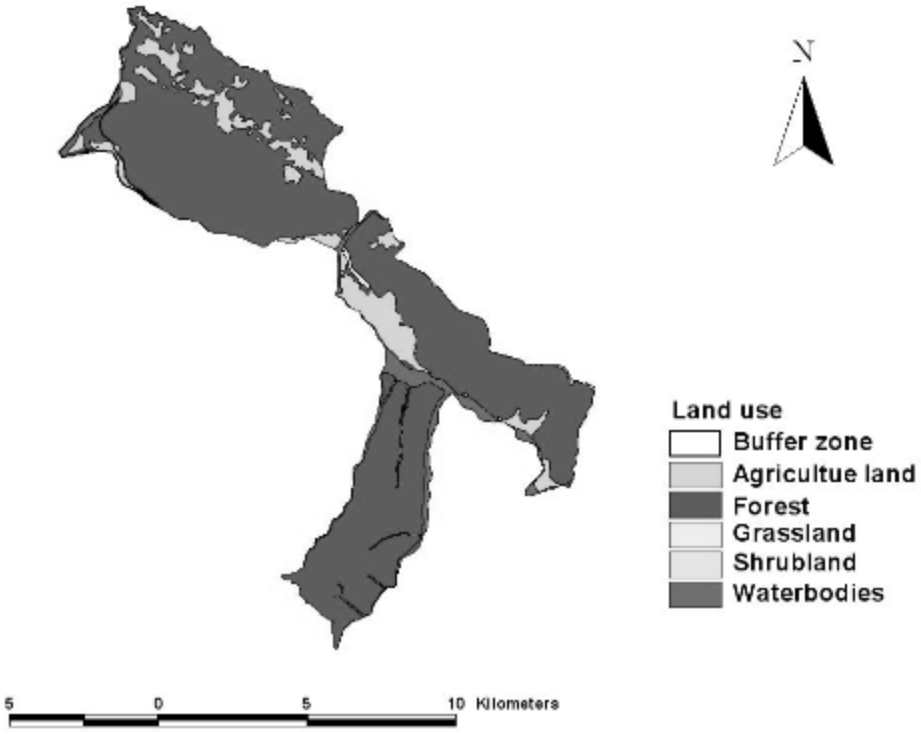


Fig: 1992 Land use map of Manahari VDC

Annex: 12

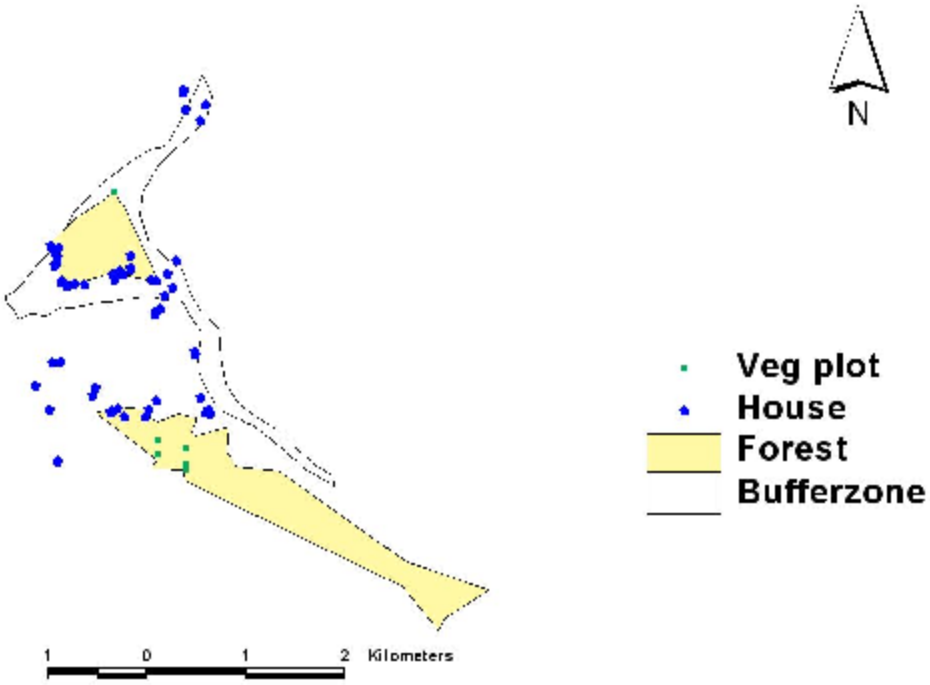


Fig: land use map of Manahari VDC

Annex: 13

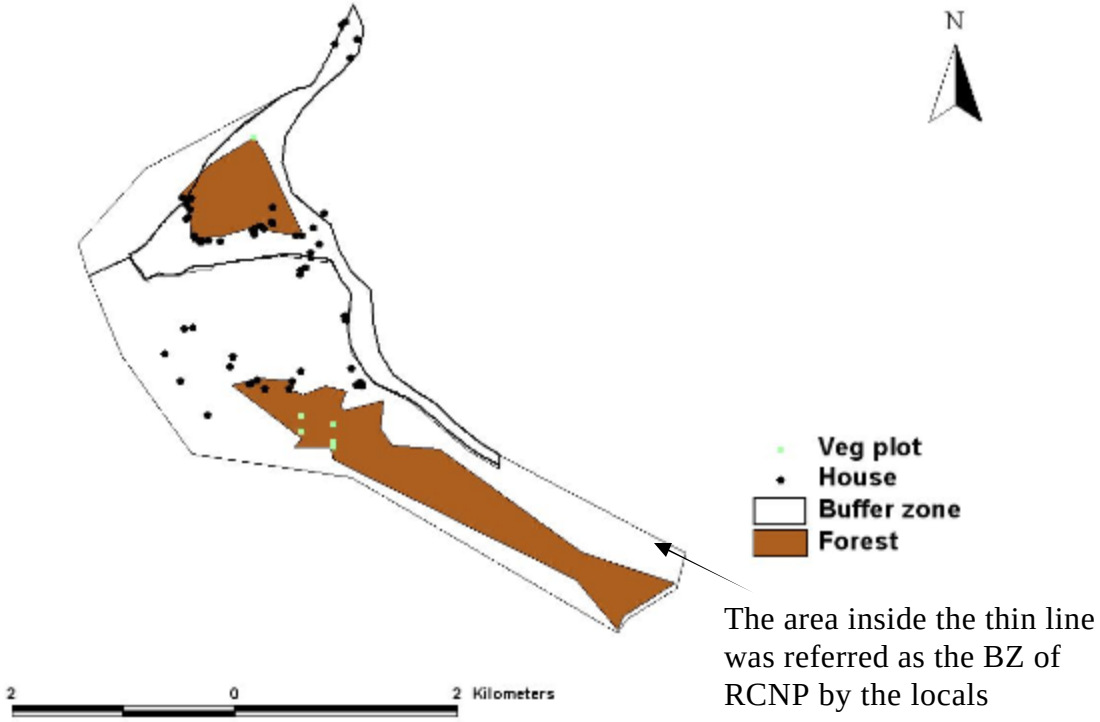
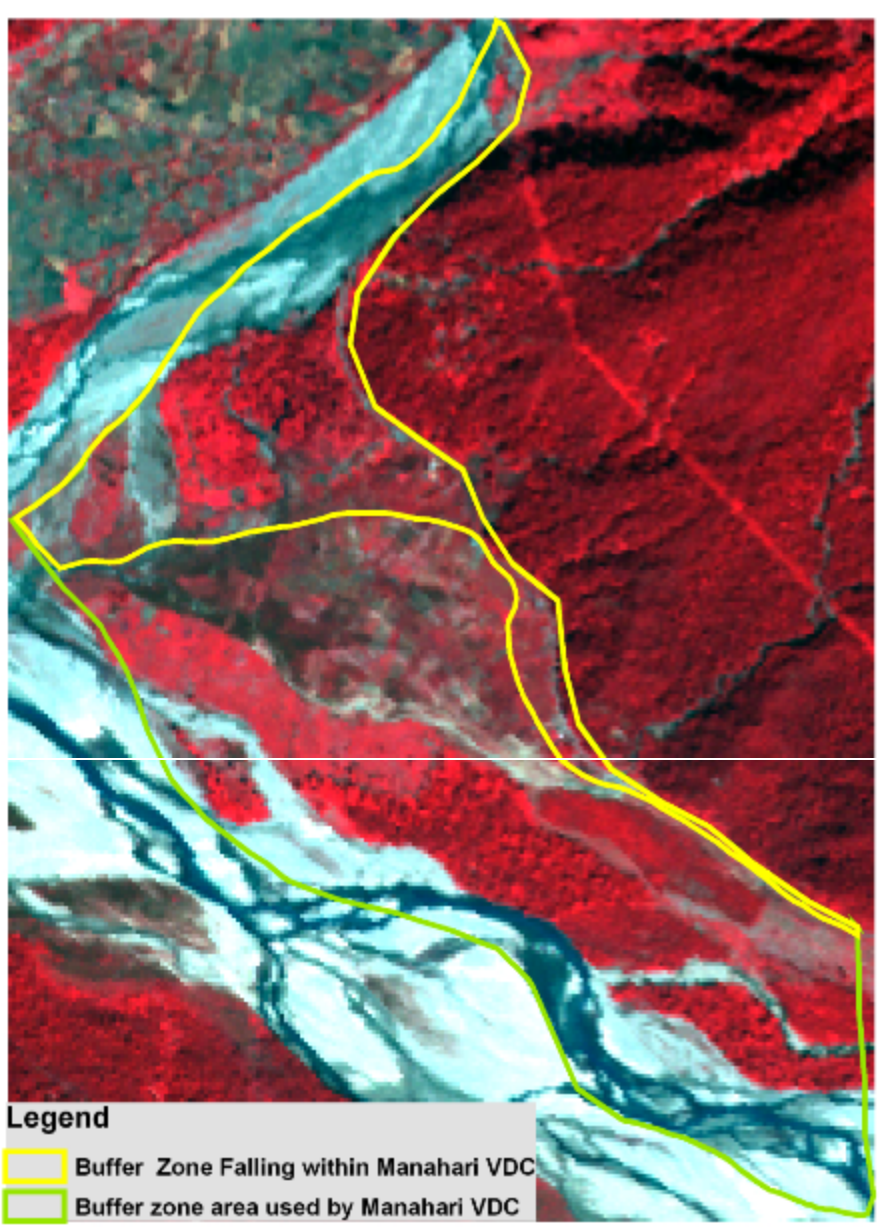


Fig: Estimated map of the existing buffer zone

Annex 14



Map showing the official buffer zone forest in the Manahari VDC (yellow boundary) and the actual buffer zone forest used by Manahari VDC (Green boundary). The background is a false colour composite of ASTER image of RCNP. The area seen in red can be visualized as forest.

Fig: Studied area map