Understanding Biodiversity Conservation, Social Structure, and Buffer zone Vegetation in Mukundapur Buffer Zone VDC, Chitwan National Park

A dissertation submitted for the partial fulfillment of Masters Degree in Environment Science

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LETTER OF RECOMMENDATION

This is to certify that Mr. Kapil Kishor Khadka has prepared this dissertation entitled, "*Understanding Biodiversity Conservation, Social Structure and VDC Buffer Zone Vegetation in Mukundapur Buffer Zone VDC, 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.

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Title of Thesis	*Understanding Biodiversity Conservation, Social Structure and VDC Buffer Zone Vegetation in Mukundapur Buffer Zone VDC, Chitwan National Park.*

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Declaration

I, Kapil Kishor Khadka, hereby declare that the work presented here in 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.

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Abstract

Mukundapur, a buffer zone VDC of Chitwan National Park, was chosen as the study area to study the ecology, economy and the social strata to understand biodiversity conservation. The study was conducted using direct interview survey by randomly sampling 68 households, 14 vegetation sampling plots (7 plots in the buffer zone forest and 7 outside buffer zone forest) that were randomly selected and land use change using Arc info and Arc view from 1978 and 1992. There was a huge deficit of fuel wood and fodder in the VDC. The estimated total demand of fuel wood and fodder were 1670.8 ton/yr and 18552.3 ton/yr of which only 2% of the fuel wood demand and green fodder demand could not be supplied from the buffer zone forest. Majority of the households were dependent on their private land and agricultural residues for fuel wood and fodder. The installation of the biogas plant was found highest in Brahmin/Chhetris and Tharus and the management level participation in the buffer zone committee was also only from these two castes.

The buffer zone had Sal forest. The yield of fuel wood and fodder was 33.3 ton/yr and 1071.5 kg/yr respectively.

The poaching and killing of wildlife species was not reported in the VDC. However, 39.7 % of the households reported that the frequency of the rhino movement in the VDC had increased and 35% reported the crop depredation by rhinos.

The land use change pattern between 1978 and 1992 suggest decrease in forest area and agricultural land while water bodies and the shrub land had increased probably because of forest degradation and annual flood that frequently changed the river course.

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ABBREVIATIONS AND ACRONYMS

BZ	Buffer Zone
BZCF	Buffer zone Community forest
BZMC	Buffer zone Management Committee
BZUC	Buffer zone User Committee
BZVDC	Buffer zone Village Development Committee
CBS	Central Bureau of Statistics
CF	Community forest
CNP	Chitwan National Park
DBH	Diameter at Breast Height
DDC	District Development Committee
d.f	degree of freedom
DNPWC	Department of National Park and Wildlife Conservation
FSSD	Forest Survey and Statistics Division
FRSC	Forest Resources and Survey Center
GCP	Grass Cutting Program
ha	Hectare
HH/hh	Household
HMG/N	His Majesty Government of Nepal
ICDP	Integrated Conservation and Development Program
IUCN	International Union for Conservation of Nature and Natural Resources
KMTNC	King Mahendra Trust for Nature Conservation
LRMP	Land Resources Mapping Project
LSU	Livestock Unit
MPFSN	Master Plan for Forestry Sector Nepal
NTFPs	Non Timber Forest Products
NPWC	National Parks and Wildlife Conservation
PPP	Park-People Program
UNDP	United Nations Development Program
VDC	Village Development Committee
WCS	World Conservation Strategy

CHAPTER 1
INTRODUCTION

1.1 Background

The conventional wisdom of how to best manage protected areas has evolved over time. One of the great challenges of the 21st century is to meet human needs without threatening the ecosystems that form the basis of human survival (Mogelgaard, 2003). Protected areas are at the centre of strategies to conserve biodiversity worldwide. Also they have become representative of vulnerable ecosystems of the world that are indispensable elements of nature conservation (Nepal and Weber, 1993). The variety and complexity of threats to protected areas – stemming from growing and changing human activities inside and outside protected areas boundaries have inspired a range of approaches to protected area management. The traditional fences and fines approach based on making entry to protected areas difficult, and penalizing those who entered in spite of the difficulties was not successful in slowing down the degradation of protected area resources. This contributed to a growing sentiment within the conservation community that successful long-term protected area management requires the involvement of local people.

Within this context, the concept of integrated conservation and development projects (ICDPs) evolved as a method of addressing both biodiversity conservation and community development and ideally to make them synergistic in ways that would draw added public and financial support (Mogelgaard, 2003). ICDPs came into vogue in the conservation community in the mid 1980s after the World Conservation Strategy (WCS) in 1980 promoted a new approach to conservation with a notion that protected area management are needed to be linked with the economic activities of local communities. ICDPs became very popular and well funded by conservation organizations and development agencies. However, the outcomes of ICDPs surfaced in the '90s calling into question the effectiveness of approach in meeting the conservation goals (Mogelgaard, 2003).

Nepal, with the enactment of National Park and Wildlife Conservation Act in 1973, embarked upon the era of conservation. The Department of National Park and Wildlife Conservation (DNPWC) presently works with a network of 9 national parks, 3 wildlife reserves, 3 conservation areas, 1 hunting reserve including 11 buffer zones

around national park covering a total of 28,998.67 sq. km or 19.7% of the country's total land (DNPWC, 2006).The major issues that surfaced with the establishment of National Park included resource use conflict, livestock grazing pressure, wildlife human encounters, inadequate alternative resources and poaching (Bajimaya, 2005). The 4th amendment to NPWC Act in 1992 made provisions for buffer zones (on the background of ICDP) including sharing of 30-50% of the park/reserve annual revenue (DNPWC, 2001).The conciliatory and partnership approach adopted were aimed to motivate local communities in the participatory management of Park resources to fulfill their needs of forest products through the regulatory actions of user groups.

A buffer zone is a designated area surrounding a national park or reserve within which the use of forest products by local people is regulated to ensure sustainability (Bajimaya, 2005).Buffer zone management activities are based on participatory, bottom-up approach, driving communities towards economic self reliance, mainstreaming gender in conservation and development, introducing appropriate rural technology that contribute to natural resource conservation (HMG,1996 and 1999 as cited in Bajimaya, 2005).

Situated in the southern part of central Nepal in the foothills of Himalayas, Chitwan National Park (IUCN category-II) is the first national park of Nepal. The park with an area of 932 sq. km, is a world heritage site (DNPWC, 2001), gazetted in the year 1973 to conserve the endangered one horned rhinoceros and Bengal tiger (Baral and Upadhya, 2006). The park is home to at least 43 species of mammals, 450 species of birds and 45 species of amphibians and reptiles. The buffer zone of Chitwan national park was declared in the year 1996 with an area of 750 km^2, which now encompasses 34 VDCs and 2 municipalities with a population of 223,260 (DNPWC, 2001). Buffer Zone Management Committee (BZMC) is an apex community institution in the buffer zone, with an elected body of 41 members (36 elected chairpersons of buffer zone user committees), 4 representatives from DDCs and chief warden of the park as member secretary (DNPWC, 2001).User groups, which are further divided into male user group and female user group are the grass root level organizations of BZMC.

1.2. Literature Review

Many studies have been conducted in Chitwan National Park in the past.

According to Seidensticker (1976) c.f Bauer and Timmerman (1987); in Chitwan National Park, mid-successional stages like grasslands and riverine forests are the major habitat for deer species and Rhino. Bauer and Timmerman (1987) suggested seven regular surveys in Chitwan and integrate them into park management. Nepal, (1987) in his study of Gitanagar VDC found that the cheetal, wildpig and rhinos were the major threats to the farmers nearby and farming in that area had become a degenerating work. Nepal and Weber (1995) illustrated five major causes of park-people conflict in Chitwan National Park. KMTNC (1998) reported that the most notable threat to Chitwan's biodiversity is poverty among the large majority of the nearly three hundred thousand people that surrounds the park. KMTNC (1998) further argued that the park management has not succeeded in reducing the dependency of the local people on the park resources. Straede and Treue (2006) too found that the Chitwan National Park provides a wide range of products that contribute considerably to the livelihood and welfare of the villagers in the park as well as in the buffer zone. Jnawali (1994) found that the monoculture plantations in Bachhauli VDC with the aim of making farmers self sufficient in fuel wood and fodder and reducing pressure on the National Park could not fulfill the objective. Straede and Helles (2000) stated that allowing collection of resources from Chitwan National Park during Grass Cutting Programme (GCP) has supplied CNP and buffer zone management with a convenient short-term opportunity to nurse local people's positive attitude towards the park, but has seriously compromised nature conservation. They further argued that GCP in CNP do not match with the concept of community based conservation but is rather an example of nature based development. Brandon and Helles (1992) c.f Straede et al (2006) concluded that villagers were not directly involved in tourism and economic benefits to them were minor. Bookbinder et al (1998) too suggested that the economic impact of ecotourism in Chitwan National Park on households' income was minimal and limited to villages closer to the main park's entrance. Budthathoki (2005) has stated that more than 30% of the fund allocated for buffer zone management is lying unused. He further suggested that buffer zone management activities do not show social momentum because of inadequate capacity within the government at both park and department levels. In contrary, Bajimaya (2005) has reported that, despite many problems and constraints, integrated conservation and

development with participatory approach have made biodiversity conservation both holistic and real.

Joshi (2003) in her study in three buffer zone VDCs of Chitwan National Park revealed that there was less participation of woman in decision making and planning stage of buffer zone activities. Poudyal (2007) in his study in Piple buffer zone VDC found that buffer zone community forest was not sufficient to meet the fodder and fuel wood demand of the villagers. He further argued that there was no clear road map on sustainability of Chitwan National Park.

Rijal (2000) studied the structure and floristic composition of six buffer zone community forests and concluded that the number of species extracted from CNP and found in the community forest was highest for fuel wood and timber species, while the presence of traditionally utilized NTFPs in the community forest was limited. Shrestha and Dangol (2006) studied the change in vegetation composition, abundance of the plant species in terms of important value index and species diversity in the grassland ecosystem of CNP and found that there was the degradation of grassland ecosystem in the CNP.

1.3. Objectives

The broad objective of the study is to detail information on biodiversity conservation through research on the socioeconomic structure, community activities and biodiversity in the Mukundapur VDCs buffer zone area of Chitwan National Park.

The specific Objectives are:

1. Determine resource needs of the households in Mukundapur buffer zone VDC.
2. Study the condition of vegetation in the buffer zone forest including assessment of firewood and fodder needs, annual yield and energy consumption pattern.
3. Study changes in land use pattern and incidence of rhino occurrence and poaching activities with inclusion of human harassment and crop depredation.

1.4. Justification

The research is carried out to understand the linkages between ecology, economy and social realities. The study includes the socio-economic condition of people, vegetation ecology of community forest, resource need and supply, land cover change of the VDC, rhino issues, community conservation which help to understand the conservation threats and guides to develop an effective program. It is important to interface the well being of the communities for long term survival of the rhinos in Chitwan. It is often argued that poor and professional castes (marginalized household) are under represented in the decision making body of the buffer zone management committee. My study argue that not only marginalized household are susceptible to poaching earnings but also well to do household.

Resources Himalaya Foundation initiated a mentorship research conservation program in 2006 in which 34 VDCs and 2 municipalities under buffer zone of CNP would be studied including different factors such as socioeconomic condition, vegetation ecology, land cover change, rhino occurrence and poaching and community conservation. By doing so, accurate information would be available for the better buffer zone management. This dissertation is a part of the mentorship program.

1.5. Limitations of the study

1. The field study was conducted during May-June only.
2. The land use changes was estimated on more than a decade old data (1978 and 1992) as recent maps were non-existent.
3. Several respondents deny answering some queries especially relating to rhino issues.

1.6. Study Area

The study area is Mukundapur buffer zone VDC, administered under the jurisdiction of western Amaltari section of Chitwan National Park. Boundaries of Mukundapur buffer zone VDC are Amarapuri Buffer zone VDC in the west, Gaidakot VDC in the east, Chitwan National Park in the south and the other wards of Mukundapur buffer zone VDC in the north. Narayani River flows from north to south in the eastern boundary. Mukundapur buffer zone VDC is included under Sikrauli user committee. Seven wards are included in the buffer zone.

The climate of the area is subtropical type with mean monthly average maximum temperature of 35.4 degree Celsius in May and minimum temperature of 9.2 degree Celsius in January. However the highest monthly average temperature recorded was 38.9 degree Celsius in the month of May in 1995 and the lowest temperature recorded was 7.8 degree Celsius in the month of January in 2001. The recorded highest mean monthly average rainfall is 658 mm in July and the lowest rainfall is 9.3 mm in November. However the recorded maximum rainfall was 1225.8 mm in July in 2003. (Annex II).

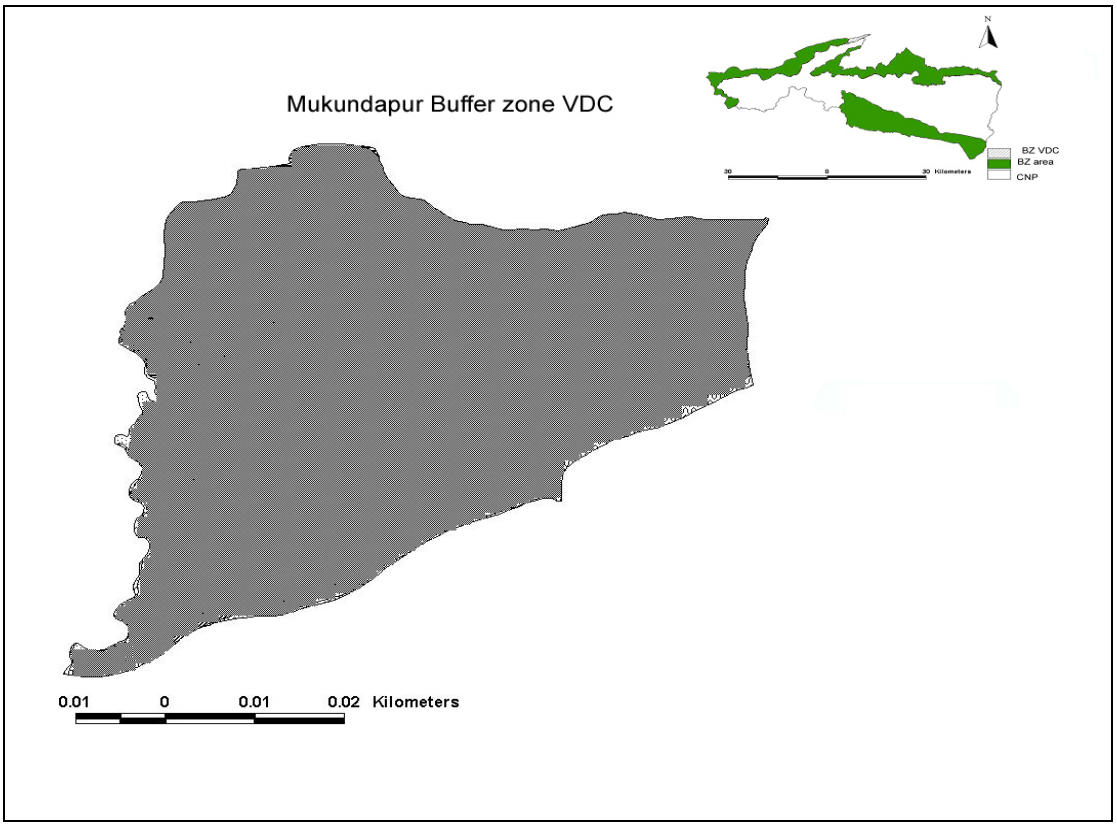

Fig1: Study Area

CHAPTER 2
METHODOLOGY

2.1. Household Socioeconomic Survey

2.1.1. Survey Design and Sample Size

The Household Socioeconomic survey covered seven wards of Mukundapur VDC. Stratified random sampling method was applied for the survey on the basis of settlement and landholding of household, which was classified into five classes (Table 1).

Table 1: Landholding Categories

Symbol	Landholding
1. Landless	No land
2. Small	0-10 kattha
3. Medium	10-20 kattha
4. Big	1-4 bigha
5. Large	>4 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 Poudyal, 2000) at 95% confidence level.

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

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**)**

Total buffer zone households of Mukundapur VDC were collected from PPP/ DNPWC. The sample size was found to be 68 households. These 68 households were chosen on the basis of settlement and landholding. Random sampling method without replacement was used for equal number of sample size distribution in each settlement and landholding categories. Each sample was drawn through lottery method.

Sixty- eight households representing from seven wards and different landholding categories were interviewed and filled in semi structured questionnaire. Questionnaire with three parts was developed including information of household, buffer zone community forest, buffer zone management issues and rhino/ wildlife related issues.

2.2. Vegetation Survey

GPS points of the forest boundary of the Mukundapur VDC were taken. Polygon was made from these points using GIS software and random points were generated within the polygon. These points were located in the field using global positioning system (GPS).

Vegetation analysis was done through quadrate method within a quadrate of 20m x 20 m for trees , 5m x 5m square shaped nested quadrates in south east and north west corner of the tree plot for shrubs and 1m x 1 m quadrate nested within shrub plot in opposite corners was laid out for herbs. Trees with diameter at breast height (DBH) $\geq$ 10 cm were studied. Number, height, DBH and canopy cover were measured. The heights of all the trees were measured by using Clinometer. The diameter was measured using diameter tape. Plants with diameter at breast height (DBH) <10 cm and height >10 cm including tree saplings were considered as shrubs. Similarly all herbs including seedlings of trees and shrubs with height <10 cm were considered as herbs. The total number of tree plots were 14 (7 inside buffer zone forest and 7 outside buffer zone forest), shrub plots were 28 and 28 herb plots were studied.

For the identification of plants, herbarium was made and identified at Godavari. Also the help of 'Annotated Checklist of the Flowering Plants of Nepal' by Press et al (2000) was taken for the identification of plants.

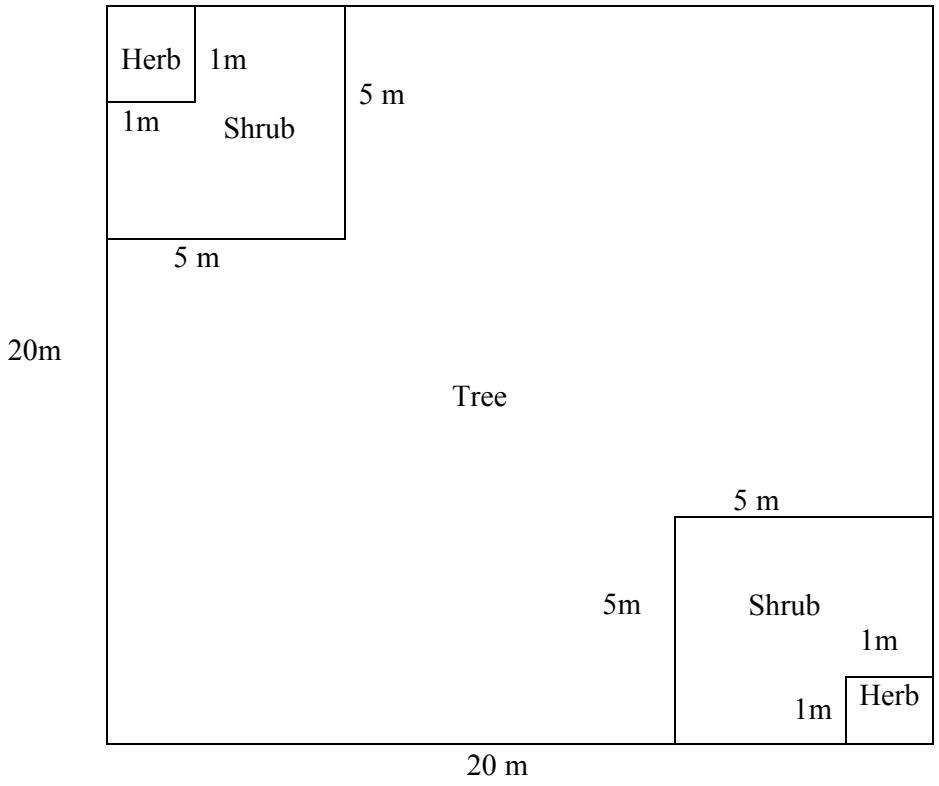

Fig 2: plot design (nested quadrate plot)

2.2.1. Vegetation Analysis

The collected data was interpreted to calculate density, relative density, frequency, relative frequency, basal area relative basal area and species diversity. The purpose of vegetation analysis is to measure the supply from forest and annual yield of the forest to know whether the demand was fulfilled from the forest or not(see annex).

2.3. Land Use Change Study

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

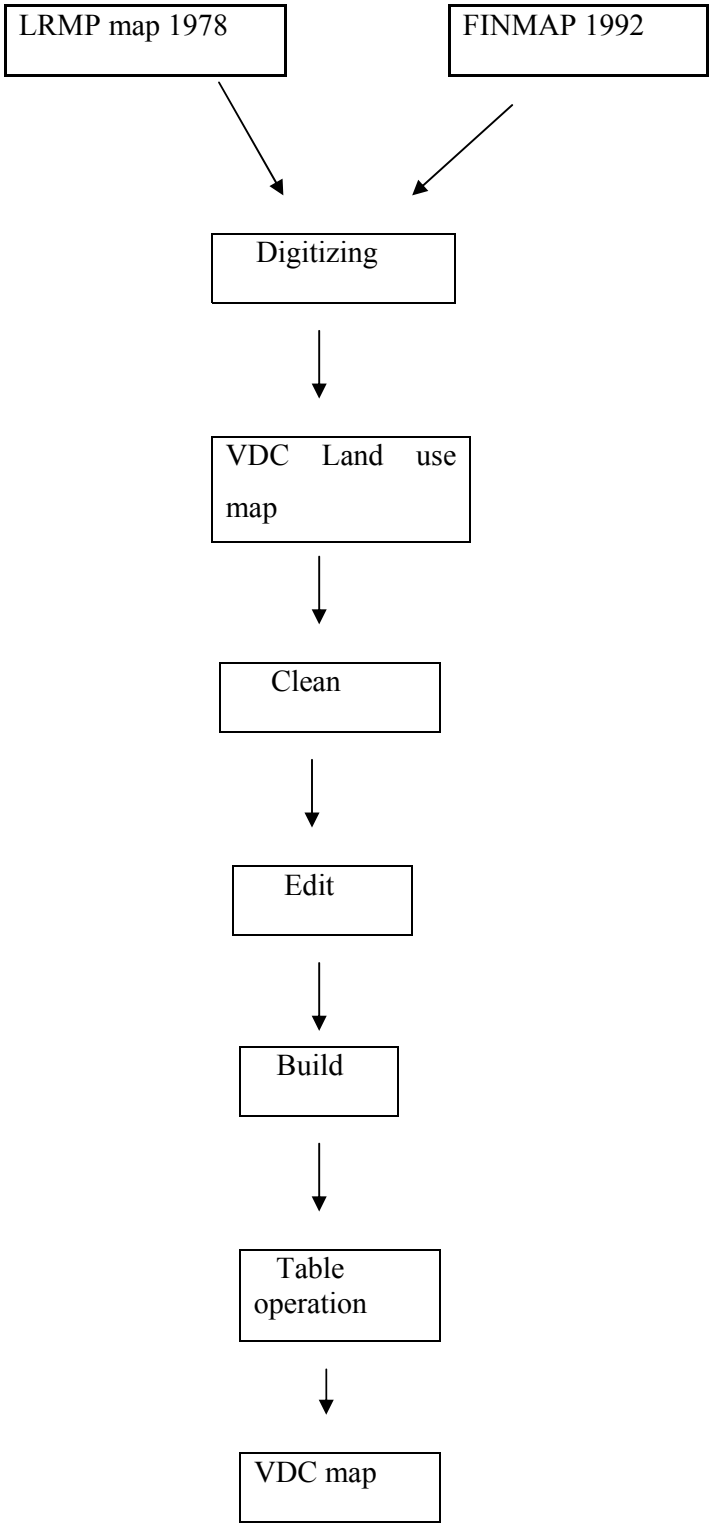

Fig 3: Schematic flow chart for land use change study

CHAPTER 3
RESULTS

3.1 Socioeconomic Study

3.1.1. General Characteristics of Respondents

Of the 68 households surveyed, 17 (25%) were female respondents and 51 (75%) were male respondents. The age of respondents ranged from 20 to 89 years and family size of respondents ranged from 2 to 10, with average family size5.7. About 55% of the respondents were from Brahmin/Chhetri, while the rest (45%) were from the other castes ie Gurung/Magar, Tharu, dalits etc. Some 32% of the respondents were illiterate, while the rest were literate with 16% having college level education.

The occupation of the majority of the respondents was farming. About 66% of the respondents were engaged in agriculture and housework, while 7.3% were in services, 13.2 % in business, 3% in skilled labor and 7.3% in wage labor. 6% of the respondents were students.

Some 63.2% of the respondents had small farm (0-10 kattha of land), 19.1%of respondents had medium farm (10-20 kattha of land), 13.2% of respondents had big farm (1-4 bigha of land) and 4.5 % of respondents had large farm (>4 bigha of land). Around 83.8% of respondents had registered (parti) land while 16.2% had unregistered (ailani) land. The distribution of sample household of the study area according to gender, age group, residence period, education, occupation, land type, caste is summarized (Table 2).

Table 2: General characteristics of respondents

Category		Number of respondents	%
By sex,			
	Male	51	75
	Female	17	25
By age group,			
	<15 years	0	0
	15-59 years	50	73.5
	>59 years	18	26.4
By residence period,			
	Late settlers (<10 years)	10	14.7
	Middle settlers (10-20 years)	16	23.5
	Early settlers (>20 years)	42	61.7
By occupation,			
	Agriculture	19	30
	Agriculture+housework	24	35.3
	Services	5	7.3
	Business	9	13.2
	Skilled labor	2	3
	Unskilled/wage labor	5	7.3
	Student	4	5.8
By education,			
	Illiterate	22	32
	Lower class	14	20.5
	Higher class	21	30.88
	College level	11	16.1
By land type,			
	Registered land	57	83.8
	Not registered land	11	16.2
By caste,			
	Brahmin/Chhetri/Thakuri	47	69.1
	Gurung/Magar/Tamang	10	14.7
	Newar	2	2.9
	Tharu	4	5.8
	Darai/Kumal/Praja	1	1.47
	Bote/Maji/Mushar	1	1.47
	Dalits	3	4.4

Source: field survey, 2007.

3.1.2. Age structure

Through household survey, the total population covered was 359. Of this, 181 (50.4%) were male and 178 (49.6%) were female. The male –female ratio was 1.01. A majority of population were from working age group (63.7%)**,** while the rest (36.3%) were from dependent population group. About 31.19% population of sampled households were students, while 8.0% population were either very young (<5years) or very old (Table 3).

Table 3: Population by age group in the sampled households

Age group	population	%
< 15 years	79	22
15-59 years	229	63.7
>59 years	51	14.3

Source: field survey, 2007.

3.1.3. Occupation

The occupations adapted by households were agriculture, housework, services, skilled labor, unskilled labor, business, and labor on foreign countries (Table 4). Members from 64.7% of sampled households were involved in agriculture, while 20.5% of sampled households were involved in salary based services. The rest households were skilled labor (20.5%), unskilled labor (16.2%), business (22.0%) and foreign earning (13.2%).

Table 4: Distribution of population by Occupation

Occupation	Population	HH number	HH %
Agriculture	63	44	64.7
Housework	77	68	100
Services	18	14	20.5
Skilled labor	15	14	20.5
Unskilled labor	18	11	16.2
Business	19	15	22.0
Labor on foreign countries	9	9	13.2

Source: field survey, 2007.

3.1.4. Landholding

About 16.2% of surveyed households had not registered land (Ailani) and 83.8% had registered (Parti) land. Although 64.7 % of the households were involved in agriculture, around 63.2% households had small farm (0-10 Kattha). Only 4.4 % households had large farm (>4 Bigha land) (Table 5).

Table 5: Distribution of households by farm size

Categories	Scale	Scale in ha	HH number	HH %
Small farm	0-10 kattha	0-0.3	43	63.2
Medium farm	10-20 kattha	0.3-0.6	13	19.1
Big farm	1-4 bigha	0.6-2.4	9	13.2
Large farm	> 4 bigha	>2.4	3	4.4

Source: field survey, 2007.

It was found that, large sized families hold more land than the small sized families. The average family size of small farm size (0-10 kattha) households was 3.7 while that of big farm size (1-4 bigha) was 6.2. Average livestock unit was found highest in the households with farm size (11-20) kattha. At the same time, biogas installation was also found the highest in these households (61.5%) (Table 6).

Table 6: General characteristics of households by farm size

Variables	Category of farmland				
	Small (n=43)	Medium (n=13)	Big (n=9)	Large (n=3)	Total (n=68)
Residence period (years)	22.5	24.7	34.6	39.3	25.3
Family size (no.)	3.7	4.8	6.2	5.6	5.3
Livestock unit(LU)	2.8	4.8	4.3	4.6	3.5
Landholding(ha)	0.14	0.5	1.3	3.3	0.5
Fodder consumption(kg/year)	18411.6	21775	32433	19600	20963
Fuel wood consumption(kg/year)	2281.6	1360	1120	833	1888
Biogas installation (%)	11.6	61.5	44.4	33.3	26.5

Source: field survey, 2007

3.1.5 Ethnicity and Household Characteristics

The ethnic composition of the study area was found to be dominated by Brahmin/Chhetri/Thakuri (69%) followed by Gurung/Magar/Tamang (14.7%), Tharu (5.8%), Dalits (4.4%), Newar (2.9%), Darai/Kumal/Praja (1.47%) and Maji/Bote/Mushar (1.47%). Tharus were found the early settlers with average residence period of 32.5 years. The average land holding of the Tharus was found the highest (1.2 ha); whereas the average landholding of the Dalits (Damai/Kami/Sarki) was found the lowest (0.03 ha). The average fuel wood consumption of the Dalits was found the highest (4160kg/year) as they have no options for the other sources of energy and also the occupation of some of the Dalits was selling fuelwood(Table 7).

Fig 4: Percentage of HHs by farm size and ethnicity

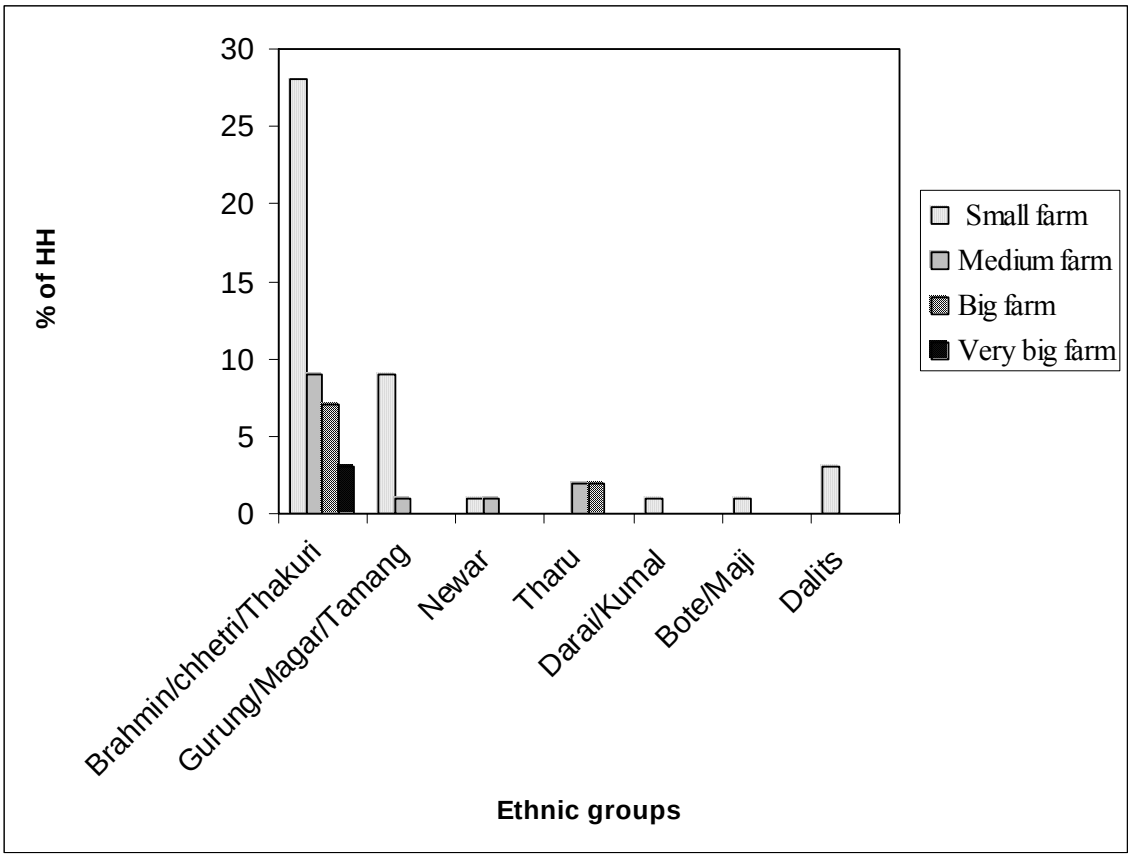

Fig 4: Percentage of HHs by ethnicity and farm size

Table 7: General characteristics of households by ethnicity

Variables	Ethnicity							
	Brahmin Chhetri/ Thakuri (n=47)	Gurung magar/ tamang (n=10)	Newar (n=2)	Tharu (n=4)	Darai/ Kumal /Praja (n=1)	Maji/ Bote n=1	Dalit n=3	Total n=68
Residence period(yrs)	26.4	21.5	20.5	32.5	25	20	17	25.3
Family size(no.)	5.3	5.6	5	5.3	3	7	4.6	5.3
Landholding(ha)	0.56	0.17	0.27	1.23	0.13	0.13	0.04	0.5
Livestock unit(LU)	3.7	3.7	-	4.6	4.8	-	0.3	3.5
Fodder consumption(kg/year/ HH)	21455	21420	-	44100	1260	-	8400	20963
Fuel wood consumption(kg/year/ HH)	1630	2112	1920	2740	-	3360	4160	1888
Biogas installation (%)	27.6	20	-	50	-	-	-	26.5

Source: field survey, 2007

3.1.6. Farm Production

Paddy was the most frequently cultivated food crops. Around 67.6% of households produced paddy, followed by maize (53%) and wheat (33.8%). Green vegetable, potato, Til and Mas were cultivated relatively in fewer households (Table 8).

Table 8: Frequency of HHs having different types of production

Crops	Number of HH	% of HH
Paddy	46	67.6
Maize	36	53.0
Wheat	23	33.8
Lentil	16	23.5
Mustard	6	8.82
Green vegetable	3	4.41
Potato	3	4.41
Sesame	2	3.0
Black gram	2	3.0
Flax	2	3.0
Fruits	1	1.5

Source: field survey, 2007.

Rice, although being the most frequently cultivated food crop was the most deficit food crop for households. Around 59% households faced deficit of rice. Around 91% of the households faced deficit of mustard (oil seed), while around 76% of the households faced deficit of masuro (pulse crop). Only around 41% of the households were food crop secured. The food crop deficit period ranged from 2-12 months (Table 9).

Table 9: Frequency of households with food crop deficit period

Deficit period(months)	Number of HHs	% of HHs
0 - 3	4	10.0
3 - 6	12	30.0
6 - 9	3	7.5
9 - 12	21	52.5
Total	40	100

Source: field survey, 2007.

Households mostly managed their food deficits by wage labor (20%), business (20%) and services (20%). Remittance also played a major role in managing deficits. Around 17.5% of the households overcome food deficits through remittance (Table 10).

Table 10: Household food deficit management

Deficit management	Number of HHs	% of HHs
Selling agricultural product	4	10
Business	8	20
Skilled labor	5	12.5
Services	8	20
Unskilled/wage labor	8	20
Remittance	7	17.5

Source: field survey, 2007.

3.1.7 Livestock

Cow, buffalo and goats were accounted as livestock. Livestock holding per household ranged from 1-20 livestock unit, with mean value of 3.48 LU and median value of 2.85 LU. Around 30.88% of the surveyed households had no livestock. Per household distribution of livestock was highest in households with medium farm size (10-20 kattha). However, per household distribution of buffalo was highest in big farm (1-4 bigha), whereas per household distribution of cattle and goat was highest in medium farm (Table 11).

Table 11: Distribution of livestock by farm size

Farm size	Mean	Number of buffaloes	Number of cattle	Number of goats	Total livestock
Small (n=43)	Mean	0.88	0.65	1.4	2.9
Medium (n=13)	Mean	1.3	1.07	2.92	5.3
Big (n=9)	Mean	1.88	0.33	1.88	4.1
Large (n=3)	Mean	2.0	0.66	1.66	4.3
Total (n=68)	Mean	1.14	0.69	1.75	3.58

Source: Field survey, 2007

The correlation coefficient of 0.11 between family size and livestock unit shows the weak correlation. That means there is no relation in the livestock size between large and small family sized households. Table 12 shows that food sufficient households

have more LU/HH (5.52LU/HH) than that of food deficit households (2.02LU/HH). Majority of the food deficit households have less than the median value of livestock units.

Table 12: Distribution of livestock units in food deficit and food sufficient HHs

Livestock units	Deficit HHs %	Sufficient HHs %	Total HH %
0.0 - 1.0	30.8	2.94	33.74
1.0 – 2.0	1.47	5.88	7.35
2.0 – 3.0	11.76	0.0	11.76
3.0 - 4.0	2.94	4.41	7.35
4.0 – 5.0	7.35	7.35	14.7
5.0 – 6.0	0.0	1.47	1.47
6.0 – 7.0	1.47	7.35	8.82
7.0 – 8.0	0.0	7.35	7.35
8.0 – 9.0	0.0	2.94	2.94
9.0 – 10.0	1.47	0.0	1.47
10.0 – 11.0	1.47	0.0	1.47
>11.0	0.0	1.47	1.47
Total	58.73	41.16	100

Source: field survey, 2007.

3.1.8. Fodder/ Fuel wood Consumption

Only 5.8% of the surveyed households mentioned that they bring fodder from community forest .Of these, 75% households were from small farm sized households and 25% from medium farm sized households. Majority (61.8%) of the households were dependent on their private farmland and agricultural residues for the fodder. However, 1.47% of the surveyed households reported that they buy fodder from others private farmland. Each household used 105-8,400 kg of fodder, averaging 1,746 kg of fodder/month/household (Table 13). There was a fair degree of association between livestock units that people hold and fodder demand (r=0.774).The correlation between fodder demand vs. landholding (r=0.257) shows that fodder consumption increases as landholding (either tilled or owned) increased. Green fodder consumption by livestock between poor (<0.7 ha) households and rich (> 0.7 ha) households was significantly different (χ^2=5.349, d.f=1, α=0.05). This was due to poor households had less farm land and gets less fodder from their private land. Moreover, majority of the poor households spend their time in other activities for livelihood.

Each household used 100-9,600 kg of fuel wood, averaging 1,887 kg of fuel wood /year/household. There was a weak correlation between fuel wood demand vs. family size (r=0.118).

Table 13: Fodder and fuel wood consumption by farm size

Farm size	Mean	monthly	
		Fodder consumption(kg)	Fuel wood consumption(kg)
Small (n=43)	Mean	1534.3	180.4
Medium (n=13)	Mean	1814.61	113.33
Big (n=9)	Mean	2702.77	93.33
Large (n=3)	Mean	1633.3	69.44
Total (n=68)	Mean	1746.91	157.32

Source: field survey, 2007

3.1.9 Household Energy Consumption

About 61.76% of the surveyed households in the study area used fuel wood as cooking. Although 30.88% of the households used LPG, however, these households also used fuel wood along with LPG for cooking. Around 26.47% used biogas (gobar gas). Kerosene was used by 26.47% of the households as an alternative energy for lightning. Only 11.76% of the households were deprived of electricity. The rest (88.23%) of the households had access to electricity (Fig 5).

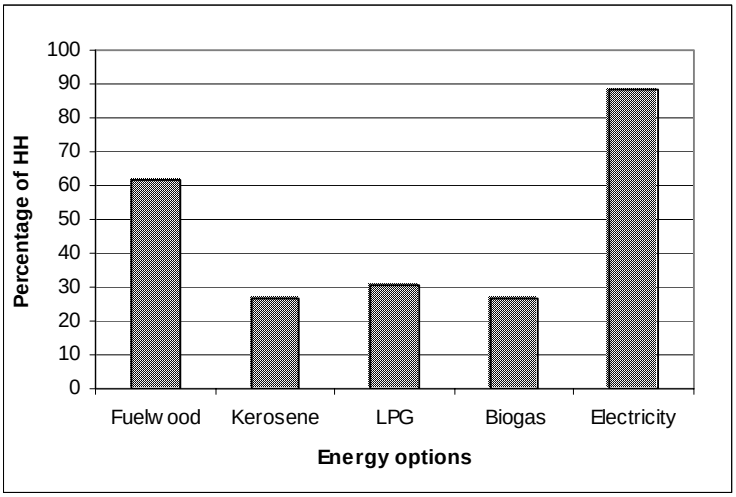

Fig 5: Percentage of HHs using different options of energy

The household distribution of energy use types varied with the households farm size (Table 13). Kerosene was used by 41.86% of the small farm sized households. Use of LPG was highest (66.6%) in the households of large farm; whereas the installation of biogas was highest (61.53%) in the households of medium farm size. Electricity was used by almost all the households. Only 18.46% households from the small farm size did not have access to electricity.

Table 14: Households energy use pattern by farm size (percentage is calculated from the sample size)

Farm size	Energy options									
	Fuel wood		Biogas		LPG		Electricity		Kerosene	
	No	%	No.	%	No.	%	No.	%	No.	%
Small (n=43)	31	72.09	5	11.6	12	27.9	35	81.4	18	41.8
Medium (n=13)	6	46.15	8	61.5	3	23.0	13	100	-	-
Big (n=9)	3	33.3	4	44.4	4	44.4	9	100	-	-
Large (n=3)	2	66.6	1	33.3	2	66.6	3	100	-	-

Source: field survey, 2007.

3.1.10. Buffer Zone Program

About 68% households were involved in activities of the buffer zone program. Among member households, 76% had member status and 24% were in provincial status of buffer zone committee and buffer zone user groups. Big farm households participation in the buffer management activities was relatively higher (33.3%). (Table 15)

Table 15: Households' buffer zone member and management level participation by farm size

Land holding	Number of households	BZM		MLP
		Member	Non member	
Small farm	43	24 (55.8)	19 (44.2)	5 (11.6)
Medium farm	13	12 (92.3)	1 (7.7)	3 (23.0)
Big farm	9	8 (88.8)	1 (11.2)	3 (33.3)
Large farm	3	2 (66.6)	1 (33.4)	-
Total	68	46 (68.0)	22 (32.0)	11(16.2)

Note: figures in the parenthesis are the percentage
BZM=buffer zone member, MLP=management level participation

Participation in buffer zone program among ethnic groups show higher participation from Brahmin/Chhetri/Thakuri (74.5%), whereas the participation from Bote/Maji, Dalits and Darai/Kumal /Praja was relatively much lower (Table 16).

Table 16: Households' buffer zone member and management level participation by ethnicity.

Ethnicity	Number	BZM		MLP
		Member	Non member	
Brahmin/Chhetri/Thakuri	47	35 (74.5)	12 (25.5)	10 (21.3)
Gurung/Magar/Tamang	10	5 (50.0)	5 (50.0)	-
Newar	2	2	-	-
Tharu	4	3 (75.0)	1 (25.0)	1 (25.0)
Darai/Kumal/Praja	1	1	-	-
Bote/Maji	1	-	1	-
Dalits	3	1 (33.3)	2 (66.7)	-

Note: figures in the parenthesis are the percentage
BZM=buffer zone member, MLP=management level participation

3.2 Rhino Occurrence and Conservation

3.2.1. Frequency of rhino Movement in the Study Area

Of the surveyed households, 39.7% responded that the movement of rhino in their area was increasing. They reported that rhino used to come only in winter (November-March) but they now visit during pre-monsoon (April-June) and damaged maize and paddy. Majority of the households who responded that rhino movement was increasing were the settlers near the park boundary. About 20.5% of the surveyed households responded that the rhino movement was decreasing in their area, whereas 23.5% of the households were unknown about the rhino movement (Fig 6).

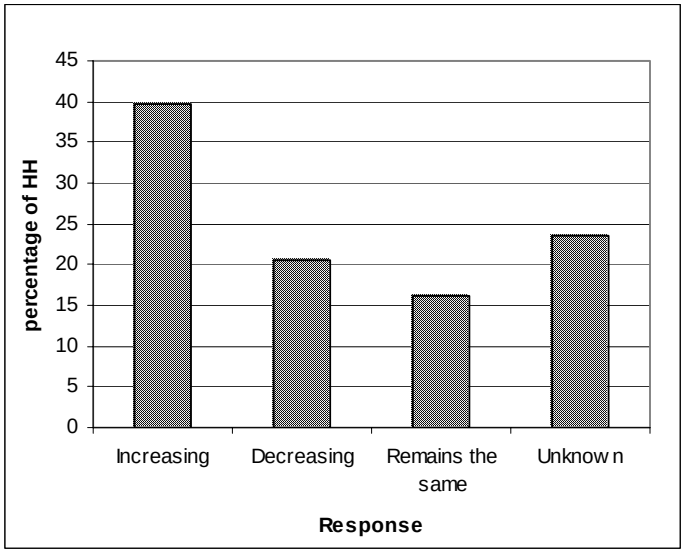

Fig 6: Frequency of Rhino movement in the study area

3.2.2. Crop Damage by Rhinos

Rhino mostly damaged the food crops (wheat, paddy, maize). Some 29.41% of the households' paddy was reported to be damaged by rhino, whereas 14.7% of the households mentioned that their masuro is damaged. About 1.47% households mentioned that their potato was damaged (Table 17). Regarding compensation for crop loss, almost all the households were found unsatisfied with the compensation .They mentioned that only 25% of the seed loss is given as compensation. Moreover

they mentioned that getting compensation was tedious and in the process of getting compensation they loss more than they get.

Table 17: Frequency of households getting damaged by rhino

Crop	Frequency % of HH Getting damaged	Season of crop
Paddy	29.4	summer
Maize	27.9	winter
Wheat	23.5	winter
Masuro	14.7	winter
Green Vegetables	4.4	winter
Potato	1.47	winter
Buckwheat	1.47	summer

Source: field survey, 2007.

3.2.3. Rhino Poaching and Conservation Activities

Of the respondents, 33.8% preferred not to speak about the rhino related issues. About 63.2% responded that the rhino is poached for money, 3% responded that the rhino is poached in the retaliatory manner and 1.47% mentioned that the rhino is poached to take the opportunity of weak governance. Of the respondents, 36.76% were familiar with the activities carried out to conserve rhino by management authorities. Majority (58.8%) of the respondents were not informed about the activities carried out to conserve rhino (Table 18).

Table 18: Activities done by Conservation Authorities to conserve rhino

Response	frequency	%
Unknown	40	58.8
Awareness program	17	25
Establishment of youth club	5	7.35
Nothing	3	4.4
Training/seminar	3	4.4
Physical development work	5	7.35

Source: field survey, 2007.

3.2.4 Suggestions

Although 48.5% of the households remained ambiguous about the suggestions (Table 19), others suggested that strict law and policy, awareness program and strong punishment to the poachers can control poaching and security strengthen, employment generation to the poor and habitat management can help to conserve rhino. They further suggested that the present activities carried out by buffer zone user committee are ineffective to conserve rhino.

Table 19: Households' suggestion to control poaching and to conserve rhino

Response	Frequency	%
Unknown	33	48.5
Awareness program	13	19
Security strengthen	7	10.3
Employment generation to the poor	5	7.3
Compensation measures should be increased	5	7.3
Literacy build up	5	7.3
Strong punishment to the poachers	4	5.9
Strict law and policy	3	4.4
Buffer zone committee should be active and responsible	2	3.0
Empower anti-poaching unit	2	3.0
Inform to committee when stranger is seen in the village	2	3.0
Reform policy	1	1.5
Good governance	1	1.5
Training and workshop	1	1.5
Establish working committee in every ward	1	1.5

Source: field survey, 2007.

3.3 Changes in Landuse

3.3.1. Land Use Pattern in Mukundapur VDC (1978-1992)

The total land occupied by Mukundapur VDC is 2761 ha. Comparison of areas of the six land cover categories (1978-1992) indicated loss in forest and agriculture land and gain in shrub land, grassland, water bodies and orchard (Table 20).

Table 20: Land cover changes between 1978 and 1992

Land cover categories	1978 land cover(ha)	% of land cover 1978	1992 land cover (ha)	% of land cover 1992	Difference land cover 1978-1992 (ha)
Agriculture land	1273	46	1161.2	42	-111.7
Forest	1421	51	1340.2	48.5	-81
Water bodies	64.5	2.3	103.2	3.7	38.7
Shrub land	1.78	0.06	137.65	5	135.8
Orchard	0	0	5.6	0.2	5.6
Grassland	0	0	13	0.5	13

From 1978 and 1992, there was loss of 81 ha of forest and 111.7 ha of agriculture land. However there was 135.8 ha increase in shrub land. Also there was gain in water bodies, orchard, and grassland by 38.7ha, 5.6 ha and 13 ha respectively.

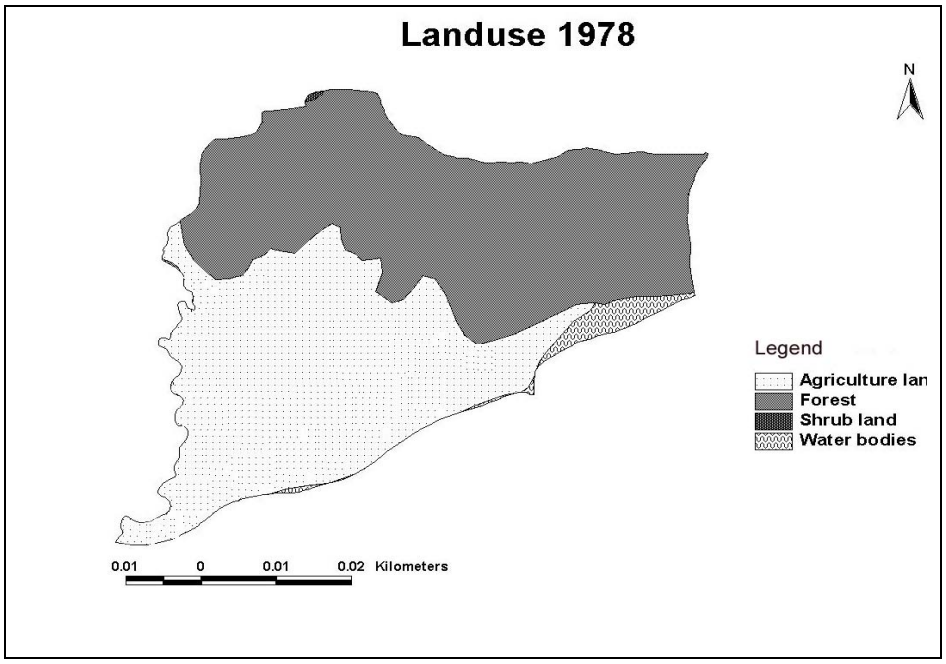

Fig 7: Land use of Mukundapur VDC in 1978

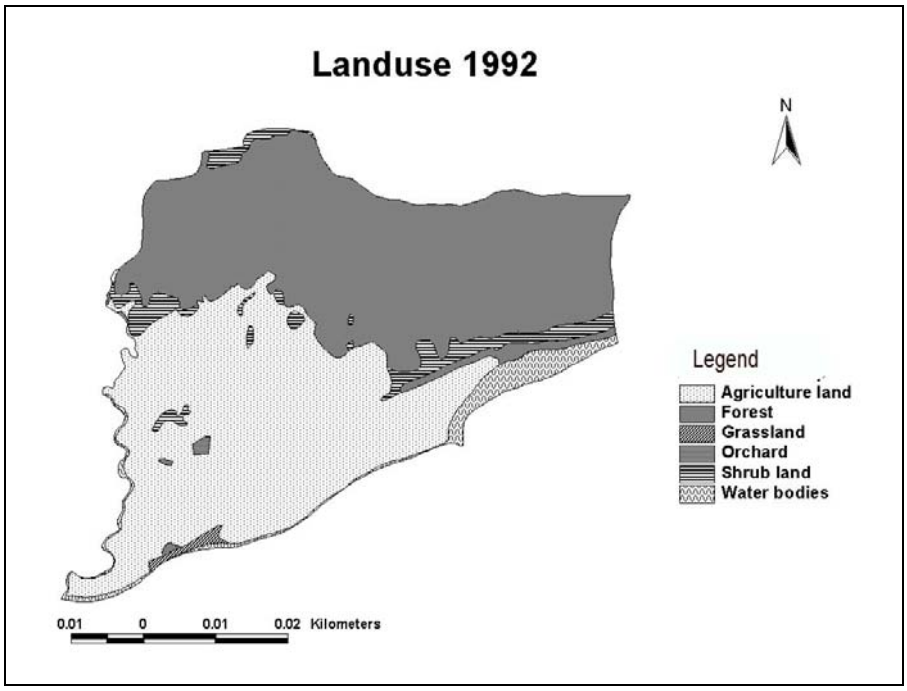

Fig 8: Land use of Mukundapur VDC in 1992

3.3.2 Details of Land Cover Change between 1978 -1992

A detail of land cover change of Mukundapur buffer zone VDC between 1978 and 1992 is presented in Table 21.There was loss in the forest cover and agricultural land. Some 3.6% of the forest covers in 1978 changed to the shrub land by 1992. Similarly 0.75 % the forest land changed to agricultural land by 1992. But 1.35 % of the agricultural land changed to forest by 1992. Agricultural land also changed to the other categories as- 0.45% to grassland, 0.2 % to orchard, 1.3 % to shrub land and 1.5 % to water bodies. Forest land that had changed to shrub land indicates deforestation (Fig 7, 8 and 9).

Table 21: Details of land cover change in between 1978-1992

Land cover categories	Area in ha	%
Agriculture land to forest	37.46	1.35
Agriculture land to grassland	12.62	0.45
Agriculture land to orchard	5.6	0.2
Agriculture land to shrub land	36.73	1.3
Agriculture land to water bodies	41.97	1.5
Forest to agriculture land	20.85	0.75
Forest to shrub land	99.13	3.6
Forest to water bodies	1.69	0.06
Unchanged agricultural land	1138.96	41.25
Unchanged forest	1299.21	47.05
Unchanged shrub land	1.78	0.06

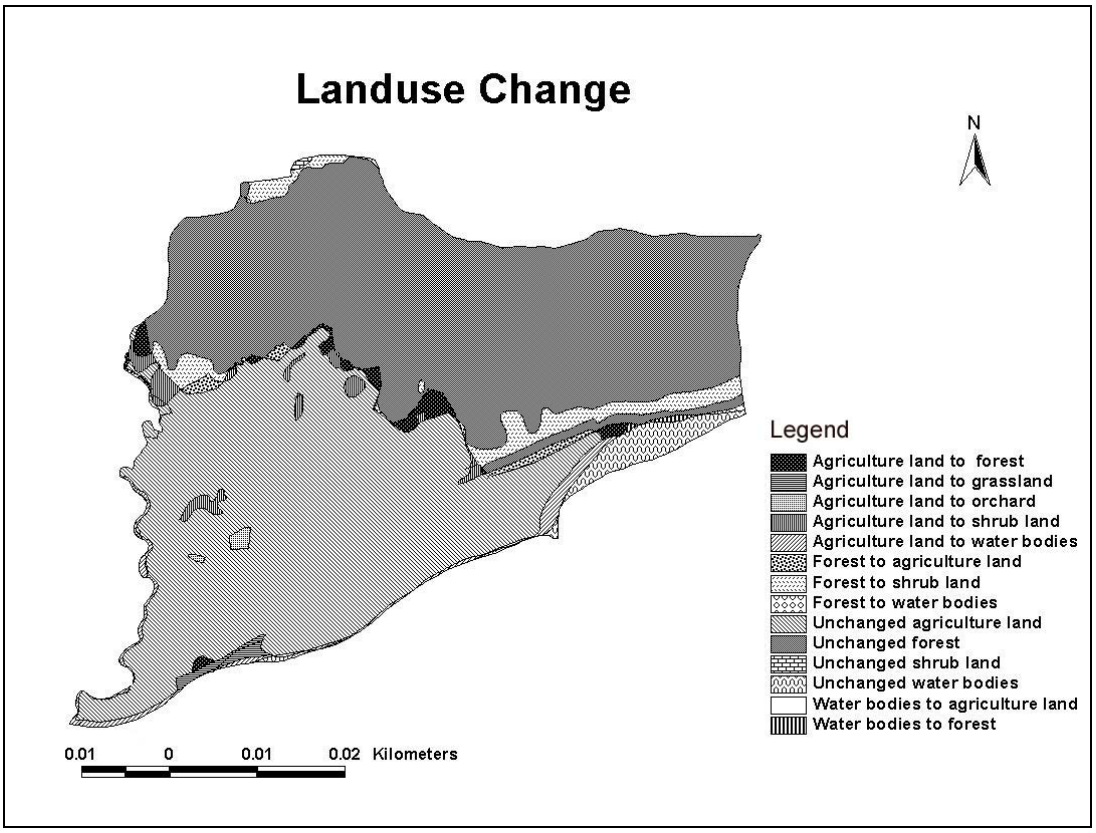

Fig 9: Details of land use change in Mukundapur VDC in between 1978-1992

3.4. Vegetation Analysis

The vegetation study was carried in the buffer zone forest and also outside the buffer zone forest which was the continuous patch and separated by highway. There were 8 species of tree, 31 species in the shrub plots and 31 species in the herb plots inside the buffer zone forest and 7 species of tree, 30 species in the shrub plots and 29 species in herb plots outside buffer zone forest.

3.4.1. Tree species

Eight species of trees were found in the buffer zone forest, whereas 7 species of trees were found outside the buffer zone forest. The diameter of tree species ranged from 10.4 cm to 109 cm. *Shorea robusta* was relatively dense and most frequent tree species both inside buffer zone forest and outside buffer zone forest. The importance value index was also high for *Shorea robusta* both inside and outside buffer zone forest (Table 22 and 23).

Table 22: Importance value index of tree species inside buffer zone forest

Species	D/ha	RD (%)	F (%)	RF (%)	BA(m^2/ha)	RBA (%)	IVI
Shorea robusta	118.75	48.7	75	23	8.75	48.5	120.2
Mallotus phillipinensis	37.5	15.4	50	15.4	2.23	12.6	43.4
Lagerstroemia parviflora	31.25	12.8	50	15.4	3.4	19.3	47.5
Careya sp.	25	10.2	50	15.4	2.1	11.92	37.5
Aegle marmelos	6.25	2.6	25	7.7	0.4	2.6	12.9
Melia azederach	12.5	5.1	25	7.7	0.2	1.2	14
Schleichera oleosa	6.25	2.6	25	7.7	0.6	3.5	13.8
Chaichui *	6.25	2.6	25	7.7	0.09	0.5	10.8
Total	243.75	100	325	100	17.78	100	300

Source: field survey, 2007.

Table 23: Importance value index of tree species outside buffer zone forest

Species	D/ha	RD (%)	F (%)	RF (%)	BA (m2/ha)	RBA (%)	IVI
Shorea robusta	228.57	80	100	38.9	12.92	85.61	204.5
Careya sp.	25	8.75	28.57	11.1	1.1	7.4	27.25
Piyari *	14.28	4.9	57.14	22.22	0.62	4.13	31.25
Syzgium cumini	7.14	2.49	28.57	11.1	0.16	1.09	14.68
Semecarpus anacardium	3.57	1.25	14.28	5.55	0.09	0.6	7.4
Rato kaiyo *	3.57	1.25	14.28	5.55	0.04	0.27	7.07
Chai chui*	3.57	1.25	14.28	5.55	0.135	0.89	7.69
Total	285.7	100	257.12	100	15.065	100	300

Source: field survey, 2007.

Shannon diversity index of tree species inside buffer zone forest was 0.6795 and outside buffer zone forest was 0.3465. It shows that the diversity of tree species inside buffer zone forest was higher than that outside buffer zone forest.

3.4.2. Stand Size Classification of Trees

From the stand size classification of observed trees, the density of poles was found the highest both inside and outside the buffer zone forest. Whereas inside buffer zone forest, the density of saplings was found the least (2.56/ha). But outside buffer zone forest the density of large saw timber was found the least (Table 24 and 25).

Table 24: Stand size classification of trees inside buffer zone forest

Stand size	dbh class (cm)	Density/ha	RD (%)
Saplings	<=12.5	6.25	2.56
Poles	>12.5-<=25	162.5	66.6
Small saw timber	>25-<=50	62.5	25.6
Large saw timber	>50	12.5	5.12

Table 25: Stand size classification of trees outside buffer zone forest

Stand size	dbh class (cm)	Density/ha	RD (%)
Saplings	<=12.5	50	17.5
Poles	>12.5-<=25	167.85	58.75
Small saw timber	>25-<=50	53.57	18.75
Large saw timber	>50	14.28	4.9

3.4.3. Shrubs

Altogether 31 species of shrubs were observed in the shrub plots inside buffer zone forest. Of the shrub species inside buffer zone forest, *Eupatorium sp.* had the highest density (6628.57/ha). But *Shorea robusta* was the most frequent and the most dense species outside buffer zone forest. The density of *Shorea robusta* was found 3628.57/ha with relative frequency 8%. Among the observed shrub species inside buffer zone forest, *Xeromphis spinosa*, *Schleichera oleosa*, Leguminosae, *Cassia fistula* and *Callicarpa macrophylla* had the lowest density of 28.57/ha. However, outside buffer zone forest *Dillenia pentagyna*, *Bombax ceiba*, *Asparagus sp.*, Thulo asare* had the lowest density of 28.57/ha (Table 26 and 27).

Table 26: density and frequency of shrub species inside buffer zone forest

S.N.	Name of species	Density/ha	RD (%)	Frequency (%)	RF (%)
1	*Shorea robusta*	3800	16.2	85	8
2	*Cleodendron sp.*	4171	17.8	85	8
3	*Mallotus phillipinensis*	600	2.5	71	7
4	Kalibhanti *	171	0.7	28	3
5	*Syzium cumini*	143	0.6	42	4
6	Chaichui *	143	0.6	57	5
7	*Xeromphis spinosa*	29	0.1	14	1
8	*Schleichera oleosa*	29	0.1	14	1
9	*Lagerstroemia parviflora*	86	0.4	28	3
10	Sano asare*	457	1.9	71	7
11	*Eupatorium sp.*	6628	28.3	100	9
12	*Careya sp*	114	0.5	28	3
13	*Grewia sp*	3457	14.7	57	5
14	*Colebrookia oppositifolia*	57	0.2	28	3
15	*Holarrhena pubescens*	57	0.2	14	1
16	Asare	114	0.5	42	4
17	*Nyctanthes sp.*	143	0.6	42	4
18	*Darbergia sisoo*	57	0.2	14	1
19	*Bombax ceiba*	85	0.4	42	4
20	Leguminosae	29	0.1	14	1
21	*Terminalia tomentosa*	57	0.2	14	1
22	*Leea macrophylla*	85	0.4	28	1
23	*Dillenia pentagyna*	57	0.2	14	3

24	*Cassia fistula*	29	0.1	14	1
25	*Costus speciosus*	200	0.8	28	1
26	Kharane *	428	1.8	14	3
27	*Mimosa pudica*	1457	6.2	28	1
28	Aankh *	57	0.2	14	3
29	*Bridelia sp.*	228	1	14	1
30	Gramineae	428	1.8	14	1
31	*Callicarpa macrophylla*	29	0.1	14	1
	Total	23425	100	1072	100

Table 27: Density and frequency of shrub species outside buffer zone forest

S.N.	Name of species	Density/ha	RD (%)	Frequency (%)	RF (%)
1	*Shorea robusta*	3628	22	100	7.5
2	Piyari *	686	4	71	5.3
3	*Leea macrophylla*	857	5	100	7.5
4	*Phoenix humilis*	1228	7	71	5.3
5	Gabjo *	2286	14	86	6.4
6	*Careya sp.*	257	1.5	43	3.2
7	*Holarrhena pubescens*	114	0.7	28	2
8	*Xeromphis spinosa*	628	3.8	71	5.3
9	Chaichui *	486	3	71	5.3
10	Asare *	257	1.5	43	3.2
11	Kalibhanti *	286	2	71	5.3
12	*Swida sp.*	1600	9.5	71	5.3
13	*Careya arborea*	57	0.3	14	1
14	*Syzgium cumini*	514	3	43	3.2
15	*Dillenia pentagyna*	29	0.2	14	1
16	Rato kaiyo *	343	2	43	3.2
17	*Semecarpus anacardium*	171	1	43	3.2
18	*Terminalia tomentosa*	314	2	57	4.3
19	*Lagerstroemia parviflora*	86	0.5	43	3.2
20	*Phyllanthus emblica*	29	0.2	14	1
21	*Cleodendron sp*	1085	6.5	43	3.2
22	*Bombax ceiba*	29	0.2	14	1
23	*Asparagus sp.*	29	0.2	14	1
24	*Eupatorium sp.*	628	3.8	57	4.2
25	*Dalbergia sissoo*	114	0.7	14	1
26	*Schleichera oleosa*	229	1.4	28	2
27	Thulo asare *	29	0.2	14	1
28	*Costus specious*	86	0.5	28	2
29	Gramineae	400	2.4	14	1
30	*Grewia sp.*	200	1.2	14	1
	Total	16685	100	1337	100

3.4.4. Shrub Stratum and Species Composition

The height wise density and relative density of species found in shrub plots is presented in the table 28. The tree species found in shrub plots in the buffer zone forest were *Shorea robusta, Syzgium cumini, Careya sp., Schleichera oleosa, Terminalia tomentosa, Lagerstroemia parviflora, Dalbergia sisso, Mallotus phillipinensis*. These tree species were at the growing stage with dbh less than 10 cm. The tree species found in the shrub plots outside buffer zone forest were *Shorea robusta,* Piyari*, *Anogeisus latifolia*, *Cochlospermum religiosum, Syzgium cumini, Phyllanthus emblica, Semecarpus anacardium, Dillenia pentagyna* and *Terminalia tomentosa.*

Table 28: Height wise shrub analysis inside buffer zone forest

S.N.	Name of species	density (ha $^{-1}$)			RD (%)		
		< 1m	1-2 m	> 2m	<1m	1-2 m	>2 m
1	*Shorea robusta*	2600	914	285	15.2	15.8	48
2	*Cleodendron sp.*	4057	114	0	23.7	2	0
3	*Mallotus phillipinensis*	400	171	28	2.3	3	4.7
4	Kalibhanti *	171	0	0	1	0	0
5	*Syzgium cumini*	114	28	0	0.6	0.5	0
6	Chaichui *	85	0	57	0.5	0	9.6
7	*Xeromphis spinosa*	0	0	28	0	0	4.7
8	*Schleichera oleosa*	28	0	0	0.2	0	0
9	*Lagerstroemia parviflora*	0	28	57	0	0.5	9.6
10	*Murraya koenigii*	342	114	0	2	2	0
11	*Eupatorium sp.*	2542	4171	0	14.8	72	0
12	*Careya sp.*	85	0	28	0.5	0	4.7
13	*Grewia sp.*	3457	0	0	20.2	0	0
14	*Colebrookia oppositifolia*	28	28	0	0.7	0.5	0
15	*Holarrhena pubescens*	0	28	28	0	0.5	4.7
16	Asare *	114	0	0	0.6	0	0
17	*Nyctanthes sp.*	114	0	28	0.6	0	4.7
18	*Darbergia sisoo*	28	0	28	0.2	0	4.7
19	*Bombax ceiba*	85	0	0	0.5	0	0
20	Leguminosae	0	28	0	0	0.5	0
21	*Terminalia tomentosa*	28	28	0	0.2	0.5	0
22	*Leea macrophylla*	85	0	0	0.5	0	0
23	*Dillenia pentagyna*	57	0	0	0.3	0	0
24	*Cassia fistula*	0	0	28	0	0	4.7

25	*Costus speciosus*	200	0	0	1.2	0	0
26	Kharane *	428	0	0	2.5	0	0
27	*Mimosa pudica*	1457	0	0	8.5	0	0
28	Aankh *	57	0	0	0.3	0	0
29	*Bridelia sp.*	142	85	0	0.8	1.5	0
30	Gramineae	428	0	0	2.5	0	0
31	*Callicarpa macrophylla*	0	28	0	0	0.5	0
	Total	17132	5765	595	100	100	100

Source: field survey, 2007.

3.4.5. Herbs

Altogether 31 species were observed in the herb plots inside the buffer zone forest. But outside buffer zone forest only 29 species were observed. Of the herb species inside buffer zone forest, *Cynodon dactylon* was dominant followed by *Imperata cylindrica* and Bolu lahara*. Species such as *Thespesia sp.*, *Colebrookia oppositifolia*, *Phoenix humilis*, Pirrejhar*, Thuloasare* had the lowest density inside buffer zone forest. Whereas outside buffer zone forest *Dioscorea bulbifera* had the highest density, followed by *Imperata cylindrica* and *Cheilanthes sp*. Species such as *Cleodendron sp.* and *Swida sp.* had the lowest density in the herb plots outside buffer zone forest (Table 29 and 30).

Table 29: Density and frequency of herb species inside buffer zone forest

SN	Species	Density(ha-1)	R.D. (%)	Frequency (%)	R.F. (%)
1	*Rumex sp.*	15000	3.83	71.4	8
2	*Cyperus sp.*	9285.7	2.37	42.8	4.8
3	*Eupatorium sp.*	1428	0.36	28.6	3.2
4	Aankhle *	4285	1.09	14.3	1.6
5	Pirrejhar *	714	0.18	14.3	1.6
6	*Dioscorea bulbifera*	17857	4.56	57.1	6.3
7	*Cissampelos sp.*	5000	1.27	57.1	6.3
8	Angure lahara*	7142	1.82	42.3	4.7
9	*Ageratum conyzoides*	36428	9.3	57.1	6.3
10	Dudhe lahara *	7142	1.82	42.8	4.7
11	*Imperata cylindrica*	141428	36.13	57.1	6.3
12	*Cynodon dactylon*	Too many	-	42.8	4.7
13	*Grewia sp.*	17142	4.38	57.1	6.3
14	Sanogola *	22142	5.65	14.3	1.6

15	*Shorea robusta*	1428	0.36	14.3	1.6
16	*Thespesia lampas.*	714	0.18	14.3	1.6
17	Thuloasare *	714	0.18	14.3	1.6
18	*Cleodendron viscosum*	9285	2.37	28.6	3.2
19	*Phoenix humilis*	714	0.18	14.3	1.6
20	*Sida sp.*	40714	10.4	42.8	4.7
21	*Mimosa pudica*	2857	0.73	14.3	1.6
22	*Saccharum spontaneum*	5000	1.27	14.3	1.6
23	*Oxalis sp.*	26428	6.75	28.6	3.2
24	Sano banso *	6428	1.64	14.3	1.6
25	*Colebrookia oppositifolia*	714	0.18	14.3	1.6
26	*Cleodendron sp.*	4285	1.09	14.3	1.6
27	Asare *	714	0.18	14.3	1.6
28	*Mallotus phillipinensis*	714	0.18	14.3	1.6
29	Thulobanso *	2857	0.73	14.3	1.6
30	*Piper longum*	2142	0.54	14.3	1.6
31	Gramineae	714	0.18	14.3	1.6
	Total	391415.7	100	899.3	100

Source: field survey, 2007.

Table 30: Density and frequency of herb species outside buffer zone forest

SN	Species	Density(ha^{-1})	R.D (%)	Frequency (%)	R.F. (%)
1	*Pogonatherum sp.*	3571	1.1	14.3	1.5
2	*Cheilanthes sp.*	30714	9.5	57.1	6
3	*Dioscorea bulbifera*	87857	27.2	85.7	9
4	Moneyplant	3571	1.1	28.5	3
5	*Rumex sp.*	5714	1.7	28.5	3
6	*Cissampelos pareira*	7142	2.2	57.1	6
7	*Cyperus sp.*	21428	6.6	57.1	6
8	*Dioscorea sp.*	1428	0.4	28.5	3
9	*Oxalis sp.*	3571	1.1	14.3	1.5
10	Bolulahara *	10714	3.3	14.3	1.5
11	*Chlorophyton sp.*	15714	4.8	57.1	6
12	*Phoenix humilis*	18571	5.7	71.4	7.5

13	*Parthenocissus semicordata*	3571	1.1	28.5	3
14	Thulobanso *	1428	0.4	14.3	1.5
15	Marcha *	1428	0.4	14.3	1.5
16	*Curcuma aromatica*	6428	1.9	57.1	6
17	*Imperata cylindrica*	48571	15	42.8	4.5
18	Angure lahara*	14285	4.4	28.5	3
19	Kalibhanti *	1428	0.4	14.3	1.5
20	*Alocasia sps*	2142	0.6	14.3	1.5
21	*Costus specious*	4285	1.3	28.5	3
22	*Sida sp.*	15000	4.6	57.1	6
23	*Dioscorea kamonensis*	2857	0.8	14.3	1.5
24	*Cleodendron sp.*	714	0.2	14.3	1.5
25	*Lygodium sp.*	2857	0.8	28.5	3
26	*Shorea robusta*	3571	1.1	28.5	3
27	*Xeromphis spinosa*	2142	0.6	14.3	1.5
28	*Chrysopogon sp.*	1428	0.4	14.3	1.5
29	*Lathikath**	714	0.2	14.3	1.5
	Total	322844	100	942.1	100

Source: field survey, 2007.

3.4.6. Volume and Biomass of Tree

The standing volume and total biomass of the observed trees inside buffer zone forest was found to be 28.7 m^3/ha and 41829.1 kg/ha respectively (Table 31), whereas outside buffer zone forest it was 17.32 m^3 /ha and 29863.9 kg/ha respectively (Table 32) i.e. less than that of trees inside buffer zone forest. It was because the tree species outside buffer zone forest were at the growing stage (see table 25). In both the forest inside buffer zone forest and outside buffer zone forest, species *Shorea robusta* had the highest standing volume and total biomass.

Table 31: Volume and biomass of tree inside buffer zone forest

Species	Standing Volume m^3/ha	Total Biomass Kg/ha	Stem Biomass Kg/ha	Branch Biomass Kg/ha	Leaf Biomass Kg/ha	Total Volume %	Total Biomass %
Shorea robusta	14.4	21685.7	12674.5	8421.0	590.2	50.1	51.8
Mallotus phillipinensis	2.9	3961.2	2556.5	1276.2	128.5	10.1	9.5
Lagerstroemia parviflora	5.7	8314.7	5007.5	3072.0	235.2	19.9	19.9
Careya sp.	1.12	1533.8	987.1	498.7	48	3.9	3.6
Aegle marmelos	0.31	422.4	279.9	124.0	18.5	1.08	1.0
Melia azederach	0.085	113.2	74.9	33.2	5	0.3	2.7
Schleichera oleosa	1.24	1705.9	1094.9	559.5	51.5	4.3	4.0
Chaichui *	0.61	840.9	539.7	275.8	25.4	2.1	2.01
Kharane*	2.37	3251.3	2086.9	1066.4	98.0	8.2	7.7
Total	28.7	41829.1	25301.9	13391.9	1020.4	100	100

Source: field survey, 2007.

Table 32: Volume and biomass of tree outside buffer zone forest

Species	Standing Volume m^3/ha	Total Biomass kg/ha	Stem Biomass kg/ha	Branch Biomass kg/ha	Leaf Biomass kg/ha	Total Volume %	Total Biomass %
Shorea robusta	13.8	25166.8	12172	6943.2	605.6	79.7	84.3
Careya sp.	1.68	2261.4	1475.4	702.3	83.7	9.7	7.6
Piyari*	1.13	1552.6	1000.0	503.6	49.0	6.5	5.2
Syzgium cumini	0.25	341.8	226.6	100.3	14.9	1.4	1.14
Semecarpus anacardium	0.18	241.8	160.34	71.0	10.5	1.04	0.8
Rato kaiyo*	0.058	77.1	51.1	22.6	3.4	0.3	0.26
Chaichui*	0.167	222.4	147.4	65.3	9.7	0.96	0.74
Total	17.3	29863.9	15232.8	8408.3	776.8	100	100

Source: field survey, 2007.

3.4.7. Sustainable Resource Yield

The sustainable resource yield from the buffer zone forest is presented in Table33. The forest can supply 1779.6 kg/ha/year and 57.3 kg/ha/year of fuel wood and green fodder respectively. The fuel wood and fodder yield from *Shorea robusta*, *Mallotus phillipinensis* and *Lagerstroemia parviflora* were comparatively higher than the other species.

Table 33: Sustainable resource yield of buffer zone forest

Species	Stem annual Yield kg/ha/yr	Branch annual yield kg/ha/yr	Leaf annual Yield kg/ha/yr	Sustainable fuel wood yield kg/ha/yr	Sustainable fodder yield kg/ha/yr
Shorea robusta	683	452.2	31.5	929.5	28.35
Mallotus phillipinensis	137.8	68.5	6.9	167.0	6.21
Lagerstroemia parviflora	270	165	12.5	355.0	11.2
Careya sps	53.2	26.8	2.5	64.8	2.2
Aegle marmelos	15.0	6.6	0.98	17.4	0.8
Melia azederach	4.0	1.8	0.27	4.7	0.24
Schleichera oleosa	59.0	30.0	2.7	68.0	2.4
Chaichui *	29.0	14.8	1.35	35.5	1.2
Kharane*	112.5	57.2	5.23	137.5	4.7
Total	1363.5	823	64	1779.6	57.3

Source: field survey, 2007.

3.4.8. Estimated Resource Supply and Demand

Total demand for fuel wood in Mukundapur buffer zone VDC was 1670.8 ton /year. However, the sustainable yield of fuel wood from the buffer zone forest was only 33.3 ton/year, i.e. only 2 % of the total fuel wood demand could be fulfilled from the buffer zone forest. Similarly the total fodder demand was 18552.3 ton/year but the sustainable yield of fodder from the buffer zone forest was 1071.5 kg/year. Only .005 % of the total fodder demand could be fulfilled from the buffer zone forest, which is negligible. Thus there was a deficit of 1637 t/yr of fuel wood and 18551 t/yr of fodder in the Mukundapur buffer zone VDC.

CHAPTER 4
DISCUSSION

4.1. Demography

Male – female population ratio in the Mukundapur buffer zone VDC was found 1.01 which is almost equal to Nawalparasi District average (CBS, 2001). Average family size was 5.27 which is slightly lower than national average (5.45 in 2001). Man – land ratio was found 10.55 persons per hectare which is much high than the national average (5.7 persons/ha) and district average (5-6 persons/ha) (CBS, 2001). Man- land ratio is one common way of expressing population resource situation. This ratio is considered as indicative of the pressure of population on land resources (Subedi, 2001). The literacy rate in the study area was found 67.6% which is higher than the Nawalparasi District average of 53.3% (CBS, 2001). Economically active population in the study area was found 63.3% which is more than the other parts of Chitwan (Nepal and Weber, 1993). Despite agriculture being the major occupation of the majority of the households, about 43.5% of the population were involved in off- farm activities. It was because, the agricultural land they hold was very less and they could not sustain by agriculture practice alone.

4.2. Landholding

Land is the primary resource for agrarian economies. The importance of land as a resource is overwhelming because majority of population i.e. more than 85% live in rural areas and more than 60% economically active population has agriculture as their primary occupation (Subedi, 2001). The average land holding in Mukundapur buffer zone VDC was 0.5 ha which is less than that of national average size of land holding i.e. 0.79 ha (CBS, 2001). This may be due to fragmentation of households. Moreover majority of the households (73.52%) had less than 0.5 ha of land and only 5.88% of the households had more than 2.0 ha of land. Of the households, 58.8% were food deficit and only 41.2% were food secured. The buffer zone program should give focus to address these poor, marginalized and food deficit households to attain the dual objective of conservation and development**.**

4.3. Caste and ethnicity

The study area was found to contain mixed ethnic groups. Tharus were found relatively the early settlers (average residence period of 32.5 years). However, the study area was dominated by Brahmin/ Chhetri. This may be due to in migration from the other places. In migration as a percentage of districts population was 17.33% for Nawalparasi District (CBS, 2001). Average landholding was found highest among Tharus, followed by Brahmin/ Chhetri. And biogas installation was also found highest in these two groups. Maji/bote, dalits and the other lower castes relatively had very less landholding. But fuel wood consumption was highest in these castes. This is because they do not have other options of energy and also some house holds from these castes sell fuel wood. Moreover, management level participation in the buffer zone program from these castes was almost negligible. Links between people and protected areas should be based on equity, rights and shared responsibilities. Many conservation authorities and their technocrats seem unconvinced of the desirability of building true partnerships with communities and still view rural communities as technically unable and politically unprepared to play a serious role in conservation (Edmund and Christo, 2002). The true beneficiaries of the buffer zone program in the study area were the people and the households who already had big farm, high livestock rearing and who is dominant in the society. Until these pro poor and marginalized people and castes are brought into the mainstream of buffer zone program, biodiversity conservation cannot be done and community development remains unfulfilled. These poor and marginalized people can become the probable collaborator to the poachers and help them in poaching.

4.4. Livestock

Livestock rearing is an integral component of the farming system. About 69% households in the study area raised livestock. Average livestock holding/HH in the study area was 3.58. Average buffaloes (1.14) holding, cattle (0.69) and goat (1.75) holding was less than the national average (cattle-3.3, buffaloes- 2.2 and goat- 4.1) (CBS, 1996).This may be due to lack of grazing land in the area and less availability of fodder. Further more, people in the area are engaged in off farm activities. Buffalo rearing was found greater in the big farm sized households. However, cattle and goat rearing was found greater in the medium farm sized households. It may be due to big

farm sized households could easily get fodder from their agricultural land. Livestock rearing in the small farm sized households and Maji/bote, Dalits and other lower castes was very low. Goat and pig farming, and the other income generating activities in these households could help them uplift their livelihood as majority of the women from these groups were just engaged in household work.

4.5 Alternative Energy

Since almost all the households (97%) practice stall feeding, there is a potentiality of installation of more number of biogas plants in the area. But still fuel wood has become the major source of energy. Only 26% of the households in the area have installed biogas. Average livestock unit in biogas installed households was 6.5, with mean standard deviation of 3.86.Thus this shows that still 27.9% of the households from small farm sized households, 15.38% from medium farm sized households, 33% from big farm sized households and 33% households from Large farm sized households could install the biogas plant if given the adequate subsidies and encourage them to install biogas. The installation of biogas was highest in Tharus (50%) followed by Brahmin/Chhetri (27%); the only two communities having management level participation in the buffer zone committee. Installation of biogas plants decreases the dependency on already scarce fuel wood, which on one hand diminishes the emission of green house gases like CO_2 and on the other health of the women in smoky kitchen of the fuel wood gets improved. Biogas is seen as a major solution to several nested problems as it mitigates not only firewood demand but also encourages stall feeding of livestock, and provides manure as well as better fodder management (KMTNC, 1998).

4.6 Buffer Zone Program

Nepal's buffer zone is conceived as a sustainable development zone to develop alternative resource base and livelihood opportunities to reduce the dependency of people on park resources (Sharma and Shaw, 1998 as cited in Budhathoki, 2005). Although 68% of the households were involved in the buffer zone program in the Mukundapur buffer zone VDC, poor, indigenous and marginalized people had no approach on executive body. And their views and voices were seen unaddressed. Despite some developmental activities like road improvement, no such activities

which improve the livelihood of the poor, needy and marginalized people were seen done in the area. This was mainly due to control of elites and rich and balanced people in the decision making body. Compensation measures of crop loss they get were inadequate and the process of getting it was long and tedious. Crop and livestock damage by wildlife is a long standing cause of conflict between park management and the local people (KMTNC, 1996). Although, improved income generation is obviously welcomed, an issue raised far more urgently by communities is that of protection from crop raiding and other damage by wildlife. Addressing the latter would be probably far greater incentives for community involvement in and support for conservation (Worah, 2002).

Activities like road improvement and river training would not address the priorities of the poor, marginalized and indigenous communities in the Mukundapur buffer zone VDC as their core problems are crop depredation, access on forest resources and hand to mouth problem. Transparency in the resource mobilization and focus should be given to the pro poor, needy and marginalized people to bring them in the mainstream of biodiversity conservation of Chitwan National Park and achieve the goal of buffer zone program. Local people should be able and willing to share responsibility for biodiversity conservation, and the benefits of participating should exceed the costs to all parties (Edmund and Christo, 2002). There is a need to broaden the understanding and scope of incentives that will encourage community participation in resource management. Incentives should be thought of as a set of factors that create an enabling environment, motivating stakeholders to participate actively in conservation, rather than as bribes to induce people to change behavior, usually temporarily (Worah, 2002).

4.7. Vegetation Analysis

The total number of tree species found in the study area was less than that of Baghmara community forest but higher than that of other forests studied by Straede et. al (2002). The density of the tree species was less than that of Baghmara, Kathar, Rapti ekta but higher than that of Chitrasen and Milijuli community forest studied by Straede et al. The calculated total density of the tree species in the study area was 243.75 ha^{-1}. The basal area of the tree species was found higher than that reported by Straede et. al (2002) in different forests of the Chitwan District. The representation of the saplings in the buffer zone forest was lowest while that of the poles was the

highest. The study of under storey vegetation showed highest density of *Eupatorium sps* in the shrub plots and *Cynodon dactylon* in the herb plots.

The supply of fuel wood and fodder from the buffer zone forest was very much low than the demand of the households. However, the people somehow managed their demand of fuel wood and fodder. It was also found that the profession of some of the households was selling fuel wood. It shows that the forest product were harvested in an unsustainable manner and also arises the question about their growing dependency on the park as most of these people did not want to speak about their sources of fuel wood for selling during the study period.

4.8. Land use Change Analysis

The 1978 to 1992 land use change analysis suggests loss in agricultural land and forest land and increase in water bodies. This result is opposite to that of total buffer zone where agricultural land had increased by 1.06% (Management plan 01-05). Increase in the shrub land was also found. This may be due to deforestation and encroachment of the forest land. Road side hotel establishment near to the buffer zone forest was found during study period.

The potential buffer zone forest in the Mukundapur buffer zone forest was 50 ha (Banskota et al 1997 cited in KMTNC in 1998), but according to DNPWC/PPP (2000) the buffer zone forest in the VDC is only 18.7 ha. There is no grassland DNPWC/PPP (2000), but the results show that there are 13 ha of grassland in 1992 map. However the grassland was flooded and covered with water during study period.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The primary objective of establishing buffer zone is to meet the natural resource needs of local communities as well as minimize human impact on protected areas so as to avoid a contention between park authorities and local communities. In the Mukundapur VDC, rich and people from higher castes were found involved in decision making. So the community participation appears to be leading towards results that are genuinely beneficial to communities, not in favour of biodiversity conservation. Because poorest of the poor and people from lower castes still not have alternative options, and forest resources on which people depend is too little, extraction threats from National Park continue to grow. Moreover, some developmental works such as gravelling of roads and river training have become pseudo developmental mask of buffer zone community, as these activities are targeted to rich and food surplus households. Farmers in the study area are not satisfied with the compensation amount and the process of giving compensation for the crop loss and damage by the wild animals, mostly by the rhino in the Mukundapur VDC. This can bring the feelings of retaliation in the farmers and rhino conservation becomes difficult. Thus the ten years long history of buffer zone in the Mukundapur VDC possesses many unsuccessful stories rather than the successful examples.

5.2. Recommendations

- Encourage and promote plantations of fodder species in barren land to meet the huge deficiency of fodder and likely dependence on the Park.

- Encourage installation of biogas by providing sufficient subsidies.

- Install active community participation in equitable manner in the decision making body of the buffer zone user committee.

- Offer skill development trainings for buffer zone communities specially targeted to special target group and the poorest of the poor, with the aim of building their skills to open up avenues of income generation.

- Allow lease hold forestry program specially targeted to the poorest of the poor to have dual benefits both to the poor and conservation of biodiversity.

- The buffer zone program should focus on conservation priorities considering the socioeconomic structure and not only the infrastructure development.

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Annex- I

A. Vegetation study formula

Density and relative density

Density denotes the average number of individuals of a given species out of the total of samples examined in a study area (the species may or may not occur in all the quadrates).

$$\text{Density per hectare} = \frac{\text{Total no. of plants of individual species}}{\text{Total no. of quadrates studied X area of quadrate}} X1000m^2$$

$$\text{Relative Density (\%)} = \frac{\text{Density of individual species}}{\text{Total density}} X\ 100$$

Density is usually used for large plants that are distinctly individuals. For very numerous plants, it is impossible to determine what represents one individual. For rhizomatous grasses, for example, determining density is not feasible.

Frequency and relative frequency:

Frequency indicates the number of sampling units in which a given species occur and thus expresses the distribution of dispersion of various species in a community. It is expressed as percentage of the total number of samples. In this no counting is involved, just a record of the presence or absence of species is made. In general, the higher the frequency, the more important the plant is in the community. A better idea of the importance of a species with the frequency can be obtained by comparing the frequency of occurrences of all the species present. The result is called the relative frequency.

$$\text{Frequency (\%)} = \frac{\text{No. of plots with the individual species}}{\text{Total no. of plots studied}} X100$$

$$\text{Relative frequency (\%)} = \frac{\text{Frequency of any species}}{\text{Total frequency of all species}} X100$$

Stand size

The following stand size classes as used by Forestry Inventory Division (FINNIDA, 1995. Chitwan) were adopted in the study area.

Table a: 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

Basal area

Basal area is one of the chief characteristics determining dominance and the nature of the community. It refers to the ground actually occupied by the stems. Basal area can be measured through:

$$\text{Basal area } (m^2) = \frac{3.1416}{4} \text{ X } (\text{DBH})^2$$

Volume

The computerize calculation system called inventory net volume (INV) developed by the Forest Inventory Section, ministry of forest and soil conservation, Nepal (FINNIDA, 1995, Chitwan) was used for the calculation of resources of the forest of the study area. 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)

Where, Ln refers to logarithm

V = total stem volume with bark (m^3)

d = diameter at breast height (m)

h = total height (m)

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).

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 (fuel wood) and foliage (fodder), ratio of branch to stem biomass and foliage to stem biomass were applied for various species (HMG, 1988 a).

Estimates of annual yield

The master plan for the forestry sector of Nepal (MPFS) has estimated the annual yield of different forest types of terai of western development region (see table b). the percent annual yield estimated by master plan in similar forest types of western development region were applied to estimate the annual yields of buffer zone forest in the study area.

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

Table b: growing stock and annual yield (tons/ha) in the natural forest of terai region of Western Development Region, Nepal (HMG, 1988).

Forest type	Forest biomass			Annual yield			Percentage yield		
	Stem	Branch	Leaf	Stem	Branch	Leaf	Stem	Branch	Leaf
Sal	80.3	30.9	5.4	4.3	1.6	0.3	5.39	5.37	5.34

Species diversity index

The ratios between the number of species and 'importance value' (number, biomass, productivity and so on) of individuals are called species diversity indices (Odum, 1996). This index is used to measure the species diversity.

Shannon and Weaver (1949) (cited in Odum, 1996) have derived the formula to find the level of species diversity of an area.

Shannon index of general diversity $\overline{(H)} = - \sum (ni/N) \log (ni/N)$

Where, ni = importance value (number) for each species

N= total of the importance value (number)

Values of the Shannon diversity index for real communities are often found to fall in between 1.0 to 6.0. The maximum diversity of a sample is H_{max} when all species are equally abundant (Stilling, 1996; cited in Odum, 1996). Species diversity tends to be low in physically controlled ecosystem i.e. subjected to strong physiochemical limiting factors and high in biologically controlled ecosystems (Odum, 1996).

Units Conversion

1 Bhari green fodder = 35 kg

1 Bhari Fuel wood = 40 kg

(Source: Field survey, 2007)

Annex II

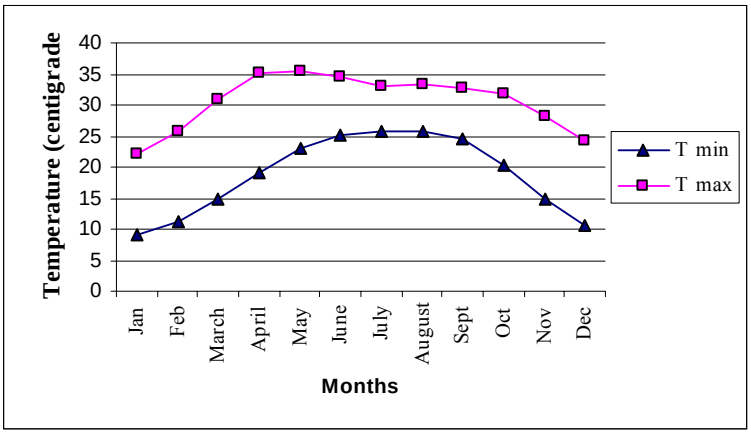

Fig Average monthly mean Maxixum and minimum temperature of the study area

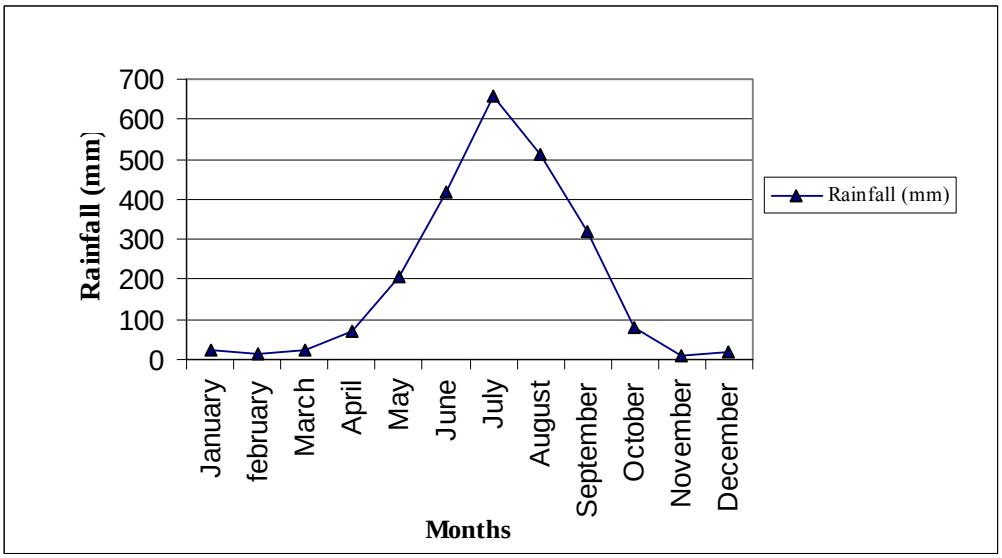

Fig Average monthly mean Rainfall of the study area

Table a.Monthly average rainfall data of the study area

Year	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1987	1.8	10.3	43	42.4	71.1	382.7	792.8	445.7	191.8	169.3	0	11.5
1988	0	6	48.8	157.5	232	318.2	757	771.4	163.8	28.4	1.1	40.6
1989	54.7	0	15	0	280	321.6	776.5	123.9	300.8	39.9	1	2.2
1990	0	21.1	39.5	13.3	332	295.4	802.6	662.5	300.4	186.1	0	7.1
1991	33.6	6.3	22.2	14	132	305.7	735.4	344.2	417.3	0	0	38.4
1992	7.2	18	0	36.5	65.7	360.8	562.5	330	263.6	125.4	8.2	0
1993	0	15.3	34	69.9	199	280.6	382.4	102.8	293.8	8.8	0	0
1994	56.4	23.3	4.6	10.8	172	442.9	443.8	545	579.8	0	0	29.5
1995	5	39.9	5.4	13	143	747.6	741.4	597.7	302.2	2.9	58.8	2.8
1996	60	43.6	0	3.8	78.8	586.1	621.6	452.8	331.6	99	0	0
1997	3.8	2.7	1	58.6	109	109	534.7	521.3	275.2	25.7	5.1	230.7
1998	10	13.6	64.9	40.9	146	312.9	646.4	925.3	271.3	150.5	1.5	0
1999	2	0	0	63.2	371	496	671.2	727.5	194.6	90.6	0	0
2000	6.5	11	45.5	63.2	256	763.7	729	432.8	301.2	3	0	0
2001	4	16.8	0	110.6	210	486.9	772.6	772.9	504.5	42.5	58.4	0
2002	35	28.4	70.2	99.8	507	381.4	828.6	263.7	261.4	65.1	50	0
2003	42.2	58.4	62.3	79.8	90.6	617.2	1226	673.9	348.7	60	0	21
2004	42.7	0	0	204.8	343	590.7	490.3	253.9	464.9	219.2	2	0
2005	76.5	0	10.2	83.4	81.4	267.8	457.7	796.6	188.7	251.5	0	0
2006	0	0	19	266	292	270.9	189.4	517.4	474	67.4	0	20.2

Source: DHM, Dumkauli station, Nawalparasi.

Table b: Monthly average maximum and minimum temperature data of the study area (Source: DHM, Dumkauli station, Nawalparasi

Year	January		February		March		April		May		June		July		August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1987	23.2	9.5	27.3	11.7	30.6	15.4	35.4	19	36.8	21.6	35.8	25.6	31.5	25.4	32.2	25.1	32.4	25.1	30.8	21.1	28.9	15.2	24.9	11.9
1988	24.6	9.6	27.5	12.1	30.7	15.4	35.8	19.6	34.9	23.4	34.1	25.2	32.6	26.1	32.4	25.7	33.4	25.2	33	20.8	30.1	13	25.4	11.7
1989	22.2	9	24.7	9.2	31	14.3	37.2	17	36.6	23.2	34.7	25.4	31.9	25.1	34.1	25.7	32.7	24.8	32.8	20.6	28.3	14.2	24	9.4
1990	24.2	10.2	25	11.7	29.1	14.5	34.4	19.1	33.8	23.3	34.8	26	32.4	25.8	33.1	25.8	32.3	24.8	31	19.9	29.8	14.8	24.8	10.6
1991	22	8.6	27.3	11.4	32.1	15.6	35.6	19.3	36.5	24.1	34	25.7	33.1	26	32.4	25.6	32.2	24.9	31.9	19.8	28	12.6	24	9.5
1992	22.2	9	23.5	10	32.6	14.6	37.8	19.6	35.6	22.8	36.3	25.1	32.8	25.2	32.7	25.7	32.1	24.3	30.5	20.9	28	14.6	23.5	10.6
1993	20.6	9.7	26.9	11.8	29	12.8	33.9	18.7	34.1	22.7	34.6	25.3	33.8	26.1	32.6	25.8	32.1	24.3	32	20.1	28.2	15.1	25.4	9.6
1994	23.2	10.3	24.9	10.4	31.3	16.3	35.9	18.5	37.1	23.3	34.9	25.6	34.4	26.2	34.2	26	32.5	24.4	31.6	19	28.4	13.1	23.9	9.9
1995	21.9	8.1	24.9	10.2	30.8	13.9	36.9	18.1	38.9	24.3	33.5	26.3	33.2	25.8	33.7	25.6	32.5	24.6	32.2	20.8	27.8	15.1	23.7	11.7
1996	21.4	9.9	25	11.6	31.3	16.3	36.1	17.8	37.2	23.3	33.9	24.7	32.9	25.9	33.3	25.7	32.9	24.6	30	20.3	28.3	14.8	24.6	9.6
1997	22.4	8	24.4	8.5	31	13.6	32	18.3	36	21.2	35.4	24.5	34	25.9	33.5	25.7	32.5	24.5	30.5	18.3	27.7	14.8	21.9	11
1998	20.2	9.3	25.6	11.1	28.4	14	33.7	19.2	36.1	24.1	36.5	26.5	32.3	25.8	32.6	25.8	33.6	25.4	32.8	22.9	28.7	17.5	25.1	10.7
1999	23	8.5	28.3	12.3	33.6	14	37.8	21.4	34.6	23.8	34.4	24.9	32.7	25.5	33	25.4	33.2	24.8	31.8	20.7	28.4	15.1	25.1	11.1
2000	21.6	9	24	9.3	30.8	13.4	34.6	19.3	33.5	23.9	33.6	25.1	32.9	25.7	32.7	25.5	32.1	24.2	32.6	20.6	27.9	16.5	24.5	9.5
2001	22.3	7.8	26.7	11	32.1	13.8	35.6	18.5	33.8	23.2	33.5	25.2	33.3	26	33.8	25.6	32.1	24.3	31.6	21.2	28	15.9	22.8	11
2002	22.5	9.5	25.8	11.8	31.1	15.2	33.6	20.4	33.1	23.2	34.3	25	32.5	25.7	33.4	25.9	32.5	24.1	30.9	20.2	27.8	15.4	23.2	11.4
2003	19	8.8	24.7	11.9	28.7	15.2	34.6	20.2	35.1	21.9	33.6	24.6	33.3	25.6	33.3	25.7	31.9	24.7	31.2	20.7	27.4	15.9	23.7	10.1
2004	20.7	9.6	25.6	11.2	32.8	17	33	21	34.3	23	33.7	24.6	31.9	25.4	33.8	25.7	32.4	24.3	30.2	19.7	26.7	14	23.5	11
2005	22.1	9.9	25.8	12.4	31.8	16.3	35.4	18.7	35	22.6	36.1	25.6	33	25.9	32.7	25.6	33.9	25.4	30.4	20.5	27.1	14	24.6	10
2006	22.5	9	28.1	14.4	31.8	14.5	34.2	19.5	34.7	23.5	33.8	24.7	34	26.2	34.5	25.9	32.3	24.2	31.7	20.3	27.1	15.1	23.6	11.6

Annex III

Questionnaires for the analysis of buffer zone community of RCNP

HOUSEHOLD SOCIO-ECONOMIC SURVEY:

Respondent Name:
Caste/Ethnic Group:
Sex:
Current Address (Village/VDC/Ward):
Household number:
Family Structure: a) Nuclear b) Joint
Name of the data collector(s):
Date:
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	

HOUSING CONDITION:

What type of roof does the house have?
Thatch/ Slate/Tin/RCC/Others
Do you have a separate shed for livestock?
Yes/No
How many houses do you own?
One/Two/Many
Household assets?

FARM SIZE:

How much of the land do you own?
Bigaha:……..Kattha:……Dhur:…….Ha:……..
Type of land?

Land type	Area
Land title owned	
Shared tenant	
Parti ailani	

Do you cultivate your own all land? Yes/ No
If No, How much land do you give for tenant?
Bigaha:……..Kattha:……Dhur:…….Ha:……..
How much of land do you hold as tenure land from others?
Bigaha:……..Kattha:……Dhur:…….Ha:……..

Crop type	Area			Production				Consumption	Surplus	Deficit
	Bigha	Kattha	Dhur	Muri	Pathi	Manna	Kg			
Food Crop										
Vegetables										
Cash Crop										
Oil seeds										
Others										

If surplus what do you do with the surplus crops?
Store/Sale/Others:…….

If deficits, how many months is deficit? ……..
How will you manage for the deficit months?
Business/Wage labor/ Buy/Borrow/ Barter/others

C: LIVESTOCK'S TYPES AND HOLDING:

Types of Animals	Numbers	Stall-feeding	Grazing	Total

How much of income do you get from livestock/ poultry production?

S.N	Item	Income (Rs)
1	Egg	
2	Milk	
3	Meat	
4	Others	

Nutritional Status of livestock (Observed)

SN.	Type of Animal	Body Shape and visibility	Nutritional Status	Remarks

D: FODDER/FUEL WOOD/ TIMBER:

Where do you graze you livestock?
Inside Park/Private land/ Common land/ Govt. land/ CF/ Others
For Stall feeding where do you get fodder from?
Private land/ Community forest/Government forest/National Park/Others
What types of species are preferred as fodder/ fuel wood / timber?

Season/ Month	Fodder			Fuel wood			Timber		
	Species	Quantity	Access	Species	Quantity	Access	Species	Quantity	Access

Is fodder enough for your livestock? Yes/No
If no, where do you get deficit fodder from?
Buying/National Park
When do you collect fodder from National Park?
Season……Period…….
Do you use for cooking food?
Kerosene/Biogas/LPG/Farmyard inclusion/Electricity/Dung cake
Except fodder, fuel wood, and timber do you harvest any other products from forest (NTFPs)

Name	Quantity	Subsistence	Earning

ALTERNATIVE ENERGY CONSUMPTION PATTERN:

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)

Season	Kerosene	Electricity	Biogas	Remark

	Amount	Expenditure	Amount	Expenditure	Amount	Expenditure	

Others Specify

.....

_____

Do you have Biogas plant in your home?
If yes,

Installed Date	Biogas	
	Capacity	Expenditure

Have you installed Biogas plan on your own or did you get any support from others?
……
…..
How much livestock are needed to operate your Biogas plan?
……
……
How much fodder is required for livestock?
……
…
If no, why are you not having Biogas plan. Are there any constraints?
……
……
Do you have any plans to install Biogas plant? Yes/No
……
……

BUFFERZONE PARTICIPATION AND CAPICITY INVOLVEMENT:
Have you involved in Buffer zone management? Yes/ No
If yes, what is your status (Position) in Buffer zone management council, UC, UG?

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

Did you involved in buffer zone management in past? Yes/ No
If yes, what was your ex-status?
Do you want to join/continue to participate in buffer zone management? Yes/No
Give Reasons:
Is natural resource utilization and mobilization in the buffer zone enough to community? Yes/No
What are your suggestions/recommendations to address this issue?

ANNUAL INCOME AND EXPENDITURE:
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		

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

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

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

RHINO RELATED ISSUES:

1. Does wildlife animal come outside of the National Park?
Yes/ No/ don't know

2. Please provide the coming frequency of rhino?

3. How many months a year do you face crop damage by rhino?

4. Crop damage caused by rhino

Crop	Time of Damage				Damages Amount/year in local unit
	Morning	Day time	Evening	Night	

Livestock loss by rhino

Livestock type	Number of loss	Month of loss	Age of livestock	Attacking rhino	
				Age	Sex

Frequency of human loss

Type of injury	Season

Do you get any compensation? Yes/No
If yes,

Type of damage	Amount
Crop damage	
Livestock injury	
Livestock loss	
Human injury	
Human loss	

Are you satisfied with the compensation?
What is the frequency of rhino poaching?
Please provide some data about the poaching

What is the penalty for rhino poachers?
Are there any households being accused of rhino poaching?

Year	Time	Age	Sex

Are there any cases of rhino horn trade yet in this VDC?
What is your opinion about rhino poaching?
What should be done to reduce rhino poaching?