BUFFER ZONE RESOURCES, LIVELIHOOD AND CONSERVATION PRACTICES IN KUMROJ BUFFER ZONE VILLAGE DEVELOPMENT COMMITTEE, CHITWAN NATIONAL PARK

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN
ENVIRONMENTAL SCIENCE
Majoring in
Wildlife Management

From

Central Department of Environmental Science
Tribhuvan University

Submitted by

©Dhan Bahadur Shrestha

Reg. No. 30517-94

2007

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF ENVIRONMENTAL SCIENCE
Kirtipur, Kathmandu, Nepal
Ph no: 01-4332147, 4332711
www.cdes-tu.edu

Ref: Date:.....

LETTER OF RECOMMENDATION

This is to certify that **Mr Dhan Bahadur Shrestha** has prepared Master's dissertation entitled "***Buffer zone resources, livelihood and Conservation Practices in Kumroj buffer zone Village Development Committee. Chitwan National Park***" for partial fulfillment of the requirement for the completion of Master's Degree in Environmental Science (Wildlife Management) and he had worked satisfactorily under my supervision and guidance.

This dissertation work embodies his own work as per the requirement of Central Department of Environmental Science, Tribhuvan University.

I therefore recommend the dissertation for approval.

…….

Dr. Pralad B. Yonzon
Visiting Professor
Central Department of Environmental Science,
Tribhuvan University,
Kirtipur,Kathmandu,
Nepal

Declaration

I, Dhan Bahadur Shrestha, 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.

…….

Dhan Bahadur Shrestha

Date: 4 July, 2007

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF ENVIRONMENTAL SCIENCE
Kirtipur, Kathmandu, Nepal
Ph no: 01-4332147, 4332711
www.cdes-tu.edu

Ref: Date:.....

APPROVAL

Name:	Dhan Bahadur Shrestha
Degree	Master's degree in Environmental Science (Wildlife Management)
Title of Research Project:	Buffer zone resources, livelihood and Conservation Practices in Kumroj buffer zone Village Development Committee. Chitwan National Park

Evaluation Committee:

……..	. …….
Suman Man Shrestha Acting Head of Department, Central Department of Environmental Science Tribhuvan University	Vijaya P Singh External Examiner Assistant Resident Representative United Nation Development Program
…….	……
Dr. Pralad B. Yonzon Supervisor Visiting Professor Central Department of Environmental Science,	Dr. Arun Rijal Supervisor

Date Approved: 26 July 2007

ACKNOWLEDGMENTS

First, I want to express thanks to Resources Himalaya Foundation for providing technical help and logistic support to carry out this study. I am thankful to my respected supervisor Dr. Pralad B. Yonzon and Dr. Arun Rijal for his guidance and meticulous support for this study. I am indebted to Prof. Uma Kant Ray Yadav, Chief of Central Department of Environmental Science for being a source of inspiration to carry out this study. I would like to thank Dr. Ram Bahadur Chettri for their sincere guidance during review and preparation of household questionnaires survey form and also to Bidur Baidya for giving me valuable information and idea on GIS analysis and preparing this report.

At the field, I received enormous amount of help from local people of Kumroj BZ VDC. I would like to thank members of BZCFUG, Shyam Regmi, Krishna Lal Chaudahary, Tej P. Baurtuala, Rudra hari Dhungana and other many people. I would also like to thank all staff members of Central Library of Tribhuvan University, Department of National Park and Wildlife Reserve and Department of Forest Library for their help in providing review paper and electronic materials. Also, thanks goes to my dear friends Apar Paudyal, Badri Ghimire, Anil KC, Yogesh Dangol, and Asish Dhakal for their kind help and constant encouragement during field study work.

Dhan Bahadur Shrestha

2007

ABSTRACT

Buffer zone (750 Km^2) of Chitwan National Park (932 Km^2) was declared in 1996 to balance biodiversity conservation and human needs through devolution of resource use rights to the local communities. Kumroj buffer zone VDC of Chitwan National Park was examined as a case study to understand conservation practices through interfacing ecology, economic and social attributes of local communities. Methods included were stratified random samplings of households and analysis of vegetation and land use change. The annual demand and supply for green fodder and fuel wood from the buffer zone community forest do not match and deficits were met through national park, private land and private forest. Out of the total demand, buffer zone forest can supply only 36.49 % of green fodder and 15.58 % of fuelwood. Fuelwood was extracted four times and green fodder 1.2 times more than community forest could supply suggesting over harvest and forest degradation. Only 10% of regenerating tree species attaining height above 1m also suggests high anthropogenic pressure on buffer zone community forest. Majority of poorer households were dependent on park for forest products while richer households mostly on their private land, although these households were also dependent on park resources. Per capita fuelwood consumption and green fodder need per unit livestock was more in poorer households than rich households, mainly due to access on modern energy sources and large farm size of rich households. Poor and indigenous people were further prone to continuous marginalization by losing their ownership on land and livestocks, and were also excluded from better opportunities and decision making process. A great majority of households reported insufficient resources, wildlife occurrence, and poor management in the buffer zone community forest. However, one third of the households were not well informed about buffer zone activities. Household representatives emphasized on enforcing strict management, incentives for investment to mobilize community and plantation in the buffer zone community forest. All these suggest that conservation and development efforts at Kumroj were less compatible in meeting the twin goals of conservation and development goal.

Key words: *Protected area, biodiversity, rhino, wildlife management, community forest, forest yield, community conservation.*

TABLE OF CONTENTS

LIST OF FIGURES

LISTS OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

NTNC	Nepal Trust for Nature Conservation (Formerly, King Mahendra Trust for Nature Conservation)
BZ	Buffer zone
CNP	Chitwan National Park
VDC	Village Development committee
DNPWC	Department of National Park and Wildlife Reserve
PPP	Park People Programme
BZCF	Buffer Zone Community Forest
BZMC	Buffer Zone Management Committee
UG	User Group
UC	User Committee
BZUC	Buffer Zone User Committee
CF	Community Forest
GCP	Grass Cutting Program
GN	Government of Nepal (Formerly, His Majesty's Government)
FSSD	Forest Survey and Statistics Division
LRMP	Land Resource Mapping Project
MPFSN	Master Plan for Forestry Sector Nepal
NPWCA	National Park and Wildlife Conservation Act
UNDP	United Nations Development Program
MEA	Millennium Ecosystem Assessment
APU	Anti Poaching Unit

Chapter 1
Introduction

1.1 Context of ICDP

Protected areas are on the frontline in the campaign to conserve biodiversity on our planet (McShane and Wells, 2004). National parks in developing countries, particularly in Asia, were established beginning in the second quarter of this century (Mishra, 1991, c.f Nepal & Weber, 1993) based on US park system- a romanticized vision of primitive areas basically through bio-centric approach that recognizes only the intrinsic values. The concept of strict protection based on US park model did not suite towards the needs and problems of local people due to different realties in the third world (Nepal & Weber, 1993). The new conservation laws curtailed the customary use of natural resources of indigenous people residing nearby protected areas, thus affecting their subsistence economy. The ill-suited concepts and approaches to the needs and problems of local, often native people, lead park-people conflict and raised many questions on long term biodiversity conservation and protected areas. The relationships between protected area and human needs, and the relevancy of integrating protected areas with other major development issues were focused firstly in third world congress on National Parks, 1982 (Mishra, 1991 c.f. Nepal & Weber, 1993), nourished and reinforced by the MAB/UNESCO Biosphere Reserve Action Plan 1984 (Sayer, 1991, c. f. Nepal & Weber, 1993). This concept reiterated in the form of integrated planning and co-operative management during the fourth world congress on National parks and protected areas, 1992 (IVth World Park Congress, 1992). Although the program had an intense influence on the concept of buffer zone management, there was a debate about what is or should be the roles of buffer zone and successful working examples of buffer zone management as an integrated conservation strategy were relatively few and also controversial (Well and Brandon, 1992). The conservation and development was sealed at Earth Summit, 1992 which was coined as "Integrated Conservation and Development projects" or ICDP by Katrina Brandon and Michaels well (Christensen, 2004) which was criticized by John Christensen (2004) as bad marriage between conservation and development.

1.2 Conservation Initiatives in Nepal

In the early 1970's, Nepal endeavored to protect and preserve the luxuriant subtropical forest and big games that had started decline due to clearance of pristine wildlife habitat for human settlements and infrastructure developments, by introducing protected area

system. After the enactment of National parks and wildlife conservation act (NPWCA) in 1973, biodiversity conservation initiatives in Nepal began with the establishment of Chitwan National Park in the same year. Although strict law enforcement practices in the beginning proved to be successful in controlling human activities in core areas and in the remarkable growth of wildlife in protected areas, conflict between park authorities and local people for the use of forest resources and wildlife depredation peaked up (Maskey and Bajimaya, 2005). Protected area approach in Chitwan involves enormous local costs, not only limiting local people's livelihood opportunities but also ignoring the potential of local institution in the conservation, thus isolating local people has changed them form conserver to destroyer (Poudyal, 2002). Major sources of conflicts are restriction on resource access and wildlife depredation. Such conflicts reduce the quality of life of local people living in or around the protected areas (Paudel, 2002). It has been recognized that many protected areas have limited future prospects without the cooperation of local people especially in developing countries (Wells and McShane, 2004). From the past experience of Nepal, protected areas with strict enforcement practice neglecting the needs of local people, especially poor and marginalized indigenous people, is not sustainable (Maskey and Bajimaya, 2005) as social capital and its elemental components play a fundamental role in developing co-management of natural resources (Plummer and Gibbon, 2006).

1.3 Buffer zone concept in Nepal

In Nepal, involvement of local people in the mainstream of wildlife conservation was urged in late 1980's but was lacking due to proper legal provision (Pradhan, 1995). In the course of development of conservation policy, a participatory approach was adopted in the early 1990's with the introduction of Annapurna conservation area based on principle of ICDP's (Maskey and Bajimaya, 2005; Bajimaya, 2005; Paudel, 2002). The fourth amendment of NPWCA, 1993 became a common platform to the local communities, NGO's and government authorities for achieving the goal of conservation. Local people around the protected area were regarded not only as the conservation partners but also benefit sharing from park revenues for community development and enhancing natural resource management (Maskey and Bajimaya, 2005, Oli, 2005; Bajimaya, 2005), although many drawbacks and loopholes are present in buffer zone policy (KMTNC, 1996). This community based concept and approach was initiated by Department of National parks and wildlife conservation (DNPWC) following the buffer zone

declaration, which advocates social mobilization by maintaining a balance between conservation and human needs (Maskey and Bajimaya, 2005). Compensating local people for their lost resource access by supporting them in their socioeconomic development is the fundamental logic behind this approach (Sayer, 1991).

Form 1996-2006, 4666.67 Km^2 of buffer zone had been declared in nine protected areas of Nepal; 6 National park conservation areas and 3 wildlife reserves (DNPWC, 2005). Buffer zone (750 Km^2) was declared in Chitwan National Park (932 Km^2) in 1996 (DNPWC, 2001). Conservation initiatives in buffer zones primarily focus on promoting collaborative efforts of the buffer zone communities by providing them various development programs to generate cordial environment between park and buffer zones to a level that is sustainable to help foster a positive impact on conservation of biological resources (Bajimaya, 2005). For this purpose a three tier institutional model has been developed to manage the conservation and development activities in the buffer zone (Budhathoki, 2005) through 21 buffer zone user committees, distributed in 35 Village development committees (VDC's) and two municipalities around the Chitwan National Park (CNP)- a world heritage sites with last surviving example of natural ecosystem in Terai region providing critical and viable habitat for significant population of several rare and endangered species.

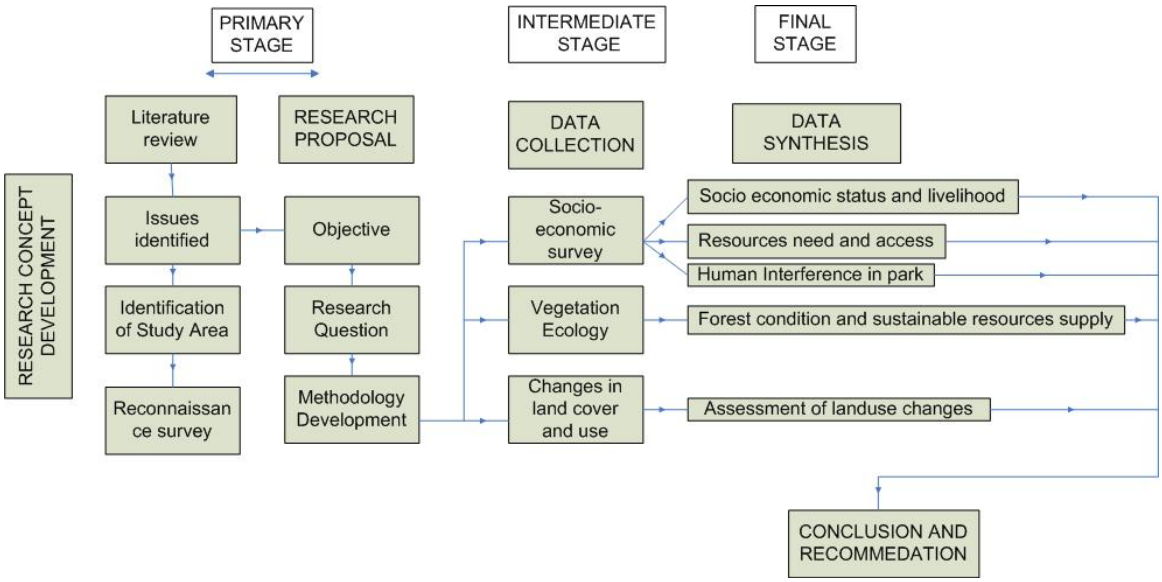
Due to widespread rampant poverty among the buffer zone communities of CNP, the park people conflicts centers around the issues of meeting basic survival needs which is the single most important threat to conservation to biological resources of the park (KMTNC, 1998). In one extreme, there is a matter of hand to mouth (subsistence economy) problem among poor people and to the other with exceptional values of rhino horn in oriental medicine, poaching and illicit activities area boosting up in recent years. Access to National park is easy as National highway around the park with 590 settlements between them. Every settlement may act as safe shelter for Rhino poachers and illicit activities (Adhikari, 2002). After a decade of buffer zone declaration, illicit activities on poaching and trading have only flourished much, and which have questioned over the protected area management system in Chitwan. At this point, it is required to have knowledge of ecology, economy, natural resources and social structure of buffer zone of Chitwan National Park to understand the potential of buffer zone management challenges and opportunities. To understand the situation of buffer zone management landscape Kumroj buffer zone VDC was studied as case study.

1.4 Statement of Study Significance

In general, threats and contemporary issues for long-term conservation in CNP have long been studied and recognized by many research scholars. But the scale and purpose of study may vary and results in with varying realties and localities. The cause of existing threats and their intensity of problems may be unique at local level. However, there has been less study on a subject matter in composite form that strives to interface the households well being of buffer zone community, natural resources availability and its status and their long-term conservation of biological resources at village level. Assessment on resource availability, subsistence livelihood economic system, access and representation of poor and marginalized people in decision making processes and social capital are important to forecast the future scenario and development initiatives to safeguard the biodiversity. This study has focused on role of socio-economy of buffer zone household and its relationship with available natural resources and community perception toward conservation hoping to avail information for better management practices for buffer zone management.

1.5. Conceptual Framework

The conceptual framework for the study was designed as follows.



1.6 Objectives

To contribute knowledge about biodiversity conservation by assessing socioeconomic structure, community activities and natural resource status of Kumroj buffer zone VDC of Chitwan National Park.

Specific objectives:

1. To determine resources (fuel wood and fodder) need and access in buffer zone households of Kumroj VDC through socioeconomic survey.
2. To study the vegetation of the community forest of Kumroj Buffer zone VDC.

3. To study the changes in land use pattern in the study area from 1978 to 1992 AD.
4. To study the buffer zone management activities, incidence of rhino occurrence and poaching activities, crop depredation by rhino and other wild animals in Kumroj VDC.

Chapter 2
STUDY AREA

2.1 Location

Kumroj buffer zone Village Development Committee (VDC) (Area 20.4km^2; 27° 30'-27° 35' E and 84° 31' -84° 35' N; Atlitude 190 m) lies in flood plain of Rapti River in Chitwan District, Narayani Zone, Central Development Region of Nepal. Major land uses include agricultural land (1133 ha), forests (237.7 ha) and other (DNPWC/PPP. 2001). The buffer zone area is managed under Budhirapti buffer zone user committee. The adjoining VDCs are: Kathar in the east, Bachauli in the west and Khairahani in the north.

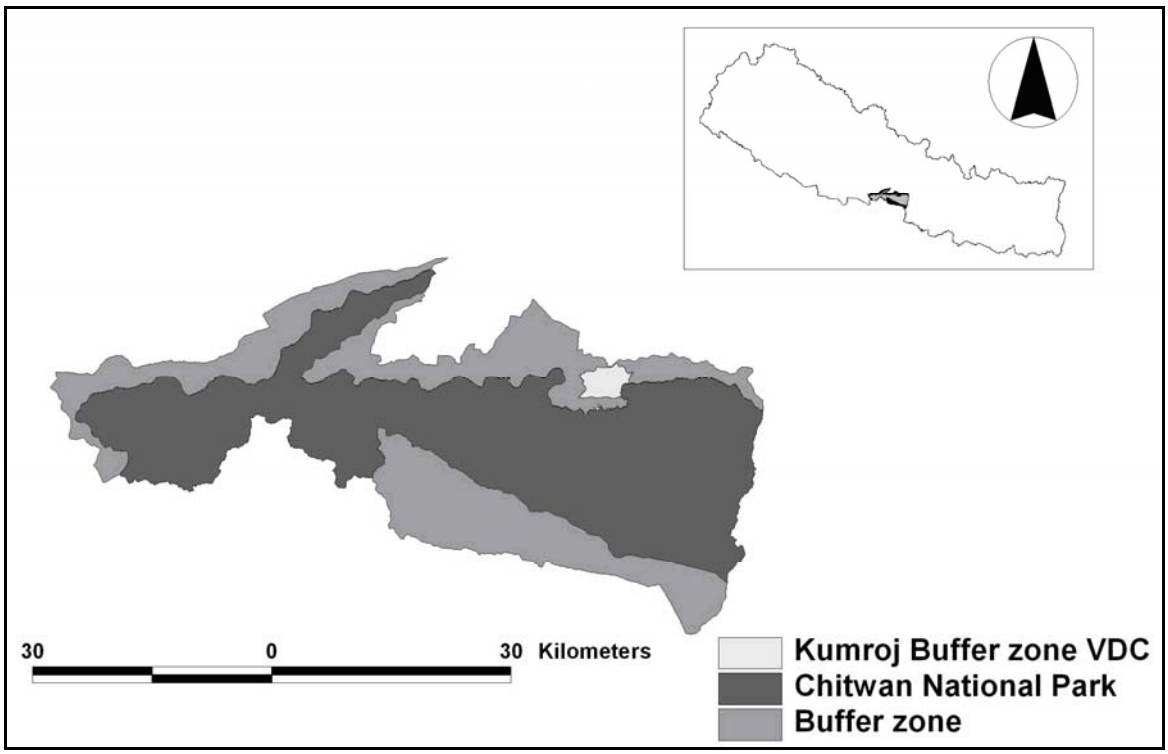


Figure 2.1 Study area

2.2 Climate

The climate of study area is subtropical (Stræde and Helles, 2000) with mean annual rainfall 1895 mm (Rampur Weather Station, 1994-2003) with 90% of rain falling as heavy rainfall in the summer monsoon from June through September. The average minimum monthly temperature is 8.2°C in January and average maximum monthly temperature is 35.9°C in May (Rampur Weather Station 1994-2003).

2.3 Socioeconomic Characteristics of the study area

The total population of Kumroj VDC is 8,729 with average family size of 6.48 (DNPWC/PPP, 2005) composed of more than 20 different caste/ethnic groups (District profile of Chitwan, 2061). Some 37.7 % population is illeterate. The dominant caste/ethnic groups were Tharu (36.2 %) followed by Brahmin/Chettri, Thakuri, Newar, Darai, Praja etc. Majority of population are dependent on agriculture and others on wage labor, business, government services and private services. More than 90 % of households use fuel wood as major source of energy. Very few households adopt alternative sources such as biogas, kerosene, LP gas and dung cake.

2.4 Buffer zone community forest

The buffer zone forest has been managed by Kumroj buffer zone community forest user group. During field study in 2006, the forests area had been restored to 1127.7 ha which includes 802.5 ha plantation forest, 280.2 ha regeneration forest and 45 ha pasture/shrub lands. The forest is predominantly riverine which includes mixed hardwood and *Acacia-Dalbergia* forest. Major plant species were *Bombax ceiba*, *Alibizia lucidor*, *Trewia nudiflora*, *Acacia catechu*, and *Dalbergia sissoo*. In the forest, 159 bird species and 20-30 mammals including rhino, tiger, leopard, deer etc are reported (BCFUG, 2004). Buffer zone community forest authority collects fuelwood twice a year and sells it to the user members. For fodder, nominal fee was charged to the user members to collects from demarcated areas, and pasture/shrub areas for livestock grazing. User members are also allowed to collect dry twigs and branches from the forest throughout the year.

Chapter 3
LITERATURE REVIEW

Park has become the most intensively as well as extensively studied area in south Asia (Yonzon, 2000 and DNPWC, 2005). After the establishment of the park, dozens of studies, researches, and analysis have been completed from species level to policy level of Chitawan National Park (CNP). KNTNC (1996) has done a detail analysis Buffer Zone policy of CNP with many drawbacks.

Tamang (1982), Mishra (1982), Dungel (1992), Shrestha (1992), Shrestha (1997) and many others have studied on various species of mammals as well as bird species to aquatic animals. Baral & Upadhyay (2006) have documented the lists of birds found in CNP and its surroundings. Laurie (1978) has already studied the ecology and behavior of rhino in north east India including CNP and has also identified probable areas of rhino translocation in Nepal. He had also warned about probable habitat degradation due to *Mikania micaranta*.

DNPWC/PCP/UNDP (2001) has mentioned that the detail exploration on flora of CNP has remained although many studies regarding floral composition and structure have been Completed. Pandit (1995) and Lamsal (1995) have studied on grassland vegetation of CNP near Kashara and resource consumption pattern among ethnic groups of adjoining villages. They have reported high densities of *Imperata cylindrica* and *Saccharum spontaneum* in grassland. Rijal (1994) did a detailed study on the dependency of local people on forest products in Padampur VDC and documented various plant species used by locals for different purposes in various occasion. He has also studied the vegetation composition and structure of riverine forests and savannas. Similarly Paudyal (2000) has also studied of Meghauli VDC and reported different species of economic values like medicinal, food, timber, fuel wood, fodder etc. Straede et.al. (2002) have reported the structure and floristic composition of six community forests established through natural regeneration of degraded Sal Forest and of former riverine forest areas. They have concluded the anthropogenic pressure on CNP is mainly villagers' traditional dependency on and extraction of NTFPs', which were not found in regenerated community forest. BZCFUG (2004) has reported densities, regenerations and yields of major species found in Kumroj Buffer Zone community Forest.

There are many studies over the park and people relationship of CNP. Joshi (1999) has conducted a detail socio-economic analysis of buffer zone residents and determined more than 78% of them collect natural resources from park. DNPWC/ PPP (2000) did extensive study on socio-economic condition, resource dependency and access on whole buffer zone area. Jnawali (1989) reported for habitat degradation of northern fringes of CNP due to livestock grazing and other human activities. He has also mentioned for the negative attitude in local people towards park management due to injuries and harassment to them by rhino. Jnawali (1994) has also studied the detail socio- economic study of Bachhauli VDC and conflict of land use due to livestock. Similarly Sharma (1991) has reported the rapid distruction of forest outside the park that intensified the pressure for fuel wood and livestock grazing on the park forests. He revealed that 45% of people were entering park for different resources. Similarly, Bhattarai (1999) and Paudyal (2002) have studied in livestock and other related issues. Nepal and Weber (1995) have reported the five major causes of park people conflict that occurred in CNP. KMTNC (1996) has identified that threats in CNP are mainly due to rampant poverty around the park and lacking alternatives that force local people to encroach park's resources and degradation of forest in and around CNP.

Straede and Treue (2005) identified a gap between local people's need for supplementing natural resources and their rights to satisfy them on a legal basis. Straede and Helles (2000) have also raised a question over the capability of BZCF to supply resources. They have argued that grass cutting programmes in CNP does not comply with the concept of community based conservation but is an example of nature based development.

Kayastha (1999) has reported the effectiveness of training programmes that the upliftment of livelihood from training programmes is not significant and very low implementation of training skills. Budhathoki (2004) has revealed inconsistencies between the vision of the programmes and its policies and practices. Maskey and Bajimaya (2005) have reported that buffer zone programmes have not been able to include the all the people in planned development process including special target groups. Paudel (2004) has also identified similar problems. Joshi (2003) has reported low representation of women at implementing stages of various buffer zone activities. Bajimaya (2000) and Shreatha (2002) have reported the positive impact of biogas on alleviating deforestation increasing soil fertility, improving health of users and reducing burden of woman. Nagendra et al. (2004) have

mentioned successful stories of buffer zone of CNP in spite of limited local decision making power.

Various researches have been completed on eco-tourism of CNP. Johnson and Orlund (1996) have reported 44% of households have directly income from tourism in Chitwan, of which 47% receives more than 25% of their income. Rijal (1996) has presented the Baghmara Community foreat as economically and ecologically sustainable model of eco-tourism and potential of this in other VDCs in the vicinity of CNP. But, Bookbinder et. al. (1998) have reported only 6 % of households earn income directly or indirectly from eco-tourism. Wells and Sharma (1998) have reported the ecological threats due to nature tourism in Nepal.

In spite of all these, Yonzon (2000) has reported the failure of ecological investigation to understand the complexities of species diversity, especially in mammals in Chitwan that led to faunal collapse. Yonzon (2002) has reported increased number of poaching of rhinos along with smuggling of timber from the park due to insurgency in country. Similarly Adhikari (2002) has raised many questions over long-term rhino conservation.

Chapter 4

METHODOLOGY

4.1. Household Socio economic survey

Household socioeconomic survey was conducted to fulfill objectives 1(To determine resources (fuel wood and fodder) need and access in buffer zone households) and 4 (To study the buffer zone management activities, incidence of rhino occurrence and poaching activities, crop depredation by rhino and other wild animals) in Kumroj Buffer zone VDC during October 2006. Research questions were set as follows:

I) How much is forest resources (fuelwood & green fodder) required in the VDC and which are sources access?

II) Is there human interference in national park for forest resources?

III) Are local communities undertaking self reliant conservation and development activities in Kumroj?

4.1.1. Survey design and Sample size

For household socioeconomic survey of Kumroj Buffer zone VDC, all wards of the VDC were included. Stratified random sampling method was applied for the survey on the basis of settlement size (table 4.1), which was based on population size, and land holding of household with five categories (table 4.2). (DNPWC/PPP, 2000)

Table 4.1 Distribution of settlement by population size (Source: DNPWC/PPP, 2000)

Symbol	Settlement	Population
S1	Hariyali	Above 300
S2	Bairiya	Above 300
S3	Gauni	Above 300
S4	Simrahani	101 to 300
S5	Kumroj	Above 300
S6	Ram Janaki Basti (Janakpur)	Above 300
S7	Ghogrela	101 to 300
S8	Kapiya	Above 300
S9	Simalghari(Shisahani)	Above 300

Table 4.2 Land holding categories

Symbol	Land holding (Local unit)	Land holding (ha)
1	Landless	LL
2	0-10 Kattha	<.34
3	10-20 Kattha	>.34-.68
4	1- 4 Bigha	>.68- 2.72
5	> 4 Bigha	>2.72

The sample size (n) of the household in the study area was determined by using formula (Arkin and Colton, 1963; cited in Sharma, A. 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 71 households. These 71 households were chosen on the basis of settlement size and land holding (figure 4.1). Random stratified sampling method with replacement was used for equal number of sample size distribution in each settlement and land holding categories with equal probability. The land categories were termed as landless, small, medium, big, and very big. Each sample was drawn through lottery method. The lottery was drawn randomly at a time from both categories for 71 times and sample size distribution (table 4.3) in each settlement with land categories was found out.

Table 4.3 Sample size distribution

Ward No	Settlement Name	Household Land holdings					
		Landless	< 0.3 ha	0.3-0.6 ha	0.6-2.4 ha	>2.4 ha	Total
1	Hariyali	3	2	-	4	-	9
2	Bairiya	-	1	1	-	1	3
3	Gauni	1	1	3	4	-	9
4	Simrahani	5	1	-	-	-	6
5	Kumroj	-	-	4	2	-	6
6	Ram Janaki Basti (Janakpur)	1	1	-	2	1	5
7	Ghogrela	1	-	3	2	-	6
8	Kapiya	5	2	2	6	-	15
9	Simalghari(Shisahani)	1	1	1	7	2	12
Total		17	9	14	27	4	71

4.1.2. Questionnaire survey

Seventy-one households representing from different wards and land holding categories were interviewed and filled structured and semi structured questionnaire with some close ended and some open-ended questions in the field.

Data on landholding of all households with name of family head person of the study area was gathered from the information collected from Buffer zone office, local social organizations, and key persons like ex-VDC chairman, ex-ward chair persons, Buffer zone management members and social workers. From these data, required number of sample size of each land categories in every ward and settlement was selected randomly and survey was conducted.

Before conducting the formal questionnaire survey, the questionnaire was pre-tested in some household and some modifications were made for more understanding to the respondent and smooth flow of subject matter. Six members research team (classmates) was mobilized for survey to bring the same level of required information. Regular discussions were made among research members on subject matter of questionnaires to make similar and equal understanding level for filling the questionnaire before conducting the formal survey. Such discussion was also made each day after conducting the survey. Interview was made with the family head member as far as possible, if such was not possible interview was made with more informative member of the household.

Questionnaire were developed having three main parts (For detail, see annex A15) to collect information on households, buffer zone community forest and buffer zone management including rhino poaching.

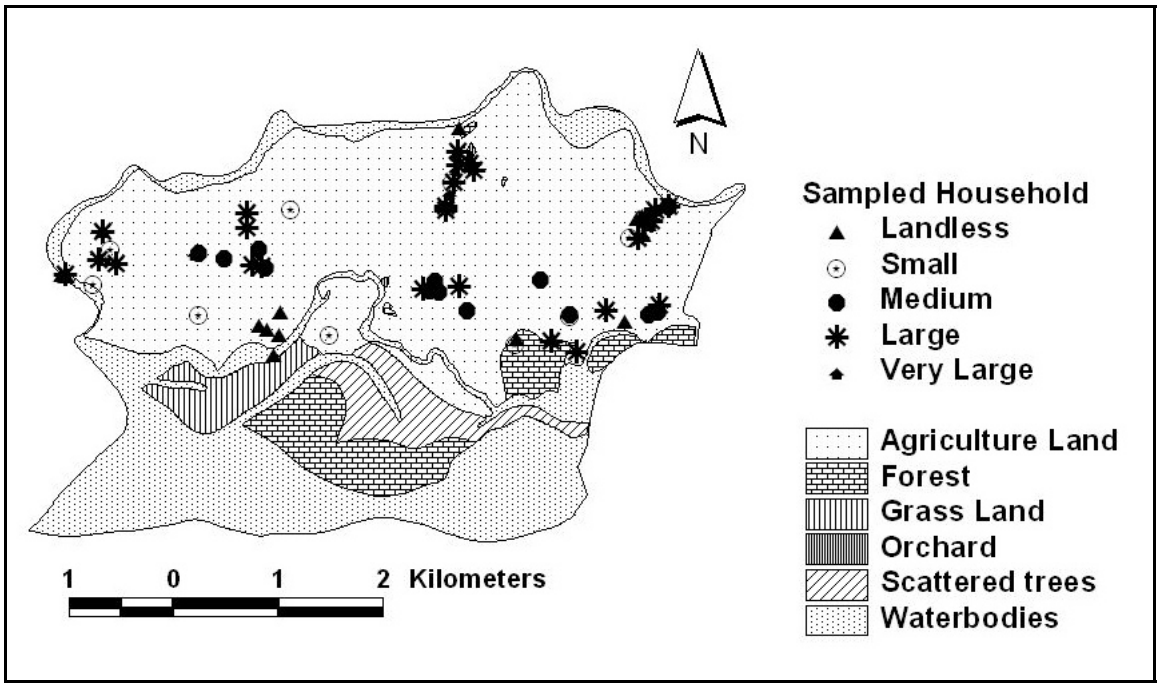


Figure 4.1 Sampled households

4.1.2.1. Household Information

This part mainly designed to obtain the household information to understand the livelihood supporting mechanism through occupation, land holding, crop types and its production, livestock holding (including feeding types), resources need (Fuel wood and fodder) and their access, energy use and consumption pattern and annual income and expenditure.

4.1.2.2. Buffer zone related issues

This part was made to obtain the household level perception about Buffer zone community forest and buffer zone management issues. Questions were set to obtain the information about household level participation in buffer zone community forest, types of resources extracted, availability of resources, problems, suggestion and recommendation for better management and resources utilization of community forest with budget sufficiency and transparency.

4.1.2.3. Rhino/Wildlife related issues

This part was set to obtain information on crop and livestock depredation by Rhino and other wildlife, compensation measures from the losses, 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.

4.1.3. Data Calculation

4.1.3.1. Farm size, crop production and livestock holding

Farm size (landholding) of each sampled households was noted in local unit (Kattha) and converted into hectare (ha). Also, agriculture production of households was noted in local unit (Muri) and converted into standard unit (Kg) (Nepal & Weber, 1993). Livestock of sampled households were counted as the head number and they were converted into the standard unit called livestock Unit (Kharal, 2000).

4.1.3.2 Estimation of Resources Need

The term need refers to the annual consumption of fuelwood and fodder resources. Resources need or demand of sampled households and their supply from different sources (Buffer zone community forest, National Park, Private land and Privare forest) were noted in local unit (Bhari) which were converted into Kilogram (Kg) based on respondent's perception and experience. Those who could not convert Bhari into Kg, equivalents given by Nepal and Weber (1993) were used. The fodder demand obtained in kilogram was converted into TDN value by multiplying the factor given by KMTNC (1996).

4.1.3.3 Household Income

Net household income was determined by subtracting overall expenditures from total income. Agriculture and livestock productions were 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.

4.1.4. Data Analysis

Data were analyzed using different statistical tools in different computer programs. Raw data and information from the completed questionnaire were first entered into the spread sheet in database form. Some necessary calculations were completed in this program. Qualitative form of data and information were also coded and entered for analysis. During data entering, each of the 71-sampled household was kept in the row and each characteristics of the household was placed in column. Once the basic calculation and modification were completed, variables were categorized according to needs. For further analysis, the variables were copied to SPSS and comparing mean operation was applied to obtain characteristics of household according to ethnic composition, farm size and net income.

4.2. Vegetation Survey

To fulfill objective 2 (To study the vegetation of the community forest of Kumroj Buffer zone VDC), vegetation survey was conducted and research questions were set as follows:
I) Does community forest yield and households demand for forest products match in Kumroj VDC?
II) What is the condition of buffer zone community forest?

4.2.1 Survey Design

Digital FINNIDA landuse map (1992) scaled at 1:25000 was used for vegetation survey by using random sampling method. Random points were fixed on the digital map of Kumroj VDC by using GIS. These random points were found in the field with the help of GPS (Garmin e-trex). Vegetation survey was conducted only in those points, which were inside the forest or other vegetation zones of buffer zone community forest.

4.2.2. Sample size

Random points were generated using GIS software by creating gridlines in each 30'' difference on the Kumroj VDC map of FINNIDA landuse map (1992) and on each such gird, random numbers were distributed. In total 50 random points were laid on the VDC. Out of 50 random points only 21 points were found within the buffer zone community forest of the VDC (figure 4.2).

4.2.3 Plot Design

At each sampling points all together 5 plots were laid. First plot was of 20x20 m^2 square shaped for tree species. 5x5 m^2 square plots (figure 4.3) were laid within southeast and northwest corner of 20x20m^2 plot for shrub species. Similarly 1x1m^2 plots nested within shrub plot were laid for herb species. For tree, 2000m^2 area was surveyed, 350m^2 for shrubs and 33m^2 for herbs.

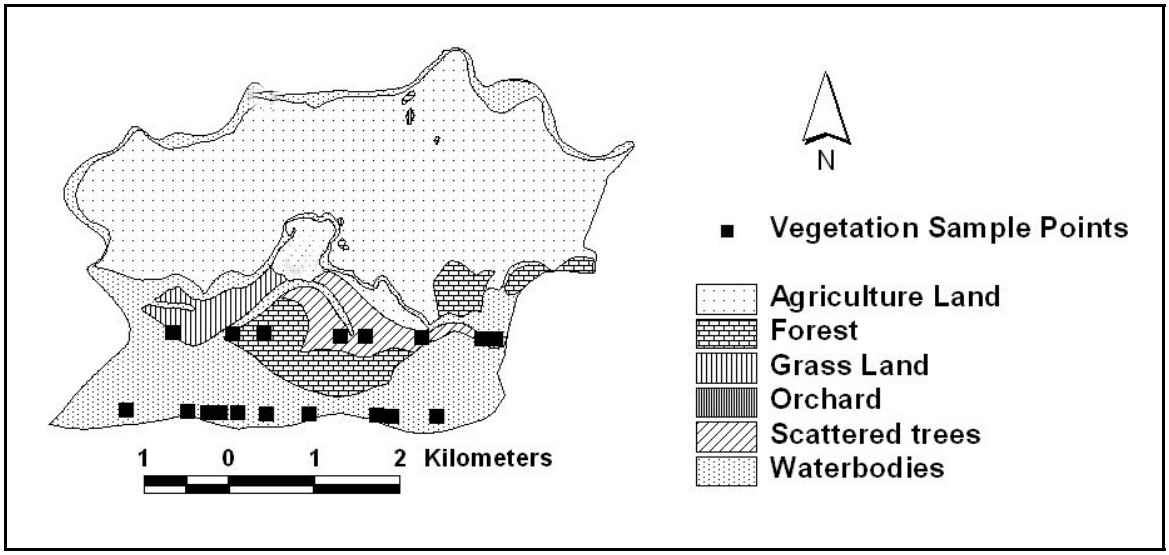


Figure 4.2 Vegetation sampled plots

All tree species having DBH greater than 10 cm were taken into account within 20x20 m^2 pot. DBH and height of all trees were measured with the help of DBH tape and clinometer respectively. Crown cover percentage of trees within the sampling plots was estimated occularly for the determination of stocking of forest. Height and number of all shrub species having height greater than 10 cm, and tree species with less than 10 cm DBH and greater than 10 cm height were studied on measurement within nested quadrate of 5x5 m^2. Similarly the number of all herb species and seedlings of shrub and tree with

height less than 10 cm were counted in 1x1 m^2 nested plot. Number of cut stump of trees species with height and circumference at top ocular estimation of lopping percentage of trees were noted in 20x20 m^2 plots to quantify human interference.

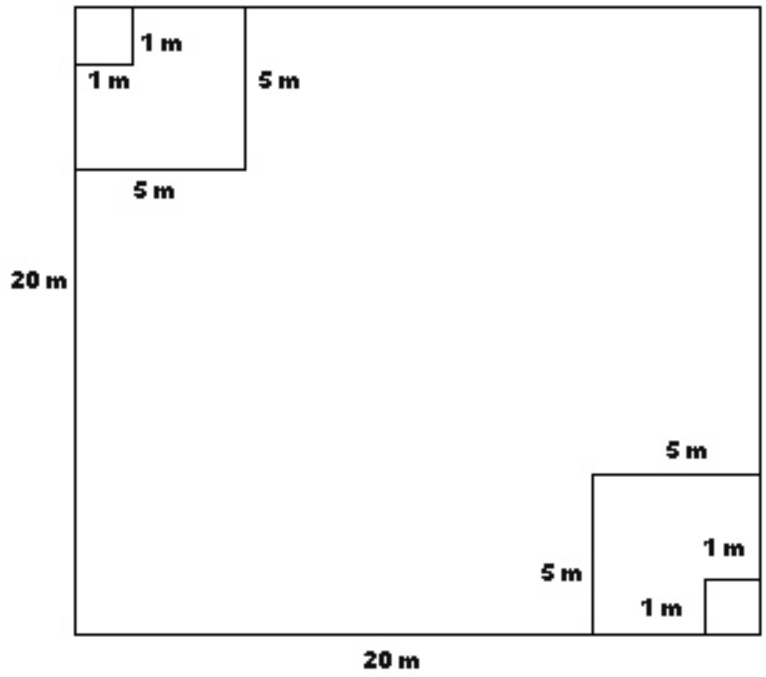


Fig 4.3: Plot Design (Nested quadrate plot)

4.2.4. Stand size

The stand size classification is presented in table 4.4. The classification is based on Forest Inventory Division (FSRC, 1995).

Table 4.4 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

4.2.5 Stocking

The classification of stocking of trees is presented in table 4.5. Determination of stocking is based on forest density, i.e. crown cover percentage (FRSC, 1995). Classes of stocking were as follows.

Table 4.5 Stocking of trees

Symbol	Description	% Crown Closure
1	Poorly stocked	10--30
2	Medium	40-69
3	Well stocked	70 or more

4.2.6 Tree Volume

The computerized calculation system called inventory (INV) developed by the Forest Inventory Section, Ministry of Forest and Soil Conservation, Nepal (FSSD, 1991) was used for the calculation of resources of the Kumroj 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

$$Ln (V) = a + b \times Ln(d) + c \times Ln (h)$$

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).

4.2.7 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).

4.2.8 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 (Table 4.6). 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 (*Alibizia lucida, Bombax ceiba, Trewia nudiflora*, etc). Although MPFSN had classified the Siwaliks, of which Chitwan valley is a part, as an area having littlte fuel wood 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 fuel wood assuming recovery factor for Terai is 90 % (HMG, 1988 a).

Table 4.6 Growing stock and annual yield (tons/ha) in the natural forest of Terai regions of The Central Development Region, Nepal (Source: HMG, 1988a)

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 basis of Total Digestible Nutrient (TDN) yields for various categories of land given by HMG, 1988 b).
Density, Relative Density, Frequency, Relative Frequency, Basal Area, Relative Basal Area and Importance Value Index (IVI) were calculated for tree species. For regeneration of tree species, height classes were made based on Rijal & Meilby (in press) and the looping intensity was classified based on Silori (2001).

4.3. Land use change pattern

To fulfill objective 3 (To study the changes in land use pattern in the study area from 1978 to 1992 AD), assessment on landuse changes was done. For this, following research question was set up.

I) How landuse pattern changed between 978-1992?

To study the land use change pattern of Kumroj 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 of land use maps of 1978-1992, comparison of areas and rates of change of the six lands cover categories were made. And also the overview of land cover changes (%) in the six categories, including land cover gained and lost from each category for the period between 1978 and 1992 was calculated.

Chapter 5
RESULTS

5.1.1 General Characteristics of Respondents

The characteristics of respondents in the study area on the basis of gender, age group, caste, education, occupation, family structure and residence period is presented in table 5.1. Male respondents were represented more in comparison to female although no biased was done in the selection of respondent. Joint family was more common in the study area. More than half of the respondents (53.52 %) were from middle aged (30-50 yrs) groups followed by early age group (<= 30 yrs) and least from old age people (>50 yrs). On the basis of caste and ethnicity, indigenous ethnic (Tharu and Darai) groups and Brahmin/Chhettri represented more than 90 %. Literate respondents (74.65 %) were almost three times higher than illiterate. Major occupation of the respondent was agriculture including wage labor (unskilled), business and services. Some 83% respondents were directly or indirectly found to be involved in agriculture. The respondents from landless and large farm categories were more than other categories. Most of the respondents (70.4 %) were found to be early settlers.

Table 5.1 (1) General Characteristics of respondent.

Category		Number of Respondent	Percentage
By Sex			
	Male	56	78.87
	Female	15	21.13
By Age group			
	<=30 years	18	25.35
	>30 to <=50 yrs	38	53.52
	>50 years	15	21.13
By caste			
	Indigenous group (Tharu/Darai)	33	46.48
	Bramhin / Chhetri	32	45.07
	Others (Gurung/Magar/Newar/Tamang)	5	7.04
	Dalit	1	1.41
By Education			
	Illiterate	18	25.35
	Literate:		
	General	22	30.99
	Lower class	6	8.45
	Higher Class	16	22.54
	College/University	9	12.68
By Occupation			
	Agriculture	31	43.66
	Service	2	2.82
	Wage labor (Unskilled)	6	8.45
	Agriculture+ Housework	13	18.31
	Agriculture+ Business	7	9.86
	Agriculture+ Wage labor (unskilled)	4	5.63
	Agriculture +student	1	1.41
	Agriculture +Service	3	4.23
	Housework +Wage labor (Unskilled)	1	1.41
	Student	3	4.23
By Residence Period			
	Late settlers (<10yrs)	3	4.23
	Middle settlers (10-30yrs)	18	25.35
	Early settlers (>30yrs)	50	70.42
By Family Structure			
	Nuclear	33	46.48
	Joint	38	53.52

5.1.2. Household's socioeconomic status

5.1.2.1 Demographic characteristics

The population of sample households was 447 with average family size 6.3 (Table 5.2). The average family size was found to be higher in large size farm size holding households. Brahmin / Chhettri households had small family size in comparison to other ethnic groups (Table 5.5&5.11).

Table 5.1: Population under basis of gender and age group

Age	Male	Female	Total
<15 Years	73	40	113
15-59 years	162	144	306
>60 years	15	13	28
Total	250	197	447

In general, major populations were from economically active age group (15-59 yr). But economically active population would be only 54.18 % if student are considered as depend populations Table (5.2).

Table 5.2: Dependent population

Dependent Population	Population	% Population
old and young age*	58	29
Student**	142	71

* above 60 and below 6 years of age not going to school and less than 15 years not going to school and handicapped, ** Student currently undergoing study at school and higher class

5.1.2.2. Household Occupation

Majority of population was found to be involved in agriculture as 73.1 % of active population were directly or indirectly involved. Other occupations were services, business and wage labor (skilled and unskilled). Some had remittance as a source of income (Table 5.3). Based on ethnicity, access on service, and business was found to be higher of dominant ethnic group i.e. Brahmin/ Chhetri group. Wage labor was common in indigenous group as well as Dalit group (Fig.5.1; Annex A2). Similarly, Business, service and remittance were common in large farm holder households while wage labor common in landless to medium size farm holder households (Annex A1).

Table 5.3 Occupation of the population

Occupation	Population	%
Agriculture	63	25.51
Agriculture+ House work	103	41.70
Housework+ wage labor	7	2.83
Agriculture+ Service	4	1.62
Service	12	4.86
Business	5	2.02
Agriculture+ Business	8	3.24
Foreign Earning	8	3.24
Wage labor	8	3.24
Skilled wage labor	4	1.62
Agriculture+ Wage labor	20	8.10
Agriculture+ Skilled wage labor	5	2.02

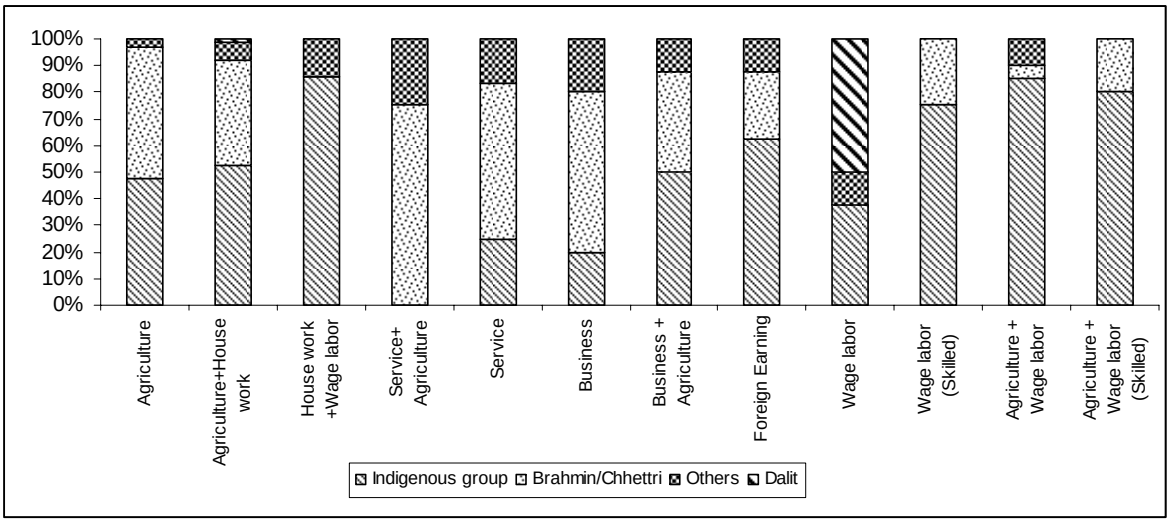


Figure 5.1: Occupation based on Ethnicity

5.1.2.3 Education

For literacy, population of above 5 yrs was taken into account. Literacy rate was 76.9 % in the study area. Among the literate people, percentage of College/ University level was higher than other groups (Table 5.4).

Table 5.4: Education status

Education	Population*	% Population	HH Number	% HH
Illiterate	97	23.10	56	78.87
Literate:				
General	93	22.14	46	64.79
Lower class	76	18.10	46	64.79
High School	58	13.81	30	42.25
College/University	96	22.86	48	67.61

* above 5 years of age are taken

Literacy was higher in Brahmin/Chhetri group than other groups. Access to higher education was also higher for this group (Fig. 5.2; Annex A4). Large farm holders had more access on all level of education (Annex A3).

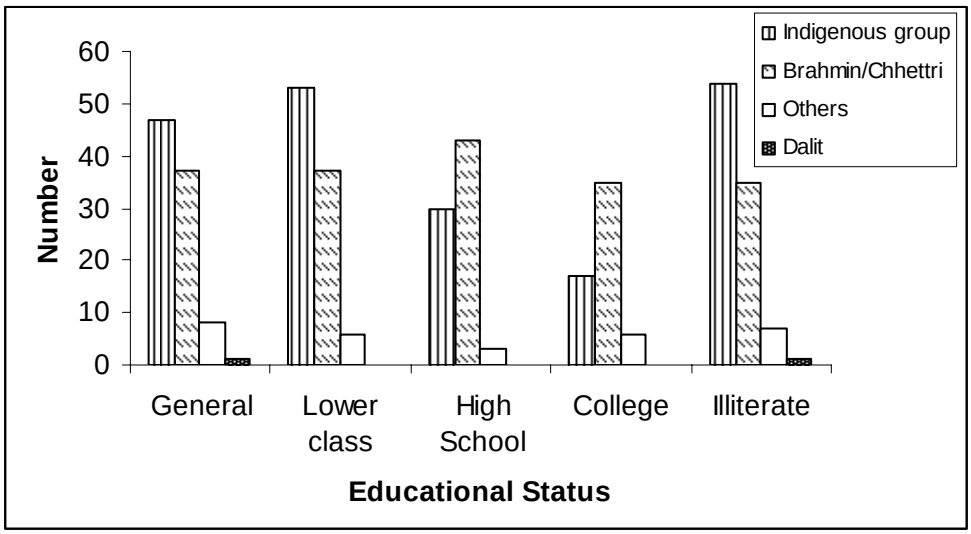


Figure 5.2: Educational status based on Ethnicity

5.1.2.4 Farm size, crop production, livestock holding and deficit management

The farm size of the household varied greatly from landless to 3.4 ha with average household farm size of 0.79 ha. Farm size showed a great role in other characteristics of households (Table 5.5). Average family size, livestock holding, net income, crop production, fodder need (or demand) and biogas installation were higher with respect to large farm size.

Table 5.5: Household characteristics based on farm size

Variables	Landless	Small	Medium	Large	Very Large
Average family size	5.65	5.89	6.07	6.85	7.00
Actual Land holding (ha/hh)	0.03	0.20	0.51	1.25	3.07
Livestock Unit	1.47	3.00	3.31	3.51	7.15
Fuel wood consumption (Kg/hh/yr)	2864.41	2377.78	1862.14	1614.81	3950.00
Green Fodder Consumption(Kg/hh/yr)	7727.27	11396.43	10037.50	11270.83	12166.67
Biogas installation (%)	0.00	11.11	7.14	33.33	50.00
Net income NRs.	3117.71	12555.56	63285.71	83759.26	201500.00

Based on ethnicity, average land holding was higher in Brahmin/Chhetri group than others. Other characteristics of households have been presented in Table 5.6 based on ethnicity.

Table 5.6 Household characteristics based on ethnicity

Variables	Indigenous group	Brahmin/ Chhettri	Others	Dalit	Total Average
Total Family size	6.76	5.72	6.8	7	6.3
Livestock unit	2.39	4.14	2.06	0	3.12
Actual Land Holding (ha)	0.76	0.96	0.62	-	0.84
Total Fodder consumption (kg/yr)	7442.42	9520.31	8395	-	8341.19
Total Fuel wood consumption (kg/yr)	2072.42	2575.63	1911	3000	2191.06
Residence Period (Yrs)	89.48	35.13	33.4	3	59.82
Biogas installation (%)	9	28	2	-	18
Net income (NRs)	62424.27	58453.13	38400	-3000	58021.14

Paddy, wheat, and maize were found to be major food crops in the study area. Cultivation of paddy was more common in comparison to other crops (Table 5.7). Cash crops like pulses, vegetables and oil seeds were also found to be cultivated but commercial production was less. The households without crop cultivation and deficit households were from landless and some from small farm size holders.

Table 5.7 Household involvements in crops production and their status

Crops Types	Household % involved in cultivation	Status		
		Deficit Household (%)	Balance Household (%)	Surplus Household (%)
Paddy	88.73	17.46	7.94	74.6
Wheat	60.56	48.84	2.33	48.84
Maize	63.38	46.67	11.11	42.22
Pulses	30.99	40.91	27.27	31.82
Vegetables	87.32	17.74	64.52	17.74
Oil seed	36.64	3.85	30.77	65.38

Agriculture was the major source of income to fulfill the basic need of the household (64.79 %), followed by unskilled labor (26.76 %). Skilled wage labor, small business like tea shops and business were other major sources of income (Table 5.8).

Table 5.8 Deficit management

Deficit Management	N of HH	%
Selling Agriculture product	46	64.79
Wage labor	19	26.76
Wage + skill labor + small business (tea shop)	1	1.41
Business	1	1.41
Skilled wage labor	4	5.63
Total	71	

Most of the landless households (82.35 %) were found to dependent on wage labor to meet their household needs. Small farm households were also dependent on wage labor (44.4 %). From medium to very large farm households they were capable to fulfill their demand from agriculture (Table 5.9).

Table 5.9 Deficit management on the basis of farm holding

Land Holding	Deficit management	N of HH	%
Landless	Wage labor	14	82.35
	Wage + skill labor + small business (tea shop)	1	5.88
	Skilled wage labor	2	11.76
	Total	17	
Small	Selling Agriculture product	3	33.33
	Wage labor	4	44.44
	Skilled wage labor	2	22.22
	Total	9	
Medium	Selling Agriculture product	12	85.71
	Wage labor	1	7.14
	Business	1	7.14
	Total	14	
Large	Selling Agriculture product	27	100
	Total	27	
Very Large	Selling Agriculture product	4	100
	Total	4	

Cow, buffalo and goat were major livestock reared in the study area. About 58 households (81.69 %) had one of the above mentioned livestock. Among households without livestock, six were land less, two from small size farm holder, two from medium size farm holder and three from large farm size householder. There was significant relationship between farm size and livestock unit (r^2=0.408; p= < 0.01)

Altogether 213 livestock were found in the study area with 3.0 average livestock head per household and 3.1 livestock unit per household. More livestock's were found with large farm holding households (Table 5.10).

Table 5.10: Distribution of livestock on the basis of farm size

Land holding	Cow	Buffalo	Goat	Livestock Unit/hh
Landless	1 (1)	10 (6)	15 (6)	1.47
Small	3 (2)	12 (6)	11 (4)	3.0
Medium	5 (2)	15 (9)	29 (10)	3.31
Large	21(10)	39 (19)	28 (9)	3.51
Very Large	4 (2)	11 (3)	9 (2)	7.15
Total	34 (17)	87 (43)	92(31)	3.09

*The number in parenthesis indicates the number of households having livestock

Stall feeding was most common in the study area followed by stall feeding as well as grazing practices (Table 5.11).

Table 5.11: Household livestock feeding types

Livestock	Household's Livestock Feeding Types					
	Stall Feed		Grazing		Both	
	HH Number	Livestock Number	HH Number	Livestock Number	HH Number	Livestock Number
Cow	13	27	0	0	4	7
Buffalo	31	48	1	2	13	37
Goat	21	48	0	0	8	44

5.1.2.5 Household energy use pattern

Fuelwood, electricity, kerosene, liquefied petroleum gas (LPG) and biogas found to be used in the study area as a source of energy for various purposes. All sampled household had access of electricity although 20 households (28.17 %) were using illegally (Table 5.12). They were almost landless or small size farm holders. 69 households (97.18%) were using fuel wood. Kerosene, LPG and biogas were found to be mostly used by big farm size households (Table 5.13).

Table 5.12 Household's energy sources

Energy Used	Number of HH	% HH
kerosene	40	56.34
Electricity	71	100.00
Battery	13	18.31
LPG	9	12.70
Biogas	13	18.31
Fuel wood	69	97.18
Others	21	29.58

Table 5.13 Energy consumption

Landholding	Kerosene	Electricity*	Fuel wood	Battery	Biogas	LPG	Others
Landless	8	4 (13)	17	2			6
Small	7	4 (5)	9	1	1		2
Medium	7	13 (1)	14	5	1	2	2
Large	14	26 (1)	25	5	9	6	10
Very Large	4	4	4		2	1	1
Total	40	51 (20)	69	13	13	9	21

* The figure in parenthesis indicates number of household using electricity illegally.

There was no statistically significant difference in household fuelwood consumption between biogas users and non users ($t=1.69$, $df=69$, $p>0.05$).

Based on ethnicity, access on biogas and LPG was higher in Brahmain/Chhettri. Habit of using electricity in illegal way was mostly found in indigenous ethnic groups (Table 5.14).

Table 5.14: Energy consumption based on ethnic groups

Ethnicity	Kerosene	Electricity*	Fuel wood	Battery	Biogas	LPG	Others
Indigenous group	19	22 (11)	33	5	3		10
Brahmin/Chettri	16	27 (5)	32	7	9	9	9
Others	4	2(3)	5	1	1		2
Dalit	1	(1)	1				
Total	40	51(20)	69	13	13	9	21

* The figure in parenthesis indicates number of household using electricity illegally.

5.1.2.6 Resources (Fodder and Fuelwood) need and access

Total annual green fodder and fuelwood need were 592225 kg and 155565 kg in the sampled household with average annual need per household 8341.2 kg and 2191.06 kg respectively and annual green fodder consumption per unit livestock was 2691.93 kg and annual per capita fuelwood consumption 348.02 kg. Resources need was found to be fulfilled by four sources namely, Community forest, National Park, Own land and Private forest. Green fodder was found to be extracted almost equally from community forest and private land while fuel wood mostly from community forest followed by National Park. Pressure on community forest for fuel wood was higher than green fodder (Table 5.15).

Table 5.15 Resources need and access

Sources	Fodder (Kg/yr)	% Fodder	Fuel wood (Kg/yr)	% Fuel wood
Community Forest	253350	42.78	96635	62.12
National Park	56575	9.55	37740	24.26
Private land	268575	45.35	19840	12.75
Private Forest	13725	2.32	1350	0.87
Total	592225		155565	

Dependency for green fodder in buffer zone community forest was found to be higher, followed by own land. Landless or small size farm holders were found to be more dependent on community forest, while big farm size holders were mostly dependent on their Private land (Table 5.16).

Table 5.16 Dependency for green fodder

Farm size	Number of household				
	Non-user	User of BZCF	User of National park	User of Private Land	User of Private Forest
Landless(17)	6(35.29)	8(47.06)	4 (23.03)	4(23.03)	1(5.88)
Small (9)	2(22.22)	4(44.44)	4 (44.44)	3(33.33)	-
Medium (14)	2(14.29)	9(64.29)	1 (7.14)	6(42.86)	1(7.14)
Large (27)	3(11.11)	13(48.15)	4 (14.81)	18(66.67)	-
Very Large (4)	1(25.00)	1(25.00)	-	3(75.00)	-
Total	14(19.72)	35(49.30)	13(18.31)	34 (47.89)	2 (2.82)

* The figure in parenthesis indicates the percentage of each farm category

About 17% of sampled households were totally dependent over the community forest for green fodder. They were almost from landless to medium farm size holder households. Similarly, 28.2 % households were found to be fully dependent on their own land for green fodder, but these households were mostly from large to very large size farm holders. There was no household that totally dependent for green fodder on National Park but 12.68 % of sampled households were using both community forest and National park as a source of green fodder. Similarly 2.82 % households were using community forest, National park and their own land for green fodder (Table 5.17).

Table 5.17: Different sources for green fodder

Land Category	CF*	PL*	CF+NP*	CF+NP+PL	NP+PL	CF+PF*	CF+PL
Landless	3(17.65)**	3(17.65)	3(17.65)	1(5.88)	-	1(5.88)	-
Small	2(22.22)	1(11.11)	2(22.22)	-	2(22.22)	-	-
Medium	4(28.57)	3(21.43)	1(7.14)	-	-	1(7.14)	3(21.43)
Large	3(11.11)	11(40.71)	3(11.11)	1(3.70)	-	-	6(22.23)
Very large	-	2(50.0)	-	-	-	-	1(25.0)

CF=Community Forest, PL =Private Land, *NP= National Park, *PF= Private Forest.
**Number in parenthesis represents percent.

- More than 50 % of total green fodder demand was fulfilled by community forest in landless, small farm and medium farm size households, while big and very big farm size households were found to be fulfilling their green fodder need from private land. Dependency on National park for green fodder was higher in landless and small farm holding households (Table 5.18). There was no significant difference between green fodder consumption between poor (landless and small farm) and rich (medium, big and very big farm) households ($\chi 2$ =1.42; df =1 p >0.05).This was mainly due to easy access in national park for poor and exclusion of dry fodder like straw during field survey**.**

Table 5.18 Green fodder need and Landholding

Land Category	Fodder Access								Total Fodder (kg/yr)
	CF		NP		PL		PF		
	A	%	A	%	A	%	A	%	
Landless	47950	56.41	14500	17.06	17425	20.50	5125	6.03	85000
Small	44350	55.59	20900	26.20	14525	18.21	-	-	79775
Medium	55800	46.33	4600	3.82	51450	42.71	8600	7.14	120450
Large	100250	37.06	16575	6.13	153675	56.81	-	-	270500
Very large	5000	13.70	-	0.00	31500	86.30	-	-	36500

CF= Community Forest, NP = National Park, PL= Private land, PF= Private forest, A= Amount (Kg/yr)

87.72 % of sampled households were using the community forest as a source of fuel wood while 33.8 % were using National park. Similarly 26.76 % households were also using own land as a source of fuel wood. Almost all category households (on the basis of landholding) were highly dependent on community forest while pressure on National park for fuel wood was higher from landless and small farm holding households. Fuelwood from only Private Land was mostly from large farm holders (Table 5.19).

Table 5.19 Sources for fuelwood and Landholding

Land Category	Non User	User*			
		CF	NP	PL	PF
Landless(17)	-	16(94.12**)	12(70.59)	1(5.88)	-
Small(9)	-	9(100.0)	4(44.44)	2(22.22)	-
Medium(14)	-	14(100.0)	4(28.57)	3(21.43)	2(14.29)
Large(27)	2(7.41)	20(74.07)	3(11.11)	11(40.74)	-
Very Large(4)	-	3(75.0)	1(25.0)	2(50.0)	-

*CF=Community Forest, PL =Private Land, NP= National Park, PF= Private Forest.

**Number in parenthesis represents percent.

The households using only BZCF for fuelwood was 27.68 % followed by using both BZCF and National Park (26.76 %). Households using BZCF and National park as source of fuelwood were more from landless and small farm size households. Private land was also used for fuel wood by big farm size households (Table 5.20).

Table 5.20 Sources for fuelwood

Land Category	Non User	User						
		CF	NP	PL	CF+NP	CF+NP+PL	CF+PF	CF+PL
Landless(17)	-	4(*23.53)	1(5.88)	-	11(64.71)	-	-	1(5.88)
Small(9)	-	4(44.44)	-	-	3(33.33)	1(11.11)	-	1(11.11)
Medium(14)	-	7(50.0)	-	-	2(14.29)	2(14.29)	2(14.29)	1(7.14)
Large(27)	2(7.41)	11(40.47)	-	5(18.52)	3(11.11)	-	-	6(22.22)
Very Large(4)	-	2(50.0)	-	1(25.0)	-	1(25.0)	-	-

*Number in parenthesis represents percent

BZ community forest was found to be main sources of green fodder for all landholding categories households (Table 5.21). National park was also main supplier of fuel wood for land less households. About one fourth of demand of big and very big farm size households were as fulfilled by their private land. There was significant difference in per capita fuelwood consumption between poor (landless and small farm) and rich (medium, big and very big farm) households ($\chi 2 = 8.84$; df =1 $p < 0.05$). This was mainly due to higher willingness to adopt alternative energy in rich households.

Table 5.21 Need and Supply of fuelwood

Land Category	Fuel wood Access								Total
	CF		NP		PL		PF		Fuel wood (Kg/yr)
	A	%	A	%	A	%	A	%	
Landless	27175	55.81	20840	42.80	680	1.40	-	-	48695
Small	15300	71.50	4600	21.50	1500	7.01	-	-	21400
Medium	15800	60.61	7400	28.39	1520	5.83	1350	5.18	26070
Large	29160	66.88	2400	5.50	12040	27.61	-	-	43600
Very large	9200	58.23	2500	15.82	4100	25.95	-	-	15800

CF= Community Forest, NP = National Park, PL=Private land, PF= Private forest, A= Amount (Kg/yr)

5.1.2.7 Household income

Based on net income, households were categorized into five groups: very poor (net income in negative), poor (net income zero), medium (net income up to Rs. 50,000/yr), rich (net income up to Rs. 100000/yr) and very rich (net income above Rs 100000/yr) (Table 5.22). Net income of sampled household was guided by farm size of the households. There was significant relationship between net income and farm size (r^2=0.578; p =0.01). Biogas installation, total green fodder requirements, livestock unit and total family size were higher with higher net income. Fuelwood requirement was found to be higher in poor households.

Table 5.22 Economic conditions

Variables	Very poor	Poor	Medium	Rich	Very rich	Total average
Actual land holding (k)	0.05	0.18	0.76	1.06	1.58	0.84
Net income (NRs)	-6111	0.00	23111	76950	166055	58021
Biogas (%)	0.00	6.00	11.00	40	33	18.3
Total Fodder Consumption (kg/yr)	7405	10298.2	10641.7	10365	11365.4	10389.9
Total Fuel wood consumption (Kg/yr)	3450.6	2405.6	1461	2286	2047.8	2191
Livestock unit (LSU)	1.17	2.84	3.13	3.7	4.01	3.12
Fuel wood consumption from NP (Kg/yr)	2082.86	1162.22	1100.00	2100	1550	1572.5
Fodder consumption from NP (Kg/yr)	3800	4633.3	3858.3	4800	-	4351.9
Total family size	5.00	5.88	6.33	5.8	7. 6	6.3

5.1.3 Buffer zone community forest

5.1.3.1. Participation in buffer zone

Some 69 sampled households (97.18 %) were registered as user member of BZCF where as 2 households were non member. These non member household were landless. Out of 71 sample households, 11 households (15.49 %) were found to be involved in the committee level management; 1 from landless, 3 from medium farm size households and 7 from big farm size households. On the basis of ethnicity, four were from indigenous group, 6 from Bramhin/chhettri group and 1 from other group.

5.1.3.2 Perception on the condition of BZCF

70 households (98.59 %) had knowledge about the condition of buffer zone CF in present context. Major perception towards present condition of BZCF was "good" in comparison to past 5 yeas before (40.85 %) (Table5.23). Also the perception as "poor" had been increased from 5.63 % to 8.45 %. 2 out of 11 buffer zone management committee level respondents accepted as the poor condition of BZCF in comparison to past.

Table 5.23 Perception on the condition of BZCF

Period	Perception				
	Poor	Satisfactory	Good	Very Good	Unknown
Present	6(*8.45)	19(23.76)	36(50.70)	9(12.68)	1(1.41)
Past	4(5.63)	25(35.21)	29(40.85)	10(14.08)	3(4.23)

*Number in parenthesis represents percent

5.1.3.3 Perception on buffer zone budget

Most of the respondent answered that there was insufficient budget for buffer zone community forest (Table 5.24). But more than 40 % respondents said that they were unknown how much money comes and where used up. Even one out of 11 committee level respondent did not know about budget.

About transparency, 53.5 % of responded did not know about budget allocation by BZM and BZCF, way of expending. Similarly 2 out of 11 committee level member blamed no transparency in budget of BZ/BZCF.

Table 5.24: Perception on buffer zone/BZCF budget Sufficiency and Transparency

Budget Sufficiency	Number of Respondents	Budget Transparency	Number of Respondents
Insufficient	41(*57.75)	Yes	18(25.35)
Unknown	29(40.85)	No	15(21.13)
Not-concerned	1(1.41)	Unknown	38(53.53)

*Number in parenthesis represents percent

5.1.3.4 Types of resource extraction from BZCF by households

Beruwa, Jhaksi, Khar-khadai, Fodder and Fuel wood were found extracted by respondent households from BZCF (Table 5.24). Among them, fodder (56.34%) and fuelwood (83.10%) were major extracted resources (See Annex A5).

Table 5.25: Types of resource extraction from BZCF

Resources use	N of HH	% of HH
Non user	10	14.08
Fuel wood	15	21.13
Khar/Khadai	2	2.82
FW+FO+KH+BE+JH	1	1.41
Fuel wood + Fodder + KH	2	2.82
Fodder + KH	37	52.11
Fuel wood + KH	4	5.63
Total	71	100

KH = Khair/Khadai, FW= Fuel wood, FO= Fodder, BE= Berauwa, JH= Jhaksi,

5.1.3.5 Problems identified by respondents

Sampled households pointed 13 different problems at the BZCF. Out of them, an insufficient resource in BZCF was highly prioritized followed by wildlife depredation

(Table5.26). Similarly stealing from community forest, poor management committee, invasions by exotic unpalatable species and no equitable distribution were other issues. About 10 % respondent said there was no problem while 19.72 % households were unknown about the problems.

Table 5.26 Problem identified by respondents

Responses	Frequency	%
Insufficient resource in BZCF	19	19.39
unknown about problem	14	14.29
wildlife depredation	11	11.22
steeling from BZCF	10	10.20
Poor management	10	10.20
invasion of mile meter	9	9.18
no problem	7	7.14
No equitable distribution	7	7.14
no plantation	4	4.08
no economic output from BZCF	2	2.04
misuse of forest resource	2	2.04
sand quarry	1	1.02
flooding	1	1.02
BZCF far from community	1	1.02

5.1.3.6 Suggestion for better management of BZCF

25.35 % respondent had no suggestion management improvement of BZCF as they said they did not know any idea. Better management and improvement in security was highly recommended by respondent for better management of BZCF (Table 5.27). Similarly, unity among villagers, financial and tourism development, plantation and awareness were also given priority for betterment of BZCF. Alternative skill development and energy promotion, human resource empowerment by park, Rapti flood control programs and removal of invasive species were also recommended. Some of them suggested for the change in buffer zone policy along with provision for poor by providing them resources free of cost, and using the resources from flood plain of Rapti River.

Table 5.27 Suggestion for better management of BZCF

Responses	Frequency	%
Unknown	18	18.95
Improve security	17	17.89
Better (strict management.)	17	17.89
Unity (social capital)	7	7.37
Proper financial investment	9	9.47
Plantation	5	5.26
Awareness	5	5.26
Removal of invasive alien species	3	3.16
Human resource empowerment	3	3.16
Provision for poor	2	2.11
Policy change	2	2.11
Flood control	2	2.11
Alternative skill development	2	2.11
Alternative energy promotion	2	2.11
Use of flood plain areas	1	1.05

5.1.4 Rhino/Wildlife related issues

5.1.4.1 Rhino movement

All the respondents told that there was regular movement of rhinos in the past. But at present, only 46 respondents (64.79%) said that there was regular movement of rhinos.60 respondents (84.51%) accepted that rhinos used to give them serious problem by damaging crops in past. But now, only 9 respondents (12.68%) commented for the crop damaged by rhinos. More than half of respondents (67.61%) said that problem due to rhinos was crop damage while 22.54% respondents said that no problem from the rhinos. Remaining respondents (9.86%) did not response on problems given by rhinos.

5.1.4.2 Wildlife depredation and compensation Measures

Crop damage and livestock loss were major problems due to rhinos and other wild animals. 36 households (50.70%) were found to be suffered from various wild animals. About one third of sampled households reported crop damage while livestock loss by 10 sampled households. Some 14 households (19.72%) said that they had lost their crops like mustard, lentil, wheat, paddy and potato by rhinos (Table 5.28). Wheat was found to be lost by high number of households (57.14%) while mustard and potato loss was reported from only one household.

Table 5.28 Crops damaged by rhino

Crops	Amount (Kg/yr)	N of HH	Average Loss (Kg/yr)
Mustard	300	1	300
Musuro	135	3	45
Wheat	2420	8	302.5
Paddy	350	2	175
Potato	200	1	200

About 23 households reported crop loss from other wild animals. Paddy, Maize, wheat and potato were the crops damaged by wild animals (Table 5.29). Paddy damaged was reported by 16 households (69%) as being highest lost while potato was the least (8.69% HH).

Table 5.29 Crop damage by other wild animals

Crops	Amount (Kg/yr)	N of HH	Average Loss (Kg/yr)
Paddy	3785	16	236.56
Maize	785	7	112.14
Wheat	900	5	180
Potato	350	2	175

Wildlife depredation due to tiger and leopard was reported from 10 households (Table 5.30). Altogether 26 livestocks of different types were found to be killed by those wild carnivores. Livestock loss was found to be higher by tiger than leopard. Nine households had livestock loss due to tiger while only 4 households mentioned by leopard.

Table 5.30 Livestock loss due to wild animal

Livestock	Wild animal	
	Tiger	Leopard
Goat	9	8
Cattle	3	-
Buffalo	6	-

Most of the respondents (70.42%) were unknown about compensation given by authority (park) for the loss of livestock's or crop damaged by wild animals. Among 36 households, who either had lost livestock's or crop damage, or both, only 30.56% had the information about compensation given by authority.

5.1.4.3 Reason of rhino decreasing

Upon interviewed, 88.73 % households believed poaching along with habitat loss, electric fences, natural death and translocation for rhino decreasing and 7.04 % sampled households did not know about rhino decrease (Table 5.31).

Table 5.31 Reason of rhino decreasing

Response	HH	%
Poaching	31	43.66
Poaching + Habitat loss	14	19.72
Poaching + Electric fences	8	11.27
Unknown	5	7.04
Poaching + Translocation	5	7.04
Habitat loss	3	4.23
Natural Death + Poaching + Habitat loss + Wire fencing	3	4.23
Poaching + Translocation + Electric fences	2	2.82

5.1.4.4 Rhino poaching event and poacher's identity

About 46.48 % respondent had the knowledge about the Rhino poaching events. Among them, 45.45 % knew the poacher's identify. About 55 % respondents either refused or did not like to speak about poachers' economic and literacy status. Some of 15 respondents blamed for poor, 1 for medium, 8 for rich and poor people. Similarly, 15 respondents accused for illiterate people, 10 for educated people and 7 for both. Based on the given information by 45.5 % respondent, ex-poachers' identity based on ethnic groups is presented in Table 5.32.

Table 5.32 Ex-poacher's identity

Caste	Frequency	%
Tharu	12	46.15
Darai	5	19.23
Chepang	3	11.54
Bot	3	11.54
Bharmin/chettri	2	7.69
Bhihari	1	3.85

5.1.4.5 Reason for rhino poaching

Respondents gave 8 reasons for rhino poaching (Table 5.33). Getting high amount of money in short period was the main reason given by respondents. Other major reasons

were illegal trade, poor security and political instability, lack of awareness, crop depredation and political protection.

Table 5.33 Reason for rhino poaching

Response	Frequency	%
Unknown	29	34.52
For money/employment	23	27.38
Trading	11	13.10
Benefit from low security and political instability	6	7.14
Lack of awareness	6	7.14
Crop depredation	3	3.57
High financial benefit in short period	3	3.57
Encouraged by high level poachers	2	2.38
Political protection for poachers	1	1.19

5.1.4.6 Opportunities for poachers to stop poaching

If opportunities arise that would divert the poachers from killing the rhino, 27.4 % of respondents hoped employment could do so and other recommended strict law, policy and management and awareness (Table 5.34). However about one third of households were unknown about the solutions.

Table 5.34 Opportunities for poachers to stop poaching

Response	Frequency	%
Unknown	28	33.33
Employment	23	27.38
Awareness	16	19.05
Strict law/policy/management	13	15.48
Safety from Wild animals	4	4.76

5.1.4.7 Awareness about rhino conservation programs

About one third of households were unknown about the activities carried out by authorities to conserve rhino. Remaining 61.97 % respondent identified five activities done by authorities viz. security, awareness, skill development training, habitat management practices and research oriented program and 5.6 % respondent blamed authorities for doing nothing to protect rhino (Table: 5.35).

Table: 5.35 Activities done by BZCF/BZMC/Park to stop rhino poaching

Response	Frequency
Unknown	23
Awareness	21
Security	17
Anti poaching unit	17
Fencing	7
Trainings	5
Nothing	4
Habitat mgmt	3
Counting	2
Research/study	1

5.1.4.8 Prioritized activities of respondents for Rhino conservation

Respondents stressed on improvement in security. Similarly, habit management, awareness, and control on illegal poaching and trade were also highly prioritized. Other prioritized activities were policy reform, replacement of Nepalese Army, punishment to high level poachers, removal of hotel concessionaires from inside the park and further research on rhino. Around one-fourth of respondents were unknown about the activities that could conserve rhino (Table 5.36).

Table 5.36 Prioritized activities by respondents for Rhino conservation

Response for Activities to conserve rhino	Frequency	%
Improved security	21	19.81
Unknown	18	16.98
Protection of habitat/management	17	16.04
Awareness to all level people/conservation education	17	16.04
Control on illegal hunting, poaching and trade	16	15.09
New innovative programs n formulation of policy	5	4.72
Arms security personnel should be replaced by new mechanism	5	4.72
High level poachers should be punished	3	2.83
hotel concessionaires should be remove from park	2	1.89
Research and study on rhino	2	1.89

5.1.5 Land-use

5.1.5.1 Land-use in 1978 and 1992

Total land area in Kumroj VDC was found to be 20.24 km^2. In 1978, there were four categories of land in Kumroj VDC namely Agriculture land, Forest, Grassland and Water body (See Annex A6). Agriculture land (62.61%) had covered the highest land cover,

followed by water bodies (20.33%).Forest and grassland had combinely covered only 17.06% out of total land area.

In 1992, there were six categories of land in the VDC, increased landuses were scattered tree and orchard (See Annex A7). Agriculture land was the major land type in 1992 same as in 1978, but this decreased by 11.06%. Similarly, forest and grassland also decreased by 40.66% and 28.32% respectively (Table 5.37).

Table 5.37 Comparison between land cover areas of different categories (1978-1992)

Land Cover Categories	Land Cover in 1978 (Km2)	% of land cover 1978	Land Cover in 1992 (Km2)	% of Land cover (1992)	Difference in Land Cover 1978-1992 (Km2)	Change in cover 1978-1992 (%)
Agriculture land	12.67	62.61	11.27	55.69	-1.40	-11.06
Forest	2.63	12.99	1.56	7.71	-1.07	-40.66
Grassland	0.82	4.07	0.59	2.92	-0.23	-28.32
Water bodies	4.11	20.33	5.89	29.11	1.78	43.15
Scattered trees	0.00	0.00	0.91	4.50	0.91	4.50
Orchard	0.00	0.00	0.02	0.08	0.02	0.08

5.1.5.2 Land Cover Change in between 1978 to 1992

Agriculture land, forest and grassland lost area to other categories in between 1978 to1992 while water bodies gained. So overall land cover in three categories namely, agriculture, forest and grassland were found decreased. Scattered trees and orchard land were developed in 1992, which were not observed in 1978 (Table 5.38; Figure-5.3). Out of 12.67 km^2 agriculture land in 1978, 85.64% remained unchanged, remaining changed into forest, grassland, water bodies and orchard; of which water bodies got the highest (10.51%). Similarly, only 10.4% forests were found to be unchanged in 1992. Remaining forest land changed into agriculture land, grassland, water bodies and scattered trees. Forest land degraded into scattered tree by 31.78% while 28.69% into water bodies. Out of total grassland in 1978, only 16.91% remained unchanged. 80.56% of grassland was encroached by water bodies from 1978 to1992. Likewise, 76.34% of water bodies of 1978 remained same in 1992.It changed into forest, grassland and scattered tree by 1.95%, 2.36% and 1.80% respectively. Scattered tree area was mostly developed from forest degradation and dynamics of water bodies, while orchard land was developed from agriculture land (Table 5.39).

Table 5.38 Land Cover Change in-between 1978-1992

Land Cover Categories	Unchanged Land Cover Between 1978-1992(km2)	Unchanged Land Cover % Between 1978-1992	Lost % in Land Cover from 1978-1992	Gain % in Land Cover from 1978-1992	Difference in % of Land Cover Change(1978-1992)
Agriculture land	10.85	85.64	14.36	3.30	-11.06
Forest	0.27	10.40	89.60	48.94	-40.66
Grassland	0.14	16.91	83.09	54.77	-28.32
Water bodies	3.14	76.34	23.66	66.82	43.15
Scattered trees	-	-	-	100.00	100.00
Orchard	-	-	-	100.00	100.00

Table 5.39 Land Cover Change in different categories in-between 1978-1992

Land Cover Categories	Area(km2)					
	Agriculture land	Forest	Grassland	Water bodies	Scattered trees	Orchard
Agriculture land	10.8505	0.4694	0.0022	1.3321	-	0.01594
Forest	0.4138	0.2734	0.3516	0.754	0.8351	-
Grassland	0.0045	0.0163	0.1391	0.6629	-	-
Water bodies	-	0.08	0.0968	3.1407	0.0741	-
Scattered trees	-	-	-	-	-	-
Orchard	-	-	-	-	-	-

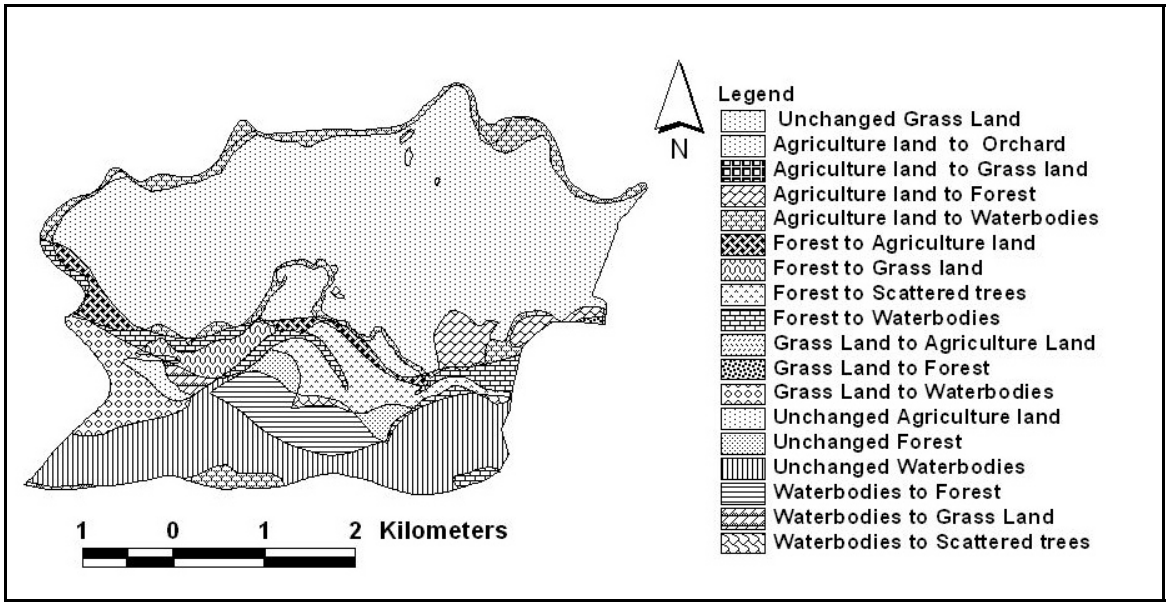


Figure-5.3 Land use change in Kumroj VDC (1978-1992)

5.1.6 Vegetation Analysis

5.1.6.1 Tree species

Seven tree species of seven families were found in the study area (Annex A16). Total density of tree was 135 per hectare, of which 64.10% was *Dalbergia sissoo*, having highest density (75/ha). Next was of *Trewia nudiflora* (25/ha) and other species were *Mellusa velutina, Wedlandia puberula, Litsea monopetala, Ehertia laevis and Bombax ceiba* with low density (Table 5.40). Total basal area was5.48 m^2/ha. The relative basal area was also highest in *D. sissoo* (43.28%), followed by *T. nudiflora* (40.31%). The IVI showed that *D. sissoo* was more common than other species in the study area.

Table 5.40 IVI of tree species

Species	D(no/ha)	RD	F	RF	BA(m^2/Ha)	RBA	IVI
Bombax ceiba L.	5	4.27	20	10	0.33	6.03	18.47
Dalbergia sissoo Roxb. ex DC.	75	64.1	60	30	2.37	43.28	124.32
Ehertia laevis Roxb.	5	4.27	20	10	0.09	1.61	15.41
Litsea monopetela (Roxb.) Pers.	15	12.82	40	20	0.26	4.8	36.17
Miliusa velutina (Dunal) Hook. f. & Thomson.	5	4.27	20	10	0.04	0.72	14.77
Trewia nudiflora L.	25	21.37	20	10	2.21	40.31	89.67
Wendlandia puberula DC.	5	4.27	20	10	0.18	3.25	16.5
Total	135		200		5.47	100	

D = Density, RD = Relative density, F= Frequency, RF= Relative frequency, BA= Basal Area, RBA= Relative Basal Area, IVI= Important Value Index

5.1.6.2 Shrub species

There were 46 plant species of 24 families (Annex A17). The number of plant in shrub plot was found to be 106428.46/ha. The highest density was of *Mikania micaranta* (34371.43/ha), next was of *Eupatorium adenophorum* (20257.14/ha). Both are invasive by nature. Similarly *Boehemeria turniflora, Callicarpa macrophylla, Cissamplos pareira, Cissus repens, Coolebrokia oppositifolia, Pilea* sp. and *Solanum xanthocarpum* had higher density compared to others. *Callicarpa macrophylla* had the highest frequency in the study area. *Cissamplos pareira, Cissus repens and Colebrookia oppositifolia* had frequency little more than 50%. *Boehemeria turniflora, Clerodendron viscosum, Eupatorium adenophorum, Litsea salicifolia, Pilea* sp. and *Pogostemon bengalensis* had more than 25% of frequency while *Artemesia vulgaris, Coccinea grandis, Lantana camara, Solanum xanthocarpum and Zyziphus mauritiana* had in between 20-25% of frequency. Remaining species had almost 7.14% of frequency (Table 5.41).

Table 5.41 Density and frequency of shrub species

Species	Density (no/ha)	Relative Density	Frequency	Relative Frequency
Albizia odoratissima Benth.	57.14	0.05	14.3	1.84
Artemisia vulgaris Linn.	1428.57	1.34	21.4	2.75
Boehmeria ternifolia D. Don.	4200	3.95	28.6	3.67
Bombax ceiba L.	85.71	0.08	7.14	0.92
Buddleja asiatica Lour.	85.71	0.08	7.14	0.92
Callicarpa macrophylla Vahl.	4400	4.13	64.3	8.26
Cirsium sps	314.29	0.3	7.14	0.92
Cissampelos pareira L.	3114.29	2.93	57.1	7.34
Cissus repens Lam.	8457.14	7.95	57.1	7.34
Clerodendrum viscosum Vent.	685.71	0.64	35.7	4.59
Coccinea grandis (L.) VOIGT	685.71	0.64	21.4	2.75
Colacacia sp	200	0.19	7.14	0.92
Colebrookea oppositifolia Sm.	2800	2.63	50	6.42
Dalbergia sissoo Roxb. ex DC.	28.57	0.03	7.14	0.92
Eupatorium adenophorum Spreng.	20257.14	19.03	28.6	3.67
Eupatorium odoratum L.	1285.71	1.21	14.3	1.84
Ficus hederaceae Roxb.	257.14	0.24	7.14	0.92
Flemingia macrophylla (Wild.) Merr.	57.14	0.05	7.14	0.92
Indigofera phulchella Roxb.	1485.71	1.4	7.14	0.92
Trichosanthes wallichiana (Ser.) Wight	171.43	0.16	7.14	0.92
Ipomea sps	514.29	0.48	7.14	0.92
Labitiatae	657.14	0.62	7.14	0.92
Lantana camara L.	1257.14	1.18	21.4	2.75
Leea macrophylla Roxb. ex Hornem.	57.14	0.05	7.14	0.92
Litsea monopetala (Roxb.) Pers.	57.14	0.05	7.14	0.92
Litsea salicofolia (Roxb. exNecs) Hook.f.	514.29	0.48	35.7	4.59
Maesea chisia Buch. Han. ex D.Don	200	0.19	7.14	0.92
Xeromphis spinosa (Thunb.) Keay	28.57	0.03	14.3	1.84
Mikania micarantha Kunth.	34371.43	32.3	7.14	0.92
Miliusa velutina (Dunal) Hook. f. & Thomson.	171.43	0.16	7.14	0.92
Mimosa sp	685.71	0.64	7.14	0.92
Morus alba L.	342.86	0.32	7.14	0.92
Mucuna pruriens (L.) DC	514.29	0.48	7.14	0.92
Natsiatum herpeticum Buch.-Ham. ex Arn.	400	0.38	7.14	0.92
Pilea sp	7314.29	6.87	28.6	3.67
Piper longum L.	28.57	0.03	7.14	0.92
Pogostemon glaber Benth.	1371.43	1.29	28.6	3.67
Porona sp	714.29	0.67	7.14	0.92
Pragmites karka (Retz.)Tren.ex Steud	57.14	0.05	7.14	0.92
Rungia sps	1685.71	1.58	7.14	0.92
Sida cordifolia L.	771.43	0.72	14.3	1.84
Solanum torvum Sw.	742.86	0.7	7.14	0.92
Solanum xanthocarpum Schrad. & J.C. Wendl	2714.29	2.55	21.4	2.75
Urtica dioica L.	1714.29	1.61	7.14	0.92
Veronica cineria L.	142.86	0.13	14.3	1.84
Zyziphus mauritiana Lan.	771.43	0.72	21.4	2.75
Total	106428.6	100	778.44	100

5.1.6.3 Herb species

A total of 33 plant species were belonging to 18 families occurred (Annex 18); 7 from graminae, 5 from compositae and remaining from other families. The total number of plants per hectare was found to be 62150. *Impereta cylindrica* had the highest density (22430/ha). *Saccharum spontaneum* (20160/ha) and *Cyperus plastilysis* (13060/ha) had also more density relative to other species. *Impereta cylindrica* and *Saccharum spontaneum* had equal frequency (37.5%), which was the highest in the study area. Other species had relatively low frequency (Table 5.42).

Table 5.42 Density and frequency of herb species

Species	Density (no/ha)	Relative Density	Frequency	Relative Frequency
Ageratum conyzoides L.	280	0.45	10	4.9
Bracharia sp.	720	1.16	5	2.5
Commelina sps	30	0.05	2.5	1.2
Cyanodon dactylon (L.) Pers.	170	0.27	2.5	1.2
Cyperus platistylis R.Br.	13060	21	5	2.5
Digitaria ciliaris (Retz.) Koeler	200	0.32	7.5	3.7
Eclipta prostata (L.) L	40	0.06	2.5	1.2
Equisetum sp.	1220	1.96	7.5	3.7
Eupatorium adenophorum Spreng.	40	0.06	2.5	1.2
Ficus cunia Guch-Han. ex.Roxb	10	0.02	2.5	1.2
Geranium sp.	10	0.02	2.5	1.2
Gnaphalium sp.	10	0.02	2.5	1.2
Graminae	110	0.18	2.5	1.2
Imperta cylindrica (L.) P. Beauv	22430	36.1	37.5	19
Lindernia sp	30	0.05	5	2.5
Phylla nodiflora (L.) Rich	50	0.08	7.5	3.7
Mimosa pudica L.	40	0.06	2.5	1.2
Mimulus nepalensis Benth.	20	0.03	2.5	1.2
Persicaria barbata (L.) H. Hara	30	0.05	2.5	1.2
Pilea sp.	150	0.24	2.5	1.2
Pogostemon glaber Benth.	60	0.1	2.5	1.2
Polygonum sp.	230	0.37	2.5	1.2
Polypogon monospelliensis (L.). Desf	10	0.02	2.5	1.2
Rungia sp.	50	0.08	5	2.5
Ranunculus scleratus L.	40	0.06	2.5	1.2
Saccharum spontaneum L.	20160	32.4	37.5	19
Salvia sp.	10	0.02	2.5	1.2
Sassurea sp.	100	0.16	7.5	3.7
Solanum xanthocarpum Schrad. & J.C. Wendl	10	0.02	2.5	1.2
Thelypteris auriculata (J. Sm.) K. Iwats	1110	1.79	15	7.4
Trifolium sp.	1680	2.7	2.5	1.2
Typha angustifolia L.	30	0.05	2.5	1.2
Veronica anagalis L.	10	0.02	2.5	1.2
Total	62150	100	202.5	100

5.1.6.4 Diversity Index

Shannon Diversity Index was calculated for tree, shrub and herb species. Highest diversity index was found in shrub (2.53), followed by herb (1.54) (Table 5.43).

Table 5.43 Shannon Diversity Index of plant species

	Shannon DI
Tree	1.37
Shrub	2.53
Herb	1.54

5.1.6.5 DBH class of trees

Poles with DBH 12.5 - 25 cm (62.96%) represented the highest in the study area. Timber yielding trees were found to be least (Figure 5.4) (See Annex A8).Sapling (DBH <12.5cm) had also low density, but higher than small saw timber (DBH 25-50cm) and large saw timber (DBH >50cm).

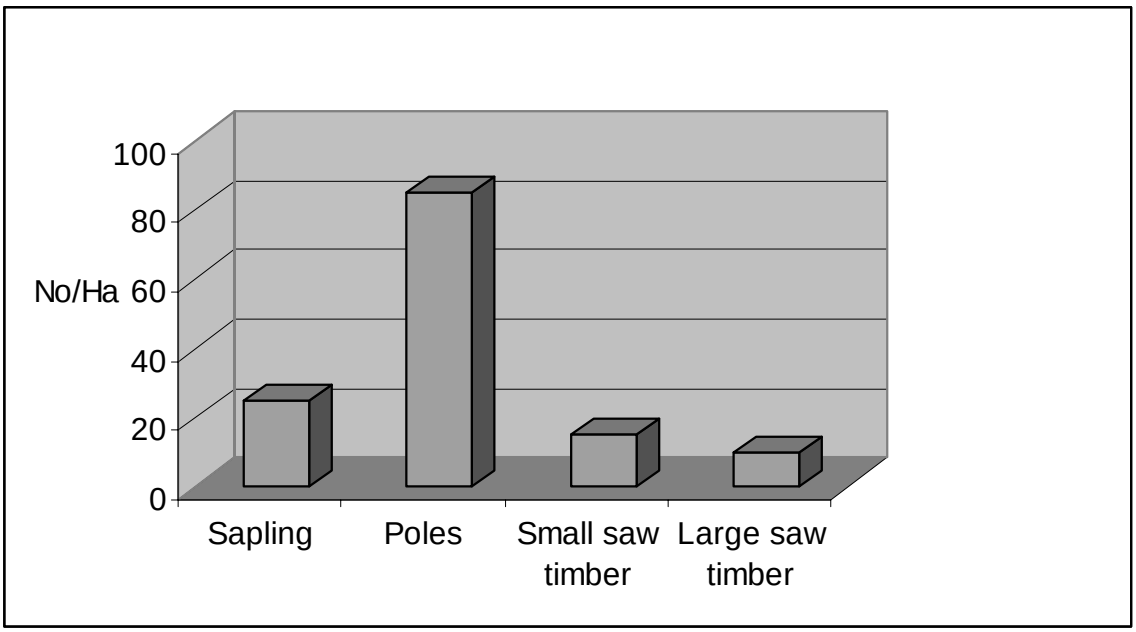


Figure-5.4: DBH class of trees

In sapling and pole categories, *D. sissoo* dominated over other species while in large saw timber categories, there was only *T. nudiflora* (Figure 5.5 and see annex A9).

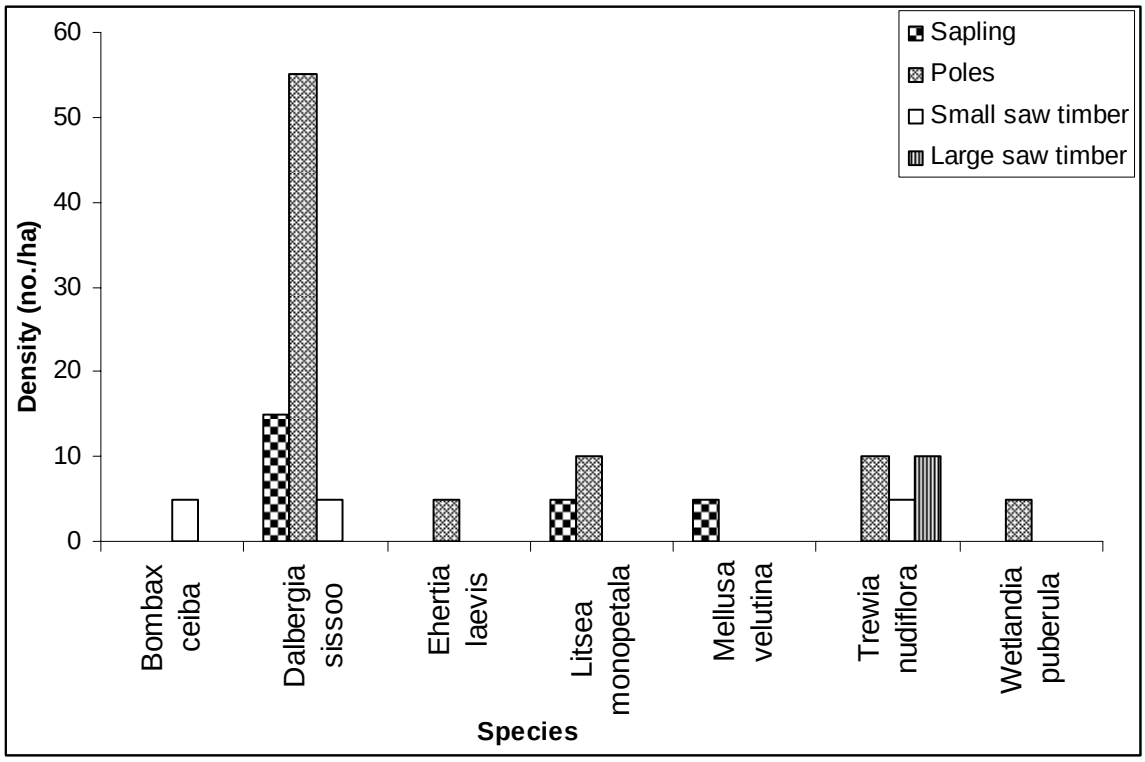


Figure-5.5: DBH class of each species

While categorizing DBH class in the interval of 5cm; the number of trees in group of 16-20 cm was the highest (33.33%), followed by 10-15 cm (25.92%) group. It was found that there was no single tree from 36-65cm DBH group (Figure 5.6 and see annex A10).

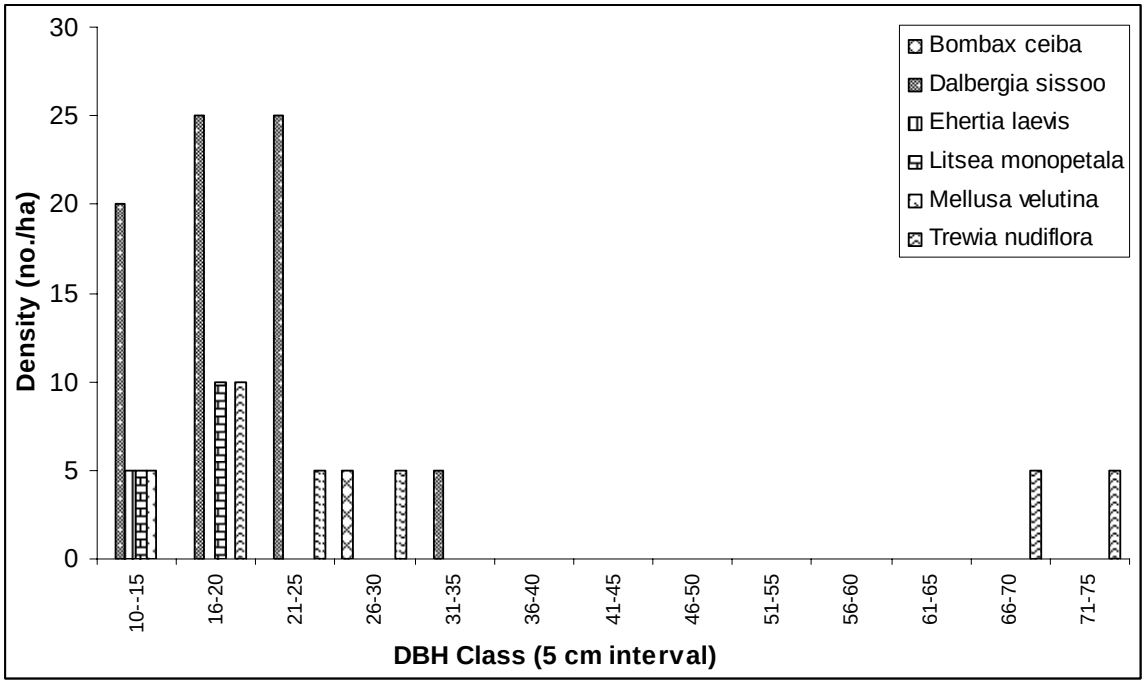


Figure-5.6: DBH category at 5cm interval

5.1.6.6 Regeneration of tree species

For the calculation of regeneration of tree, all the trees within tree plot having DBH less than12.5 cm, and trees seedling and sapling in shrub and herb plots were taken into account. Total number of regenerating plants was found to be 2751.16/ha in the study area (Figure 5.7 & 5.8 and see Annex A11). *D. sissoo* had highest number of regenerating individuals, followed by *M. velutina*. On the basis of height class, less than 1m category represented more and next of 1-2 m category.

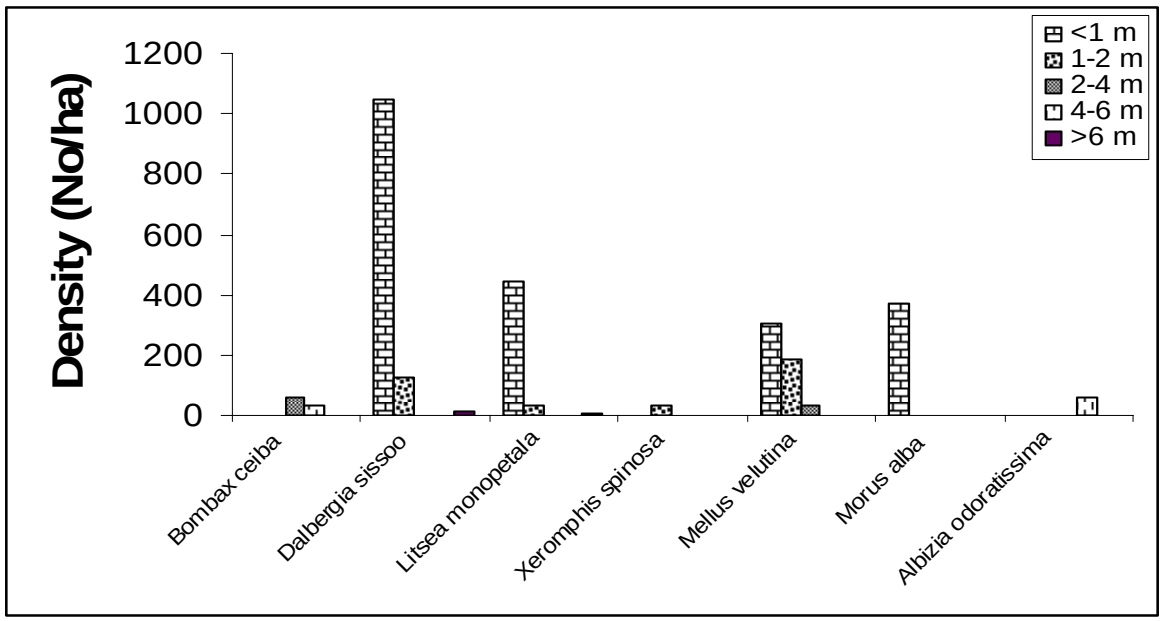


Figure-5.7: Regeneration of tree species

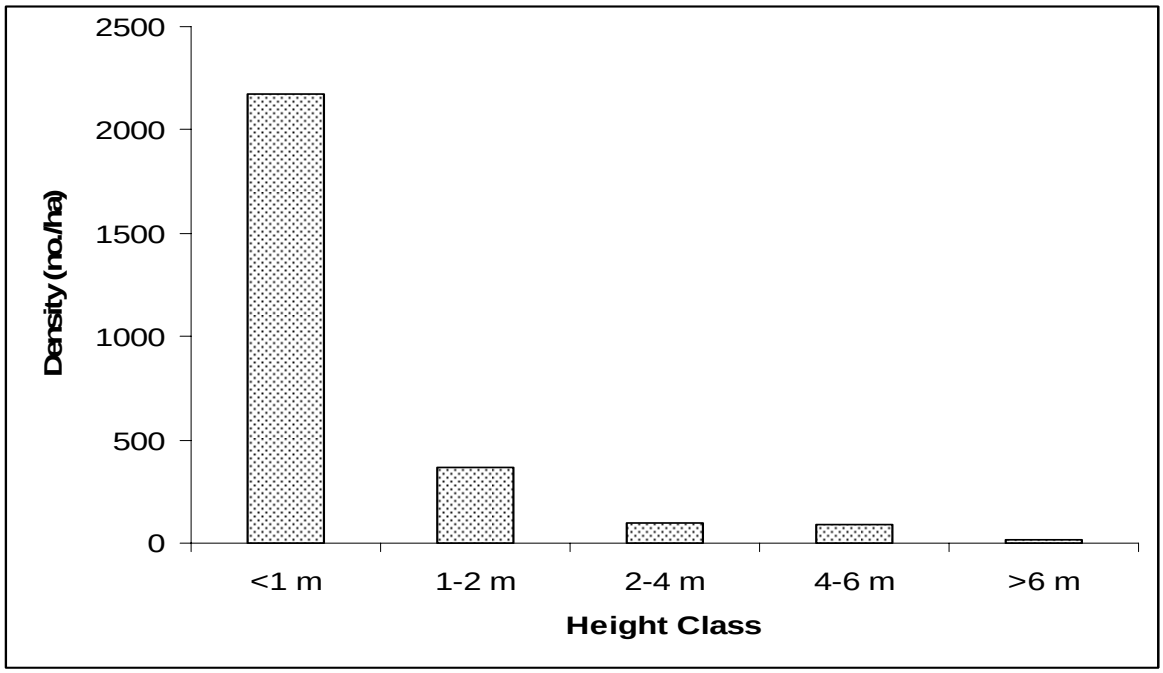


Figure-5.8: Regeneration of tree species by height class

5.1.6.7 Tree volume and biomass

Total tree volume was 13.28 m^3/ha in the study area. *D. sissoo* had occupied nearly 50% out of total volume and next was of *T. nudiflora* (42.58%).Total biomass was found to be 12.86 t/ha, out of which 66.25% was of *D. sissoo*, *T. nudiflora* had 26.33% biomass. Other species had fewer amounts in terms of volume and biomass (Table 5.44).

Table 5.44 Volume and Biomass of tree species

Species	Volume (m3/Ha)	% Volume	Stem Biomass (t/ha)	Branch Biomass (t/ha)	Leaf Biomass (t/ha)	Total Biomass (t/ha)	% Biomass
Bombax ceiba	0.53	3.98	0.19	0.1	0.01	0.3	2.36
Dalbergia sissoo	6.44	48.5	5.03	3.44	0.05	8.52	66.25
Ehertia laevis	0.08	0.6	0.06	0.03	0	0.09	0.67
Litsea monopetala	0.31	2.3	0.19	0.08	0.01	0.28	2.18
Mellusa velutina	0.03	0.19	0.02	0.01	0	0.03	0.22
Trewia nudiflora	5.65	42.58	1.99	1.3	0.1	3.39	26.33
Wetlandia puberula	0.23	1.77	0.17	0.07	0.01	0.26	1.98
Total	13.28		7.65	5.03	0.18	12.86	

5.1.6.8 Annual Yield and Sustainable Supply

Annual yield from Buffer Zone Community Forest (BZCF) of Kumroj VDC was 0.65t/ha, out of which 67.23% from *D. sissoo* and 25.56% from *T. nudiflora*. Sustainable fuel wood supply was found to be 0.52 t/ha/yr. Out of this 67.93% was from *D. sissoo* and 25.17% from *T. nudiflora*. Total sustainable green fodder supply from leaf was 0.0089t/ha/yr (Table 5.45).

Table 5.45 Annual Yields and Sustainable Resources 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)
Bombax ceiba	0.0095	0.0049	0.0005	0.0149	0.0117	2.2307	0.0005
Dalbergia sissoo	0.2581	0.1765	0.0027	0.4373	0.3563	67.9314	0.0024
Ehertia laevis	0.0028	0.0013	0.0002	0.0043	0.0033	0.6292	0.0002
Litsea monopetala	0.0091	0.0041	0.0007	0.0139	0.0106	2.0210	0.0006
Mellusa velutina	0.0009	0.0004	0.0001	0.0014	0.0010	0.1907	0.0001
Trewia nudiflora	0.0971	0.0641	0.0051	0.1663	0.1320	25.1668	0.0046
Wetlandia puberula	0.0082	0.0037	0.0006	0.0125	0.0096	1.8303	0.0005
Total	0.3900	0.2500	0.0100	0.6500	0.5200		0.0089

5.1.6.9 Forest-resource Supply and Demand

Demand on resources (fuel wood and green fodder) was found to be higher than the supply from the BZCF. So over harvesting of the resources from BZCF was found (Table 5.46).Although 42.8% of fuel wood demand of landless was found to be fulfilled from NP, total estimated extraction was from medium size farm holder households. Same condition was found in case of community forest also (Annex A12). Similarly, total estimated fodder extraction from NP was highest by small farm holders. Estimated fodder extraction from NP was found to be higher by big farm holders relative landless (Annex 13).

Table 5.46 Sustainable Supply and Estimated Demand

Total Forest area	1127.7ha*
Total Estimated Fuel wood need	3613.09t/yr
Total Estimated Green fodder need	13830.07t/yr
Total Estimated sustainable fuel wood supply from BZCF	563.0t/yr
Total Estimated sustainable green fodder supply from BZCF	5046.67t/yr
Total Estimated fuel wood extraction from BZCF	2313.12t/yr
Total Estimated fuel wood extraction from NP	822.52t/yr
Total Estimated green fodder extraction from BZCF	6164.02t/yr
Total Estimated green fodder extraction from NP	1629.54t/yr
Over Extraction of fuel wood from BZCF	1750.12t/yr
Over Extraction of green fodder from BZCF	1117.35t/yr
Deficit fuel wood	3050.09t/yr**
Deficit green fodder	8783.4t/yr**

*Plantation area 802.5ha; Natural regeneration area 280.2 ha; Pastureland/Shrub land 45ha, (BZCFUG, 2004) ** Excluding over harvesting

5.1.6.10 BZ Forest condition, Human pressure and Management Practices

5.1.6.10.1 Stocking of forest

Forest condition was found to be good looking through the point of stocking as 80% of sampled forest area was found to be well stocked and remaining medium (Table 5.47).

Table 5.47 Stocking of tree

Stocking	Area (m2)	%
Poorly stocked	-	-
Medium	400	20
Well stocked	1600	80

5.1.6.10.2 Cut stump and lopping percentage of tree species

Cut stump density of large saw timber category in BZCF was found to be 5/ha which only of *Bombax ceiba* (Table 5.48).

Table 5.48 Cut stump Density

Species	girth class	Height (m)	Density(no/ha)
Bombax ceiba	61-80 cm	0.6	5

Similarly, lopping was observed only in *Dalbergia sissoo*. Average lopping percentage was 20% in the study area. Lopping intensity was least to medium. Total density of lopped trees was only 10/ha (Table 5.49).

Table 5.49 Lopping intensity of trees

Species	Loping Damage	Scale	Density(no/ha)
Dalbergia sissoo	Least	25% damage	5
Dalbergia sissoo	Medium	26-50% damage	5
-	High	51-75% damage	-
-	Very High	>75% damage	-

5.1.6.10.3 Management practices

Intensive forest management practices were observed in BZCF. Controlled burning was observed in 60% of sampling area (Table 5.50).

Table 5.50 Management practices

Plot No	Status	Management Intervention	% Management Intervention
1	Controlled Burnt	yes	60
2	Controlled Burnt	yes	-
3	Controlled Burnt	yes	-
4	Naturally grown	-	-
5	Naturally grown	-	-

Chapter 6

DISCUSSION

6.1 Demographic features, household economy and education status

The average family size in the sample households (6.3/hh) was high compared to National (5.6/hh) as well as district average (5.4/hh) of Chitwan (DNPWC/PPP/UNDP, 2001) and Kumroj VDC average (5.68/hh) (BZCFUG, 2004). But it was less compared to DNPWC/PPP (2000) (6.5/hh) and Joshi (2003) (8.0/hh for Kumroj, Bacchauli and Rajhar VDCs). And it is almost equal to DNPWC/PCP/UNDP (2001) (6.16/hh for whole buffer zone areas). Variation in the average family size in sampled households among different ethnic groups may be due to the educational status and traditional systems as the educational status was better in Bramhin/Chhettri groups compared to other ethnic groups (See Chapter 5.1.2.3) and joint family was most common among indigenous groups (see chapter 5.1.2.1). The population under 15 years age (25.28 5) in the sample household is less compared to DNPWC/PPP, 2000 at Kumroj VDC level and of whole buffer zone area of CNP (41.5%) given by DNPWC/PCP/UNDP (2001).

Household economy in the study area was based on subsistence agriculture system. The major occupation of active population was agriculture (82.19 %) which was almost equal to the whole VDC level (80 %) given by DNPWC/PPP (2000). But population dependency on the wage labor (17.81 %) in sampled household was lower compared to VDC level (29.7%) reported by DNPWC/PPP (2000). The population involved in the business 5.26 % was slightly higher than given by DNPWC/PPP (2000) at VDC level (4.3 %). The population engaged in service government as well private was lower compared to DNPWC/PPP (2000) at VDC level (6.48 %). Population going outside the country for job in sampled households (3.24 %) was significant as compared to DNPWC/PPP (2000) as they have reported nobody had gone outside the country for earning.

Factor determining household economy in the sampled household was the farm size (see chapter 5.1.2.7). Food deficiency households (35.12 %) were less compared to DNPWC/PPP (2000) (40.1 %) at VDC level, these households were almost of landless to small farmers. The variation may be due to the different sample size. Wage labor was a

major basis of poorer households to cope with food scarcity. Businesses, service and foreign were extra sources of income of big farm holders and mostly of Brahmin/Chhettri.

Literacy rate in the sampled households (76.9 %) was higher compared to DNPWC/PPP (2000) at VDC levels (63.3 %) and whole buffer zone VDCs (59 %) and also to DNPWC/PCP/UNDP (2001) at eastern Sauraha sector (56.3 %). This shows the increasing trend of literacy in the study area. Literate percentage was higher under SLC (31.91 %) which is lower compared to Joshi, 2003 (48.36 %) but higher above SLC (22.86 %) compared to Joshi, 2003 (4.92 %). The difference could be due to different sample size. Access to higher education was high for those with big farm and Bramhin/Chhetri group (See Chapter 5.1.2.3). This may be due to the better economic condition.

6.2 Wildlife depredation

Among sampling households, more than 50 % were suffering form wild animals either losing livestocks or crops. The percentage of sampled house reporting for crop loss due to wild animals was almost equal to given by Bhattarai (1999) for Ayodhyapuri, Kalyanpur Bagauda and Gardi. Rhino had damaged the crop of 42.42% households (among the household who lost crops) damaging 37% of total lost. So, rhino was the major crop raiding animals in the study area. Jnawali (1989) and Sharma (1991) have found the rhino as the principal crop raiding animal around the village adjacent CNP. Sharma & Weber (1993) and Paudyal (2002) have reported the loss caused by rhino far exceeded to loss caused by other animals like wild pig and chital. Highest loss was found in paddy that was also found similar to reported by Jnawali (1989) in Sauraha area.

DNPWC/PPP (2000) has reported only one registered cases of livestock loss in Kumroj VDC while 20 cases were found in sampled household only. Similarly, 76 cases for livestock depredation were reported in whole buffer zone area during 1997-1998 (DNPWC/PCP/UNDP, 2001). Tiger was found to be major wild animal for killing livestock's as only 30.77 % out of total were killed by leopards and rest by tiger. Bhattarai (1999) has also reported 80 % livestock depredation is due to tiger only in Ayodhayapuri, Kalyan pur Bagunda and Gardi areas.

The low number of cases of livestock depredation report could be due to lack of information to people about the compensation program (see chapter 5.1.4.2), and may also be discouraged by long and tedious legal process (see Box No 1).

6.3 Floral composition and distribution; Condition of buffer zone community forest

Only 7 tree species were found with in the sampling plot of the study area. Rijal (1994) has reported 16 tree species in riverine forest of the CNP. BZFUG (2004) has mentioned only six major tree species in buffer zone community forest of the Kumroj VDC. *Alibizia odoratisima* and Acacia catechu were not found during the survey. Straede et al (2000) has also mentioned low representation of *A. catechu* in Kumroj. The total number of tree 135/ha was less compared to BZCFUG (2004) (261/ha) in BZCF. *D. sissoo* had highest density (75/ha), which was less compared to BZCFUG (2004) (147/ha) and higher compared to Rijal (1994) (1.76/ha). Similarly densities of *Trewia nudiflora, Litsea monopetala* and *Bombax ceiba* were also lower compared to given by BZCFUG (2004). The density of *Eheartia leavis* (5/ha) is little more than reported by Rijal, 1994 (3.56/ha), but less of *L .monopetala* and *B. cieba*. The variation in number of species and their density compared to BZCFUG (2004) may be due to the different area in the sample plot within the forest and less number of tree plots in the forest. Higher density, frequency and IVI of *D. sissoo* in the study area was mainly due to the plantation as it is the most preferred species for plantation by government, private land owner and communities in Terai (Gautam, 1996).

Growing stock of tree in the study area was very low compared to estimation of HMG (1988a). It has estimated that growing stock 76.69 m^3/ha for Khair-Sissoo forest and 107.74 m^3/ha for Terai mixed hardwood forest of the Central Development Region. The growing stock of *D. sissoo* was only 8.4 % and of mixed hardwood forest 6.35 % compared to given by HMG (1988a). Similarly the BZCFUG (2004) reported 29.85 m^3/ha, 30.68 m^3/ha, 14.03 m^3/ha and 0.44 m^3/ha growing stock of *D.sissoo, B.cieba, T.nudiflora* and *L.monopetala* respectively which all are higher compared to present study. Growing stock estimated by BZCFUG and present study are lower compared to estimation of HMG (1988a) mainly due to fact that the BZCF was plantation and regenerated forest. HMG (1988a) has estimated for whole CDR including protected area. FRSC (1995) has reported the growing stock of *D. sissoo* (1.4 m^3/ha), *B .ceiba* (5.4m^3/ha)

and *T. nudiflora* (1.3m^3/ha). *B.ceiba* has lower growing stock compared to FRSC, 1995 while higher of *D. sissoo* and *T. nudiflora*. The average biomass for Khiar-Sissoo and mixed hardwood forest of Terai of CDR are 132.13 ton/ha and 148.87 ton/ha respectively (HMG, 1988a) which are higher compared to present study. Average biomass per ha of *D. sissoo* and Mixed hardwood forest was only 6.45 % and 2.9 % respectively (HMG, 1988a). But the average biomass of *D. sissoo* and *T. nudiflora* was higher compared to FRSC (1995) and of *B. ceiba* was lower. Estimated biomass by HMG (1988a) is higher due to inclusion of protected area and other government forest and plantation was just started in the study area in that period.

Seven regenerating tree species were found in the study area with density of 2754.2/ha, which was higher compared to tree density in the study area. *T. nudiflora, W. puberula* and *E. laevis* had no any sapling or seedling in the study area. Instead of this, *Xeromphis spinosa*, *M. alba* and *A. ordoratissima* were found in regenerating condition. Regeneration density of these species was higher compared to given for major species by BZCFUG, (2004). *D.sissoo* and *L. monopetela* had higher density while *B. ceiba* and *A. odoratissima* had lower density compared to BZCFUG, (2004). Higher regeneration of *D. sissoo* may be due to plantation forest. While looking at height categories, more than 75 % density was under 1 m height which shows less viability of tree species. This may be due to the management practice as control burning was found in 60 % of total sampling area. Above six meter only 0.72 % regenerating species were found. More than 90 % of regenerating species has disappeared before attaining the height of two meter. So the chance of regenerating species to develop into mature tree was less than 10 % in the study area.

While looking at DBH category, poles sized trees were dominant of which more than 60 % was of *D. sissoo*, it may be due to plantation forest in BZCF. There was poor representation of large saw timber in the study area. *T. nudiflora* was only species in this category. Trees on this category might be used up by locals for timber as cut stump of *B. ceiba* in same category and absence of tree having DBH between 36 to65 cm proves for this.

Looking on the stocking of tree in the study area, forest was medium to well stocked. Cut stump was also very less in the study area. Similarly lopping intensity was also least to

medium in very low density. Low success of regenerating species, but good quality in terms of stocking, cut stump and lopping intensity shows the easy extraction of fuel wood and fodder through cutting regenerating species.

6.4 Dynamics of land use change

Water bodies and agriculture land were almost equal to report of by DNPWC/PP (2000) but forest and grassland were less while shrub/scattered were more. Agriculture land, forest and grassland were in decreasing trend. While the areas of water bodies, scattered trees and orchard have increased. DNPWC/PCP/UNDP (2001) has also reported decrease in trend of forest and grassland while increase in shrub land and water bodies in park area. But agriculture land has increased by 1.06 % during same period in whole buffer zone. The decrease in trend of forest and grassland during 1978-1992 in whole buffer zone area (DNPWC/PCP/UNDP, 2001) is less compared to Kumroj VDC over the same period. Change in area and water bodies was tremendous in that period within the VDC. It has acquired land area from agriculture, forest and grassland. Similarly, agriculture land has acquired some part of forest and grassland. Some part of agriculture land, grass land and water bodies have converted into forest land. Agriculture, forest and water bodies have also changed into grassland. Change in forest into scattered trees, agriculture land, grass land and water bodies indicates the gradual degradation of forest quality.

The per-household forest area in Kumroj VDC based on forest area of 1992 (0.10 ha) was less compared to DNPWC/PPP (2000) but based on forest area reported by BZCFUG (2004) per household forest area (0.67ha) was more.

6.5 Ownership in land and livestock; access on resources and opportunities

Average household farm size (0.79 ha/hh) in the sampled household was smaller compared to whole VDC (0.84 ha/hh) DNPWC/PPP (2000) and Jnawali (1994) (1.19 ha/hh for Bachhauli VDC). This may be due to the increase in population that led land fragmentation with family separation. It was 1348 in 2000 (DNPWC/PPP, 2000) and in 2006 it reached to 1599 (Official record of Kumroj buffer zone community forest user group).

Variation in land distribution has been found among different ethnic groups (See chapter 5.1.2.4); highest with Brahmin/Chhettri groups followed by indigenous groups, others and dalit respectively. The landownership showed gradual shift from indigenous groups to dominant Brahmin/Chhettri group because in the past the indigenous groups (Tharu) had largest average farm size (1.60 ha/hh), followed by Brahmin/Chhettri (1.08 ha/hh) and no one of Tharu (indigenous groups) was landless (Jnawlali, 1994). But reality in my study was that 24.26 % (8 out of 33) landless household were from indigenous groups

The percentage of household having livestock in sampled households (81.69 %) was lower compared to KMTNC (1996) (84.4 %) at all buffer zone level and of Jnawali (1994) (83.5) for Bachhauli VDC. The average livestock head (LSH) in sampled household (3 LSH/hh) was also lower compared to 4 LSH/hh for whole buffer zone area given by DNPWC/PCP/UNDP (2001) and of DNPWC/PPP (2000) for Kumroj VDC (4.2 LSH/hh). It is only about one third compare to report of KMTNC (1996) for Kumroj VDC (9.5 LSH/hh). This shows the decreasing trend of livestock number in the study area. This may be due to decreased access for grazing in buffer zone community forest and National park, decrease in grazing land and average farm size as farm size has also played great role in fodder supply for livestock's (see chapter 5.1.2.6).
Distribution of average livestock unit has varied in sampled household according to ethnicity; higher in Brahmin/Chhettri group relative to other ethnic groups (see chapter 5.1.2.4). Although average livestock unit per household in sampling households (3.12 LSU) has decreased compared to KMTNC (1996) (3.7 LSU/hh), the average livestock unit in Brahmin/Chhettri group had increased compared to KMTNC (1996) (4.0 LSU/hh). Ownership on LSU in the study area was with Brahmin/Chhettri group. Although keeping large number of livestock is prestigious in Tharu communities (Jnawali, 1994), they had least livestock unit in the study area.

The trend of using modern sources of energy in sampled household seems to be increasing. User of biogas in the sampled households (18.31 %) was higher compared to DNPWC/PPP (2000) (5.8 %) in Kumroj VDC. Similarly access on kerosene had increased from 0.5 % to 56.34 % and 0.2 % to 12.7 % in LPG, although the user of fuel wood in sampled household (97.18 %) was higher compared to DNPWC/PPP (2000) (93.2 5%). But access on these modern energy sources was only of those with big farm and almost of Brahmin/Chhettri group.

Access of landless, small farmers and marginalized indigenous groups on decision making process in buffer zone management was very poor. About two third members of the buffer zone user committee and buffer zone community forest were from big farm holders and near about 55 % of Brahmin/Chhettri group (see chapter 5.1.3.1). Paudel (2004) has reported more than 60 % members in overall buffer zone committees from dominant ethnic groups that is Brahmin/Chhettri, Newar either almost excluding landless, small farmer, indigenous groups and other poor or placing them in weak position so that they could not voice on setting and promoting a conservation agenda.

6.6 Resources need and their access; dependency on park

Need of green fodder per livestock unit in the sampled household was very less compared to reported by Jnawali 1994 (9733.3 kg/LSU/yr). The green fodder consumption per LSU varies on the basis of ethnicity. Jnawali (1994) has reported more green fodder requirement in Brahmin/Chhettru groups than in Hill Matwali (other groups) and least in Tharu indigenous group, but in this study other groups need more green fodder for their livestock followed by indigenous groups and least in Brahmin/Chettri groups. Similarly green fodder need per LSU varied according to farm size. Highest need was found in landless and gradually decreased as farm size increased. This is mainly due to the fact that dry fodder like straw and crop residue production was higher in big farm holding households, which was not considered in the study.

Box No. 1. Talking with landless...

Sir, without telling any lies I say that we are poor people. I am not using the electricity illegally and not even user member of BZCF. We don't know much about what the buffer zone is doing but I hear the opening of forest to collect thatch and reed grass and fuel wood. I bring dried twigs, branches occasionally from BZCF. But we don't have money and can't take and collect fuel wood from buffer zone forest. So to meet my demand I often collect drift wood and good quality fuel wood even from National Park. I have no problems for green fodder as I have only one young buffalo. The mother was killed by Tiger last year. I know about compensation measure for loss but it is inadequate and long process jobs to get our self compensated for the loss. So I am not encouraged to do this task.

Response by - D.R Chaudary; 38 yrs,Landless. Kumroj-4, Dharampur.

To meet the demand of green fodder, users of BZCF and own cultivated land were almost equal. Users of the BZCF for green fodder (49.3 %) were lower compared to DNPWC/PPP (2000) (66.5 %) while the users of own land (47.89 %) were higher (30.9

% hh) reported by DNPWC/PPP (2000). The household using National Park was 14.8 % of sampled household. DNPWC/PPP (2000) has reported no collection from National Park while DNPWC/PCP/UNDP (2001) has reported 23 % households fulfill their fodder requirement from the National park in whole buffer zone area. Similarly KMTNC (1996) has reported the National Park entering households are 2.4 % during summer and 27.8 % during winter season. DNPWC/PPP/UNDP (2001) has mentioned 30.5% household entering into the park from Eastern sector. So, overall trend in entering into the park seems to be decreasing for fodder. The data indicate that people entering into the park green fodder are mainly landless or small farmers. This may be due to lack of farm land and also entry fee in BZCF but some large farm holding households were also found going to national park for green fodder.

The annual per capita fuelwood consumption (348.02 kg/yr) in sampled households was lower compared to KMTNC (1996) (555.8 kg/yr) for VDC level and Sharma (1991) (579 kg/yr). The variation in per capita fuelwood consumption based on ethnicity and land holding may be due to the increase in access to other alternative sources of energy and may be due to tradition and livestock number. The access to the alternative energy sources were mostly used by large farmers and Brahmin/Chhettri groups so the per capita fuelwood consumption in these groups was comparatively low in the sampled household, although per capita fuelwood consumption in sample household based on ethnicity has decreased compared to KMTNC (1996) for eastern sector. The overall trend shows the per capita fuelwood consumption is decreasing with the increase in use of biogas, kerosene and LPG.

User of BZCF (87.32 %) in sampled household had increased than the reported by DNPWC/PPP (2000) (78 %), DNPWC/PCP/UNDP (2001) (53.1 %) for eastern sector and Joshi (1999) (10 %) for whole buffer zone VDCs. Similarly the user of National park for fuelwood in the sampled household (33.8 %) have decreased than reported by DNPWC/PCP/UNDP, 2001 (34.64 %) for eastern sector but increased compare to Joshi, 1999 (19 %) for all buffer zone VDC level, and DNPWC/PPP (2000) (1.6 %) for Kumroj VDC. Sharma (1991) has reported that 45 % respondents accepted their illegal entry for resources extraction in the park. Form this overall view, pressure on National park have not decreased for fuelwood. Users of park for fuelwood were almost landless to medium size farm holders and park fulfills 20 % to one third of their need. Dependency of big and

very big farm holders in park for fuelwood was found less, although they also enter into the park for fuelwood (see chapter 5.1.2.6). This is mainly due to big farm size that provides the fuelwood but landless and small farmers were dependent only on BZCF where they have to pay for fuelwood which ultimately leads them to enter the park (Box 1).

Pressure on BZCF and National Park (NP) was mainly due to mismatching of resources need of the people and supply by BZCF. BZCF can supply green fodder 5046.67 ton/ha which was only 36.49 % of total demand extracting rate was higher than it can supply sustainability. Green fodder extraction is higher by 22.14 % than BZCF can supply, although need doesn't meet. So, NP was used as a source for green fodder. NP was supplying 11.78 % of total demand of green fodder in the VDC. Similarly BZCF can supply only 15.58 5 fuelwood of total demand. The fuelwood extraction was four times more than its sustainable supply. NP was second major sources of fuelwood by supplying more than 20 % fuel wood need of the VDC. Thus degradation of BZCF and NP was prevailing due to lack of resources availability in BZCF.

6.7 Buffer zone Management: Conservation and Development programs

Local organizations such as DDCs, VDCs, and BUCs were largely controlled by local elites (Paudel, 2004). These elite groups with high income, big farm and superior political as well as administrative power have controlled over the Buffer Zone Management Committee and programs of community development were prioritized on behalf of them. The household level participation (See chapter 5.1.3.1) and the perception of respondents on buffer zone budget (See chapter 5.1.3.3) clearly show the prevailing budget expenditure system and its transparency. Similarly, conservation education programs, alternative energy promotion programs, income generating programs and community development programs have also become questionable.

The responses given by respondent on the problem and suggestion for better management of BZCF, about livestock depredation, on going activities for the conservation and protection of rhino and poaching events simply show how poor effect of conservation education programs (see chapter 5.1.3.5, 5.1.3.6, 5.1.4.2 and 5.1.4.4). The programs on income generation are also questionable due to poor implementation of skills as indicated by negative attitude trainees towards such trainings (Kayashta, 1999). Furthermore, it was

reported that only 30 % trainers were using their skills in Rajhar and 17 % in Meghuali VDCs. This clearly shows mismatching of such programs as preference of local people was different. The subsidies given for installation of biogas through buffer zone program seem to be inappropriate, although household's environment and health conditions have improved due to biogas installation (Shrestha, 2002; Bajimaya, 2000). Rich and big farm households have taken the benefit of subsides from the alternative energy promotion program rather than by landless, small farmers and marginalized indigenous groups (See chapter 5.1.2.5 and 5.1.2.7). Shrestha (2000) has also reported that 60 % of biogas holders were from dominant ethnic groups (Brahmin/Chhettri) which was less compared to this study (69.23 %). 84.61 % of biogas holders were from big farm holders who have ability to install biogas plant with their high income (see chapter 5.1.2.4 and 6.1.2.7). Biogas subsidy program could be said complete failure because no change in fuelwood consumption. Moreover, the program could not reach landless or marginal farmers who are highly dependent on Park Forest for fuelwood.

BoxNo.2. Realties in the name of conservation …….

Look, money earned by conservation flows with the water of Rapti in the name of community development. Gravels are piled up for road construction and improvement every year, it flows away with rainwater during monsoon then didn't the money flow with Rapti water? Roads are made, whose vehicles run over there, only of rich people. Irrigation canals are constructed, whose field is filled with water, only of rich people. Electric poles are constructed, can poor people pay for electricity, and you can see everywhere the hanging of "Tango" (a long stick hooked with wire to steal electric line) in front of house. Subsidy is provided for biogas installation in the name of alternative energy promotion program, who have installed, only by rich households. In reality, no such developments programs are designed that lift up the economic condition of poor households. Worryingly enough, there is a big game of politics in the name of conservation.

Response by - S.Regmi; 40 yrs, Medium class, Farmer/social activist. Kumroj-4.Sisahani

Community development program run by community forest user committee are doubtful. Physical infrastructure development like road construction and improvements building construction, installation of electric poles, bridge construction and irrigation project are not in priority of target groups (Box No2). In the context of poor economic condition of target groups, as they are even incapable of using electrify by legal means (see chapter 5.1.2.5), physical infrastructure for community will not help people to improve their livelihood development but it is more important to uplift economic base of the target

group first to make them able to benefit from these physical infrastructure and development.

6.8 Target groups and benefit sharing partners

Farm size and ethnicity have not only played a great role in household economy, but also in access on resources and opportunities. Access on education, farm size and livestock holding, better occupation and modern means of energy sources, and decision making process is out of hand of landless, small farm and marginalized indigenous groups. In one hand they are more prone to further marginalization due to lack of access of resource and opportunities and have to depend on park to fulfill their traditional resources need (fuel wood and fodder), on the other hand big farm holders and dominant ethnic group have hold over the resources, opportunities and decision making bodies in the name of conservation and community development and using such program like road construction, irrigation project, installation of electric poles, building construction, alternative energy and skill development program and so on, that give direct benefit to them, not to landless and marginalized people and blaming the poor marginalized and landless as destroyers and poachers (Box 3). In this situation who was target groups of buffer zone program and who should be the benefit sharing partners?

Box No. 3 Places to find Landless: Rich man's suggestions

If you are searching for landless people, you will get enough at the settlement nearby community forest boundary. They dwell there and are people doing illicit activities including fuel wood and fodder collection from the park. We rich people are relatively far away from the forest. So we have very little idea on forest status. Poor people need forest most and to find the answers about conditions and activities in the forest, you have to go there, and they will give you the right information.

Response by - M.N.Kharel; 63 yrs, a big farmer, Kumroj-7. Shisahani.

6.9 Rhino conservation

Perception of respondent on rhino decline and reason for decreasing has matched with the present context of rhino poaching events as 38 rhinos have been poached after February 2005 census and in addition 10 rhinos have died naturally (RHF, 2006). According to respondent electric fence have played great role to prohibit movement of rhino towards the village. Local people are said custodian to safeguard the rhino and its long term survival, but their knowledge on poaching event was frustrating. The lack of knowledge

and information regarding the activities done by park and it's allied agencies for rhino conservation among one third of respondent clearly shows a gap of dialogue between park and other concerned agencies, and local people, and of course the reflection of unenthusiastic of respondent for conservation which may be due to the exclusion in decision making process and benefit sharing. The percent of respondent on reason for rhino poaching and identity of poachers are somehow matched as most of identified are from indigenous ethnic groups (see chapter 5.1.4.4) who are almost became victim of exclusion in the name of conservation that ultimately leads to become destroyer from conserver (Paudel, 2002). These identified ex-poachers only are the partners of illicit activities at initial stage of poaching i.e. at the time of information gathering about rhino movement to dehorning of rhinos (Box4).

Local people have only knowledge on local ex-rhino poachers but do not have any knowledge on high level poachers. This clearly possesses problems in arresting the high level poacher who is involved in international trade market as the park authorities need information from locals. It seems that park authorities are trying only short term solution to control rhino poaching by arresting and punishing local poachers only rather than uprooting and disrupting the network of high level poachers. In one hand protected area approach has evolved inner most social cost, not only limiting livelihood opportunities but also ignoring the potential local institution in conservation (Paudel, 2002) and at the other hand, the poaching event of rhino has questioned over protected area management system in Chitwan.

Box No. 4. About poachers

"Whom I say but you should not hear and when you say then I shouldn't hear". These are poacher's identity. Whatever the matter is and whoever the poachers are, outsiders alone cannot poach without help of local people. In most cases, it has been seen that locals go to other neighboring area where they either stay with relatives, or work as wage labor on share tenant for sometimes to become familiar with others. During this period gathering of weapons as well as rhino movement information are collected. Other people living there may support indirectly in most cases rich people help more directly and poor indirectly. In this way locals people helps them at initial stages i.e. gathering information on rhino movement and weapons to day of killing. There must be well designed network among different level of poachers but most surprising matter is that only local level poachers are caught not the high level poachers who involve in trade. Even if they caught up, they get easy escape.

Response by - S.Regmi, 40 yrs, Medium class, Farmer/social activist. Kumroj-4,Sisahani

Degradation of riverine forest which is the prime habitat of rhino was continuous due to the people's need for fodder and fuel wood. Not only the BZCF was on the way of degradation but there was still high pressure on National park for fuel wood and green fodder need of local people.

Chapter 7
CONCLUSION

Kumroj BZ VDC household community structure and function was largely based on subsistence agricultural system. The farm size was determining factor for household well being. Household having big farm size had more access to opportunities as they had more options for economic security than others. As access to education, better occupation, livestock holding and modern means of energy and decision making body were all lopsided to big farm households. The pressing problems were evident in landless, small farmers and marginalized indigenous groups as they are deprived of basic resources and socioeconomic freedom.

Though, buffer zone community forest area was restored to present size, all households irrespective of their farm size demand more green fodder and fuel wood than forest can supply. Furthermore, buffer zone community forest has been degraded affecting most of the regenerating species and the deficits were met chiefly from the national park.

The community forest harbors different wildlife but community incentives and participation for conservation was non existence as households have differing perspectives due to recurrent crop damage and livestock's depredation without adequate compensation measures for the loss. Though households have their prioritized lists of suggestions for better management of resources and prospects for better livelihood but there was no such plan for arrangement.

Chapter 8

RECOMMENDATION

From the above mentioned conclusion (chapter 7) followings are recommended to achieve the goal of buffer zone concept:

- Kumroj buffer zone institutional landscape needs restructuring and strengthening of social capital and institutional capability.
- Before the implementation of buffer zone programmes, target group should be identified.
- Access on various resources and opportunities should be provided to poor and marginalized people.
- To meet the demand of forest produce, condition of forest should be improved by plantation and controlling on illegal extraction.
- Before declaration of buffer zone area, science based resource assessment should be done.

- **Reference**

Adhikari, T.R. 2002. The curse of success. *Habitat Himalaya*. Vol. 9 (3).

Bajimaya, S. 2000. An Impact Assessment of Biogas in Buffer Zone of chitwan National Park (Kumroj).B.Sc.Thesis. St. Xavier's College, K.U., Kathmandu, Nepal

Bajimaya, S. 2005. Participatory Conservation in Protected Areas of Nepal. People & Protected Areas in South Asia, IUCN/Resources Himalaya Foundation, Kathmandu, Nepal

Baral, H.S.and Upadhyay, G.P. 2006. Birds of Chitwan. BCN/DNPWC/PCP II, Kathmandu, Nepal

Bhattrai, T.P.1999. Livestock depredation and human harassment by wildlife and its control. BSc Thesis. Institute of Forestry, Pokhara Campus, Tribhuvan University, Nepal

Bhudhathoki, P. 2004. Linking communities with conservation in developing countries: buffer zone management initiatives in Nepal. *Oryx*., 38: 334-341

Bookbinder, M. P., Dinerstein, E., Rijal, A., Cauley, H. and Rajauria, A. 1998. Ecotourism's Support of Biodiversity Conservation. *Conservation Biology*,12 (6): 1399-1404.

Budhathoki, P. 2005. Chitwan National Park: A World Heritage Site with Buffer Zone. People & Protected Areas in South Asia, IUCN/Resources Himalaya Foundation, Kathmandu, Nepal

BZCFUG, 2004. Kumroj Buffer Zone Community Forest Operational Plan (2004-2005). Serial No. RCNP/CHI/17

Christensen, J. 2004.Win-Win Illusions. *Conservation in Practice*, 5(1)

Dhakal, G. 1992. Studies on diet preference of elephant (*Elephas maximus*) in Chitwan Park. MSc Thesis.Central Department o f Zoology, TU, Kathmandu, Nepal

Dhungel, S.K. 1985. Ecology of Hog deer in Chitwan National Park, Chitwan. Ph.D. thesis.University of Montana, USA

Dinerstein, E. & Wemmer, C.M. 1988 Fruits Rhinoceros Eat: Dispersal of *Trewia nudiflora* (Euphorbiaceae) in low land Nepal. *Ecology*, 69(6):1768-1774

DNPWC, 2001. Annual Report (2000-2001). Department of National Park and Wildlife Conservation, Kathmandu, Nepal

DNPWC, 2005. 25 years of commitment to conservation. A fact file (1980 to 2005). Department of National Parks and Wildlife Conservation, Kathmandu, Nepal

DNPWC, 2005. Annual Report (2004-2005). Department of National Park and Wildlife Conservation, Kathmandu, Nepal

DNPWC/ PPP. 2000. Chitwan National Park and Buffer Zone Resource Profile. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal

DNPWC/ WWF, 2006. The greater one horned rhinoceros conservation action plan for Nepal (2006-2011). Department of National Parks and Wildlife Conservation, Kathmandu, Nepal

DNPWC/PCP/UNDP, 2001. Chitwan National Park and Buffer Zone Management Plan (2001-2005). Department of National Parks and Wildlife Conservation, Kathmandu, Nepal

FRSC, 1995. Forest Resources of Chitwan District. Forest Resource and Survey Centre, Ministry of Forests and Soil Conservation, Kathmandu, Nepal. Publication No. 62

FSSD, 1991. Volume equation and biomass prediction of forest trees of Nepal. Forest Survey and Statistical Division, Ministry of Forests and Soil Conservation, Kathmandu, Nepal

Gautum, K.H. 1996. Growth of multistem in two year old *Dalbergia sissoo* plantation in Nepal's Terai. *Banko Jankari*, 6(2):82-84

HMG, 1988a. Master Plan for Forestry Sector of Nepal. Forest resources information and status and development Plan. Ministry of Forests and Soil Conservation, Kathmandu, Nepal

HMG, 1988b. Master Plan for Forestry Sector of Nepal: Main Report. Ministry of Forests and Soil Conservation, Kathmandu, Nepal

IV World Congress, 1992. Parks for Life. The Caracas Action Plan. An unplublished draft prepared during the IV World Congress on National Parks and Protected Areas held in Caracas, Venezuela, 10-21 February 1992

Jnawali, S. 1994. Conflict of land use: Livestock management and community forestry in Bachhauli VDC adjacent to Chitwan National Park in Lowland Nepal. . MSc Thesis. Agriculture University of Norway, Norway

Jnawali, S.R. 1989. Park-People Conflict: Assessment of crop damage and human harassment by Rhinoceros (*Rhinoceros unicornis*) in Sauraha area adjacent to Chitwan National Park, Nepal. MSc Thesis. Management of Natural Resource and Sustainable Agriculture, Agriculture University of Norway, Norway

Jonshon, N.H. & Orlund, K.1996. National Park Tourism in lowland Nepal. A comparative study between Chitwan National Park and Bardia National Park. Department of Biology and Nature Conservation, The Agriculture University of Norway, Norway

Joshi, A. 2003. Gender, Woman and Participation in Buffer zone Management (A case study of Chitwan National Park). MSc Thesis. Institute of Forestry, Pokhara Campus, Tribhuvan University, Nepal

Joshi, S. 1998. A socioeconomic analysis of residents in buffer zone of Chitwan National Park, Nepal. M.Sc. Thesis. University of Minnesota, USA

Kayastha, P.K.1999. Effectiveness of income generation related training programmes launched by Park-People Programme in the Buffer Zone of Chitwan National Park (A case study of Rajhar and Meghauli VDCs). BSc Thesis. Institute of Forestry, Pokhara Campus, Tribhuvan University, Nepal

Kharal, D.K. 2000. Diversity and Dynamics of Tree species and its sustainability in rural farmland: A case study in Chitwan district, Central Terai of Nepal. Agricultural University of Norway. M.Sc thesis. unpublished

Lamsal, P. 1995. Biomass production of grassland of Chitwan National Park and consumption of Park resources by local villagers. M.Sc. Thesis. Central Department of Zoology, TU, Kathmandu, Nepal

Laurie, A. 1978.The Ecology and Behavior of the Greater One Horned Rhinoceros. Ph.D. Thesis. University of Cambridge, USA

Maskey, T. & Bagimaya, S. 2005.Participatory management of Buffer Zone for natural resource conservation. *Banko Jankari*, 15(1)

McShane, T.O. & Wells, M.P. 2004. Getting Biodiversity Projects to work: Towards More Effective Conservation and Development. Columbia University Press, New York, USA

Mishra, H.R. 1982. The ecology and behavior of Chittal (Axis axis) in Chitwan National Park: with comparison with hog deer (Axis porcinus), sambar (Cerbus unicolor), and barking deer (Muntiacus muntjack). Ph. D. Thesis. University of Edenburgh, UK

Mishra, H.R. 1991. Regional Review: South-east Asia.A Review Developed from a Regional Meeting on National parks and Protected Areas held in Bangkok from 1-4 Dec.1991 under the co-sponsorship of IUCN, AIT and the World Bank

Nagendra, H.Tucker, C., Carlson, L., South Worth, J., Karmacharya, M. and Karna, B. 2004. Monitoring Parks through Remote Sensing: Studies in Nepal and Honduras. *Environmental Management*, Vol.34

Nepal, S.K. & Weber, K.F.1995. The quandary of local people park relations in Nepal's Chitwan National Park. *Environmental Management*, 19(6)

Nepal, S.K. & Weber,K.E., 1993. Struggle for existence: Park-People Conflict in Chitwan National Park, Nepal. Asian Institute of Technology, Thailand.

KMTNC, 1996. Chitwan National Park after Twenty Years .An assessment of values, threats and opportunities. National Trust for Nature Conservation, Kathmandu, Nepal.

KMTNC, 1998. Buffer Zone Policy Analysis of Chitwan National Park. Technical Report, National Trust for Nature Convervation, Kathmandu, Nepal.

Oli, K.P. 2005.Lessons from Collaborative Management of Protected Areas. People & Protected Areas in South Asia, IUCN/Resources Himalaya Foundation, Kathmandu, Nepal.

Pandit, S.N. 1995. Vegetation Composition, Biomass Production of the Grassland and Park Resources consumption pattern by ethnic groups of adjoining villages of Chitwan National Park. M. Sc. Thesis. Central Department of Zoology, TU, Kathmandu, Nepal.

Paudel, N. S**.** (2004). Buffer Zone Management in Royal Chitwan National Park, Understanding the Micro-Politics. Proceeding of the IVth Conference of Science and Management of Protected Area Association, 11-16 May, 2003, Victoria, Canada.

Paudel, N.S. 2002. Integrating People and Nature: A perspective for Environmental Conservation and livelihoods in the context of Nepal. *Journal of Forest and Livelihood*, 2(1): 62-67.

Paudyal, S. 2002. Ethno-botanical study of Chitwan National Park: an approach towards reducing park dependency. Park-People Programme, Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Plummer, R. & Gibbin, G.F. 2006. People matter: The importance of social capital in the co-management of natural resources. *Natural Resources Forum*, 30:51-62.

Pradhan, N.M. 1995.Buffer Zone Management in Nepal: A case study in Bardia National Park with emphasis on sustainable use of fuel wood and timber resources. M.Sc. Thesis. Agricultural University of Norway, Norway

RHF, 2006.Annual Report,2006. Resources Himalaya Foundation, Kathmandu, Nepal.

Rijal, A. & Meilby, H (In print). Is the life-supporting capacity of forests in the lower Mid-Hills of Nepal threatened?

Rijal, A. 1997. Baghmara Community Forest: An example of linkage between Communities and Ecotourism, Royal Chitwan National Park, Nepal. Paper presented in International Seminar on "Ecotourism and Community Development", RECROFT-FAO. Thailand.

Rijal, A. 1994. Ethnobotany of Padampur. Analysis of Dependency and Conflict. M.Sc. Thesis. University of Norway, Norway.

Sayer, J. 1991. Buffer Zone Management in Rain Forest Protected Areas. Tiger paper, xviii (4): 10-17.

Sharma, A. 2000. Wildlife Corridor Management: Analysis of Biodiversity and Socioeconomic in Buffer Zone of Chitwan National Park, Nepal. M. Sc. Thesis. Asian Institute of Technology, School of Environment, Resources and Development, Thailand.

Sharma, U. R. 1991. Park-People Interaction in Chitwan National Park, Nepal. Ph.D. Thesis. University of Arizona, USA.

Sherpa, L. N. 1993. Guidelines for Buffer Zone Identification: Protected Area Buffer Zone Working Paper No. 1 Kathmandu. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Shrestha, A.K.1997. Status of Bengal Florican (*Houbatopsis bengalensis*) in Grassland of Chitwan National Park. BSc Thesis. Institute of Forestry, Pokhara Campus, Tribhuvan University, Nepal.

Shrestha, L. K. 2002. Socioeconomic impact of Biogas installation in Rural Nepal. A case study of Kumroj Village, Chitwan District. M.A. Thesis. Central Department of Sociology/ Anthropology, T.U., Kathmandu, Nepal.

Shrestha, T.K.1993. Status, Ecology and Behavior of Gangetic Dolphin in the Narayani River of Nepal. *J. Fresh water Biol*. 5(4): 365-377.

Silori, C.S. 2001. Status and distribution of anthropogenic pressure in the buffer zone of Nanda Devi Bioshpere Reserve in Western Himalaya, India. *Biodiversity and Conservation*, 10:1113-1130.

Straede, S. & Helles, F. 2000. Park-people conflict resolution in Chitwan National Park, Nepal: buying time at high cost ? *Environmental Conservation*, 27(4): 368-381.

Straede, S. & Treue, T. 2005. Beyond buffer zone protection: A comparative study of park and buffer zone product's importance to villagers living inside Chitwan National Park and to villagers living in its buffer zone. *Journal of Environmental Management*, 78:251-267.

Straede, S., Nobel, G. & Rijal, A.2002. Structure and floristic composition of community forests and their compatibility with villager's traditional needs for forest products. *Biodiversity and Conservation*, 11: 487-508.

Tamang, K.M.1982. The Status of tiger and its impact on principal prey population in the Chitwan National Park, Nepal.Ph.D. Thesis. Michigan State University, USA.

Thapa, V.2003. Habitat heterogeneity and distribution of some ungulate prey species in Barandabhar Forest, Chitwan, Nepal. Master Thesis. Management of Natural Resource and Sustainable Agriculture, Agriculture University of Norway, Norway

Wells, M. & Brandon, K. 1992. People and Parks: Linking protected area management with local communities. The World Bank, Washington, DC.

Wells, M.P. & McShane, T.O. 2004. Integrating Protected Area Management with Local Needs and Aspirations. *Ambio*.33 (8):513-519.

Wells, M.P. and Sharma, U.R. 1998. Socioeconomic and political aspects of biodiversity conservation in Nepal. *International Journal of Social Economics*, Vol. 25: 226-243.

Yonzon, P. 2000. Win Little, Lose more. *Habitat Himalaya*, 7(1).

Yonzon, P. 2002. The wounds of neglect. *Habitat Himalaya*,Vol. 9(1)

ANNEXES

Annex A1 Occupation based on land holding

Occupation	Farm Category				
	Landless	Small	Medium	Large	Very Large
Agriculture	5	7	9	35	7
Agriculture+House work	20	14	18	45	6
House work +Wage labor	7	-	-	-	-
Service+ Agriculture	-	-	3	1	-
Service	2	-	4	4	2
Business	-	1	2	1	1
Business + Agriculture	-	1	1	6	-
Foreign Earning	1	2	2	3	-
Wage labor	7	1	-	-	-
Wage labor (Skilled)	2	-	2	-	-
Agriculture + Wage labor	15	4	1	-	-
Agriculture + Wage labor (Skilled)	2	2	1	-	-
Total	61	32	43	95	16

Annex A2
Occupation based on Ethnicity

Occupation	Ethnicity			
	Indigenous group	Brahmin/Chhettri	Others	Dalit
Agriculture	30	31	2	-
Agriculture+House work	54	41	7	1
House work +Wage labor	6	-	1	-
Service+ Agriculture	-	3	1	-
Service	3	7	2	-
Business	1	3	1	-
Business + Agriculture	4	3	1	-
Foreign Earning	5	2	1	-
Wage labor	3	-	1	4
Wage labor (Skilled)	3	1	-	-
Agriculture + Wage labor	17	1	2	-
Agriculture + Wage labor (Skilled)	4	1	-	-
Total	130	93	19	5

Annex A3 Educational status based on farm size

Farm Category	Educational Status				
	Literate				Illiterate
	General	Lower class	High School	College	
Landless	19	18	13	2	28
Small	18	13	6	4	8
Medium	6	28	19	12	20
Large	43	34	33	35	34
Very Large	7	3	5	5	7
Total	93	96	76	58	97

Annex A4 Educational status based on Ethnicity

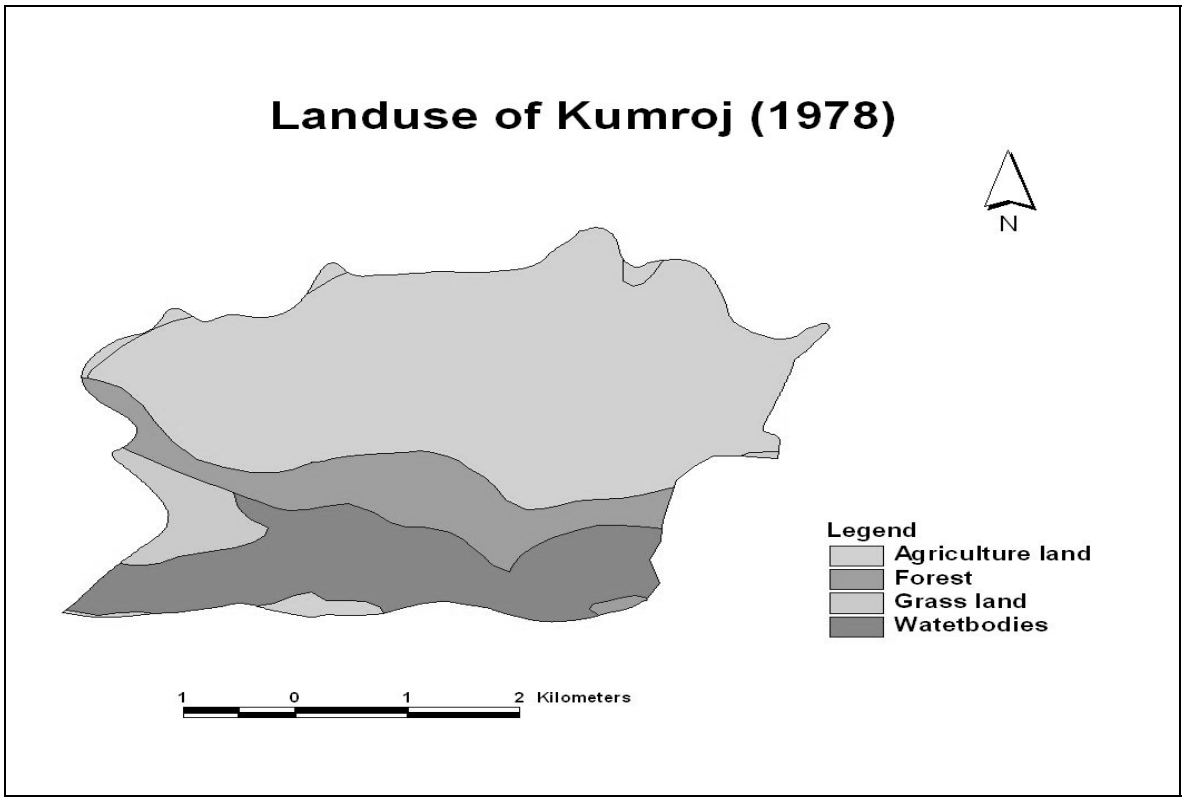
Ethnicity	Educational Status				
	Literate				Illiterate
	General	Lower class	High School	College	
Indigenous group	47	53	30	17	54
Brahmin/Chhettri	37	37	43	35	35
Others	8	6	3	6	7
Dalit	1	-	-	-	1
Total	97	96	76	58	96

Annex A5 Types of resource extraction from BZCF on the basis of land holding

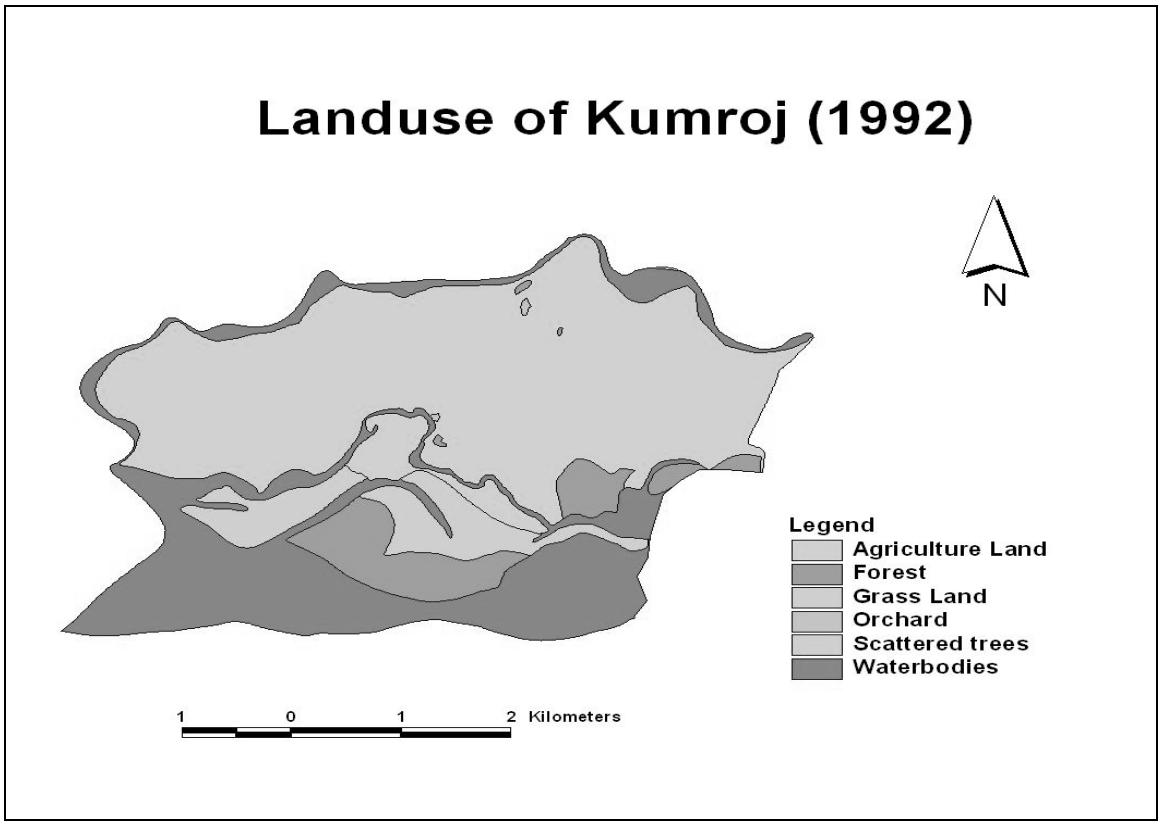
landholding	RCF	N of HH	% of Total N
Landless	Non user	4	23.53
	Fuel wood	4	23.53
	Fuel wood + Fodder + KH	1	5.88
	Fodder + KH	7	41.18
	Fuel wood + KH	1	5.88
	Total	17	100.00
Small	Fuel wood	3	33.33
	Fodder + KH	6	66.67
	Total	9	100.00
Medium	Fuel wood	2	14.29
	Fodder + KH	11	78.57
	Fuel wood + KH	1	7.14
	Total	14	100.00
Large	Non user	5	18.52
	Fuel wood	5	18.52
	Khar/Khadai	2	7.41
	FW+FO+KH+BE+JH	1	3.70
	Fuel wood + Fodder + KH	1	3.70
	Fodder + KH	11	40.74
	Fuel wood + KH	2	7.41
	Total	27	100.00
Very Large	Non user	1	25.00
	Fuel wood	1	25.00
	Fodder + KH	2	50.00
	Total	4	100.00

RCF= Resources use from community forest, KH = Khar/Khadai, FW= Fuel wood, FO= Fodder, BE= Berauwa, JH= Jhaksi,

Annex A6



Annex A7



Annex A8 DBH class of trees in the study area

DBH Category	No/Ha	%
Sapling	25	18.52
Poles	85	62.96
Small saw timber	15	11.11
Large saw timber	10	7.41

Annex A9 DBH class of each species (no/ha)

species	Sapling	Poles	Small saw timber	Large saw timber
Bombax ceiba	-	-	5	-
Dalbergia sissoo	15	55	5	-
Ehertia laevis	-	5	-	-
Litsea monopetala	5	10	-	-
Mellusa velutina	5	-	-	-
Trewia nudiflora	-	10	5	10
Wetlandia puberula	-	5	-	-

Annex A10 DBH class of each species (no/ha) at 5cm interval

dbh class	10-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75
Bombax ceiba	-	-	-	5	-	-	-	-	-	-	-	-	-
Dalbergia sissoo	20	25	25	-	5	-	-	-	-	-	-	-	-
Ehertia laevis	5	-	-	-	-	-	-	-	-	-	-	-	-
Litsea monopetala	5	10	-	-	-	-	-	-	-	-	-	-	-
Mellusa velutina	5	-	-	-	-	-	-	-	-	-	-	-	-
Trewia nudiflora	-	10	5	5	-	-	-	-	-	-	-	5	5

Annex A11 Regeneration of tree species in the study area

Species	Density (No/ha) at different height class					Total
	<1 m	1-2 m	2-4 m	4-6 m	>6 m	
Bombax ceiba	-	-	61.54	30.77	-	92.31
Dalbergia sissoo	1049.23	123.08	-	-	15.00	1187.31
Litsea monopetala	446.15	30.77	-	-	5.00	481.92
Xeromphis spinosa	-	30.77	-	-	-	30.77
Mellus velutina	307.69	184.62	35.77	-	-	528.08
Morus alba	369.23	-	-	-	-	369.23
Albizia odoratissima	-	-	-	61.54	-	61.54
Total	2172.31	369.24	97.31	92.31	20.00	2751.16

Annex A12 Estimated fuel need (t/yr) and sources based on farm size

Farm size	Sources				
	Community Forest	National Park	Private land	Private Forest	Total
Landless	258.16	197.98	6.46	-	462.6
Small	831.8	250.08	81.55	-	1163.43
Medium	546.79	256.09	52.6	46.72	902.2
Large	345.38	28.43	142.61	-	516.42
Very Large	330.99	89.94	147.51	-	568.44
Total	2313.12	822.52	430.73	46.72	3613.09

Annex A13 Estimated fuel need (t/yr) and sources based on farm size

Farm size	Sources				
	Community Forest	National Park	Private land	Private Forest	Total
Landless	455.52	137.75	165.54	48.69	807.5
Small	2411.13	1136.25	789.67	-	4337.05
Medium	1931.07	159.19	1780.53	297.62	4168.41
Large	1187.41	196.32	1820.2	-	3203.93
Very Large	179.89		1133.29	-	1313.18
Total	6165.02	1629.51	5689.23	346.31	13830.07

Annex A14 Plant species

Species	Family
Ageratum conyzoides L.	Compositae
Albizia odoratissima Benth.	Leguminosae
Artemisia vulgaris Linn.	Compositae
Boehmeria ternifolia D. Don.	Urticaceae
Bombax ceiba L.	Bombacaceae
Bracharia sp.	Graminae
Buddleja asiatica Lour.	Buddlejaceae
Callicarpa macrophylla Vahl.	Vebernaceae
Cirsium sps	Compositae
Cissampelos pareira L.	Menispermaceae
Cissus repens Lam.	Vitaceae
Clerodendrum viscosum Vent.	Verbenaceae
Coccinea grandis (L.) VOIGT	Crassulaceae
Colacacia sp	Araceae
Colebrookea oppositifolia Sm.	Labiatae
Commelina sps	Commelinaceae
Cyanodon dactylon (L.) Pers.	Graminae
Cyperus platistylis R.Br.	Cyperaceae
Dalbergia sissoo Roxb. ex DC.	Leguminosae
Digitaria ciliaris (Retz.) Koeler	Graminae
Eclipta prostata (L.) L	Compositae
Ehertia laevis Roxb.	Cordiaceae
Equisetum sp.	Equisetaceae
Eupatorium adenophorum Spreng.	Compositae

Eupatorium odoratum L.	Compositae
Ficus cunia Guch-Han. ex.Roxb	Moraceae
Ficus hederaceae Roxb.	Moraceae
Flemingia macrophylla (Wild.) Merr.	Leguminosae
Geranium sp.	Graminae
Gnaphalium sp.	Compositae
Graminae	Graminae
Imperta cylindrica (L.) P. Beauv	Graminae
Indigofera phulchella Roxb.	Leguminosae
Trichosanthes wallichiana (Ser.) Wight,	Cucurbitaceae
Ipomea sps	Convolvulaceae
Labitiatae	Labiatae
Lantana camara L.	Verbenaceae
Leea macrophylla Roxb. ex Hornem.	Leeaceae
Lindernia sp	Linderniaceae
Lippia nodiflora (L.) Rich *Phylla nodiflora* (L.) Rich	Valerianaceae
Litsea monopetela (Roxb.) Pers.	Lauraceae
Litsea monopetela (Roxb.) Pers.	Lauraceae
Litsea salicofolia (Roxb. exNecs) Hook.f.	Lauraceae
Maesea chisia Buch. Han. ex D.Don	Marsinaceae
Xeromphis spinosa (Thunb.) Keay,	Rubiaceae
Mikania micarantha Kunth.	Compositae
Miliusa velutina (Dunal) Hook. f. & Thomson.	Annonaceae
Mimosa pudica L.	Luguminosae
Mimosa sp	Luguminosae
Mimulus nepalensis Benth.	Scrophulariaceae
Morus alba L.	Moraceae
Mucuna pruriens (L.) DC	Luguminosae
Natsiatum herpeticum Buch.-Ham. ex Arn.	Icacinaceae
Persicaria barbata (L.) H. Hara	Polygonaceae
Pilea sp.	Urticaceae
Piper longum L.	Piperaceae
Pogostemon glaber Benth.	Labiatae
Polygonum sp.	Polygonaceae
Polypogon monospelliensis (L.). Desf	Polygonaceae
Porona sp	Convolvulaceae
Pragmites karka (Retz.)Tren.ex Steud	Gramineae
Ranunculus scleratus L.	Ranunculaceae
Rungia sps	Acanthaceae
Saccharum spontaneum L.	Graminae
Salvia sp.	Labiatae
Sassurea sp.	Compositae
Sida cordifolia L.	Malvaceae
Solanum torvum Sw.	Solanaceae
Solanum xanthocarpum Schrad. & J.C. Wendl = *Solanum virginianum* Dunal.	Solanaceae
Thelypteris auriculata (J. Sm.) K. Iwats	Thelypteridaceae
Trewia nudiflora L.	Euphorbiaceae
Trifolium sp.	Luguminosae
Typha angustifolia L.	Typhaceae
Urtica dioica L.	Urticaceae
Veronica anagalis L.	Scrophulariaceae
Veronica cineria L.	Scrophulariaceae
Wendlandia puberula DC.	Rubiaceae
Zygiphus mauritiana Lan.	Rhannaceae

Annex A15 Sample household questionnaires

HOUSEHOLD QUESTIONNAIRE SURVEY

Household Information

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

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

Individual ID (Full Name)	Relation to Respondent	Sex	Age (Yrs)	Marital Status (M/U)	Occupation			Education
					I	II	III	

Farm Size / Production

Ownership	Area			Land Type
	Bigha	Kattha	Dhur	
Own				Parti/Ailani
Shared Tenant				Parti/Ailani

1. What type of crop do you grow?

Crop Type		Area			Production		Consumption (Kg)	Surplus (Kg)	Deficit (Kg)	Deficit Period (Month)
		Bigha	Kattha	Dhur	Mann	Kg				
Food Crop	Wheat									
	Paddy									
	Maize									
Pulses										
Cash crop	**Vegetables**									
	Oil seeds									
	Others									

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

3. If surplus what do you do with the surplus crops?
   Store /Sale/ others.....

Livestock's Type and Holdings

Types of Animals	Numbers	Stall Feeding	Grazing	Both

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

Livestock	Observation	Status	Remark
	Body Line Round	Good	
	Body Line Angular	Intermediate	
	Body line Angular, Rib cage visible	Poor	

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 energy consumption (Record use for the each month, Liter for Kerosene, No. of Cylinder for Gas, Number of Batteries)

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

4. Do you have biogas plant in your house? Yes/No

   .....

5. If Yes,

Installed Date	**Biogas**	
	Capacity (cb.m)	Expenditure

6. Did you receive any support from others while installing Biogas? Yes/No

   .....

   .....

7. How much Livestock's are needed to operate your biogas plant

Livestock	Numbers	Fodder requirement

8. If No, why are you not having Biogas plant. Are there any constraints?
   .....
   .....
9. Do you have any plans to install biogas plant? Yes/No
   .....
   .....

BUFFERZONE COMMUNITY FOREST, HOUSEHOLD DEMAND AND MANAGEMENT ISSUES

1. Which BZ community forest do you use?
   .....
2. Are you member of User group? Yes/No
3. What is your User Group name?
   .....
4. What is your position in User group: General Member or if any other specify……
5. Any other household member involved in Buffer zone management council, UC, UG?

Date	Buffer zone Management UC/UG	Status	Relation with respondent

6. What type of resources do you bring from your BZCF?
   Fodder/Fuel wood/Timber/All
7. What do you say about your BZ community forest status?
   Very Good/ Good/Satisfactory/ Bad/Very Bad
8. What was the condition of your Buffer zone CF in Past/ Present?
   .....
   .....
   .....
9. What do you think about current management practice of your community forest?
   Very Good/ Good/Satisfactory/ Bad/Very Bad

10. Are available resources from your community forest fulfilling your demand? Yes/No
    If No and if you buy from your CF/ Others CF/Go to RCNP/ how much you need?

Resources	Time	Demand	Amount Paid (Rs)	Access
Fodder (Bhari/Kg)	Daily/Monthly/Weekly/Yearly			
Fuelwood (Bhari/Kg)	Daily/Monthly/Weekly/Yearly			
Timber (Cu.Ft)	Daily/Monthly/Weekly/Yearly			

11. Do you have any idea of resources allocation system in your BZCF? Yes/No
    If yes, on what basis
    Well being/Population/ No. of livestock/Profession/Others.....
    .....
12. Is there any land categorization for different purposes in your BZCF? Yes/No.....

If yes, are there following zone

Pasture land/Recreation zone/Habitat management zone/Fodder zone/Fuel wood zone/ Soil mining zone/others.....

13. Are you happy with distribution and consumption of available resources from your Community Forest? Any problems. Yes/ No

    .....

.....

Any other problems,……..

    .....

    .....

14. Do you have any suggestions/ recommendations for better management of your CF resources utilization as well as conservation?

    .....

    .....

    .....

    .....

    .....

    .....

15. What do you think about Budget allocated by RCNP for Buffer zone VDC for management? Is it being spending wisely for conservation as well as development of your area? Yes/No

    .....

    .....

    .....

16. What kind of programs User committee launched in the past? Did you involve/participate in those programs? Yes/No. If yes what kind of program?

    .....

    .....

    .....

RHINO RELATED ISSUES

1. Crop Damage caused by Rhino/Wildlife

Wildlife	Crop	Time of Damage				Damage amount/Year in local unit	Compensation Amount (Rs)
		Morning	Day Time	Evening	Night		

2. Livestock Loss by Wild animals

Wildlife	Livestock	Number of Loss	Time in Year and month	Compensation

3. Frequency of Human Loss by wild animals

Wild animal	Date/Time	Killed	Injured	Compensation

4. Are you satisfied with compensation measures for loss made by wildlife? Yes/No
5. If No, what do you think it should be?

    .....

.....
.....

6. How many Rhino you have observed into your area?

Time	Season/Month/Year	Place	Number of Rhino
Past Years			
Recent Years			

7. Do rhino comes every year around your area. Yes/No
8. How do you defense against rhino movement into your area?
   Fence/Trench/ Firing/Shouting/Any other…….

9. What do you know about Rhino movement into your area?
   Increasing/ decreasing/remains the same/No idea

10. If decreasing, do you know why it is happening?
    Natural death/ Killing (Poaching)/Habitat loss/Translocation /Any others……

11. Do you know when and where Rhino were killed?

Date	Place

12. Do you know what types of people are involved in Rhino poaching?
    a)Poor/Medium/Rich b)Educated/Uneducated

13. Do you know any household who have been accused of rhino poaching? Yes/No, If yes

Name	Address	Involved date

14. What do you think, why they are killing the rhino?
    .....
    .....
    .....
15. Would any opportunities to poachers help stop killing? Yes/No
    If Yes what.....
    .....

16. What kind of activities are/ were done by BZCF/BZMC/Park management to stop Rhino poaching?
    .....
    .....
    .....
    .....
    .....
17. Do you think existing activities/policies/conservation practices have helped conserve Rhino? Yes/No/No idea

18. If No, What do you think what kind of activities/polices/conservation practices will help conserve rhino?

.....
.....
.....
.....
.....

ANNUAL INCOME AND EXPENDITURE (OPTIONAL)

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

Source	Amount	
	Calculated	Rectified
Agriculture		
Service		
Livestock		
Business		
Tourism		
Off-Farm employment		
Others		
Total		

Remarks.....
.....
.....

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

Item	Amount	
	Calculated	Rectified
Education		
Health		
Maintenance		
Agriculture		
Livestock Poultry Maintenance		
Loss of livestock		
Loss of crops		
Total		

Remarks.....
.....
.....

3. Who will help you incase of need for taking loan?
   ……
   ……..
4. From the above two tables the saved amount becomes Rs....., Do you save this much annually? Yes/No

Annex A16 Tree species with family

Tree Species	Family
Bombax ceiba L.	Bombacaceae
Dalbergia sissoo Roxb. ex DC.	Leguminosae
Ehertia laevis Roxb.	Cordiaceae
Litsea monopetela (Roxb.) Pers.	Lauraceae
Miliusa velutina (Dunal) Hook. f. & Thomson.	Annonaceae
Trewia nudiflora L.	Euphorbiaceae
Wendlandia puberula DC.	Rubiaceae

Annex A17 Plants species with family in shrub plots

Species	Family
Albizia odoratissima Benth.	Leguminosae
Artemisia vulgaris Linn.	Compositae
Boehmeria ternifolia D. Don.	Urticaceae
Bombax ceiba L.	Bombacaceae
Buddleja asiatica Lour.	Buddlejaceae
Callicarpa macrophylla Vahl.	Vebernaceae
Cirsium sps	Compositae
Cissampelos pareira L.	Menispermaceae
Cissus repens Lam.	Vitaceae
Clerodendrum viscosum Vent.	Verbenaceae
Coccinea grandis (L.) VOIGT	Crassulaceae
Colacacia sp	Araceae
Colebrookea oppositifolia Sm.	Labiatae
Dalbergia sissoo Roxb. ex DC.	Leguminosae
Eupatorium adenophorum Spreng.	Compositae
Eupatorium odoratum L.	Compositae
Ficus hederaceae Roxb.	Moraceae
Flemingia macrophylla (Wild.) Merr.	Leguminosae
Indigofera phulchella Roxb.	Leguminosae
Trichosanthes wallichiana (Ser.) Wight	cucurbitaceae
Ipomea sp	Convolvulaceae
Labitiatae	Labiatae
Lantana camara L.	Verbenaceae
Leea macrophylla Roxb. ex Hornem.	Leeaceae
Litsea monopetela (Roxb.) Pers.	Lauraceae
Litsea salicofolia (Roxb. exNecs) Hook.f.	Lauraceae
Maesea chisia Buch. Han. ex D.Don	Marsinaceae
Xeromphis spinosa (Thunb.) Keay	Rubiaceae
Mikania micarantha Kunth.	Compositae
Miliusa velutina (Dunal) Hook. f. & Thomson.	Annonaceae
Mimosa sp	Luguminosae
Morus alba L.	Moraceae
Mucuna pruriens (L.) DC	Luguminosae
Natsiatum herpeticum Buch.-Ham. ex Arn.	Icacinaceae
Pilea sp	Urticaceae
Piper longum L.	Piperaceae

Pogostemon glaber Benth.	Labiatae
Porona sp	Convolvulaceae
Pragmites karka (Retz.)Tren.ex Steud	Gramineae
Rungia sps	Acanthaceae
Sida cordifolia L.	Malvaceae
Solanum torvum Sw.	Solanaceae
Solanum xanthocarpum Schrad. & J.C. Wendl = *Solanum virginianum* Dunal.	Solanaceae
Urtica dioica L.	Urticaceae
Veronica cineria L.	Scrophulariaceae
Zygiphus mauritiana Lan.	Rhannaceae

Annex A18 Plant species with family in herb plots

Species	Family
Ageratum conyzoides L.	Compositae
Bracharia sp.	Graminae
Commelina sps	Commelinaceae
Cyanodon dactylon (L.) Pers.	Graminae
Cyperus platistylis R.Br.	Cyperaceae
Digitaria ciliaris (Retz.) Koeler	Graminae
Eclipta prostata (L.) L	Compositae
Equisetum sp.	Equisetaceae
Eupatorium adenophorum Spreng.	Compositae
Ficus cunia Guch-Han. ex.Roxb	Moraceae
Geranium sp.	Graminae
Gnaphalium sp.	Compositae
Graminae	Graminae
Imperta cylindrica (L.) P. Beauv	Graminae
Lindernia sp	Linderniaceae
Lippia nodiflora (L.) Rich *Phylla nodiflora* (L.) Rich	Valerianaceae
Mimosa pudica L.	Luguminosae
Mimulus nepalensis Benth.	Scrophulariaceae
Persicaria barbata (L.) H. Hara	Polygonaceae
Pilea sp.	Urticaceae
Pogostemon glaber Benth.	Labiatae
Polygonum sp.	Polygonaceae
Polypogon monospelliensis (L.). Desf	Polygonaceae
Rungia sp.	Acanthaceae
Ranunculus scleratus L.	Ranunculaceae
Saccharum spontaneum L.	Graminae
Salvia sp.	Labiatae
Sassurea sp.	Compositae
Solanum xanthocarpum Schrad. & J.C. Wendl = *Solanum virginianum* Dunal.	Solanaceae
Thelypteris auriculata (J. Sm.) K. Iwats	Thelypteridaceae
Trifolium sp.	Luguminosae
Typha angustifolia L.	Typhaceae
Veronica anagalis L.	Scrophulariaceae

ANNEX A19

Date:……
Plot No:……..…..
Method:……...

VEGETATION
TREE SHEET

Lat:…….
Long:… …….....
Altitude:……m

Name of the Forest/CF/Buffer zone ……..
Forest Type:…… ……Coverage:……..% Grazing:…… …..%
Interference:……Aspect:…… Status:…….

S / N	Plant Species	Dbh (cm)	Ht. (m)	No	Lp (%)	CS (no)	No. of branch	Remark

Note:……
…….....……

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

ANNEX A20

VEGETATION SURVEY
SHRUB/HERB SHEET

Name of the Forest/CF/Buffer zone ……..
Forest Type:…… ……Coverage:……..% Grazing:…… …..%
Interference:……Aspect:…… Status:……

S / N	Plant Species	Ht. (m)	No	Remark

Note:……
…….....……

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