

**HUMAN-RHINO CONFLICT IN BUFFER ZONE OF CHITWAN  
NATIONAL PARK, NEPAL: A CASE STUDY FROM  
MADI VALLEY**

**A Dissertation**

**Submitted for the Partial fulfillment of the requirement for the Master's  
Degree of Science  
In  
Zoology (Ecology)**

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**DECLARATION**

I hereby declare that the work presented in this thesis has been done by myself and has not been submitted elsewhere for the award of any degree. All sources of the information have been specially acknowledged by reference to the authors or institutions.

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**RECOMMENDATION**

This is to recommend that the dissertation entitled "**Human-Rhino Conflict in Buffer Zone of Chitwan National Park, Nepal: A Case Study from Mandi Valley**" has been carried out by **Mr. Anil Prasai** for the partial fulfillment of M. Sc. degree in Zoology (Ecology). This original work was conducted under my supervision. To the best of my knowledge, this dissertation work has not been submitted for any other degree.

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**LETTER OF APPROVAL**

On the recommendation of supervisor, **Tej Bahadur Thapa**, this thesis submitted by Mr. Anil Prasai entitled "**Human-Rhino Conflict in Buffer Zone of Chitwan National Park, Nepal: A Case Study from Madi Valley**" is approved for examination and submitted to the Tribhuvan University in the partial fulfillment of the requirements for Master's Degree of Science in Zoology with special paper Ecology.

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**CERTIFICATE OF APPROVAL**

This dissertation submitted by Mr. Anil Prasai entitled " Human-Rhino Conflict in Buffer Zone of Chitwan National Park, Nepal: A Case Study from Madi Valley" has been approved as a partial fulfillment of the requirement for the Master's Degree of Science in Zoology specializing in Ecology.

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## **ABBREVIATIONS AND ACRONYMS**

CNP	- Chitwan National Park
CITES	- Convention on International Trade in Endangered Species of Wild Flora and Fauna
DNPWC	- Department of National Parks and Wildlife Conservation
BZ	- Buffer Zone
GoN	- Government of Nepal
HMG	- His Majesty's Government
IUCN	- International Union for Conservation of Nature and Natural Resources
Kg	- Kilogram
NRS	- Nepalese Rupees
Hh	- Household
UNESCO	- United Nations Educational, Scientific and Cultural Organisation
NPWC	- National Park and Wildlife Conservation
UG	- User Group
Sq. km/km <sup>2</sup>	- Square Kilometer
MFSC	- Ministry of Forest and Soil Conservation

## ABSTRACT

Agricultural crop and livestock depredation by wildlife results in disputes between the park authorities and the local people. Human–rhino conflict poses a serious threat to rhino conservation in many parts of Asia including Nepal. The study entitled “Human-Rhino Conflict in Buffer Zone of Chitwan National Park, Nepal: A Case Study of Madi Valley” was carried out between July to October, 2008 to assess the causes and extent of human-rhino conflict in Mandi valley adjacent to Chitwan national park. The questionnaire survey of 222 households and key informant interviews were used to assess the level human- rhino conflict in Madi valley. Compensation claim against the human harassment by rhino were collected from park head quarter and analyzed. A total of 50 quadrates of the size 1x1 m<sup>2</sup> and 24 quadrates of 20x20 m<sup>2</sup> were used for vegetation analysis in the grassland and forest respectively in the rhino habitat.

The Total crop loss per household was NRS 12, 474.93 (paddy 649.15 kg accounts NRS 9088.12, maize 125.26 kg accounts NRS 1753.68, lentil 8.47kg accounts NRS 466.22, mustard 6.52kg accounts NRS 359.40 and wheat 16.26kg accounts NRS 292.82), NRS 10,516.79 (paddy 613.52 kg accounts NRS 8589.36, maize 19.45 kg accounts NRS 272.41, lentil 3.83kg accounts NRS 210.67, mustard 2.69 kg accounts NRS 148.10 and wheat 72.01 kg accounts NRS 1296.25), NRS 7896.43 (paddy 270.72 kg accounts NRS 3790.08, maize 28.53 kg accounts NRS 399.53, lentil 3.88kg accounts NRS 213.84, mustard 4.70kg accounts NRS 258.81 and wheat 50.23kg accounts NRS 904.17) and NRS 7,000.76 (paddy 467.78 kg accounts NRS 6548.97, maize 25.66 kg accounts NRS 359.35, lentil 0.28kg accounts NRS 15.84, mustard 0.06 kg accounts NRS 3.36 and wheat 4.65 kg accounts NRS 76.60) in Gardi, Kalyanpur, Bagauda and Ayodhyapuri VDC respectively. A total of 7 killings and 9 injuries have been recorded during the year 2008. Among those west and south sector of CNP are highly vulnerable for conflict between human and rhino. Relative frequencies of preferred species of rhino were *Saccharam spontaenium* (16%), *Trewia nudiflora* (8.33%) and *Narenga porphyrocoma* (10%). An alien species *Mikania mikarantha* (18%) was found in the habitat. The effective management for alien species like *Mikania mikarantha* inside the park seems very essential and the management of problem of human harassment, injuries and killing outside the park or in the settlements and cropfield..

**Key words:** *Rhinoceros unicornis*, Chitwan National Park, Mandi Valley, Conflict, Habitat assessment, *Saccharam spontaenium*, *Mikania mikrantha*

# 1. INTRODUCTION

## 1.1 Background

The greater one horned rhinoceros (*Rhinoceros unicornis*), a vulnerable mega herbivores (ICUN 2009), is included in appendix I of the Convention on International Trade in Endangered Species of wild fauna and flora (CITES) and banned all the international trade of rhinos and their products (Chapagain and Dhakal, 2002). In Nepal it is protected by National Park and Wildlife Conservation (NPWC) Act 1973.

The greater one horned rhinoceros which, once ranged from Pakistan, northern India to Nepal, Bhutan and the border with Myanmar along the flood plains of Indo-Gangetic and Brahmaputra riverine tracks, has now been confined into few small protected areas with population totaling about 2500 animals in India and Nepal (DNPWC, 2008). Its range decreased tremendously resulting in distinct Meta populations because of the disappearance of suitable rhino habitats (DNPWC, 1996).

The rhinoceros are mostly solitary creatures, with the exception of mothers and calves and breeding pairs, although they sometimes congregate at bathing areas (ASRG.1996). They have home ranges, the home ranges of males being usually 2-8 square kilometers in size, and overlapping each other (Thanet, 2007).

The greater one horned rhinoceros requires special habitat conditions including wallows, grasslands/woodlands and forest cover and is mainly adapted to flood plains where some green growth remains available all year round (Jnawali, 1995). A mosaic of various forest and tall grasslands communities on the alluvial floodplain are the critical habitats for this species (Dinerstein and Price, 1991). Other preferred habitat includes marshy lowland Sal forest, wooded grassland, and river and riverbeds. This ecological flexibility may be due to seasonal preferences and to some extent pressure from development, which forces the rhino into sub-optimal habitat (Jnawali, 1995).

The rhinoceros feeds mainly on grasses, and also fruits, leaves, branches of trees and shrubs and cultivated crops (Jnawali, 1989). *Saccharum spontaneum* grass species is the fundamental food resource of rhinos comprising more than 60% of the animal diet (Dinerstein and Price, 1999). When feeding on tall grasses rhinoceros curls its prehensile upper lips around the grass stems, bends the stems over and bits off, and

chews the top. Drinking takes place on a daily basis. Drinking normally lasted only a minute or two, and mineral licks are visited regularly (Jnawali, 1989). The Rhinoceros is adapted to floodplains and riverine vegetation where water and some green grasses remain available all year around. A mosaic of various forest and tall grassland communities on the alluvial floodplains are the critical habitats for this species (Dinerstein and price, 1991).

The rhinoceros is active mostly at night, early in the morning, and in the late afternoon (Laurire, 1978) and in the middle of the day, the animals are commonly seen resting in the shade or mud and wallowing and bathing in oxbow lakes, rivers and pools. This behaviour is especially frequent during hot seasons and seems to be important for thermoregulation and to escape from flies (Laurire, 1978).

Rhinoceros faces serious threats due to habitat depletion, poaching and conflict with human. It is poached for its valuable horn which is smuggled to Far East Asia for use in Oriental medicine. Because of illegal trade, all the five species of the rhino in the world are endangered. Rhinoceros are poached mostly by shooting, although pit poaching poisoning and electrocution are used as well (Menon and Kumar, 1999). The principal cause of the conflict between the human and rhino is the crop depredation, human harassment and also the alteration of the habitat which ultimately affects the population structures of rhinos.

The population of rhinoceros in Nepal faces problems in two major fronts; poaching and habitat loss. Poaching takes place due to high value of its horn and other body parts in the world markets (Sharma, 1991). Another threat to rhinoceros conservation is habitat loss due to the expansion of agricultural land and continued over grazing by domestic livestock (Caughley, 1969; Pelinck and Upreti, 1972).

In CNP, the major threats and damages by *Mikania* (Ram, 2008) is habitat alteration, wildlife population increase, scarcity of food for Mikania, crop raiding in buffer zone, loss of endangered species, nutrient loss resulting decrease breeding potential resulted poor offspring, Ecosystem may collapsed and loss of prey and predator may occurred. Crop loss, human harassment, killings from the rhinoceros and habitat encroachment from the people are the major sources of conflict (Jnawali, 1989; Sharma, 1981; Nepal and Webber, 1995 and Adhikari, 2005).

In Nepal the rhinoceros (Figure 1) inhabits in Chitwan National Park (408) and a reintroduced satellite population has been established at Bardiya National Park (22) and a few stragglers reside at Parsa Wildlife Reserve and at Shuklaphanta Wildlife Reserve (5) (Rhino count, 2008). Chitwan National Park is internationally recognized as one of the last remaining habitats of the Greater One-horned Rhinoceros in the world. This park alone has succeeded in restoring this important animal population. But the problem of crop damage and harassment to local communities in the buffer zone of the park has been increasing since the park was established in 1973. CNP harbored about 1000 rhinoceros until 1950s. Indiscriminate poaching and destruction of prime habitats between the mid 1950s and 1960s drastically reduced this population to about 100 animals (Jnawali, 1995). However, with the creation of a national park in 1973 and adequate protection the population at Chitwan has now revived to about 408 individuals. Besides these, habitat destruction, habitat fragmentation, lack of sufficient waterholes etc in the core area creates the movement of rhinoceros from the core zone to buffer zones including national forests, Several detrimental effects caused by Rhinoceros to the local people such as crop damage, life injuries and harassment activities creating negative attitude towards the conservation of rhino and park management (Adhakari, 2005).

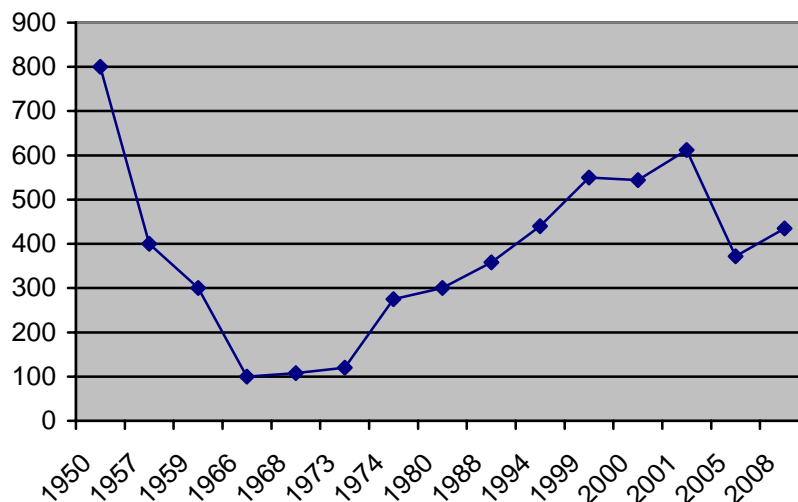


Fig. 1 Rhino population trend in CNP



## **1.2 Statement of the Problem**

The great conservation challenge to rhino conservation is the poaching and habitat loss by its size reduction, shape fragmentation and forest quality degradation. The human population in lowland is increasing rapidly due to migration from the hill to Tarai after the malaria eradication program around 50s and the habitat of rhino was limited to the Chitwan valley in leaving its population to 81 to 108 (Caughley, 1969). The activities of rhinos currently creating a conflict to the interests of people, which is experienced a problem by the local authority, administration offices, and district forest offices. According to local authorities and farmers some of Village Development Committees of Chitwan districts are affected. Habitat of wildlife degradation in the study areas is significant. Every day much of the timber, firewood and fodder have been theft by vicinity people of the study area.

Conflict among people and rhino are occurring due to human harassment and crops damage by rhino. The issue of the conflict between human and rhino has not assessed in the Madi valley of the buffer zone of Chitwan National Park. So the assessment of the level of conflict and mitigation measures is essential for management aspect in the study area.

## **1.3 Objectives**

The main objective of the study was to assess the causes and extent of human-rhino conflict in Madi valley adjacent to Chitwan national park. The specific were:

To assess the extent of crop damage in Madi valley due to rhino, so as to evaluate economic loss,

To evaluate problems of human harassment, injuries and killing

To identify the causes of conflicts between human and rhino

## **1.4. Rationale of the Research**

The existing information on the human- rhino conflict particularly crop damage by rhino is not sufficient to manage the problem. The conflicts between rhino and people due to the crop loss, and human injuries have provoked a serious problem between the conservation efforts of the government and people. Increasing crop damage and attacks on human life are creating hostile attitudes among local people towards the preservation efforts of this species (Jnawali, 1989). I have assessed the

issues of rhino- human conflicts and its extent in the Madi valley. The assessment of economic loss of the each household per year, problem of human harassment, injuries and killing, would address the impacts which are therefore important in conservation and management perspective towards policy making level. The conditions of the habitat inside the park adjacent to the buffer zone of madi valley also explores in the buffer zone forests and help to formulate habitat management activities.

### **1.5 Limitations**

This study was conducted in February to October 2008. The issues of the conflict is multidimensional factor to study and more complex than it looks, all the factor affecting the conflict may not possible to study and habitat analysis part is too difficulties to do. As there was lack of sufficient equipments and security problem also limited during the quadrature sampling inside the park. Due to the time and resource limitation study about the topics in only severly affected area adjoining to the park only included. My study was only focused on field survey, questionnaire survey and participant observation besides this Qualatitive information gathered by key informants in very much limited time.

## 2. LITERATURE REVIEW

The greater one-horned rhinoceros (*Rhinoceros unicornis*) is one of the most “important flagship” species belonging to order *Perisodactyla* and family *rhinocerotidae*. This species is large, heavy, shy and nocturnal ungulates fond of living in water and mud. The skin is very thick with scanty hair and one median horn grows as huge waste from the snout and forehead (Menon and Kumar, 1999).

Several researchers have done many excellent studies on the ecology of the rhino (Laurie, 1978; Dinerstein, 1988; Dinerstein and Wemmer, 1988; Dinerstein and Price, 1991; Dinerstein and McCracken, 1990; Jnawali, 1995) The greater one-horned rhinoceros was reported to be a mixed feeder switching from a graminoid dominated diet in the wet season to increase proportion of woody browse in the dry season (Laurie, 1982). *Saccharum spontaenium*, *Trewia nudiflora*, *Narenga prophyrocoma* are major plant species preferred by rhino (Jnawali, 1995).

The rhino is adapted to flood plain and riverine vegetation where water and some green grasses remain available all year round (Dinerstein, 1979; Jnawali and Wegge, 1993; Laurie, 1978; Mishra, 1982; Dinerstein and Price, 1991). A mosaic of various forest and tall grassland communities on the alluvial flood plain are the critical habitat for this species (Dinerstein and Price, 1991).

Mega-herbivores need more food and space than do smaller ones (Owen-Smith, 1988), but space and food are common constraints on area of high population pressure. For large herbivores where population regulation through natural predation is not common; it is likely that food is the limiting resource (Sinclair, 1975; Owen-Smith, 1988 and Sukumar, 1989). In the world today, the most productive habitats, like the flood plain areas where rhinoceros are commonly found are severely degraded by ever increasing human population and they are therefore among the most threatened ecosystem (Dinerstein, 2003). In addition, the infestation of invasive Alien species such as *Mikania mikarantha* on Rhinoceros habitat in Chitwan National Park is a severe problem in different grasslands, tress were killed from *Mikania mikarantha* most of the rhino preferred habitat (Ram, 2008).

The greatest threat to the Asian rhinoceros population is poaching for its valuable horns (Jnawali, 1989) which bore highly prized in traditional medicine as a cure of variety of illness such as nose bleeds, strokes, convulsions and fever. As a result

poachers continue to kill the animals to take the horn, despite increased surveillance and protection. Rhinoceros are poached mostly by shooting, although pit poaching, poisoning and electrocution are used as well (Menon, and Kumar, 1999).

Habitat loss and fragmentation, poaching and other human disturbances commonly cause this species to compress into small protected areas. Crop loss and local harassment by wildlife to local people is common problems in the village surrounding the park and reserve where as human activities also exert pressure to the park and reserve (Adhikari, 2005).

“The old concept of shielding parks from outside wild human influences make a large gap between the park and the local people” (Saliva, 1968; McNeely, 1984) wildlife management necessitates practices to regulate the abundance of wildlife so that it is beneficial and not harmful to human’s interest (Smith, 1971). After the establishment of park and reserve, without provisions to stabilize the cattle population and or to provide fodder and grazing facilities and to resolve the worsening fire wood situation further initiated the incipient conflicts became more pronounced (Sharma, 1991). Wildlife interaction, antipathy towards park and resources, and fishing and hunting are the main sources of conflicts, economic incentives, development schemes local participation in decision making, conservation education and management of total land scrape in the region (Uprety, 1995).

The Buffer zone concept has been introduced in the world with the message of two aspects, primarily it extends buffering that allows extension of those habitats within protected area in to the BZ and allows larger area of breeding population to survive and socio-economic buffering management is aimed to respond to the needs of the local people (MacKinnon et al., 1986; Sayer, 1991). The involvement of the local people in the management of the protected areas for mutual benefit each widely accepted today (Oldfield, 1988). These days the buffer zone concept has been widely accepted in protected area management in order to reduce conflict between protected areas authorities and local people (Burkmuller et al., 1990). However, the BZ has not yet become an effective shield for the protection of precious species (Shrestha, 2006).

Crop loss inflicted by the wild life is the main problem of the inhabitants of the areas adjoining the park with the economic loss ranges from 50 to 100% in the village Padampur Chitwan (Milton and Binney, 1980). Crop damage was also found in Shivapuri National Park and mostly Wild boar, monkey and porcupine are the common wild animals that raid crops like Maize, wheat and millet where wild boar was most responsible for damage of all crops (Poudel, 1995).

The rhinoceros is the main crop raider in northern parts of CNP and in Gunganagar and Dibyanagar VDC rhinoceros was only responsible for damaging 222195.15 kg of crop, which is 88.32% of total crop damage (Adhikari, 2005). The case of human harassment and crop damage by greater one horned rhinoceros in Sauraha adjacent to the Chitwan National park was present and the economic loss was reported Rs 172000 of, which 68.6% occurred within a distance of 500m highest economic loss 27.06% occurred to rice (Jnawali, 1989). Higher incidences of conflicts occur close to the park boundary. (Laurie, 1978) found that most of the damage occurs within 750 meters of the edge of the forest occupied by rhinos and area beyond 1500m from the forest edge was negligibly damaged and damage to paddy was greater in Sauraha area damage by other animal was found lesser.

### 3. STUDY AREA

#### 3.1 Location

This study was carried out in an around Chitwan National Park (CNP), central Nepal. CNP is located between 27° 34' to 27° 68' N and 83° 87' to 84° 74' E while the Buffer zone extends further at 27° 28' to 27° 70' N and 83° 83' to 84° 77' E (Figure 2). The park spans across portions of four districts namely, Chitwan, Nawalparasi, Parsa and Makwanpur. Initially Chitwan National Park was established under the provisions of National Parks and Wildlife Conservation Act 1993 (2029 B.S.). Covering the area 932 km<sup>2</sup>, but recent estimation from GIS analysis showed the total area to be 1,182 km<sup>2</sup> (DNPWC, 2000). The CNP borders with the Parsa Wildlife Reserve in the east and the Valmiki Tiger Reserve of India in the south. The Narayani River marks the western boundary of the park, whereas the Rapti River marks the northern east boundary. CNP was declared a World Heritage Site by UNESCO in 1984. In 1996, an area of 750 sq. km. surrounding the park was declared as Buffer Zone, which consists of forests and private lands. The park officials and the local people jointly initiate community development activities and manage natural resources in the Committee and Users Groups (DNPWC/MFSC, 1999).

This Park consists of Churia (Siwalik) hills, ox-bow lakes, and flood plains of Rapti, Reu and Narayani rivers. The Churia hill rises slowly towards the east from 150m to more than 800m. The part of the park comprises of the lower but most rugged Someshwar hills.

The specific site: The specific study site, Mandi Valley adjacent to the Chitwan National Park, consists of 4 VDCs namely Ayodhyapuri, Kalyanpur, Baguda and Gardi. Northern part of this valley is associated with Chitwan National Park and southern part is associated with India.

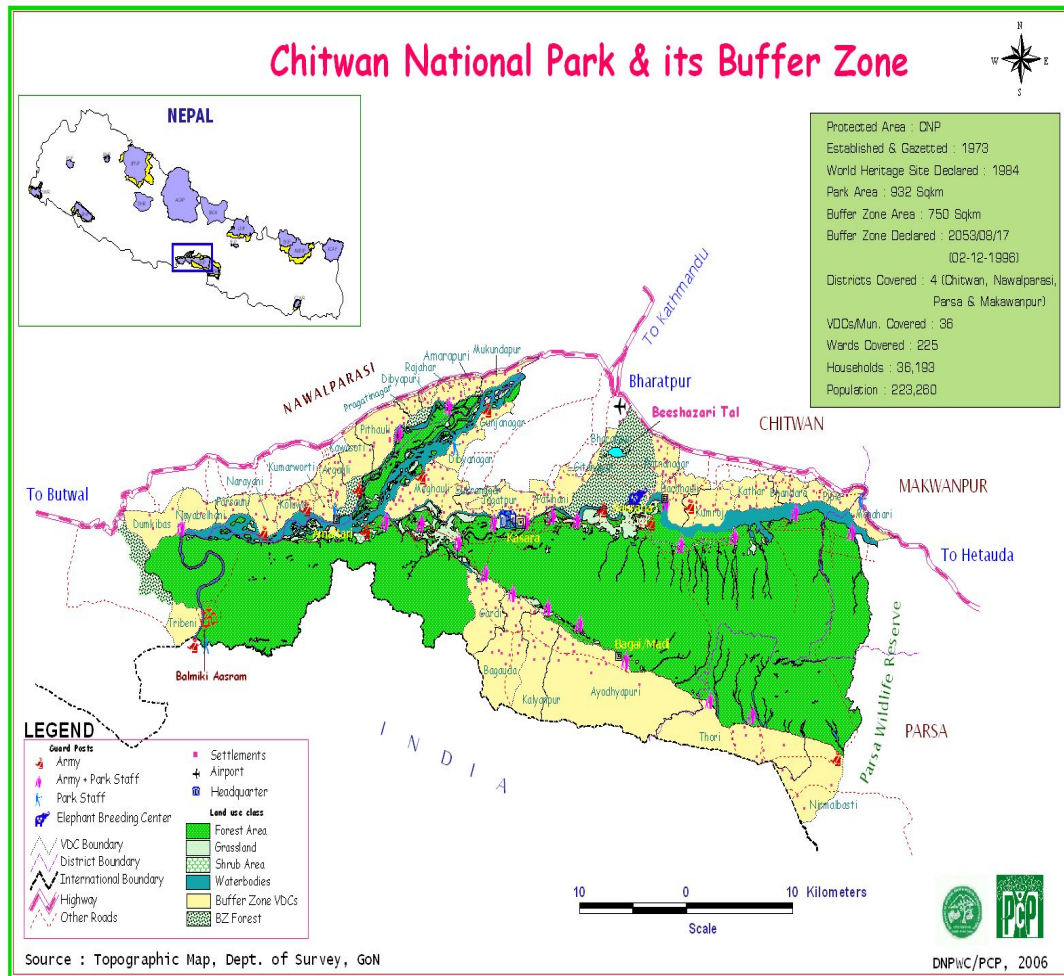


Fig 2 Chitwan National Park and its Buffer Zone

### 3.2 Geology and Soil

The Chitwan valley lies in between Siwalik and Mahabharat range and is rich in thick deposit. Narayani, Rapti and Rew are the major river systems of this valley. The park soils are representatives of Chitwan dun valleys types (Gee, 1963). Most of the land inside park is loamy with fine sand. Hills soils are sandy loam and loamy rubble with stony surfaces less than 50cm from bed rock. Soil types found in the valley has been identified as sandstone, conglomerates, quartzites, shales, and micaceous sandstones during soil survey (HMG, 1968). Alluvial soils range from sand and coarse loams on new terraces to sandy and silty-clay loam on older terraces. Drainage is variable with the water table ranging seasonally from 0-2m. older soils on fans, aprons, ancient river terraces and Quaternary basin deposits are well-drained sandy loam to loam (Lehmkul, 1994).

### 3.3 Climate

The climate of Chitwan valley is tropical and sub-tropical. There are three distinct seasons: monsoon, winter and summer seasons. The average annual rainfall reaches to 2436.88 mm and about 80% of rain falls within four months of monsoon season (June- September) (Appendix1). The monsoon rain causes dramatic floods and changes in the character and course of rivers and is one of the important and dramatic in terms of ecosystem dynamics.

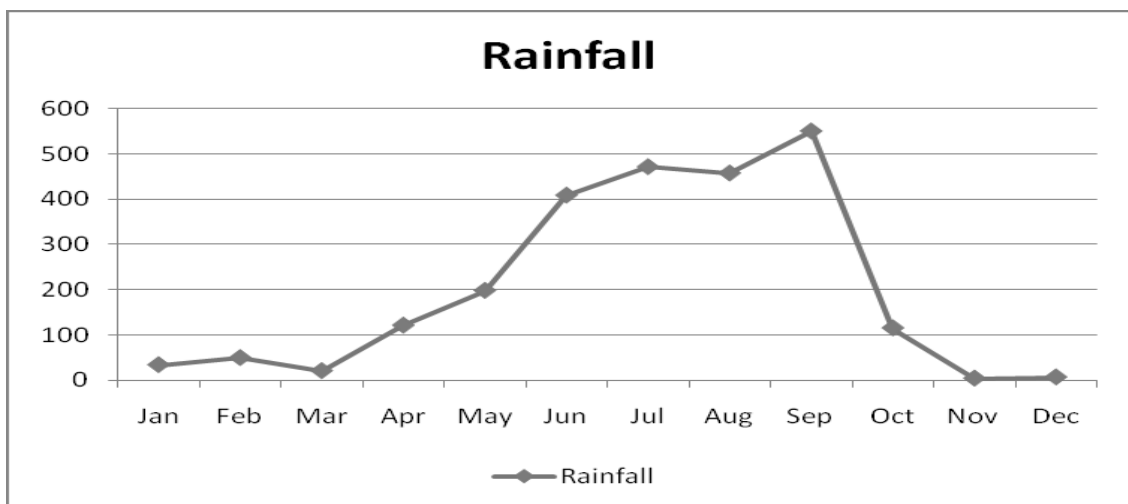


Figure 3: Mean monthly rainfall recorded at the Bharatpur Meteorological station from 2001-2007

November to mid February is marked as winter season and temperature can drop to 8° C. Spring season is marked through mid February to May and mercury may rise up to 36.6° C (Appendix2). The climate is sub-tropical with summer monsoon, which lasts from June to September. During summer rivers are flooded and most of roads are virtually impassable.



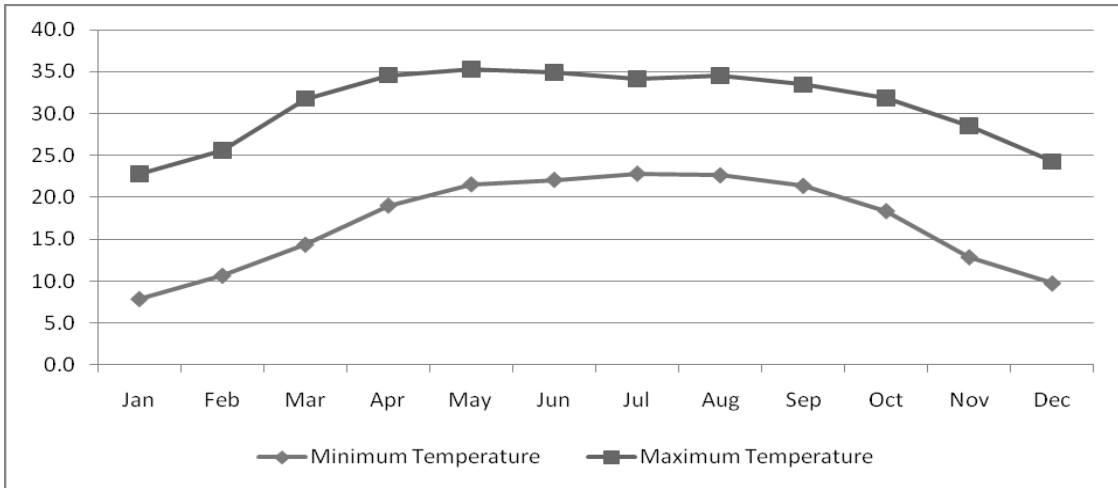


Fig. 4: Mean monthly temperature (<sup>0</sup>c) recorded at Baratpur Meteorological station from 2001-2007.

The minimum relative humidity is 89% and highest is 98%. Relative humidity is quite high. Maximum humidity records at winter season (nov-mid feb) while it lowers in (april-Jan). At the monsoon season it becomes average between spring and summer (Appendix3).

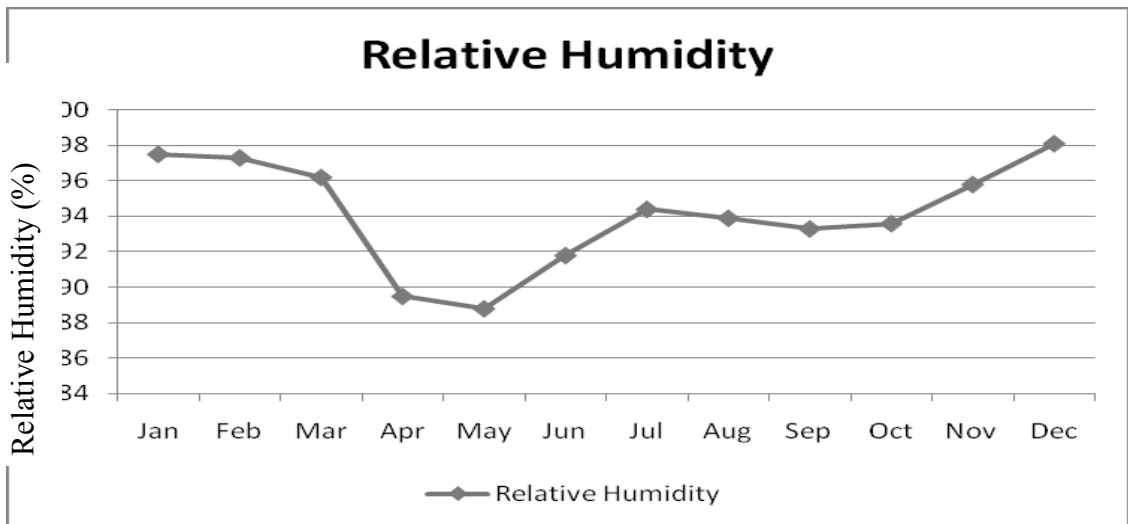


Figure5: Mean monthly Relative Humidity recorded at the Bharatpur Meteorological station from 2001-2007

### 3.4 Floral and Faunal Diversity

The vegetation of the Chitwan valley is tropical to subtropical type. About 70 percent of vegetation is predominantly Sal (*Shorea robusta*) forest, a moist

deciduous vegetation type of the Tarai region. The remaining vegetation types include grassland (20%), Riverine forest (7%) and Sal with Chir Pine, *Pinus roxburghii* (3%), the latter occurring at the top of the Churia range. The Riverine forests consists of Khair (*Acacia catechu*), sissoo (*Dalbergia sissoo*), and Simal (*Bombax ceiba*). The grasslands form a diverse and complex community with over 50 species. Elephant grass (*Saccharum* sp) can grow up to 8 m in height.

The park holds over 50 species of mammals including the last surviving population of Asian One-horned Rhinoceros. Other mammalian species are Tiger (*Panthera tigris tigris*), Leopard (*Panthera pardus*), Asian elephant (*Elephas maximus*), Sloth Bear (*Melursus ursinus*), Chital (*Axis axis*), etc. (Majupuria & Majupuria, 1998). The park is rich in avian diversity. A total of 525 number of bird species has been recorded in Chitwan (DNPWC,2006). Several aquatic birds migrate from north to spend winter in Chitwan. Reptiles found 49 species and 120 species of fish are found. Three major lakes inside the park that provide potential habitat for water birds are Tamor Tal, Lami Tal and Devi Tal and Bees Hazari Tal, a Ramsar Site, in the vicinity of the park.

### **3.5 Buffer Zone**

Buffer zone concept in Nepal was developed to demonstrate on how community can function as partners in self-reliant, socio- economic development to support conservation and sustainable use of biodiversity in protected areas (MFSC, 2002). An area of 750 sq. km. outside the park boundary with some patches of forests, farmland and settlements of about 223,000 people has been included in the buffer zone area. A commitment to invest 30% to 50% of CNP income to resource management and socio-economic development within the BZ area has been made. According to BZMC, 2007 of CNP, there are 39,983 household forming 1,527 user groups and 21 users committees in 36 VDC and 2 municipalities within the boundary of CNP buffer zone (Appendix II). The buffer zone includes settlements, cultivated land, forest, water bodies, and grassland. Cultivated agricultural land (46.3%) is dominant followed by forest (42.9%), shrub land, grassland and others (Fig.5).

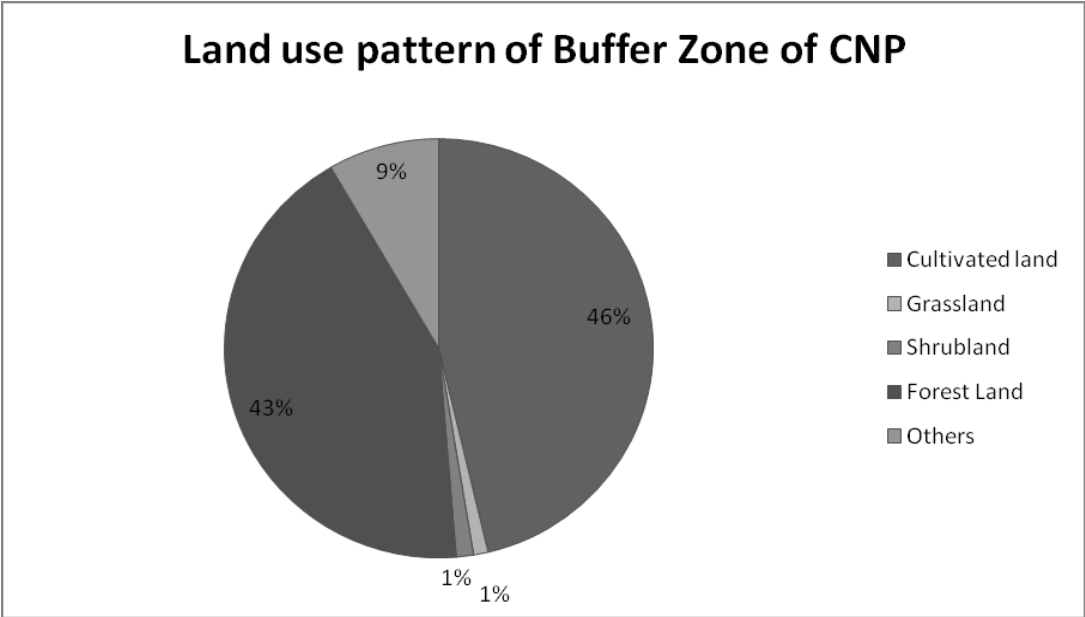


Fig. 5 Land use in buffer zone of CNP (Source: DNPWC 2000)

## **4. METHODS**

### **4.1 Research Procedures**

#### **4.1.1 Reconnaissance Survey**

The reconnaissance survey was done from 1-7 January, 2008. I made informal talks with experts, park's related authorities and local communities so as to identify the potential site of rhinoceros- human conflicts and their likely impact zones.

#### **4.1.2 Interviews with Key Informants**

Interviews with local leaders, park authorities, and selected old and experienced farmers were conducted to gather information on the conflict situation and related issues. At least interviews of 4 persons of one VDC were taken.

#### **4.1.3 Questionnaire Survey**

Household level questionnaire survey method was used to assess the problem and extent of crop loss due to rhino. Questionnaire survey was done in July-October, 2008. The questionnaires for local farmers were divided into three parts: the problem associated with crop damage, human harassment and control measures used by people. Broad and open-ended questions were designed to give the respondents an opportunity to express their views freely. At first different wards were selected from the discussion with Buffer Zone User Groups and local communities. Before interview, people were briefed about the study and tried to interview the head of the household. In absence head of household, the person next to head was interviewed. The interview was conducted in an informal setting mostly in the interviewers' country yard, often in the presence of family members of neighbors. To reduce bias, door to door visit of respondents was done.

#### **4.1.4 Survey Design**

I selected four wards 1, 4, 7 and 9 from Gardi VDC, 2, 5 and 6 from Bagauda; 6, 8 and 9 from Kalyanpur and ward number 4 and 1 from Ayodhyapuri VDC after discussion with local people and Buffer Zone User Groups (Table 1 ). Eighty six households were selected from 4 wards of Gardi VDC. . Likewise, 26 households from Bagauda VDC, 70 households from Kalyanpur VDC, and 30 households from Ayodhyapuri VDC were selected (Table 1).

Table 1 Sampled Wards, Name of VDCs, Villages, no. of Hh Sampled and Total Hh of different VDCs.

VDC	Ward No.	Name of village	Total number of Hh *	Number of affected Hhs	Number of sampled Hhs
Gardi	1	Amiliya	211	90	18
	7	Serawa, Chandrapur and Ratanpur	165	165	33
	4	Pandavnagar and Bankatta	160	135	27
	9	Draupatinagar	154	40	8
Baguda	6	Dhobaha	50	25	5
	5	Simara	80	80	16
	2	Pauvari	40	35	7
Kalyanpur	6	Harinagar	175	145	29
	8	Gopalnagar	88	55	11
	9	Gaurinagar and Raitol	155	150	30
Ayodhyapuri	4	Shivadwar	55	55	11
	1	Divanagar	162	95	19

#### 4.1.5 Analysis of compensation claim

Compensation claim against the human harassment, inquiries and killing recorded at the park head quarter were collected and analyzed.

#### 4.1.6 Habitat Assessment

Quadrates sizes of 20x20 m<sup>2</sup> were laid down randomly to assess the availability of the food resources for the rhinoceros among trees, and 1x1 m<sup>2</sup> sized quadrates were taken for grasses. Altogether 50 quadrates of 1x1m<sup>2</sup> and 24 quadrates of the size of 20x20 m<sup>2</sup> were taken.

Analysis of qualitative data for good rhinoceros habitat, direct field observation, household survey were employed to assess the condition of shelter, availability of water holes/muddy/wallow, linkage to the main park area, and current threats to rhinoceros population in buffer zone of Madi Valley of Chitwan National Park. These parameters were assessed through visual observation and direct field visit during study period.

In each quadrat, the percentage cover of each species assumed to be available for rhinoceros was estimated and recorded. These data were later used to calculate relative frequency of each species available in the study area. Unique Species in the habitat were also assessed from Jackknife Estimate method (Heltshe & Forrester, 1985). The relative frequency of the key feeding grass species of the rhino were calculated. Which were identified based on previous research of Jnawali, 1995, Kandel 2003, and Pradhan 2007, Comparison of these findings with previous research the present habitat condition is assessed.

#### **4.1.7 Data Analysis**

Simple data analysis technique was done for this study. After conducting questionnaire survey mean crop loss per household in NRS was calculated.

$$\text{Mean crop loss per household} = \frac{\text{Total crop loss}}{\text{Total no. of households}}$$

By multiplying mean crop loss in kg and unit crop price in NRS/kg, total crop loss per household of each VDC was calculated.

Total crop loss per household of each VDC = mean crop loss of the household in kg x market price in NRS/kg

Current local price of the crop was adapted from the local market and price of crop multiplied by total crop loss. So the total economic loss per household was calculated.

$$\text{Frequency of a species (\%)} = \frac{\text{No. of sampling units in which the species occurred}}{\text{Total no. of sampling units studied}} \times 100$$

## 5. RESULT

### 5.1 Land holdings, crop production and crop loss

The average land holding of each four VDC were calculated (table 2) and the production of their also analyzed and the percentage loss of each household was finally calculated in NRS (table ,3,4,5 and 6).

Table: 2 Average land holding per household in 4 VDCs of Madi Valley

SN	Name of VDCs	Sum of Land holding (in Bigha) of sampled Hhs	Number of sample Hh	Land holding (in Bigha) per sample Hh
1	Gardi	94.25	86	1.09
2	Bagauda	27.05	26	1.04
3	Kalyanpur	85.5	70	1.20
4	Ayodhyapuri	24.4	30	0.81

Land holding of the Gardi VDC was 1.09 bigha, similarly, the average land holding of Bagauda VDC was 1.04 bigha, Kalyanpur VDC was 1.20 and that of Ayodhyapuri was 0.81. (Fig;6)

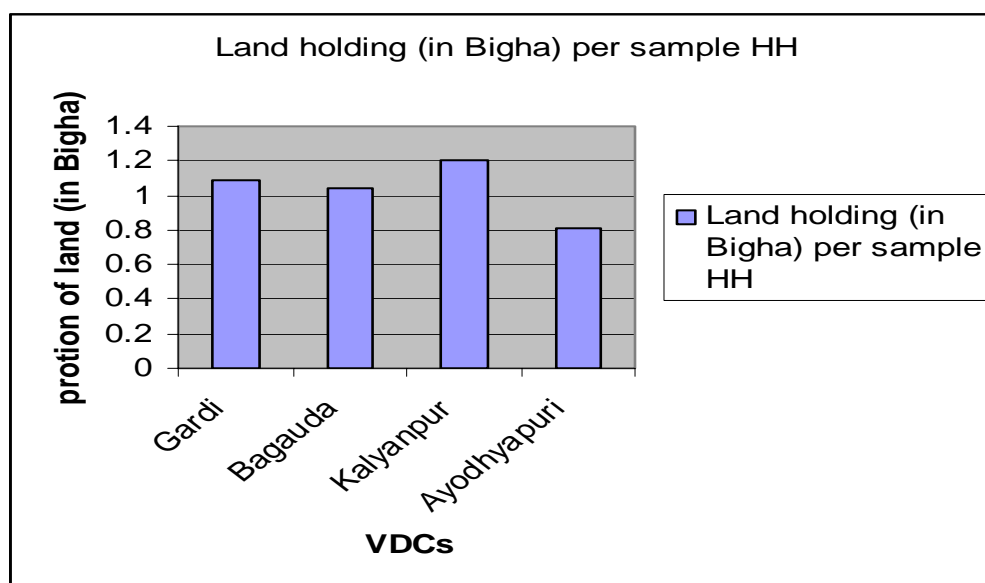


Fig. No. 6 Land holding (in Bigha) per sample Hh.

The mean crop production of the per household was calculated, from the calculation of land coverage perhousehold and proportion of cultivation, each household production was calculated, for determination of the crop loss loss in percentage was calculated and loss of crop in kg was obtained which finally converted in to Rupees According to the market price which was sampled from different places (Shop) and mean market price of the crop was calculated from which paddy are as Rs 14/kg, maize Rs 14/kg, lentils Rs 55/kg, mustard Rs 55/kg and wheat Rs 18/kg.

Mean crop production of Madi Valley for paddy, maize, lentil, mustard and wheat are 24 quintals/bigha, 12quintals/bigha, 6 quintal/bigha, 6 quintal/bigha, 8 quintal/bigha respectively

Table: 3 Mean landholding, crop production and loss/yr/hh (in NRs) in the Gradi VDC

SN	Crop Type	Size of land holding/Hh (in bigha)	Proportion of cultivation	Crop grown Field/Hh(in bigha)	Production /Hh (in Kg)	Mean % loss/hh	loss (in Kg) /Hh	loss in NRS/Hh
1	Paddy	1.09	0.90	0.98	2352	27.60	649.15	9088.12
2	Maize	1.09	0.62	0.67	804	15.58	125.26	1753.68
3	Lentil	1.09	0.15	0.16	96	8.83	8.47	466.22
4	Mustard	1.09	0.30	0.32	192	3.40	6.52	359.40
5	Wheat	1.09	0.45	0.49	392	4.15	16.26	292.82

In Gardi VDC, loss of the crop annually per household accounts 12,474.93 NRS. In which the highest loss found in paddy field of which 649.15 kg loss was calculated in terms of cost 9,088 Rupees. Maize loss per household was 125.26kg in terms of cost 17,55Rupees. Mustard was found 11.01kg loss per household which costs 605 Rupees. Lentil was found 16.95kg per household in terms of cost 932.44 Rupees and 5.31kg of Wheat was loss which accounts 1,755 Rupees per household (Table3).



Table: 4 Mean landholding, crop production and loss/yr/Hh (in NRs) in the Bagauda VDC.

SN	Crop Type	Size of Land Holding /Hh (in bigha)	Proportion of cultivation	Crop grown Field/Hh (in bigha)	Production /Hh (in Kg)	Mean % loss/Hh	Loss (in Kg) /Hh	Loss in NRS/Hh
1	Paddy	1.04	0.93	0.96	2304	11.75	270.72	3790.08
2	Maize	1.04	0.45	0.46	552	5.17	28.53	399.53
3	Lentil	1.04	0.15	0.15	90	4.32	3.88	213.84
4	Mustard	1.04	0.30	0.31	186	2.53	4.70	2588.81
5	Wheat	1.04	0.45	0.46	368	13.65	50.23	904.17

In Baguda VDC, loss of the crop annually per household accounts 7896.43Rupees NRS. In which the highest loss found in paddy field of which 270.72 kg loss was calculated in terms of cost 3,790.08 Rupees. Maize loss per household was 28.53kg in terms of cost 399.53Rupees. Mustard was found 4.70kg loss per household which costs 258.81 Rupees. Lentil was found 3.88kg per household in terms of cost 210.67 Rupees and 50.23kg of Wheat was loss which accounts 904.17 Rupees per household (Table 4).

Table: 5 Mean landholding, crop production and loss/yr/Hh (in NRs) in the Kalyanpur VDC.

SN	Crop Type	Proportion of cultivation	Size of Land Holding/Hh (in bigha)	Crop grown Field/Hh (in bigha)	Total Production/ Hh(in Kg)	Mean % loss	Total loss (in Kg) /Hh	Total loss in NRS /Hh
1	Paddy	0.90	1.20	1.08	2184	23.67	613.52	8589.36
2	Maize	0.58	1.20	0.69	828	2.35	19.45	272.41
3	Lentil	0.24	1.20	0.28	168	2.28	3.83	210.67
4	Mustard	0.28	1.20	0.33	198	1.36	2.69	148.10
5	Wheat	0.45	1.20	0.54	432	16.67	72.01	1296.25

In kalyanpur VDC, loss of the crop annually per household accounts 10,516.79 Rupees NRS. In which the highest loss found in paddy field of which 613.52kg loss was calculated In terms of cost 8,589.36Rupees. Maize loss per household was 19.45kg in terms of cost 272.41Rupees. Mustard was found 2.69kg loss per household which costs 148.10 Rupees. Lentil was found 3.83kg per household in terms of cost 210.67 Rupees and 72.01kg of Wheat was loss which accounts 1,296.25 Rupees per household (Table5).

Table: 6 Mean landholding, crop production and loss/yr/Hh (in NRs) of Ayodhyapuri VDC.

SN	Crop Type	Size of Land Holding /Hh (in bigha)	Proportion of cultivation	Crop grown Field/Hh (in bigha)	Production /Hh (in Kg)	Mean % loss/Hh	loss (in Kg) /Hh	loss in NRS/Hh
1	Paddy	0.81	0.91	0.73	1752	26.70	467.78	6548.97
2	Maize	0.81	0.58	0.46	552	4.65	25.66	359.35
3	Lentil	0.81	0.30	0.24	144	0.2	0.28	15.84
4	Mustard	0.81	0.22	0.17	102	0.06	0.06	3.36
5	Wheat	0.81	0.25	0.20	160	2.66	4.65	76.60

Source: Field survey (2008)

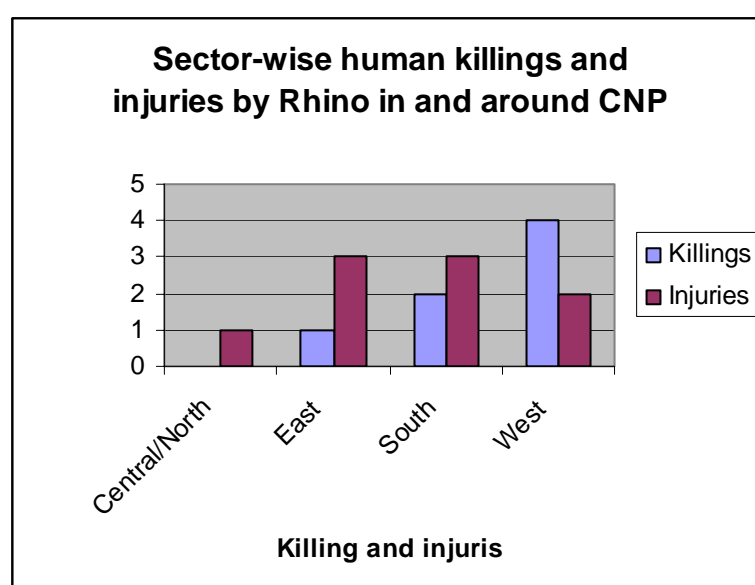
In Ayodhyapuri VDC, loss of the crop annually per household accounts 7,000.76 Rupees NRS. In which the highest loss found in paddy field of which 467.78 kg loss was calculated In terms of cost 6,548.97 Rupees. Maize loss per household was 25.66kg in terms of cost 359.35 Rupees. Mustard was found 0.06kg loss per household which costs 3.36 Rupees. Lentil was found 0.28kg per household in terms of cost 15.84 Rupees and 4.65kg of Wheat was loss which accounts 76.60 Rupees per household (Table 6).

The paddy loss was highest in Gardi (27.60%) followed by in Ayodhyapuri (26.70%) similarly in kalyanpur (23.67%) and found lower in Baguda (11.75%). Loss of maize in Gardi was highest (15.58%) followed by (5.17%) in Baguda,

(4.65%) in Ayodhyapuri and least (2.35%) in Kalyanpur VDCs. Loss of Lentil was also found highest (8.83%) in Gardi followed by (4.32%) in Baguda, (2.28%) in Kalyanpur and least (0.2%) in Ayodhyapuri. Likeas loss of mustard highest in Gardi (3.40) followed by (2.53%) in Baguda, (1.36%) in Kalyanpur and least (0.06%) in Ayodhyapuri.

## 5.2 Human Injuries and Killings by Rhino

A total of 7 cases killings and 9 cases injuries have been recorded during the year 2008 in CNP. Among those west and south sector of CNP are highly vulnerable for rhino attacks (Table: 6 & Appendix IV).



## 5.3 Habitat Analysis

A total of 77 species of plants were recorded in the study area during our field survey.

Relative frequencies of different plant species that are known to feed by rhinoceros are as follows: *Saccharum spontaneum* (16%), *Imperata cylindrica* (74%), *Ageratum conyzoides* (8%), *Mallotus philippinensis* (20.83%), *Trewia nudiflora* (8.33%), *Bombax ceiba* (8.33%), *Cyperus compressus* (20%), *Cynodon spp* (24%), *Eragrostis tenella* (12%), *Solanium erianthum* (4%), *Themeda arundinacea* (16%), *Typha angustifolia* (10%), *Dropteris cochleata* (36%), *Chrysopogon aciculatus* (14%), *Phragmites karka* (10%), *Litsea monopetala* (12%), *Ficus glomerata* (4%), *Eupatorium odoratum* (2%), *Narenga porphyrocoma* (10%) and *Calicarpa*

*macrophylla* (2%). Along with these species the *mikania mikarantha* also found (20%).

#### **5.4 Unique Species in the Habitat from Jackknife Estimate**

From Jackknife Estimate, altogether 23 unique species were recorded in the study area. They are *Solanum sculeatissimum*, *Equisetum spp.*, *Calicarpa macrophylla*, *Ipomia spp.*, *Curculago spp.*, *Bhurunga lahat*, *Eupatorium odoratum*, *Gossipium spp.*, *Sapium spp.*, *Stephinia glandulifera*, *Bhuania varigata*, *Pogostemon amarantoides*, *Cleistocalyx operculatata*, *Cleistocalyx spp.*, *Adina cardifolia*, *T. belerica*, *Stepha niadlara*, *D. latifora*, and *Patke*.

#### **5.5 Causes of Human- Rhino Conflict**

##### **5.5.1 Cause of Rhino Visiting Crop Fields**

The field survey and questionnaire survey as well as direct observation revealed that the rhinoceros visits the crop fields due to lack of sufficient food throughout the year. Now a day the serious impact of *Mikania* deteriorates the rhino habitat and made it to enter into the settlements. Sometimes they enter the crop fields to change their feeding taste. The points are described as follows:

**a. Lack of food availability:** Due to the human encroachment to the rhino-habitat, unsustainable collection of rhino's food items from the park by local people and the impact of *Mikania* affect the food availability. With increasing number of rhinoceros inside the park required more demand of food inside the park which might not sufficient for subsistence, so wild animals mainly rhino have to come out of the park and damage the agricultural crops.

**b. Taste of agricultural crops:** Crops such as paddy, wheat, maize etc. cultivated around the park are rich in protein and carbohydrates as well as some mineral nutrients than most of the wild plants available in the park. Agricultural crop may be tastier than wild plant species. In spring season rhino come less frequently outside the park because they find less nutritious food inside the park. Rhinoceros need to spend much energy in search of qualitative food in the park as the foods are found scattered (Adhikari, 2005).

**c. Lack of effective physical barrier:** The effectiveness of physical barrier also prevents the rhinos come to the agricultural fields has been practicing in the protected areas in Chitwan also Sauraha site were covered by electric fencing and also trench management reduced the conflict between human and rhino. But there were not found such type of management in the study area is one of the causes of the conflict. Although there is Rewa River but area like Amaliya and Simara were directly associated with park in which the wild animals can freely come. Animal like rhino easily cross the river and raid the adjoining agricultural fields. According to local people there must be strong physical barrier wild animals cannot come.

**d. Flood:** The study area lies in the alluvial flood plains of the Rewa River during the adjacent part of Rewa River is under water and the wild animals are forced to come out from the park to the surrounding field and damage the crops.

**e. To change the taste:** One of the reasons of entering the rhinoceros to the surrounding settlements is to change the taste of their food. The foods inside the park are always found the same type. So, they like to change the taste and raid field crops.

**f. Succession:** Due to succession, grasslands in Chitwan National park are changing into forest and animals that live in grass migrate towards the surrounding field in search of surrounding food.

**g. Exotic Species:** Exotic species like *Mikania mikrantha* vigorously invaded the core and buffer zone of the park threatening to biological diversity and ecosystem. The eight invasive plant species were identified as problematic in CNP out of which *Mikania mikrantha* to be highest invasive in terrestrial ecosystem which were directly related to the habitat of the wild animals including rhino.

### **5.5.2 Sources of Human-Rhino Conflict Due to Reserve**

The most serious problems created by the reserve are crop damage, human harassment, injuries and killings. The wild animals from the park frequently visit nearby crops and damage crop. The major crops like paddy, wheat, maize, lentil, mustard and kitchen garden plants were seriously damaged by rhino which already mentioned in earlier chapter.

### **5.5.3 Sources of Human-Rhino Conflict Due to Local People**

The Chitwan National Park is surrounded almost all side by the settlements. One time people around the National Park were using accesses of National Park freely. After the establishment of park all the accesses are prohibited and people were restricted to enter the park. Economic status of local people found very weak by which there is compulsion to use protected area illegally. Although I found the people around the national park were conscious and know the forest should be protected and establishment of national park is good but there is also compulsion to collect the firewood, thatch grass because they have no any alternatives. According to questionnaire survey and field visit local people arising pressure to the park on the following topics:

#### **Firewood and thatch Grass Collection**

Every year DNPWC allows collecting the fallen firewood and thatch for local people. Almost all entire respondents in the study area used to enter the jungle for the collection of the firewood, thatch grass and kharai. Due to collection of forest products creates heavy impact in the ecology of the forest.

#### **Grazing**

There were found pressure of the live stock inside the park in the study area which is the most serious problem of rhino habitat degradation. It is challenging and most difficult task to solve. Most of the people of the study area are farmers. They are rearing cattle for milk, meat and work. As there is no alternatives to graze the cattle some of villagers leave their cattle at the bank of Rewa River and jungle this creates very bad impact to the wild animals. Certain diseases (communicable) may be transferred from domestic animal to wild animal due to entering of domestic animals inside the park.

#### **Poaching of Wild Animals and Timber**

Poaching of wild animals and timber is a reality of the CNP. Hunting in Chitwan has been practice since historical time. The heavy toll on wildlife mainly tiger, rhino and deer was largely caused by organized royal hunting and Rana rulers. Wildlife such as deer and wild pig are hunted for their meat. Rhinoceros is heavily poached for its

highly valued horns but in my study area I haven't recorded a single rhino poaching, although rhino poaching in Chitwan is prevalent.

### **Herb Collection**

Settlements associated with parks mostly depend upon the resources of the park. The edible herbs were collected from park by the local people. They have practiced to collect herbs since long time. The forest products like Neuro (*Dryopteris cochleate*) are heavily collected for curry. Many people collect fodder grass for cattle.

### **5.6 Seasonal Effects on Crop Damage**

The crop damage by rhino is varying with season. The frequency of entering and damaging is higher in winter than in summer especially in the case of rhino. The farmers are most destructive in misty and cloudy night because of difficulty on detection. In winter season, the availability of the food inside the park is lower level than summer season. The vegetation found inside the park is less palatable and the vegetation found outside the park is more palatable. Beside seasonal, the other affects on crop damage are following:

- A. Distance from forest to field affect the crop loss has directly correlated i.e. near the distance from the park higher will be the loss.
- B. The volume of crop loss increased as the size of land holding and frequency of crop raid increased.
- C. Presence and effectiveness of barriers between the crop land and the park and the type of means of preventive measures affects the extent of damage.
- D. The population fluctuations of crop raiding wildlife (rhino) in the reserve, forest adjacent to the village have an important effect on crop depredation.

## 6. DISCUSSION

As the people around the world continue to expand into wilderness areas and as we successfully conserve healthy wildlife population, the need of people and need of wildlife increasingly clash. Consequently, we must find better land use management practices and policies to support people and wildlife to share the landscape. To set priorities for conservation, it is better fuse the ecological need of wildlife rather than political boundaries, to define conservation landscape. To protect the wildlife and their habitat, there must be sustainable utilization of natural resources. In this complex world, where growing population and global economics are altering the natural resources at a scale and pace never before seen, we need new tools to help us to reconcile people use of the land with the need of wildlife.

After the establishment of national park in Chitwan, the people who are using natural resources are prohibited to enter inside the park for the collection of their basic needs. On the other hand due to effective conservation, the numbers of animals inside the park increased and frequently visit the settlement areas and destroyed the crops and even human lives. The aim of this study was to know the cause of conflicts, mitigate the disharmonies and to suggest the appropriate human-rhino conflict management recommendations to the concerned authorities. This study finds the loss of major crops in four VDCs and also deals quantity and economic loss by rhinoceros at the buffer zone areas of Madi Valley.

The study finds out that the paddy coverage was higher (0.98 bigha per household) in the area which concludes mostly people farm paddy so that percentage loss of paddy found also higher. The loss of maize in Gardi was higher followed by Baguda, Ayodhapuri and least in Kalyanpur. The loss of lentil was also higher in Gardi followed by Baguda, Kalyanpur and least in Ayodhapuri. The loss of mustard was also highest in Gardi followed by Baguda, Kalyanpur and least in Ayodhapuri. In the case of wheat highest loss found was in Kalyanpur followed by Baguda, Gardi and least in Ayodhapuri. This result identify that the loss of this staple crop paddy is the major source of conflict between local people and rhino. Loss of crop depend on proportion of grown and coverage. directly almost all crops were raided by rhino the frequency was somewhat up and down in different VDCS. The loss of wheat in Kalyanpur was higher then maize. The proportion of coverage was higher and also the rhino preferred wheat most that maize, lentil, maize and mustard so that the



cultivation of the wheat was least in all VDCS. The loss of mustard in Gardi was highest because of high coverage, it was least in Ayadhuri due to distance and also low proportion of farming. The loss of lentil was also highest in Gardi also distance and coverage. This conflict directly impact not only in the food security of these subsistence farmers but also in the sustainable conservation of this vulnerable rhinoceros.

Upreti, (1985) has explained the main source park people conflict on his paper “Park People Interface problem and New Direction”. The paper concluded that, crop damage encountered with wild animals and loss of livestock by predator as the main problems for people and points out the illegal activities of people like grazing encroachment, collection of natural resources, fishing and hunting of wildlife as the impact of local people on park conservation. Mishra, (1984) enumerates four basic cause of conflict between the park authorities and local people i.e. loss of life, livestock and crop depredation by wild animals from park and difficulties and emphasizes crop loss is the main serious problem. My study also reveals that in Mandi Valley, there is also the similar type of causes responsible for raising the conflict with park wildlife including the loss of life.

Adhikari (2005) also reported that paddy is the main raided crop (50.43% of total damage) in the buffer zone area of northern part of CNP. Similarly, Jnawali (1989) also found that economically highest paddy (27.6%) loss occurred in Sauraha area. In Gardi VDC, the second major crop loss was maize 125.26 kg per household which costs NRS 1755.00 which also coverage 0.67 bighas per household and loss per household was also secondly higher. Likewise, in Ayodhyapuri VDC, the maize farming coverage was 0.46 bighas per Hh and loss was 25.66 kg per Hh which costs NRS 359.35. Cultivation of maize in Kalyanpur VDC was 0.69 bighas per household and loss was 19.45 kg which costs NRS 272.41. Though the maize farming per Hh is higher than wheat the amount of loss of wheat is higher than the maize shows that wheat is more preferable than maize. The case was similar in Baguada VDC in which the cultivation of maize and wheat per Hh was 0.46 and 0.46 bighas respectively but the amount of loss in maize was 28.53 kg that costs NRS 349.53 and the amount of loss in wheat 50.53 kg that costs NRS 904.17. The cultivation of wheat in Gardi VDC per Hh was 0.49 bighas of which 5.31 kg loss was found which costs NRS 95.61. Wheat cultivation per Hh in Ayodhyapuri was

0.20 bighas and loss in Kg was 4.65 which cost NRS 76.60 per Hh. The cultivation of mustard per Hh in Gardi was 0.32 bighas, in Kalyanpur 0.33 bighas, in Bagauda 0.31 bighas and in Ayodhyapuri, 0.17 bighas and loss per Hh in Kg was 11.01, 2.69, 4.70 and 0.06 and in terms of cost NRS 605.88, NRS 148.10, NRS 258.81 & NRS 3.36 respectively. The cultivation per Hh was found lower in Ayodhyapuri show the loss per Hh found lower.. The cultivation per Hh was found highest in Gardi show the loss per Hh found highest. In Kalyanpur VDC, the cultivation of Mustard was 0.33 bighas per Hh but the loss per Hh relatively lower than other VDCs concludes the loss of mustard in this VDC comparatively lower than others. The cultivation of lentil per Hh was 0.32 bighas in Gardi VDC, 0.28 bighas in Kalyanpur, 0.31 bighas in Bagauda and 0.24 bighas in ayodhyapuri VDC. The loss of lentil was 16.95 kg in Gardi VDC per Hh, 2.69 kg in Kalyanpur, 3.88 kg in Bagauda and 0.28 kg in Ayodhyapuri. In terms of amount in Gardi per Hh were NRS 932.44, NRS 210.67, NRS 213.84 and NRS 15.84 in Ayodhyapuri.

During study period 2008, 7 killings and 9 injuries were recorded and the events were more concentrated in the west and south sectors of the park. The events of killings and injuries were found mostly in winter season which represents the seasonal effect on the killings and injuries. With comparison of these researches, the level of conflict due to human harassment, killing and injuries were in somewhat lower level. The frequency of the accident during the study period of 1978-1988 was 7.8/year at the sauraha sector (Jnawali, 1989), while in my result it was 16 cases around CNP and 5 cases in Madi valley. This data shows the relevance of study of the park people conflict at present as the same level after 20 years while it was practicing conservation and Buffer Zone management activities. Shrestha (1994) found, 10 people were attacked in which 2 victims were killed and 8 victims were seriously injured in CNP.

In this study the relative frequencies of *Saccharum spontaenium*, *Trewia nudiflora*, *Narenga porphyrocoma* were 16.00 %, 8.33 % and 10% respectively. These species are preferred food items of rhino (Jnawali, 1995). This numerical values of different rhinoceros preferred species for diet indicates that this study sites are potential habitat for rhinoceros. *Saccharum spontaenium*, *Trewia nudiflora*, and *Narenga porphyrocoma* were key species and their prominence values in all habitats in CNP were (270.6), (50.6), and (207.0) respectively (Jnawali 1995). In comparison to the

total PV of these three species almost 36% and my study the relative frequency of these three species were 33.33% which is lower in amount. Besides these, *Mikania micrantha* was found 18% which is alien species and continuously spreading and deteriorating the marshy and grassland areas where the rhino wallowing.

Altogether 23 unique species were found in the study area. They are *Solanum sculeatissimum*, *Equisetum* spp., *Callicarpa macrophylla*, *Ipomia* spp., *Curculago* spp., *Bhurunga lahat*, *Eupatorium odoratum*, *Gossipium* spp., *Sapium* spp., *Stephinia glandulifera*, *Bhuania varigata*, *Pogostemon amarantoides*, *Cleistocalyx operculatata*, *Cleistocalyx* spp., *Adina cardifolia*, *T. belerica*, *Stepha niadlara*, *D. latifora*, and *Patke*. Besides these, other 50 species were recorded in which *Mikania mikarantha* found 18% which is greater than the quantity of *Saccharum spontaenium* which shows the presence of adverse effect of *Mikania* on its prime habitat.

*Mikania* was concentrated on rhino habitat in large amount. It has been flourishing after the massive flooding of Rapti River in 1993. Seeds of the plant, which is a native of Central and Latin America, might have been brought here by the flood. It was also concluded that rhino consumed *Mikania* as stress food (during lean period) in rainy season, winter season (after the fruiting of *Mikania* December and January recorded by Dhan Bdr Tamang,( Tiger Mountain, Tharu Lodge) and also found mid-March (personal commuvnicatin with Bed Bahadur Khadka, CNP). Although researchers got eaten *Mikania* by elephant and rhino during rainy season only in little amount mixed with *Hemertheria comparusa* and *Eragrotis uniolooids* (Ram, 2008). Though *Mikania* was found to be consumed by rhino in little amount, it has altered preferred rhino-habitat in more amount in the area where once grasslands were found.

## 7. CONCLUSION

The southern part of CNP, the Madi valley is the buffer zone area in which the situation of conflicts were due to the interaction between park and people as well as the effect of invasive alien species inside the park. The common sources of conflict arises problem created due to reserve to the local people through crop damage, human harassment and problem emerges through local people to the park were habitat encroachment (grazing, firewood and thatch grass collection, herb collection, fishing and river poisoning).

The result indicates that the annual crop loss in Gardi, Bagauda, Kalyanpur and Ayodhyapuri VDC per household were NRS 12474.13, NRS 7896.43 NRS 10516.79 and NRS 7000.76 respectively. The crop loss % per household in Gardi VDC was highest in which the cropfield area more closer and relatively near from the rhinoceros prime habitat. Minimum among 4 VDCs was Ayadhyapuri; second more impact Zone was kalyanpur, and 3<sup>rd</sup> in Baguda respectively. A total of 7 killings and 9 injuries have been recorded during the year 2008. Among those west and south sector of CNP are highly vulnerable for rhino killings and injuries. In the winter season the rhinoceros generally causes more damage, the events of killing found at that time was maximum. Since the preferred plant species for rhino were found in good numerical value indicates the study area is the potential for rhinoceros. Altogether 23 unique species were found in the study area within 50 quadrates of the size of 1x1 m<sup>2</sup> plots and 24 quadrates of the size of 20x20 m<sup>2</sup> plots. The presence of key species in the habitat was relatively lower than the findings of (Jnawali, 1995). However the presence of alien species *Mikania mikrantha* shows that potential habitat is continuously degraded which ultimately affects the rhino habitat causes probability of entering into the local crop fields.

## 8. RECOMMENDATIONS

The concept of the Buffer zone in Nepal is playing a vital role in conservation activities it minimizes the park people conflict and incorporate the people's role in the conservation for mutual benefits. Although its objectives achieved only some extend which one can easily observe in and around the protected areas. Some recommendations have been put forwarded for the improvement of the park people relation as well as the sustainable conservation.

1. The periodic study on human-rhino conflict should be done in more adjacent areas of CNP on the research level such as analysis and measurement of the habitat so that what the factors governing alteration of habitat which affects fluctuation of the population ecologically.
2. Alternative ways of income source to the local people from the park revenue or from government should be provided.
3. Community outreach program for local people and conservation education for local school children should be carried out periodically in the area. Outreach materials like posters, pamphlets, leaflets, stickers should be published and distributed to the local residents around rhino-habitat. Periodic workshops and meetings with local stakeholders should be carried out in the area.
5. It is strongly recommended that a national level policy and control mechanism should be prepared for the control and management of *Mikania micrantha* for vulnerable species conservation.

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## APPENDIX I

Rainfall (in mm) pattern in Chitwan.

Year/Month	Rainfall				Mean
	2004	2005	2006	2007	
Jan	58.8	41.7	-	0.0	33.5
Feb	0.0	6.0	-	141.5	49.2
Mar	9.0	24.1	-	27.5	20.2
Apr	184.4	24.0	-	155.5	121.0
May	145.8	218.9	-	228.4	198.0
Jun	603.7	215.6	-	408.4	409.0
Jul	336.3	479.0	436.5	635.0	472.0
Aug	293.4	532.0	429.0	576.4	458.0
Sep	443.9	115.5	643.7	1002.3	551.0
Oct	92.9	192.7	-	60.4	115.0
Nov	9.1	0.0	5.5	0.0	3.65
Dec	0.0	-	19.0	0.0	6.33

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu, 2009.

## APPENDIX II

Maximum temperature (°C) pattern in Chitwan from 2001-2007

Year/Month	Maximum Temperature							Mean
	2001	2002	2003	2004	2005	2006	2007	
Jan	24.5	22.8	-	22.6	22.8	-	21.4	22.8
Feb	26.3	26.5	-	26.3	25.0	-	23.9	25.6
Mar	32.4	31.5	-	33.7	31.5	-	29.7	31.8
Apr	35.6	34.1	35.3	34.0	33.4	-	34.9	34.6
May	33.8	33.6	35.8	37.1	35.5	-	35.8	35.3
Jun	33.8	34.8	33.8	34.4	38.1	35.0	34.2	34.9
Jul	34.4	33.2	33.6	35.0	36.6	34.1	31.7	34.1
Aug	34.0	33.5	34.1	35.6	36.9	33.8	33.4	34.5
Sep	33.1	33.2	33.1	34.4	35.6	32.7	31.9	33.4
Oct	32.4	32.0	32.3	32.2	31.4	31.6	31.0	31.8
Nov	28.1	28.7	28.2	29.0	27.9	29.3	28.3	28.5
Dec	22.9	24.1	25.4	25.9	-	-	23.2	24.3

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu, 2009.

Minimum temperature (°C) pattern in Chitwan from 2001-2007

Year/Month	Minimum Temperature							Mean
	2001	2002	2003	2004	2005	2006	2007	
Jan	7.5	8.8	-	9.7	5.5	-	7.8	7.86
Feb	10.9	12.2	-	11.2	6.7	-	12.2	10.6
Mar	14.4	16.3	-	14.2	12.1	-	14.7	14.3
Apr	20.0	21.1	22.0	14.2	15.4	-	21.3	19.0
May	23.0	23.3	22.2	17.7	19.4	-	23.6	21.5
Jun	24.8	24.8	24.3	17.0	20.9	18.0	24.7	22.1
Jul	25.5	25.4	25.2	18.0	20.1	20.4	25.0	22.8
Aug	25.1	25.2	25.3	19.2	19.7	19.0	24.8	22.6
Sep	24.0	23.7	24.3	18.2	18.5	17.3	23.5	21.4
Oct	21.4	19.9	20.7	16.1	14.4	14.5	21.4	18.3
Nov	15.4	14.7	15.0	9.2	9.1	10.9	15.6	12.8
Dec	9.7	10.8	11.2	7.1	-	-	9.8	9.72

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu, 2009.

### APPENDIX III

Relative Humidity (in %) in Chitwan

Year/Month	Relative Humidity							Mean
	2001	2002	2003	2004	2005	2006	2007	
Jan	97.2	100.0	-	98.9	97.7	-	93.9	97.5
Feb	99.8	98.8	-	97.8	97.7	-	92.5	97.3
Mar	100.0	99.8	-	96.0	97.9	-	87.2	96.2
Apr	100.0	87.4	90.6	94.3	91.5	-	73.4	89.5
May	100.0	81.0	85.8	95.1	93.0	-	77.8	88.8
Jun	100.0	87.4	90.0	97.8	88.3	95.8	83.4	91.8
Jul	99.7	95.6	93.1	97.1	89.2	96.3	89.6	94.4
Aug	100.0	92.3	93.9	95.5	89.0	96.4	90.4	93.9
Sep	100.0	91.5	95.6	91.3	89.6	94.1	90.8	93.3
Oct	100.0	92.8	96.7	88.0	93.7	95.6	88.4	93.6
Nov	100.0	97.6	96.0	96.0	97.7	96.8	86.3	95.8
Dec	99.9	98.6	99.4	99.4	-	-	93.3	98.1

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu, 2009.

## APPENDIX IV

Human -killing events due to rhino in and around Chitwan National Park in the year 2008

SN	Name	Address	Sector of National Park
1	Harka Bahadur Chhettri	Gardi-2	South
2	Narmati Gurung	Mangalpur-9	West
3	Kalu Limbu	Bagauda-3	South
4	Durga K.C.	Bagauda-3	South
5	Yogmaya Gurung	Ratnanagar-3	East
6	Ram Prasad Sapkota	Pithauli-2	East
7	Sumitra B.K.	Pithauli-6	East
8	Bishnu Ojha	Patihani-8	Central/North
9	Dhani Maya Thapa	Gunjanagar-6	West

Human -injurious events due to rhino in and around Chitwan National Park in the year 2008

SN	Name	Address	Sector of National Park
1	Hom Bahadur Thapa	Meghauri-5	West
2	Ayata Ram Bote	Gardi-4	South
3	Chalai Mahato	Ratnagar-5	East
4	Sichan Mahato	Meghauri-5	West
5	Hari Ram Devkota	Mangalpur-8	West
6	Thakur Prasad Mahato	Argauri-5	West

Sector-wise human killings and injuries by Rhino in and around CNP

Sector/Events	Central/North	East	South	West	Total
Killings	0	1	2	4	7
Injuries	1	3	3	2	9
Total	1	4	5	6	16

## APPENDIX V

List of plant species recorded during this study inside the CNP adjacent to the southern Mandi sector

SN	Common Name (Local)	Scientific Name	Habit
1	Lajjabati Jhar	<i>Mimosa appudica</i>	Grass species
2	Siru	<i>Imperata Sylindrica</i>	Grass species
3	Fern	<i>Dryopteris</i> sp	Grass species
4	Ghode Dubo	<i>Cynodon</i> sp	Grass species
5	Dalle Kuro	<i>Triumfettapilosa</i>	Grass species
6	Banmara (Lahara)	<i>Mikania mikrantha</i>	Grass species
7	Kantakari	<i>Solanum sculeatissimun</i>	Browse species
8	Gandhe Jhar	<i>Ageratum conyzoides</i>	Browse species
9	Talcha Marne Jhar	<i>Equisetum</i>	Grass species
10	Preyae Jhar	<i>Preyae jhar</i>	Grass species
11	Kans	<i>Saccharum spontaneum</i>	Grass species
12	Mothe	<i>Cyperus compressus</i>	Grass species
13	Dhurselo	<i>Colebrookia oppositifolia</i>	Browse species
14	Karante Jhar	<i>Scleria biflora</i>	Grass species
15	Sal	<i>Shorea robusta</i>	Tree species
16	Pyauli Jhar	<i>Trifolium repens</i>	Grass species
17	Ghatu	<i>Clerodendrom viscosum</i>	Browse species
18	Kuro	<i>Biden</i> sp	Grass species
19	Bhuin Amala	<i>Embllica</i> sp	Grass species
20	Kutmero	<i>Litsea monopetala</i>	Browse species
21	Saruwa	<i>Ipomia</i> sp	Browse species



22	Bot Dhayaro	<i>Woodfordia fruticosa</i>	Browse species
23	Tatari	<i>Dilenea pentagyna</i>	Tree species
24	Kalo Musle	<i>Curculago sp</i>	Browse species
25	Ban Tarul	<i>D. deltoid</i>	Grass species
26	Ban Haledo	<i>Curcuma sp</i>	Browse species
27	Thakal	<i>Cycus pectinata</i>	Tress species
28	Karang	<i>Adina cardifolia</i>	Tree species
29	Jamuno	<i>Syzygium cuminii</i>	Tree species
30	Dudhe Jhar	<i>Euphorbia sp</i>	Grass species
31	Sindure	<i>Malotus phillipunsis</i>	Tree species
32	Bet Lauri	<i>Costus speciosus</i>	Browse species
33	Lahare Siris		Grass species
34	Kurilo	<i>Asparagus recemosus</i>	Browse species
35	Kosae Khirro	<i>Sapium sp</i>	Browse species
36	Patpate		Grass species
37	Camuno	<i>Cleistocalyx operculata</i>	Tree species
38	Bhatte	<i>Desmodium sp</i>	Grass species
39	Kali Kath	<i>Myrsime semiserrata</i>	Tree species
40	Seto Musli	<i>Chlorophytum borivillionam</i>	Browse species
41	Janai Lahare	<i>Lygodium japonicum</i>	Browse species
42	Golani		Tree species
43	Jibre Sag	<i>Ophioglossum sp</i>	Browse species
44	Arali Kanda	<i>Caesalpinia decapetala</i>	Grass species
45	Pharsa		Grass species
46	Norcot	<i>Phragmites karka</i>	Grass species

47	Banso	<i>Paspalum species</i>	Grass species
48	Simal	<i>Bombax ceiba</i>	Tree species
49	Simthee	<i>Helicteres irosa</i>	Browse species
50	Bayar	<i>Zizypus mauritiana</i>	Browse species
51	Mothe	<i>Cyperus species</i>	Grass species
52	Bhote Khirro	<i>Sapium sp</i>	Tree species
53	Khaniyo	<i>Ficus semicordata</i>	Tree species
54	Vellar	<i>Prewia nudislora</i>	Tree species
55	Simali	<i>Vitex negundo</i>	Tree species
56	Harro	<i>Terminalia chebula</i>	Tree species
57	Khar	<i>Imperata sp</i>	Grass species
58	Amala	<i>Phyllanthus emblica</i>	Tree species
59	Kumvi	<i>Chlospermum religiosum</i>	Tree species
60	Kukur-dino	<i>Smilax sp</i>	Browse species
61	Ban Mara	<i>Eupatorium adenophorum</i>	Browse species
62	Badkamle	<i>Stephania dlabra</i>	Browse species
63	Bel	<i>Agel mamalus</i>	Tree species
64	Sati Sal	<i>Dalbergia latifolia</i>	Tree species
65	Ban Kapas	<i>Gossipium sp</i>	Tree species
66	Koirala	<i>Bhunia varigata</i>	Tree species
67	Dahi Chamal	<i>Calicarpa macrophylla</i>	Browsespecies
68	Khadai	<i>Typha angustifolia</i>	Grass species

## APPENDIX VI

List of rhino edible plant species recorded during present study inside the CNP adjacent to the southern Mandi sector

SN	Local Name	Scientific Name	Habit
1	Karang	<i>Caesalpinia aecapetala</i>	Browse species
2	Siru	<i>Imperata Sylindrica</i>	Grass species
3	Fern	<i>Dryopteris</i> sp	Grass species
4	Ghode Dubo	<i>Cynodon</i> sp	Grass species
5	Dalle Kuro	<i>Triumfetta pilosa</i>	Grass species
6	Banmara (Lahara)	<i>Mikania mikrantha</i>	Grass species
7	Kantakari	<i>Solanum sculeatissimun</i>	Browse species
8	Gandhe Jhar	<i>Ageratum conyzoides</i>	Browse species
9	Talcha Marne Jhar	<i>Equisetum</i>	Grass species
10	Kans	<i>Saccharum spontaneum</i>	Grass species
11	Mothe	<i>Cyperus compressus</i>	Grass species
12	Dhurselo	<i>Colebrookia oppositifolia</i>	Browse species
13	Sal	<i>Shorea robusta</i>	Tree species
14	Ghatu	<i>Clerodendrom viscosum</i>	Browse species
15	Kuro	<i>Biden</i> sp	Grass species
16	Kutmero	<i>Litsea monopetala</i>	Browse species
17	Saruwa	<i>Ipomia</i> sp	Browse species
18	Bot Dhayaro	<i>Woodfordia fruticosa</i>	Browse species
19	Tatari	<i>Dilenea pentagyna</i>	Tree species
20	Ban Tarul	<i>D. deltoid</i>	Grass species
21	Ban Haledo	<i>Curcuma</i> sp	Browse species

22	Norcot	<i>Phragmites karka</i>	Grass species
23	Banso	<i>Paspalum species</i>	Grass species
24	Simal	<i>Bombax ceiba</i>	Tree species
25	Mothe	<i>Cyperus species</i>	Grass species
26	Vellar	<i>Prewia nudislora</i>	Tree species
27	Simali	<i>Vitex negundo</i>	Tree species
28	Khar	<i>Imperata sp</i>	Grass species
29	Ban Mara	<i>Eupatorium adenophorum</i>	Browse species
30	Dahi Chamal	<i>Callicarpa macrophylla</i>	Browse species
31	Khadai	<i>Typha angustifolia</i>	Grass species

## APPENDIX VII

### Households Questionnaire

Respondent No:

Group A: General

1. Name:                      Date:    VDC/Village:                      Ethnicity:  
2. Sex:                      Age:                      Occupation:                      No of Family:

Group B: Problem Associated with Crop Damage

3. Distance from settlement to the Jungle: a) 100-500m b) 500-1 km c) 1-1.5 km  
d) 1.5 km-2km e) Over 2km

4. How much land do you have? .....

5. What kind of crops do you grow in your field?

a) Rice b) Maize c) Wheat d) Lentils e) Mustard f) others i).....  
ii)..... iii).....

7) Do rhino enter the field during the day time? Yes/ No

6) If yes, how often do they enter the field? a) Every night b) once or twice in a  
week c) once or twice in a moth d) occasionally e) Never

8) If No, How do you identify the damage done by the Rhino? a) Last night you saw  
rhino entering field b) last night you heard rhino noise in field c) footprints d)  
grazing patterns e) any others 1).....2).....3).....

9) Do you think baby rhino damage more or less than the mother? Yes/ No

10) If yes can you explain why? .....

11) Are rhinos selective on crops? Yes/ No

12) If yes which crop do they prefer most? a) Rice b) Maize c) Wheat d) Lentils e)  
Mustard f) others i)..... ii)..... iii).....

13) Do rhinos damage equally in all growing period? Yes/ no

14) If no when do they damage most?

1. Maize a) Juvenile stage

b) When they are of waist height

c) Tasseling stage

d) Mature stage

2. Wheat a) Juvenile stage

b) Medium stage

c) Mature stage

3. Mustard a) Juvenile stage

b) Flowering stage

c) Mature stage

4. Lentil a) Juvenile stage

b) Flowering stage

c) Mature stage

5. Rice a) Green stage

b) Flowering stage

c) Mature stage

6. Others 1.....a.....b.....c.....

2.....a.....b.....c.....

15) Did you have damage problem this year? Yes/no

Completely

Rice.....

Maize.....

mustard.....

Lentils.....

Wheat.....

16) If yes how much crop field was damaged from rhino?

Partially

Rice.....

Maize.....

Mustard.....

Lentils.....

Wheat.....

17) How much crop was lost from the rhino damage this year?

	0-1%	1-10%	10-25%	25-50%	50-75%	75-100%
Rice .....	.....	.....	.....	.....	.....	.....
Maize .....	.....	.....	.....	.....	.....	.....
Mustard.....	.....	.....	.....	.....	.....	.....
Lentils .....	.....	.....	.....	.....	.....	.....
Wheat .....	.....	.....	.....	.....	.....	.....

18) Do you apply some techniques to chase rhino from field? Yes/ no

19) if yes what kinds of techniques do you apply?

S.N.	Remedy Measures	Effectiveness				Reasons
		3	2	1	0	
1	Machan Guard					
2	Community protection					
3	Use of fire					
4	Barbed wire fences					
5	Electric fences					
6	Trench					
7	Madal/tin hitting/ others					

20) Does only your family chase rhino from the field? Yes/ no 21) if no who else? 1.

Your neighbors 2. All farmers in your village, 3. Farmers from neighboring village

22) Do you leave some land area fallow during some period in the year due to rhino problem? Yes/no

23) If yes how much lands do you leave fallow? .....

24) Are you able to support your family from agriculture? Yes/no

25) If no because part of your crops are destroyed by rhinos? Yes/no

26) Do you think the damage problem is growing every year after the establishment of park? Yes/no

27) Have you received any compensation at the damage demand? Yes/no A. if yes how much? a) Very less than damage b) moderate c) 50% d) all

28) What is your opinion about rhinos? Good Bad No. Opinion.

Group C: Problem Associated with Human Killings and injuries

How often have you been attacked by rhino? a. daily b. in a week c. fortnightly d. in a month e. rarely

How was attacked? a. during grazing inside b. firewood/fodder collection c. outside park d. at home

Which part of the body was damaged? a. head b. chest c. back d. limbs

If injured by rhino, do you receive any help or medical facilities from related authority? Yes/no

If yes what kinds of help do you need?

.....  
.....

Is the aggressive behavior differs when alone or in a social groups? Yes/no

If yes which social group reacts aggressive by? A. male b. female c. male with female d. female with calf

Circumstances of actual kill

Name: Age: Sex: M/F

Year:

Number of people killed till date:



## Some Photo Plates



1. *Mikania Mikrantha* covered in grassland



2. Machan in Gardi VDC Near Rewa River



3. Machan in the Paddy field in Gardi VDC



4. Footprints of Rhino



5. Researcher asking Questionnaire in the field



6. Damage occurred by Rhino in Paddy field



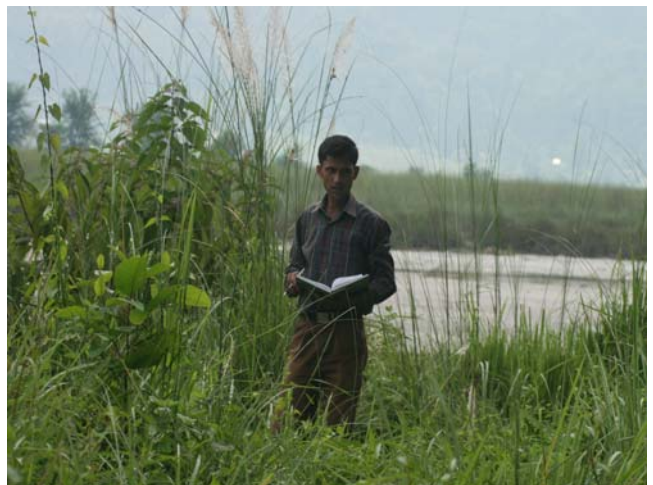
7. An Injured women by Rhino in Gardi VDC



8. Grassland on the River side Invaded by *Mikania*



9. Quadrata Sampling inside the Park



10. Vegetation Noted during Sampling



11. Sampling inside the Tall Grassland



12. Sampling around Sukibhara Post