WILDLIFE-HUMAN INTERACTIONS IN THE NORTHEN SIDE OF THE SHIVAPURI NAGARJUN NATIONAL PARK

Ratee Shrestha

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T.U. Examination Roll No: 1309

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WILDLIFE HUMAN INTERACTIONS IN THE NORTHERN SIDE OF THE SHIVAPURI NAGARJUN NATIONAL PARK

By

Ratee Shrestha

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN CENTRAL DEPARTMENT OF ZOOLOGY-ECOLOGY PROGRAM

INSTITUTE OF SCIENCE AND TECNOLOGY
TRIBHUVAN UNIVERSITY
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TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu, Nepal

Ref No:

DECLARATION

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

Date.....

Signature

Ratee Shrestha

☎ 01-4331896

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu, Nepal

Ref No:

RECOMMENDATIONS

It is my pleasure to mention that the thesis entitled "**Wildlife-Human Interactions in the Northern side of the Shivapuri Nagarjun National Park**'' has been carried out by Ratee Shrestha under my supervision. This is her original work that brings out important information required for the park management. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions. I recommend that the thesis be accepted for the partial fulfilment of the Degree of Master of Science in Zoology with special paper in Ecology.

Date..... .....

Khadga B. Basnet, Ph.D
Professor and Supervisor
Central Department of Zoology
Tribhuvan University, Kirtipur
Kathmandu, Nepal

☎ 01-4331896

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu, Nepal

Ref No:

LETTER OF APPROVAL

On the recommendation of supervisor Prof. Dr. Khadga B. Basnet this thesis submitted by Ms. Ratee Shrestha entitled "**Wildlife-Human Interactions in the Northern side of the Shivapuri Nagarjun National Park**'' is approved for the examination and submitted to the Tribhuvan University in partial fulfilment of the requirements for the Degree of Master of Science in Zoology with the special paper in Ecology.

Date.....

.....

Tej Bahadur Thapa, Ph. D

Professor and Head of Department

Central Department of Zoology

Tribhuvan University, Kirtipur

Kathmandu, Nepal

☎ 01-4331896

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu, Nepal

Ref No:

CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Ms. Ratee Shrestha entitled "**Wildlife-Human Interactions in the Northern side of the Shivapuri Nagarjun National Park**'' has been accepted as partial fulfilment of the requirements for the Degree of Master of Science in Zoology with special paper in Ecology.

EVALUATION COMMITTEE

.....

Khadga B. Basnet, Ph.D
Professor and Supervisor
Central Department of Zoology
Tribhuvan University, Kirtipur
Kathmandu, Nepal

.....

Tej Bahadur Thapa, Ph. D
Professor and Head of Department
Central Department of Zoology
Tribhuvan University, Kirtipur
Kathmandu, Nepal

.....

External Examiner
Sudeep Thakuri, Ph.D.
Associate Professor
Central Department of Environmental Science
Tribhuvan University, Kirtipur
Kathmandu, Nepal

.....

Internal Examiner
Hari P. Sharma, Ph.D.
Associate Professor
Central Department of Zoology
Tribhuvan University, Kirtipur
Kathmandu, Nepal

Date of Examination.....

ABSTRACT

Wildlife-human interactions result negative impact on people, natural resources, wild animals and their habitat. The research conducted in the northern side of Shivapuri Nagarjun National Park (Samundradevi, Sikre and Sunkhani VDCs) during October 2007-Augutst 2008 investigated the occurrence of human wildlife conflict focusing on crop loss and livestock depredation due to wildlife, research on land abandonment, preventive methods used and perception of local people towards the park. Both direct and indirect methods including literature review, field survey, identification of wildlife species and questionnaire survey were used. ANOVA and correlation regression were used in data analysis. Among 95 households surveyed, an annual loss of 8,489.8 US$ of crop and 755.28 US$ of livestock were recorded. There was a significance difference in crop loss for maize (*F= 12.30*), and millet (*F=12.11*) but no significant difference for paddy (*F= 0.81*) and wheat (*F = 0.44*) and crop losses were concentrated near boundary walls. A total of 11.30 ha of land was abandoned in three VDCs due to various reasons and there was no significant difference in the land abandonment (*F = 0.662*). The various techniques adopted by local people for protection of crops were less effective and there was no significance difference in the preventive methods used in three VDCs. More than 50% of local people knew that wildlife killing was illegal but only 30% of the responders showed the positive response towards wildlife. The local people were highly dependent on the forest for fodder, firewood and timer. These activities of the locals created a conflict between them and the park leading to degradation of the forest and wildlife habitat.

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Ratee Shrestha

T. U. Regd. No: 5-1-33-412-2000

Roll No: 1309

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1. INTRODUCTION

1.1 Background

Wildlife-human interaction has been increasing globally creating problems in conservation threatening many wildlife species (Dickman 2010). Quite often several factors are involved in the wildlife-human interaction (Cai and Zhigang 2006). They include the human population growth wildlife habitat losses, change of land use pattern and wildlife population growth (Cai and Zhigang 2006). Protected areas are always linked with local people and there is always some interactions between these protected areas and the people living close to it (Shrestha 1994, Studsord and Wegge 1995, Kasu 1996). When wildlife and humans are sharing the same landscape, it is not possible to avoid wildlife damage (Treves et al. 2006). Wildlife-human interactions result both positive and negative impact on people or their resources or wildlife animals or their habitat (Dhakal 2017).

Numerous National Parks in developing countries are in close proximity to agricultural land and the people living in and around such parks have interacted with them in multifarious ways (Nepal and Weber 1992). Establishment of National Parks and Reserves has played a vital role in conserving biological diversity (Soule 1991), but very little attention has been paid to local people by prohibiting on resources uses (Wells and Brandson 1993). Damage of agricultural crop, human harassment, injuries and death and livestock predation are the common problems of the unbalanced relationship between park and people (Sharma 1986, Heinen and Kattel 1992). Crop damage caused by degrading wildlife is a prevalent form of human- wildlife conflict along protected area boundaries (Rijal 2015). The raiding of crops depends on many factors such as reason, spatial and temporal distribution from the forest (Hill 2000, Warren et al. 2007). Livestock predation occurs in almost all areas where livestock and large carnivores co-exist (Karlsson and Johansson 2010).

Local people have seen the protected areas as an attempt by the government to curtail their access to their traditional rights of resources use. As a result, many illegal activities like hunting and poaching have intensified and park people conflicts appeared (Nepal and Weber 1992). Wildlife conservation in Nepal has been quite successful in terms of achievements in safeguarding the habitats of

several threatened species (Mishra et al.1992). However, increasing number of wildlife within protected areas started to damage the agricultural crops of the surrounding inhabitants. Besides this, the cause of human harassment by these wild animals has also increased the conflict. Park- people conflicts are prevalent in all protected areas of Nepal, although the extent of conflict varies due to separate legislations (Heinen 1993). A complex relationship between the residents and protected areas continue to be an obstacle to successful conservation of protected areas. Conflicts between park authority and people living around the park pose a threat to conservation. Moreover, crop depredation due to wildlife incurs a severe economic loss to communities living in the close vicinity of the park, affecting the livelihood and well-being of locals (Pandey and Bajracharya 2015).

1.2 Objectives

The main objective of the study is to assess the overall wildlife-human interactions in the Northern side of SNNP. The specific objectives of the study are as follows:

- Examine the wildlife damage;
- Find different preventive methods applied to control crop loss and livestock depredation; and
- Explore the perception of local people towards the wild animals and park.

1.3 Justification and limitation

Wildlife is a renewable natural resource but unfortunately it is rarely managed (Asibey and Child 1990). Protected areas cannot coexist in long term with communities that are hostile to them. However, when placed in the proper context, protected areas can make significant contributions to human welfare. To build strong support for conservation, contributions are required from all parts of the society. Crop raiding, livestock depredation, restriction over the firewood and timber collection are the major sources for park-people interface in the SNNP. Many studies had been conducted on crop damage and wildlife interactions in SNNP but only few have been done in the Northern side. Therefore, present study was conducted in the northern side of the SNNP, particularly in Sunkhani, Sikre and Samundradevi Village Development Committees (VDCs) to identify and analyze the problems there and find possible solution to raise the quality of human life. The information was mainly based on the questionnaire survey.

2. LITERATURE REVIEW

2.1 Wildlife damage

Crop raiding by wild animals has become one of the crucial management issues in the arena of wildlife conservation and has severe confrontations of wild animals with agricultural crops, the lost properties and lives (Aziz and Feroz 1993). Conflicts between wildlife and people have emerged as a problem in the arena of wildlife management. The conflicts which results from the destruction of crops and damage to property, are serious conservation issues inside and outside the reserve. Efforts to keep animals out of crop fields by frustrated wildlife officers are often futile and sometime result in people perceiving the animals (elephant) as being malevolent (Miah et al. 2001). Crop lost by wildlife animals is common thing in the adjoining villages of park and reserve as the limited grass land areas within park boundaries and highly nutritious supplement food in the crops grown in adjacent agricultural areas and it becomes probable that the wild animals may be forced to expand their dependence upon the agricultural lands periphery to the park (Sukumar 1990).

A survey carried out in Padampur VDC adjacent to the Chitwan National Park (CNP) to study the conflict between Wildlife Conservation and agricultural land use found that the crop lost by wildlife is the main problem of the people of the areas adjoining the Parks (Milton and Binney 1980). In CNP the crop damage, depredation of livestock and human loss from 10% to 100% and summarize that the part authorities should develop an area as a buffer zone for multiple use (Mishra 1984). A survey conducted in Sauraha, Chitwan found that the economic loss by rhinos to farm crops was 17,200 rupees within distance of 0 to 10 meters and the highest loss was to paddy with 27.6% (Jnawali 1989). Laurie (1978) in his study of ecology and behaviour of greater and horned rhino included that the rhino are most destructive and damaged paddy crops within 750 meters of the edge forest. He concluded that rice crop damage in Sauraha area is 17%, north of the river is 16% and south of the river is 19.5%. The Chital, Wild boar and Rhinoceros were identified as the most destructive pest up to 2.5 km from the park boundary to Gitanagar of CNP respectively (Nepal 1988). Ulak (1992) reported that Wild boar and Langurs destroyed buckwheat and barley mainly in Langtang, Rara and Sagarmatha National Parks. In the North Bilaspur Forest Division in Madhya

Pradesh, India, habitat of the sloth bear (*Melursus ursinus*) is highly fragmented in and is interspersed with human habitation. Because of largely depended on village for food, resulting in frequent human-bear encounter, some of which led to mauling and fatalities (Akhtar et al. 2004). In Gujrat state of India, the population of leopard has increased and also increased man-leopard conflicts in some areas, especially around Gir and Panchmahals. Leopards are capable of exploiting degraded habitats, rocky hills and ravines for shelter and uses village sites in night to manage food by killing domestic animals mainly goat, sheep and dog, level of man-leopard conflict ban seasonal variation in the study area due to change in availability of food and water (Singh 2006, Pokharel 2015). Annual report (2008) of Department of National Parks and Wildlife Conservation (DNPWC) report shows that different wildlife species have attacked people for example the buffalo of Koshi Tappu Wildlife Reserve attacked and injured some locals living nearby the reserve while cutting grass in the buffer zone community forest at Kausha. Similarly leopard killed two boys of Kailali VDC of ward no.1in Kaski district. Likewise, nine people have already lost their lives in wild elephant attack during the month of October and November 2006.

A survey conducted in Sunkhani VDC of Nuwakot district estimated economic loss of crop by using questionnaire survey and Net Area Damage (NAD) method to assess crop and livestock depredation. The result of economic loss of crop was around Rs. 554,989 of maize (33.24%), millet (10.14%), wheat (17.35%), paddy (19.5%), mustard (3.39%) and potato (16.2%). The total economic loss of livestock was Rs. 48,355 in Sunkhani VDC and average loss was around Rs. 400 per household. And Wild boar was the main crop raider (Gurung 2002). There are wild boars in all protected areas of Nepal (Jnawali et al. 2011, Thapa 2010, Sapkota et al. 2014) which played vital role in human- wildlife interactions by causing great crop damage (Bajracharya 2005, Barrios-Gracia and Ballari 2012, Linkie et al. 2007, Pandey et al. 2016, Powell 2004, Schley et al.2008). Poudyal (1995) in his study calculated the loss of paddy was 20.6% of total production in Sundarijal Village Development Committee (VDC) adjacent SNNP. Similarly, the total loss of wheat, maize and millet were 30.41%, 35.21% and 47.36% respectively and wild boar destroyed maize, wheat and millet by 85%, 70% and 90% of total loss respectively. In Gokarna, the value of crop damage by NAD method was 50% less than showed by interview and monkey , chital, wild boar, porcupine were

identified as major crop raiders and leopard, jackal, jungle cat and common mongoose as livestock predators (Gurung 1997). Soti (1995) found that the loss of maize was almost 1,000 quintal in Kakani VDC adjacent to SNNP. Similarly, the loss of millet, wheat and paddy were more than 55, 23 and 23 quintals respectively and the wild boar was the main crop raider. A survey conducted by Bajracharya (2005) in three sites (Kakani, Sundarijal and Bajrayogini) showed the total economic loss of crop of almost Rs 492,900 per annum and Rs 18,500 loss per household and Kakani was the most affected area in terms of crop depredation. Along with this, she calculated a loss of Rs 46,360 in livestock predation.

2.2 Preventive methods used to control wildlife damage

Spatial separation of human and wildlife through physical barriers (fences), guards, and repellents are common preventive measures (Goodrich 2010; Karanth and Madhusudan 2002; Treves et al. 2009). Different preventive methods have been used by the local residents living in and around the National Parks. Machan fencing (permanent and temporary), trenches, scare crow, noise making, tools, light, fire, dogs, poison, electric current, etc were used to prevent wildlife from crop and livestock depredation (Adhikari 2009, Bajracharya 2005, Bajracharya 2009). These local preventive methods adopted by farmers are only partially effective (Paneru 2004).

2.3 Perception of local people towards wild animal and park.

Since wild boars were exotic and introduced, local people considered it as a problem introduced entirely by the Reserve management (Poudyal 1995). Due to crop depredation by wild animals, local people have negative attitude towards the park and animal. Besides, crop depredation, grazing due to livestock and human encroachment for fodder and firewood collection were the negative interaction between wild animals and local people (Paneru 2004). According to Adhikari (2005), wildlife visited crop lands due to lack of abundance of food in the protected area, taste of agriculture crops, lack of effective barriers, flood, to change the taste. In addition, people used park for livestock grazing, firewood, thatch-timber, herb collection and fodder collection, poaching, fishing and river poisoning. Bajracharya (2005) also mentioned that local people were illegally using resources like fodder, firewood from SNNP.

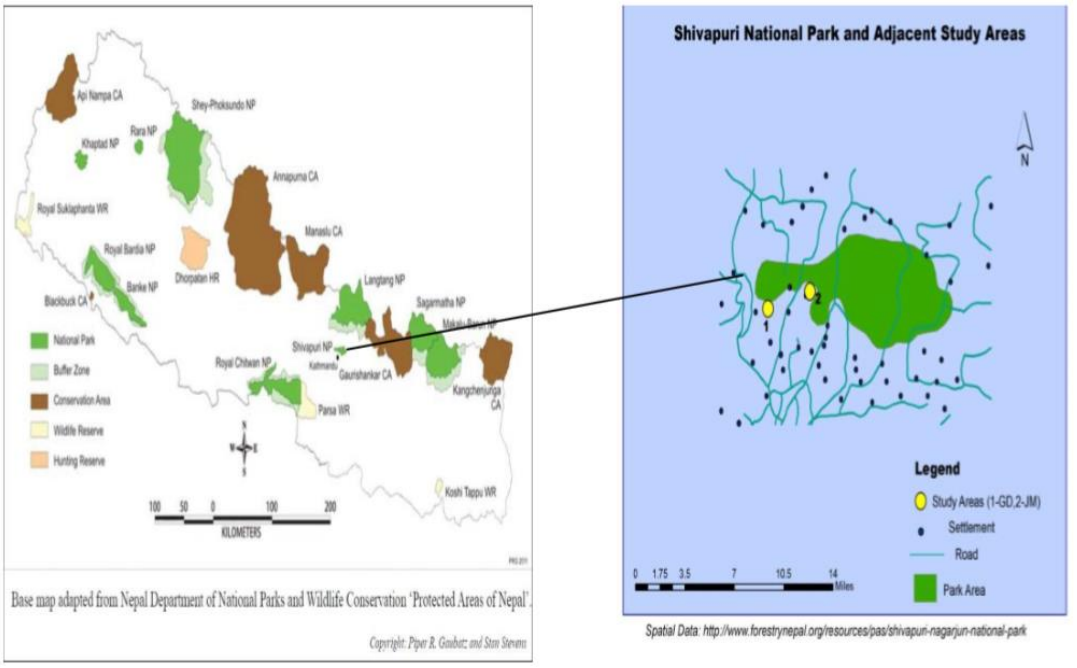

Figure 2.1 Map of Shivapuri Nagarjun National Park and Adjacent Study Areas (http://www.dnpwc.gov.np/index.php)

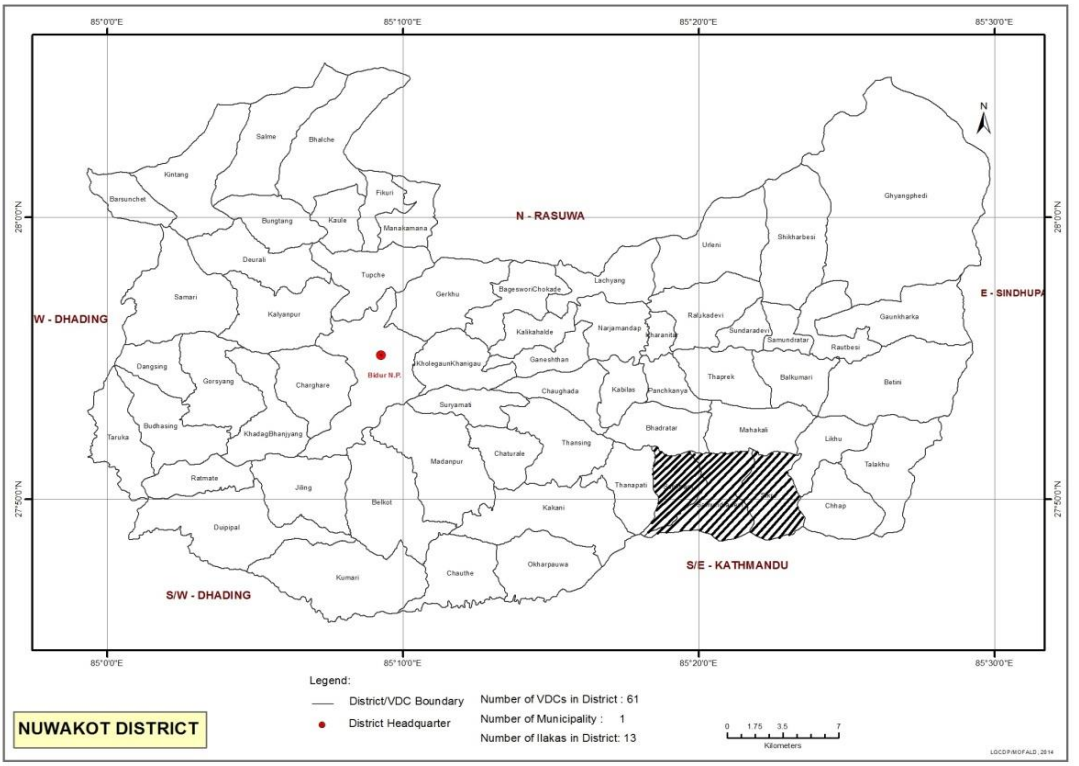

Figure 2.2 Map of Nuwakot district showing Sunkhani, Samundradevi and Sikre VDCs.

3. MATERIALS AND METHODS

3.1 STUDY AREA

3.1.1 Area and Location

Shivapuri Nagarjun National Park elevates up to 2732 m above the sea level. It lies between 27^{o} 45' and 27^{o} 52' North latitude and 85^{o} 15' and 88^{o} 30' East longitude (Shivapuri area) and 27^{o} 43' and 27^{0} 47' North latitude and 85^{0} 13' and 85^{0} 18' East longitude (Nagarjun area) (Figure 2.1).It is the only protected area lying entirely within Nepal's midhills ecosystem. Initially it was established as Shivapuri Watershed Reserve in 1976, then Shivapuri Watershed and Wildlife Reserve in 1984 and later gazetted as National Park in 2002 and in 2009 it was extended to the Nagarjun Forest Reserve. The park covers an area of 159^{2}km (Shivapuri 144^{2}km and Nagarjun 15^{2}km). It is the only park demarcated by a wall of 141km long which runs along 26 former Village Development Committees (VDCs) of Kathmandu, Nuwakot, Sindhupalchowk and Dhading districts. It is the main sources of water for the people of capital city, Kathmandu.

3.1.2 Geology, topography and elevation

Geologically, SNNP falls in the inner Himalayas region of Nepal. Dominant rocks are Gneisis and Magmatite with mica schist and Pegmatic granite. The soils range from loamy sand on the northern side to sandy loam on the southern slope. Soil moisture is higher in the natural forest than in barren area. It has mostly mountainous topography with steep slope of >30 at least in 50% of the total area of the park. Due to the steep topography and the nature of soil, soil erosion is a serious problem particularly in the northern part of the park.

3.1.3 Land use pattern

The land use pattern in and around the SNNP is mostly dominated by 40.7% of forest which is followed by agriculture (35.3%), shrubs (14.8%), grassland (2.9%), grassland with shrubs (2.6%), landslides (0.5%), settlement (0.9%), riverine features (0.2%) and abandoned land (2.0%) (Shivapuri National Park, Management Plan 2004).

3.1.4 Climate and weather

SNNP lies in the central mid-hill region of Nepal and lies in a transition between subtropical and temperate climate. There are three climatic stations at Shivapuri range at Kakani, Sundarijal and Budhanilkantha.

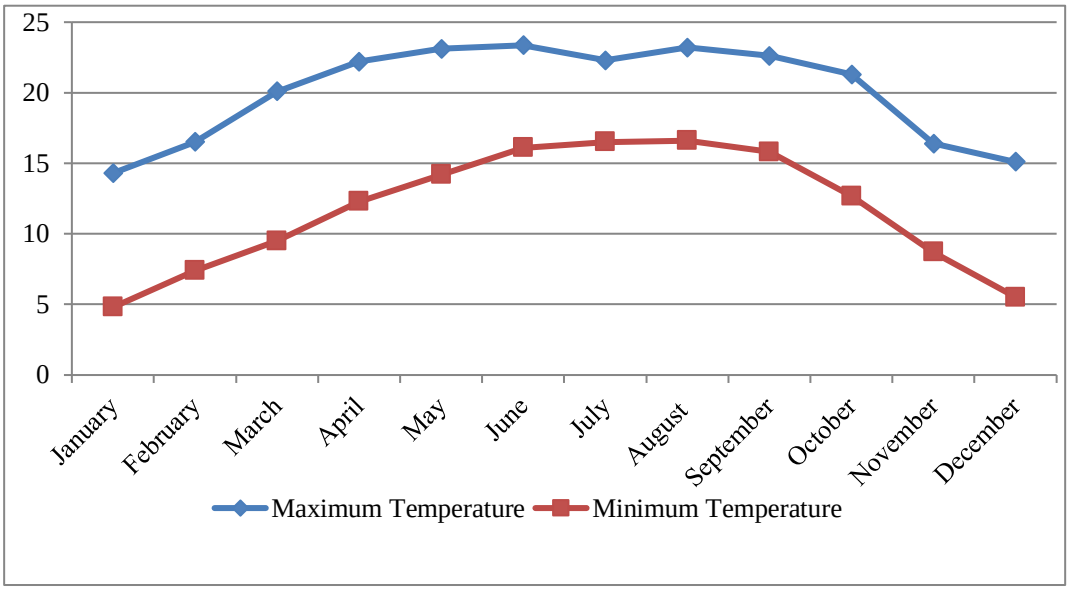

Figure 3.1 Average maximum and minimum temperature (°C) of Kakani Station (

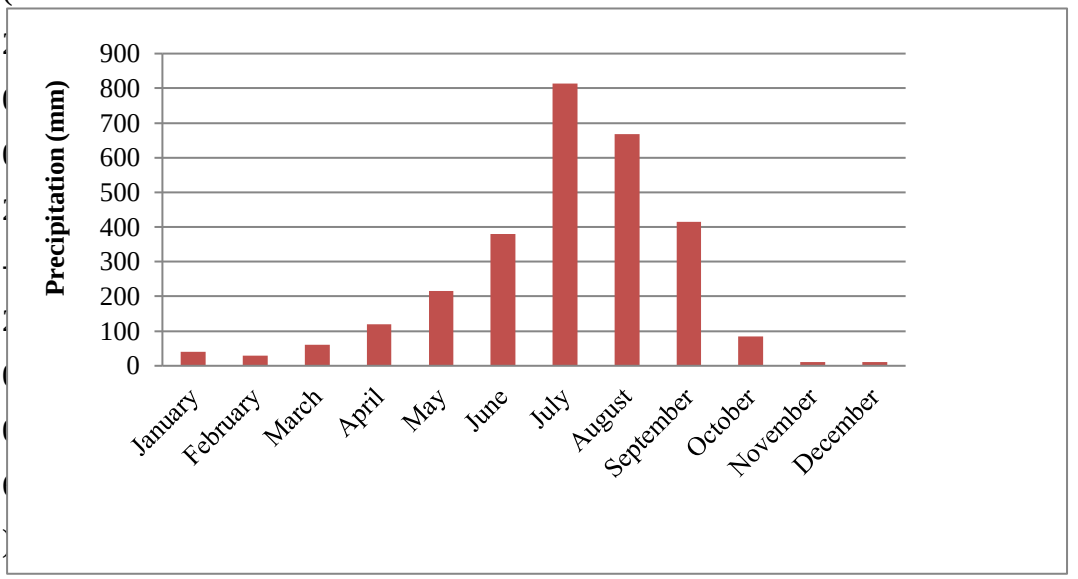

Figure 3.2 Average precipitations (mm) at Kakani Station (2002-2006)

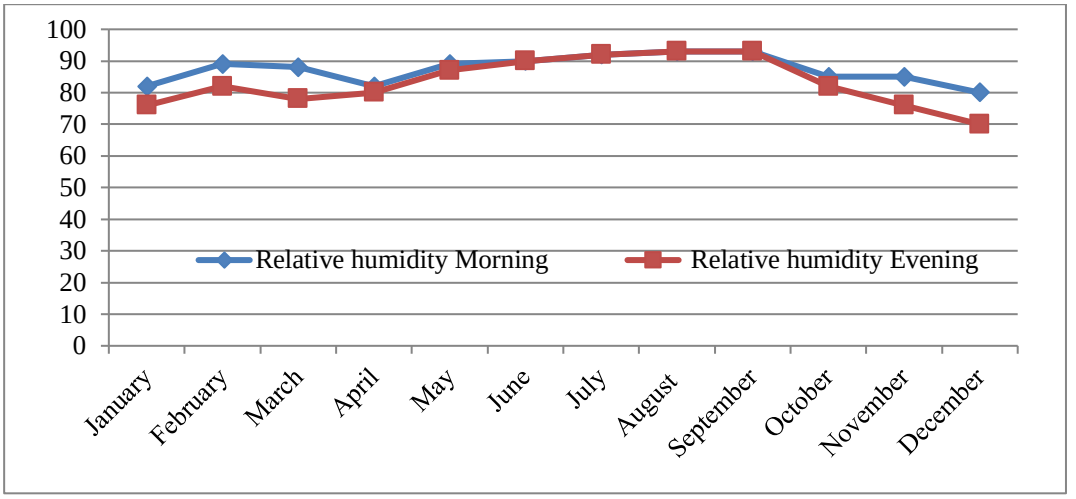

Figure 3.3 Average relative humidity morning and evening (%) at Kakani station (2002-2006)

According to climatic data (2002-2006) of Department of Hydrology and Meteorology, Babarmahal, the maximum temperature at Kakani reached around 23.4 ^{0}c on June and minimum temperature fell around 4.8 ^{0}c on January (Figure 3.1). Likewise, the maximum rainfall in Kakani was on July with about 813.62 mm and minimum rainfall was on November with 6.32mm (Figure 3.2). The mean relative humidity (morning) reached maximum during July to September and the mean relative humidity (evening) reaches maximum during month of July to September (Figure 3.3).

3.1.5 Biological components

The SNNP is very rich in faunal and floral diversity due to its location, altitudinal and climatic variations. There are twenty-one species of mammals out of which nine are threatened (BPP 1995). Some of them are Pangolin (*Manis pentadactyla* Linnaeus), Common Leopard (*Panthera pardus*), Rehsus Monkey (*Macacca mulatta* Zinmermann), Hanuman Langur (*Presbytis entellus*), Himalayan Black Bear (*Selenarctos thibetanus*), Wild Boar (*Sus scrofa* Linnaeus), Jungle Cat (*Felis chaus* Guildenstaedt), Yellow Throated Marten *(Martes flavigula* Boddaert). There are almost more than 2122 species of flora and 16 of them are endemic (Shakya et al. 1997, Shrestha and Joshi 1996). About 129 species of mushroom including *Lactarius pleuritides* have been described from SNNP (BPP 1995). Four different types of forest are found within the park (Amatya 1993). They include Lower mixed hardwood forest, Chir-pine forest, Oak forest and Upper mixed hardwood

forest. A total of 318 bird species have been recorded in SNNP. These includes globally threatened species Cinerous Vulture (*Aegpius monachus* Linnaeus), Grey-sided laughing thrush (*Garrulax caerulattus* Hodgson), Hodgson's Bustichat (*Saxicola insignis* Gray), Oriental Hobby (*Falco sevrus* Horsfield). More than 102 species of butterfly have been recorded from SNNP and its surrounding (Smith 1996). This park is the only habitat for relict Himalayan Dragonfly (*Epipophlebia laidlawi*) in Nepal (HMG/FAO 1996).

3.2 Detailed sampling sites

Among former 26 VDCs, the study was focused on three VDCs Sikre, Samundradevi and Sunkhani (Figure 2.2) of Nuwakot district. Now, these former VDCs lie in Shivapuri Rural Municipality of Province No.3. Among these VDCs, the wards which were included in proposed buffer zone by the SNNP Management Plan 2004 and Nepal Government were selected for the survey. Only 5 wards (1-4,8) of Sikre, 6 wards (1-3, 7-9) of Samundradevi and 2 wards (1,2) of Sunkhani VDCs were included in the proposed buffer zone, so these wards were the main focus of study. These VDCs lies side by side on the northern slope of SNNP and located at $27^0$83' to $27^0$84' northern latitude and $85^0$32' to $85^0$38' eastern longitude. These VDCs are accessible from Budhanilkantha and Jhor Mahankal. There are total 1,603 households and a total population of 7,084 with 3,342 male and 3,742 female (CBS 2011) in the selected three VDCs. During the study period the total households of the focused area was 719 (CBS 2001).Tamang, Chhetri and Gurung are the main ethnic groups of the study area (CBS 2011). Among 719 households, 95 households were surveyed. Maize, millet, paddy, wheat, potatoes and other vegetables are cultivated in the study area. Agriculture, livestock rearing and poultry farming are the main sources of income in these VDCs.

3.3 General methodology

3.3.1 Field survey and observation

The collection of data was done by using both direct and indirect methods. Direct method includes filed survey and observation while indirect methods included questionnaire survey, interview and group discussion. The field survey was conducted in the month of October 2007 in the study area. Details in the study area were conducted from October 2007- August 2008. The data for wild animals and

their damage to crops were obtained from questionnaire survey among the sampled households.

3.3.2 Sample size

Among the selected wards of three VDCs, Sikre, Sunkhani and Samundradevi, the questionnaire survey of total 34 household of Sikre, 50 households of Samundradevi and 11 households of Sunkhani was conducted. Altogether 95 households (compromising 13% of the total 719 households) were selected randomly from boundary wall of park up to 2km. The households were selected according to the accessibility, availability and willingness of the local people.

3.3.3 Questionnaire Survey

The quantitative information was gathered from questionnaire survey from the local people. The structured questionnaires (Annex I and II) were developed to collect primary data. The questionnaires were designed to receive information about the crop damage and other local conflicts due to wild animals. The information about the land abandonment by the local people and the preventive methods used were also obtained from the questionnaire survey. The face to face questionnaire survey was conducted with the head of the household. In the absence of head of the household, the person next to head was interviewed. The present study was mainly focused in four crops like paddy, wheat, maize and millet.

3.4 Data Analysis

After conducting questionnaire survey, data were quantitatively analyzed by using various statistical tools. The total loss of different crops like paddy, wheat, millet and maize by wild animals was estimated in the local scale (e.g. muri, pathi) which was converted into kilogram (kg) by weighing ‘a pathi’ of different crops for three times and concurrent weight were considered as the standard value (Annex III). Price of different crops were obtained from local people, local market of the study area (Annex IV). For calculation of total crop loss, following formula has been used

$XL = XE-XA,$

Where XL = Total loss, XE = Expected production, XA = Actual production

$$\text{Crop loss per household (kg)} = \frac{\text{Total crop loss (kg)}}{\text{Total number of household cultivated that crop}}$$

Total economic loss (Rs) = Price of crop (Rs) × Total crop loss (kg)

Correlation regression between two variables i.e. distances and loss for the major crops (paddy, wheat, millet and maize) was done to see the distance travelled by pest species from the boundary wall and crop loss in weight. As my study area was in three different VDCs, ANOVA- test was used to find out the significance difference in crop loss, land abandonment and the preventive methods used in three different VDCs.

The grouping method was used to analyse the mode for the most common preventive methods used.

4. RESULTS

4.1 Wildlife Damage

4.1.1 Major species for crop depredation and livestock predation

Eight mammalian species were recorded (Table 1.1) in the study area. The most preferred crops were maize, paddy, millet and wheat and the most preferred preys were chicken and goats.

Table 1.1.Wild pest of different crops and livestock and frequency of raiding

Wildlife species	Raid crops/livestock	Preferred crops	Frequency of visiting	Non preferred crops
Wild boar	Maize, Paddy, Yam, Wheat, Arum, Potato, Sweet potato,	Maize, Millet, Potato, Paddy, Wheat	Very Frequent	Radish, Chilly, Ginger, Turmeric
Monkey	Maize, paddy, Wheat, Millet, Soybean, Arum	Maize, paddy, Wheat, Millet	Very Frequent	Garlic
Porcupine	Maize, Soybean	Maize, Soybean	Very Frequent	NK
Bear	Maize	Maize	Rare	NK
Deer	Millet, Paddy	Millet, Paddy	Rare	NK
Leopard	Goat	Goat	Frequent	NK
Jackal	Chicken	Chicken	Rare	NK
Jungle cat	Chicken	Chicken	Frequent	NK

Note: NK = not known, Very Frequent = every day and night during crop season, Frequent = twice a week or once, Rare = once in a month).

Among these, maize was the most preferred crops as they were preferred by the entire pest. So, the loss of maize was higher in all three VDCs. The wild boar was the main crop raider in all VDCs. Monkeys and porcupines also visited frequently in the field while deer and bear were very rare crop raider. Among 95 households surveyed almost 75 respondents complained about the wild boar. Similarly 67, 34, 24 and 21 complained about monkey, porcupine, deer and bear respectively. The

most frequent predators were leopard and jungle cat (Table 1.1) and they mostly preferred goats and chicken. Leopard hunted their prey mostly when they were set free to graze in the forest awhile jungle cats attacked chicken at home. Besides, these cows and buffaloes were rarely killed by leopard.

4.1.2 Total crop loss in Sikre

Out of 34 households surveyed, 29 households cultivated paddy in 12.638 hectare of land. The total expected production was 19,080 ton and loss was 0.306 ton. The crop loss was limited only in the ward number one. Twenty seven households cultivated wheat in 10.712 hectare of land with expectation of 6.293 ton and the actual yield was 6.230 ton with loss of 0.060 ton. Wheat loss also occurred in ward number one. However, maize and millet were cultivated in 34 households in 11.525 hectare of land. The expected yield of the maize and millet were 8.057 ton and 3.780 ton with the loss of 1.295 ton 0.295 ton respectively. I estimated a total economics loss of around 471.85 USD per annum and 13.8 USD per household (Table 1.2). Then maximum loss was followed by paddy, millet, and wheat.

4.1.3 Total crop loss in Samundradevi

Among 50 households surveyed, 33 households cultivated paddy and wheat in the gross of 15.804 ha of land. The loss in paddy and wheat due to crop raiding animals were 3.441 ton and 2.74 ton respectively. The paddy and wheat were not cultivated in ward one and two and only partially in ward nine. However, all households' sown maize and millet in the area of 21.54 hectare of land and the loss were 150.57 ton and 6.291 ton respectively. In this VDC, the total economic loss was 6910.9 USD per annum and 138.2 USD per household (Table 1.2).

4.1.4 Total crop loss in Sunkhani

Only 11 households were surveyed in Sunkhani. Among them, none cultivated paddy and wheat. They cultivated only maize and millet in 15.63 hectare of land and the loss of maize and millet were 3.731 ton and 12.15 ton respectively. The total crop loss estimated was 1106.7 USD per annum and 100.6 USD per household (Table 1.2).

Table 1.2 Loss of agriculture crops due to depredation of wildlife

Name of crops	Sikre		Samundradevi		Sunkhani	
	Loss in weight(ton)	Economics loss(USD)	Loss in weight(ton)	Economics loss(USD)	Loss in weight(ton)	Economics loss(USD)
Paddy	0.306	111.43	3.441	1253.1	-	-
Wheat	0.063	16.52	2.740	718.5	-	-
Maize	1.259	275.2	15.057	3289.9	3.731	815.2
Millet	0.295	68.7	6.291	1649.49	1.251	291.5
Total	1.923	471.85	27.529	6910.9	4.982	1106.

4.1.5 Economic loss and its distribution

The correlation analysis was done to find the degree of correlation between two variables, distance and crop loss in three VDCs for different crops like paddy, maize, wheat and millet. The distance parameter was 0 km to 2 km from the boundary wall of park.

Table 1.3 Correlation between distance and crop loss in three VDCs

Crop types	Name of VDCs					
	Sikre		Samundradevi		Sunkhani	
	Correlation	Remark	Correlation	Remark	Correlation	Remark
Paddy	0.35	Low degree	0.06	Low degree	-	-
Wheat	0.28	Low degree	0.24	Low degree	-	-
Maize	0.50	Moderate	0.12	Low degree	0.27	Low degree
Millet	0.40	Low degree	0.07	Low degree	0.06	Low degree



S

a. View of Sunkhani VDC b. View of Samundradevi VDC


c. View of Sikre VDC d. Questionnaire Survey


e. Paddy with Soybean f. Paddy harvesting


g. Livestock rearing h. Chicken rearing

Plate 4.1 Views of study area and methods used for collections of data

a. Spines of porcupine

b. Crop damaged by wild boar

c. Wild boar in captive

d. Deer raised by local people

e. Scarecrow used for protecting crops

f. ‘Chhapro’ used for night guard

g. Broken wall of the park in Sunkhani VDC

h. Abandoned land in Sunkhani VDC

Plate 4.2 Crop damage, human disturbance and preventive measures used.

The correlation coefficient was found negative in all three VDCs with a value of below than 0.5 except Sikre for maize (Table 1.3) which indicated that there was a low degree for correlation between the distance and crop loss. This showed that there was a higher crop loss nearer the boundary wall and it decreased away from the boundary wall.

Table 1.4 Results of F-test of crops between three VDCs.

Crops	S.S between	S.S within	d.f	m.s	F-cal	F-tab	Remarks
Maize	116495.98	432614.33	2/92	58247.99/4762.32	12.25	3.07	Significant
Millet	30283.71	115011.62	2/92	15141.855/1250.12	12.11	3.07	Significant
Wheat	1804.73	188262.27	2/92	902.36/2046.32	0.44	3.07	Non-Significant
Paddy	4308.46	243984.54	2/92	2154.23/2652	0.81	3.07	Non-Significant

The F-test showed that there was a significance difference in crop loss among three VDCs for maize and millet at 5% level of significance but there was no significance difference in crop loss among three VDCs for paddy and wheat (Table 1.4).

4.1.6 Estimation of livestock depredation by wildlife

The common livestock reared in the study areas were goat, buffalo, cow, sheep and chicken (Figure 1.5) (Plates 4.1). The economic loss of livestock for the last two years (2006-2008) was calculated. The total economic loss of livestock was 51,850 in three VDCs and the common leopard caused the maximum economic loss of Rs 32,400 (Table 1.5).

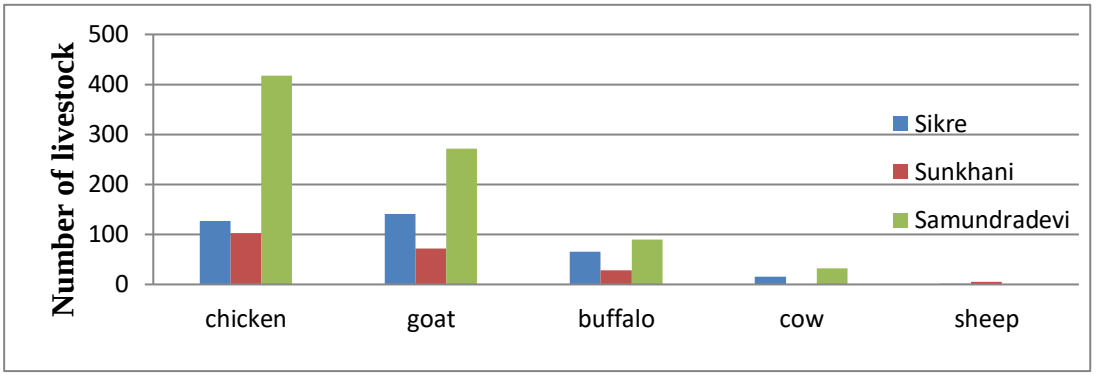

Figure 4.1 Presence of different livestock in three VDCs

Table 1.5 Numbers of livestock lost and the cost in rupees

Name of crops	Livestock					
	Goat		Chicken		Cow	
	Number	Cost(USD)	Number	Cost(USD)	Number	Cost(USD)
Samundradevi	17	297.2	14	91.8	-	-
Sunkhani	5	87.4	2700	39.3	-	-
Sikre	5	87.4	1	6.6	1	145.7
Total	27	472.0	21	137.7	1	145.7

Note: The market price of the livestock was calculated based on village's information during field visit. And then converted to the USD according to NRB (1 USD= Rs 68.65) on 15 August, 2008.

4.1.7 Land Abandonments

The total lands were 12.638 hectare, 15.804 hectare and 15.63 hectare in Sikre, Samundradevi and Sunkhani VDCs of surveyed households (Table 1.6). The abandoned lands among the surveyed households were 2.62 hectare, 5.95 hectare and 2.8 hectare respectively. Almost all abandoned land was sloppy land locally called as 'Bhiralo Pakho bari' (upland), where productivity was very low. There were no abandonment of land in ward three of Sikre VDC and ward numbers seven and eight of Samundradevi VDC.

Table 1.6 Land abandonment in three VDCs

Ward no	Land abandoned in hectare(ha)		
	Sikre	Samundradevi	Sunkhani
1	1.62	1.17	1.52
2	0.10	1.9	1.32
3	-	0.50	-
4	0.61	-	-
8	0.25	-	-
9	-	2.34	-
Total	2.62	5.95	2.8

Table 1.7 Land abandonment due to different reasons in percentage

Reasons for land abandonment	Abandoned land in hectare	Percentage of land abandoned
Wildlife depredation	4.83	10.95%
For meadow/posture	0.61	1.38%
Lack of man power	4.68	10.61%
Lack of proper irrigation	0.72	1.6%
Others-erosion, siltation and gully	0.45	1.02%
Total	11.30	25.63%

Due to different reasons 11.30 ha (25.63%) of land was abandoned among the total land 44.072 ha of the sampled households (Table 1.7). Among them the major causes of abandonment of land was due to wildlife damage (10.95%) and lack of man power (10.61%). Similarly, due to lack of proper irrigation (1.6%), meadow/posture (1.38%), and due to natural factor like erosion, gully, siltation (1.02%) of lands are abandoned. Twelve ropanis of land in ward number two of

Sunkhani VDC are abandoned in huge patch for the artificial meadow while other abandoned land were scattered. The most abandoned lands were sloppy and nearer the boundary of wall of SNNP.

Table 1.8 Results of F-test for land abandonment in three VDCs

Land abandoned	S.S between	S.S within	d.f	M. S	F-ratio calculated	F-ratio tabulated	Remarks
	338	1789.25	2/7	169/255.6	0.661	4.74	Accepted

The F-test showed that there was no significance difference in lands abandoned in three different VDCs (Table 1.8).

4.2 Preventive methods

Different methods were applied by the locals to prevent the crop loss from wild animals (Table 1.9). Among the techniques the popular one was day night guard on the wood constructed locally called 'Chhapro' (Plates 4.2). Sound production and chasing was second most applied techniques.

Table 1.9 Techniques of prevention for crop and livestock depredation

Preventive methods	Users	Users (%)
Day-night guard	58	61.05%
Sound production and chasing	55	57.89%
Drumming	49	51.57%
Dog watch	9	9.47%
Traps	5	5.26%
Fence/Current	3	3.15%
Poisoning	2	2.10%

The F-test showed that there is no significance difference in the methods of preventive measure used in three VDCs (Table 1.10).

Table 1.10 Results of F-test for preventive methods used in three VDCs

Preventive methods	S.S between	S.S within	d.f	M.S	F – Cal	F- Tab
	-825.14	5263.14	2/18	-412.57/292.39	-1.41	3.55

4.3 Perception of local people on wildlife and park

The questionnaire survey showed more than 58.50% of the local knew that wildlife killing was illegal. However some cases of illegal activities such as killing of porcupine, capturing and rearing of wild boar, and raising of a calf deer were found in Sikre and Samundradevi VDCs (Plates 4.2). Only about 33% of respondents showed positive behaviour towards the animal protection and about 12% showed strong positive behaviour and about 33% and 12% of respondents showed negative and strong negative behaviour towards the Park's animals. They were in favour of killing the wild animal especially wild boar which damaged their crops. More than 45% of respondents advocated that they used forest for resource utilization like firewood, fodder, timber etc.

5. DISCUSSION

5.1 Crop and livestock depredation

Soti (1995) estimated the total loss of Rs.11, 59,999.45 in Kakani VDC. Bajracharya (2005) estimated the total loss of Rs. 5, 03,655.90 in Kakani, Sundarijal and Bajrayogini VDCs. Gurung (2002) estimated the total economic loss of Rs. 5, 54,989.31 and average loss of Rs. 4,586.68 per household in all the wards of Sunkhani VDC. The difference may be due to the price rise during the study years and also due to the study area. Poudyal (1995) in adjoining VDCs of the SNNP calculated the percentage of millet loss was higher that other crops like maize, wheat and paddy. Purkoit (2008) estimated the total economic loss of Rs. 3, 51,618.74 per annum in Sundarijal VDC due to crop depredation by wild pests. A recent study (Pandey et al. 2016) on Thanapati VDC estimated approximately US$ 24,000 lost to wildlife damage annually.

From the present study, it was found that wild boar was a main crop raider. About 74.37 of the respondents complained about wild boar. The other crop raiders were monkey, porcupine, deer and bear. Wild boar has been described as the most notorious and destructive animal among the other wild animals. (Paneru 2004, Poudyal 1995 and Soti 1995) also found wild bear as the main crop raider in Sunkhani (VDC) along with porcupine, monkey, bear, deer and other birds. The crop loss was more near the park boundary. A recent study on wild boar habitat use and movement pattern in Europe (Thurfjell et al. 2009) indicates that wild boars often move towards agriculture field and crop damage is more severe along forest edges (Linkie et al. 2007). The main crops were damaged near the forest edges in Thanapati VDC (Pandey et al. 2016). Gurung (1997) found monkey, chital, wild boar and porcupine as major crop raiders around Gokarna forest. General lack of active defence of crop fields and less height of boundary wall had offered easy opportunities for wildlife to raid the crops because crop fields were often fully unprotected, frequently far from villages and located on forest edges. Thus, they were highly vulnerable to crop raiding by a variety of animals. The park offers have as agreed with this reason to some extend and added that habitat of wild animals to change the food taste during different seasons was also another cause for wild animals coming out from the park. Due to the lack of preferred food inside the park of wild animals move towards the agricultural fields which were due to

livestock, grazing collection of fodder and firewood and harvesting of timber by the locals.

Besides crop raiding, some isolated cases of livestock depredation by wild animals were also reported in the study area. Studies showed common leopard and jungle cat as major predators for livestock (goat, cattle). Likewise, (Purkoit 2008) identified leopard and jungle cats as major predator for livestock in Sundarijal VDC. Bajracharya (2005) also estimated an economic loss of Rs 46,300 of livestock in three VDCs of SNNP. She also identified leopard, jackal and jungle ca as livestock depredator. Gurung (2002) estimated total economic loss of Rs. 48,355 and average loss of 399.62 per household in all wards of Sunkhani VDC and the total economic loss of livestock due to wildlife in Sunkhani ward number one and two was Rs. 8,700 and Rs. 790.90 per household. The difference in the estimation may be due to price difference then and now. Gurung (2002) found a case of wildlife attack to human in Sunkhani VDC. A five year old daughter of Bharat Tamang was killed by a leopard inside the house (Gurung 2002). This was a very rare case; I did not record any such incident in the area because the destruction of even small forest area can push certain species into core areas where there is less or no disturbance (Wilson 1998).

A total of 11.30 hectare of land was abandoned in Sikre, Samundradevi and Sunkhani VDCs. Adhikari (2009) concluded that 6.286% of land was abandoned in Nayapati and Gagalphedi VDCS. Similarly, 15% and 5% of total land was abandoned in Kavresthali and Sangla VDCs (Bajracharya 2009). According to HMG/FAO (1996), some people in northern part have abandoned more than 15 % of the cultivated land because of wildlife crop damage. There was no maintenance of the broken wall which indicated lack of effective conservation management of the park. New generations had tendency to leave their parents for other opportunities, due to which there arise a problem of lack of manpower, Due to the lack of manpower, more than 10.61 % of land has been abandoned. Beside these, there were a number of other reasons if other causes including migration to urban areas for better life, lack of irrigation, sandy soil siltation and gully erosion.

5.2 Preventive methods

The local people had adopted different techniques for crop protection from wild animals like shouting, guarding, dog watch, catapult poisoning and fencing / applying current. Kattle (1993) recorded using traps/snares, digging pits and hire hunters as means of preventing wildlife crop raiding. But nowadays hiring hunters to kill wildlife are not allowed. Bajracharya (2005) recorded using different methods for preventing of crops and livestock depredation. The different methods for prevention of crop depredation and livestock predation like shouting, guarding, dog watch, catapult and flags were used (Adhikari 2009, Bajracharya 2005, Bajracharya 2009, Thapa 2010, Sapkota et al. 2014). The day night guarding was labour intensive and one had to give their whole night sleep. The local people reported many complaints about crop loss in the SNNP office. However, all the villagers expressed their dissatisfaction against the park authorities for not taking any action in favour of their complaints. There was no compensation given to the local people whose livestock had been lost due to park animals.

5.3 Perception of local people on park and wildlife

The local people living in and around the National Parks and protected areas have built an ecological relationship with the park, where as in certain cases the existence of their observation areas has been questions because of growing conflict over different mattes. People of the study area were largely dependent on the forest resources like fodder, firewood, timber and bedding materials. More than forty five percentage of households used forest for resource utilization. Unlike, some people have claimed that a decision to establish park and protective areas has pushed the livelihood of the local people who were depending on the forest resources towards more vulnerability (Phuyal 2003). Despite the crop depredation and livestock predation, 81% of households among 777 households around five protected areas in India and Nepal were positive towards the existence and importance of the protected areas as long as their livelihood needs are met (Karanth and Nepal 2012).

6. CONCLUSIONS AND RECOMMENDATIONS

The study conducted during October 2007 – August 2008 in the three adjoining VDCs (Sikre, Sunkhani and Samundradevi) of Shivapuri Nagarjun National Park showed eight mammalian species involved in human-wildlife conflict. Crop depredation was the major problem affecting the local people along with livestock predation particularly living adjacent to the SNNP. Wild boar, porcupine and monkey were the main crop raiders in all three VDCs. About 59% of the respondents knew that wildlife killing was illegal and only 12% of the local people had negative attitude towards the wildlife protection. But every respondent had negative feelings towards wild boar and suggested to remove them from the SNNP. The collection of firewood, fodder, timber, bedding materials and livestock grazing inside the Park were the main issues of conflict between the locals and the parks. These activities damaged the park resources and jeopardized the accomplishment of the set objectives of the park management. The participation of the local people in biodiversity conservation was important particularly in designated adjacent area as buffer zone to maintain the wildlife habitat intact and to meet the legitimate and growing need of the local people on sustainable basis.

The present study derives following recommendations:

a. Extensive research on population status of crop depredating animals and carrying capacity of SNNP in terms of food and space availability should be urgently required.
b. Unpalatable crops should be introduced in damaged areas to minimize the level of conflicts created due to crop loss. Before introducing such crops to local farmers, their demand and profit level should be studied which will be helpful to uplift the economy condition of the local people.
c. Aware the local people by launching different programs from Government, NGO or INGO about importance and necessities of conservation and protected areas for the benefits of people and wildlife as well and local people should be taken as helping hands rather than opponents.

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8. ANNEXES

I. INDIVIDUAL QUESTIONNAIRE SURVEY FOR WILD MAMMAL

(Ratee Shrestha 2007/2008)

Date: ..... Serial No: ..... Name: ..... Age: .....

VDC: ..... Ward No: ..... Education: ..... Occupation: .....

1. What wild animals have you seen in southern side of Shivapuri National Park?

S.No	Name of mammal species	Frequency of Raiding	Abundance	Location	Remarks
1.	Barking deer				
2.	Wild boar				
3.	Common leopard				
4.	Clouded leopard				
5.	Jungle cat				
6.	Leopard cat				
7.	Large civet				
8.	Himalayan black bear				
9.	Hanuman languor				
10.	Rhesus monkey				
11.	Himalayan Goral				
12.	Brown-toothed shrew				
13.	Chinese pangolin				
14.	Fawn coloured mouse				
15.	Golden jackal				
16.	Himalayan Squirrel				
17.	House rat				
18.	Indian Hare				
19.	Porcupine				
20.	Royal's pica				
21.	Small Indian mongoose				
22.	Yellow throated marten				

II. QUESTIONNAIRE FOR HOUSEHOLD SURVEY

(Ratee Shrestha 2007/2008)

Name: ..... Age: ..... Sex: .....

Occupation: ..... VDC: ..... Ward No: .....

Education: .....

1. How much land do you own? (Ropani / Anna)

   Khet..... Bari.....

2. How far is your land from the Park boundary? .....

3. Do the wild animals of the Park raid in your land (Yes/No). If yes.....

Which wildlife	Raid crops	Most preferred crops	Time of raiding	Unpreferred crops	Frequency of visit
Wild boar					
Monkey					
Porcupine					

4. Which crops do you grow in your land? And what is their average yield?

Crop types	Season	Expected yield	Actual yield	Loss due to wildlife	Damage stage
Paddy					
Wheat					
Maize					
Millet					

5. Have you abandoned any land due to wildlife? If yes how much..... and the land is either productive or not?
   a. .....
   b. .....
   c. .....

6. What are the main livelihood options?

S.No.	Types of livestock	Numbers
1.	Cow	
2.	Buffalo	
3.	Goat	
4.	Chicken	
5.	Duck	

7. How you raised your livestock?
   a. Stall feeding
   b. Open grazing with attendant
   c. Open grazing without attendant
8. Do you compensation for the crop loss from the park?
9. What are the preventive measures you are using to control the wildlife damage?
   a. Guarding day night
   b. Use of wire flames
   c. Dog watch
   d. Sound producing and chasing
   e. Pit construction
   f. Trap
10. Are these techniques effective?
11. Are these techniques effective?

12. How did you know the crop damage by wild animals?
    a. Footprint
    b. Faces
    c. Damage pattern
13. Where do you complain this problem?
14. Do you have community forest?
    a. Yes
    b. No
15. In your view why do the animals from the Park enter the crop field?
    a. Low quality of boundary wall
    b. Open fencing
    c. Inadequate food inside the park
    d. Liking of field crop
16. What do you suggest to control this problem?
    a. Translocation of the animal
    b. Compensation
    c. Others
17. Do you enter the Park Forest for fodder, firewood and timber?
18. What are the impacts of this National Park in your livelihood?
19. What would you like to suggest give for the Park Management?

III. UNIT CONVERSION

1 Ropani = 0.0523076 Hectare

1 Muri = 20 pathi

Paddy = 1 pathi = 3 Kg

Wheat = 1 pathi = 3.5 Kg

Maize = 1 pathi = 3.5 Kg

Millet = 1 pathi = 3 Kg

IV. MONETARY VALUE OF DIFFERENT CROPS FROM LOCAL MARKET IN THE STUDY AREA (2007/2008)

1 Kg of paddy = Rs 25

1 Kg of wheat = Rs 18

1 Kg of maize = Rs 18

1 Kg of millet = Rs 17.50