Understanding Biodiversity Conservation: Buffer Zone Resources and Land Use Change in Argayuli VDC of Chitwan National Park, Nepal

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Key words: Buffer Zone, Community Forest, land use change, Biodiversity Conservation

SUMMARY:

Study included socio-economic characteristics, biodiversity assessment and land use of Argayuli Buffer Zone VDC of Chitwan National Park where information from 70 households based on random design, was gathered to tie up with vegetation ecology. The study forecast the socio-economic status of buffer zone households where deficit is mainly managed through remittance and wage labor. About 48.6% of the households faced food deficit and 15.7% did not have food even for a month, suggesting widespread poverty. Though forest area in Argayuli VDC increased by 12.71% between 1978 and 1992, buffer zone forest can only sustainably fulfill 32% of fuel wood and 0.9% of green fodder annually suggesting dependency on national forest and park. People extract 47.36% fuel wood and 16.03% fodder demand from buffer zone forest indicating over harvesting of resources. Rhinos were considered the most destructive animal in poverty-stricken area as they damage crops all-round the year, threatening their subsistence that made local people behave adversely on park and park management. Besides, invasive species, Mikania micrantha inside community forest indicated the wildlife habitat may get deteriorated.

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1. INTRODUCTION

In the global context of biodiversity richness, Nepal is believed to be in twenty-fifth position (Budhathoki, 2003). Such repository of biodiversity carries both national and international significance. Despite being rich in biological diversity and natural splendors, Nepal faces some of the most serious conservation threats besetting any nation in the world today (DNPWC, 2004-2005). The root cause of being world's biodiversity under threat is due to poverty, social change and lack of government capacity, as to the more obvious proximate causes, including habitat loss, invasive species and pollution (Wood et. al, 2000).

Chitwan National Park ($27^0$28' to $27^0$70' North latitude and $83^0$83' to $84^0$77' East longitude) is the oldest national park in Nepal, situated in the inner Terai lowland of South Central Nepal. UNESCO designated the Park as a World Heritage Site under the World Heritage Convention, recognizing its unique biological resources (DNPWC, 2000). During its establishment, Chitwan National Park had an area of 544 km^2 which was extended to 932 km^2 in 1978/1979. However, the GIS study showed the park occupies 1182 km^2 area and buffer zone covers 767 km^2 (Aryal, 2005; DNPWC, 2000). This park is considered as one of the highly diversified and most studied national parks in the Asia (Joshi, 2003). Over six hundred plant species have been recorded from the Chitwan National Park (Annual report, 2005). The Chitwan National Park is equally rich in fauna (Aryal, 2005) as it is home to over 50 species of mammals including globally endangered species like Greater One horned Rhinoceros (*Rhinoceros unicornis*), Asiatic Elephant (*Elephas maximus*), Bengal tiger (*Panthera tigris*), Four horned Antelope (*Tetracerous qaudricorinis*) etc (Aryal, 2005; DNPWC, 2004).

Area surrounding park or reserve, encompassing forest, agriculture lands, settlements, cultural heritages, village open spaces and other landuse forms has been considered as buffer zone. The buffer zone forests function as an extended habitat for animals from the park and serves as the main sources of fuelwood and fodder for the buffer zone community (DNPWC, 2003).

Greater one horned rhinoceros (*Rhinoceros unicornis*) is considered as one of the flagship species of Nepal and is listed as critically endangered in IUCN red data book (KMTNC, 2003; Dinerstein and Price, 1991). Government of Nepal has approved Rhino Conservation Action Plan (2006-2011) which could be a significant step for conservation of rhino in Nepal. Considering its endangered status, the rhino is listed in Appendix I of CITES (Convention on International Trade of Endangered Flora and Fauna) which is widely poached as their horns are believed to bear exceptional values in oriental medicine (Adhikari, 2002).

2. Rationale of the Study

Appreciable number of research on ecology has been conducted. Likewise in-depth study about buffer zone settlement and their economics are completed (Paudel, 2004). However these two have been rarely interfaced to determine what causes risks to the biodiversity and rhino poaching. This study intends to focus on the role of buffer zone community based conservation including estimation of demand and supply of resources to sustain livelihood of people. It will also focus on possible threats on rhino conservation in the park.

3. Objectives

The study is focused on:

- To analyze the vegetation of Argayuli Buffer Zone Community Forest.
- To determine the Socio-economic status of households of Argayuli, Buffer Zone VDC.
- To find out the need and supply of forest resources in the Argayuli Buffer Zone VDC.
- To study the land use change pattern in Argayuli Buffer Zone VDC.
- To study the incidence of rhino occurrence and involvement of Argyauli Buffer Zone VDC people in Rhino poaching activities in the past and at present context.

4. Limitation of the study

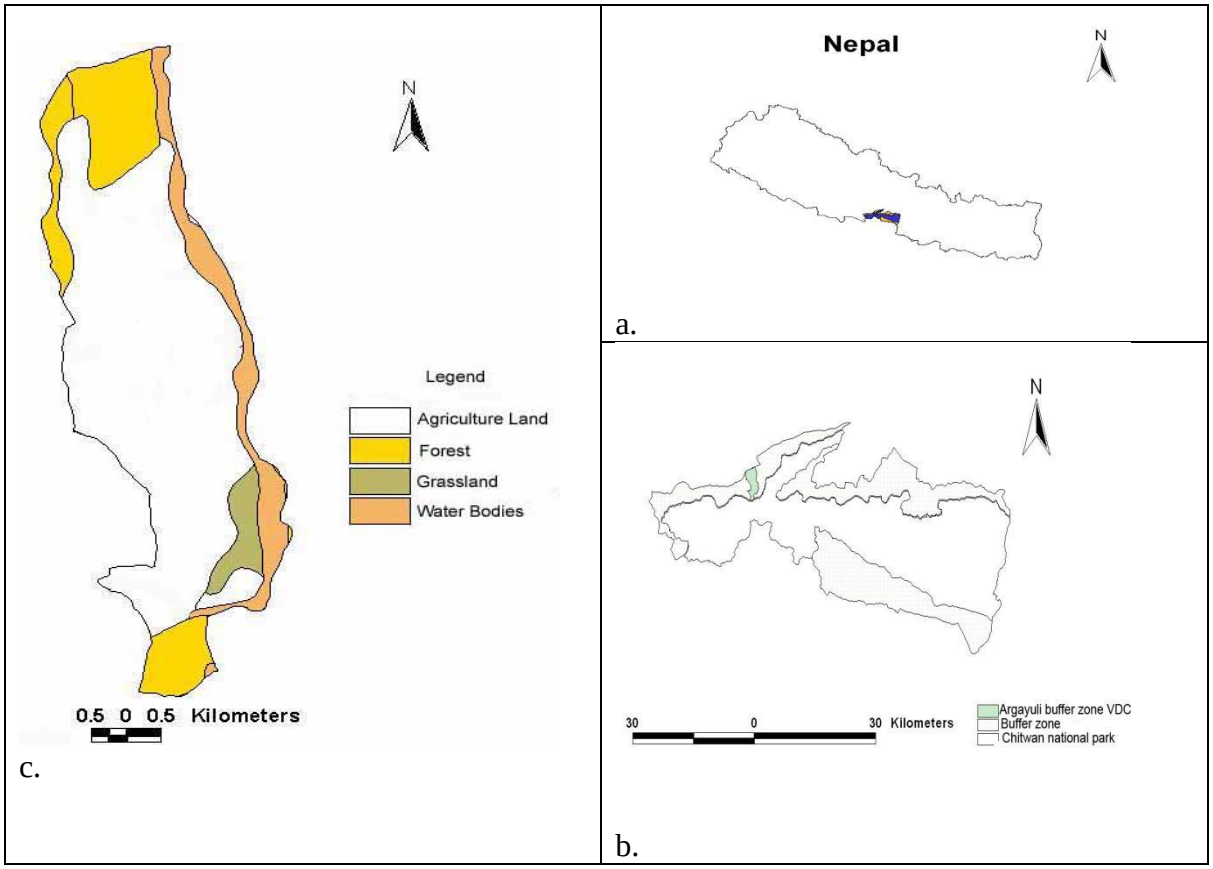
- Due to lack of recent map, the landuse change is estimated based on 1978 and 1992 data.
- Though the study area was very large, only 70 households out of 1065 households were surveyed which cover just 6% of the total households.
- Secondary data was used for rhino related issues. The information from the household survey using questionnaire and the published and unpublished data from various sources were used in case of rhino issue.

5. STUDY AREA

The buffer zone of Chitwan National Park is divided into four sectors namely, East Sauraha sector with 6 VDCs and 1 municipality, Central Kasara sector with 7 VDCs and 1 municipality, west Amaltari sector with 15 VDCs and south Madi sector with 6 VDCs. Argayuli VDC where the study was conducted, is one of the buffer zone VDCs of Chitwan National Park, which lies in the west Amaltari sector, Nawalparasi district, Nepal. The total area of the VDC is 1467.5 ha, which consists of 1065 households with total population 6865 and there are 30 user groups (DNPWC/PPP, 2000). The climate of Nawalparasi is tropical and sub tropical with maximum annual rainfall 1588.4 mm/yr and minimum annual rainfall 205 mm/yr. The maximum temperature of this district is 28.9^{o}C and minimum temperature is 20.5^{o}C (Ghimire, 1999).

Argayuli VDC is bordered by east-west highway in the north, Narayani River in the south, Kawasoti VDC in the east and Kumarworti VDC in the west. Although there are 9 wards in the VDC, only 8 wards are included in the buffer zone. There is one proposed community forest namely Gundrahi community forest. Buffer zone people are using national forest as well which lies outside the buffer zone to fulfill their needs.

Map 1: Location of Study area; a. Nepal and Chitwan National Park, b. Location of Argayuli VDC, CNP c. Study area (Argayuli VDC)



6. METHODOLOGY

6.1 Household Socioeconomic survey

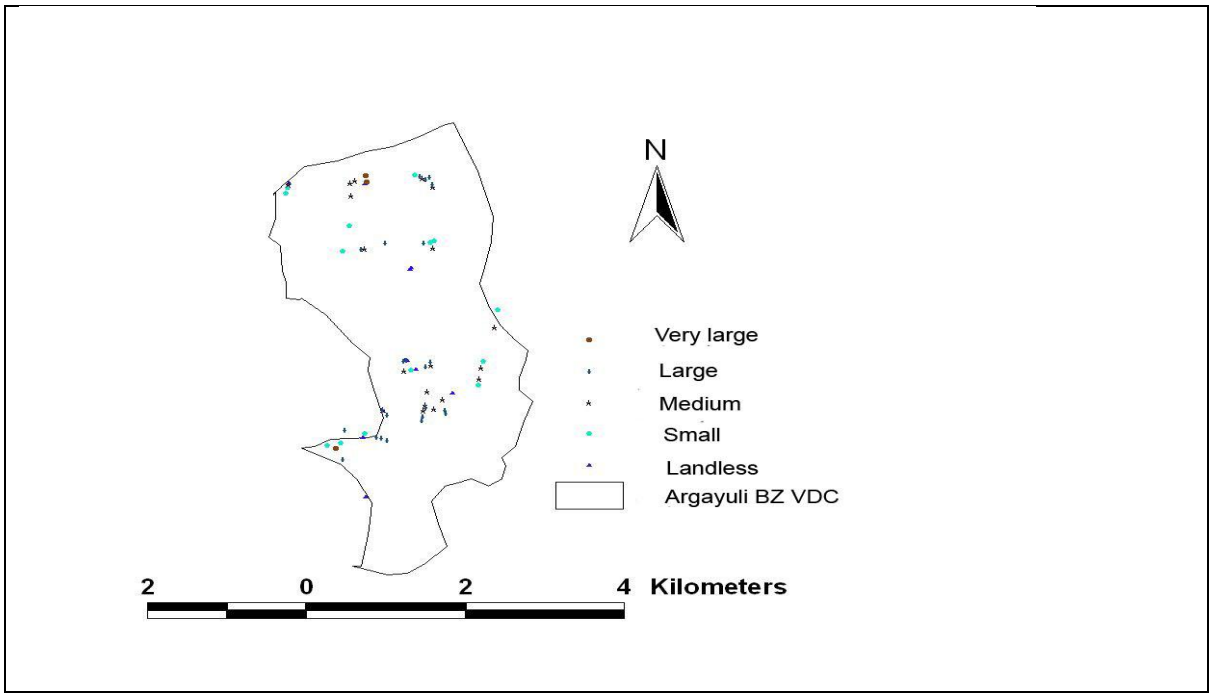
This survey was conducted to determine the socioeconomic status, farm size and condition, livestock, forest resources (fuel wood and fodder) need and access, alternative energy, income and expenditure, rhino and other wildlife issues in Argayuli buffer zone VDC during May-June 2007. For household socioeconomic survey of Argayuli VDC, all wards of the VDC within buffer zone were included. Stratified random sampling method was applied for the survey on the basis of settlement size which was based on population size and land holding of household (DNPWC/PPP, 2000).

The sample size was determined before going to the study area on the basis of data provided by PPP, 2000. The sample size for 1065 households at study area was found to be 70 households by using formula adopted by Arkin and Colton (1963) and used by Paudyal (2000). The sample households for questionnaire survey were selected by lottery method.

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

Where, n = sample size
N = total number of households
Z = confidence level (at 95% level z = 1.96)
P = estimated population proportion (0.05, this maximize the sample size)
d = error limit of 5% (0.05

Map 2: Distribution of sampled households included in the survey



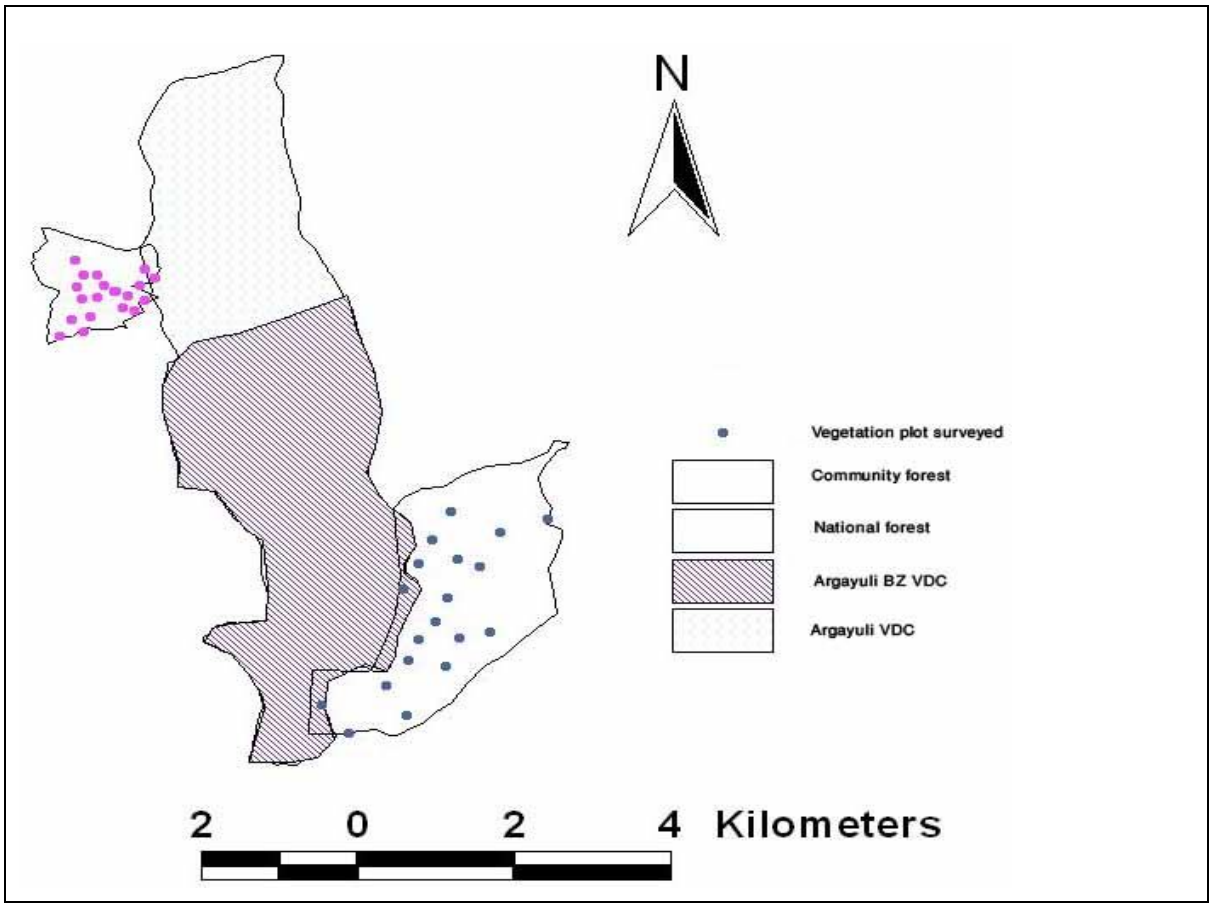
Data Analysis
The collected data from the field were entered in the data sheet of Microsoft Excel 2003 program of computer. Some calculations were made through this program and for other necessary calculations; these data were exported to SPSS-13 (Statistical Program for Social Survey).

6.2 Vegetation Survey
This vegetation survey was conducted to quantify annual yield especially fuelwood and fodder supply from the forest.

Survey Design and Sampling
Latitude and longitude of forest boundary was collected using GPS (GPS model: etrex, Garmin USA) and then boundary map of forest was prepared by using Arc-GIS with the help of GIS expert in which random points were generated at a fixed distance. The latitude and longitude

of these random points were noted with the help of GPS and the points were located in the field. Vegetation survey was carried out in 21 locations at buffer zone community forest and 22 locations at national forest which is located outside the buffer zone (Map 3). Since old map of VDC was provided, while overlaying the recent map of community forest, seems to be present outside of the VDC. But in fact, community forest lies inside the buffer zone VDC in current situation.

Map 2 Distribution of vegetation sample plots in the forest



Each sampling plot was designed to be surveyed through quadrat method. At each sampling plot, all together 5 plots were laid. First plot was of 20x20 m^2 shaped for tree species. 5x5 m^2 in two diagonally opposite corners were laid within northwest and southeast directions of 20x20 m^2 for shrub stratum. Similarly 1x1 m^2 plots nested within shrub stratum were laid for herb stratum.

All tree species having dbh > 10 cm were measured within 20x20 m^2 plot. Diameter and height of all trees were measured with the help of DBH tape and clinometers respectively. Crown coverage percentage of trees within the sampling plots was estimated occularly. Saplings/Shrubs (diameter < 10cm and height > 10cm) of all the obtained species were

recorded within shrub stratum. Similarly, Seedlings/Herbs (height < 10cm) of all the obtained species were recorded in herb stratum (Rijal, 2003). Number of cut stump of tree species with height and diameter at top usually about 0.75m above ground and lopping intensity of tree species were noted in each plot

Estimate of Annual Yield

Stem Annual Yield = Stem Biomass × Percent yield
Branch Annual Yield = Branch Biomass × Percent yield
Foliage Annual Yield = Leaf Biomass × Percent yield

Where, Percent Yield is obtained from Forestry sector Master Plan, 1988 (HMG, 1988 a), as shown in Table 1 for the TMHF and Sal forests.

Sustainable fuel wood yield and sustainable green fodder yield were also calculated following Zobel et.al (1987) and Odum (1996). Fodder yield from buffer zone forest was calculated on the basis of Total Digestible Nutrient (TDN) yields for various categories of land as mentioned in MPFSN (HMG/N, 1988 b) as the yield from leaf biomass can only be used as fodder if the tree is fodder species (Table 2). Density, Relative Density, Frequency, Relative Frequency, Basal Area, Relative Basal Area, Coverage, Relative coverage, Importance Value Index (IVI) and Diversity Index were calculated for tree, shrub and herb stratum. For regeneration of tree species, height classes were also measured (Rijal, 2003).

Table 1: Growing stock and annual yield (tons/ha) in the natural forest of Terai regions of Western Development Region, Nepal (Source: HMG, 1988 a)

Forest	Forest Biomass (t/ha)			Annual Yield (t/ha)			Percentage Yield (%)		
Type	Stem	Branch	Leaf	Stem	Branch	Leaf	Stem	Branch	Leaf
TMHF	64.34	41.41	2.86	3.28	2.08	0.15	5.09	5.02	5.24
Sal	80.32	30.89	5.43	4.33	1.66	0.29	5.39	5.37	5.34

THMF = Terai Mixed Hardwood forest

Table 2: FODDER YIELD FROM VARIOUS LAND CATEGORIES (Source: HMG, 1988 b)

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

6.3 Landuse change pattern

To study the land use change pattern of Argayuli buffer zone VDC, LRMP-data (1978) and FINNIDA maps (1992) were used. The map were digitized and prepared in the assistance of GIS expert through Arc-GIS software. The data was analysed using ESRI's software's, Arc info 3.5.2 and Arc view 3.2. From the overlay map of landuse between 1978-1992, each category of land use of 1978 was compared with the land use of 1992 and the net gain and loss within the period of 1978-1992 was studied.

6.4 Rhino Related study

Primary and Secondary data were collected to get information regarding rhino related poaching in the VDC. Primary data were collected through interview. Secondary information was collected from data base of relevant organization on rhino poaching.

7. RESULT AND DISCUSSION

7.1 Household well being

The result showed that Indigenous Tharu were dominant ethnic groups followed by hill migrants Brahmin/Chhetri. Though the significant percentage of households population were educated (42.9%), dominancy were illiterate. The major occupation of the population was agriculture (82.9%) which was less than whole buffer zone VDC level (100%) given by DNPWC/PPP, 2000 and (89.9%) given by Joshi 1999 and the major crops grown by them were paddy, maize and oil seed followed by wheat, pulse and vegetables. In the VDC, 48.6% of households faced food deficit problem and 15.7% of households did not have food even for a month. The deficit households managed their demand mainly by foreign earning which is not the program of buffer zone, wage labour and so on. 4% of the household used their community forest for fodder and 66% of the household used for fuel wood purpose.

7.2 Vegetation Analysis

16 different tree species were recorded in the buffer zone community forest which is of riverine type having more common species *Trewia nudiflora* and *Mallotus phillipensis*. The density of *Shorea robusta* in the national forest was 78.4/ha which was less compared to study carried out by Rijal, 2006 in Shaktikhor-3 (464/ha) and Shaktikhor-4 (495/ha), Chitwan, Nepal and Straede et al., 2002 in Chitwan Nepal (175/ha). 18.7% of stands are of timber category and 73.7% stand of trees are of sapling category in community forest where as in national forest 4% of stands are of timber category and majority 95.9% stand of trees are of sapling category.

The total shrub stratum density of national sal forest (25390.9/ha) was less as compared to the value given by Rijal, 2006 in Shaktikhor-3 and 4, Chitwan, Nepal (145556/ha and 118760/ha respectively) and also to the value given by Straede et al 2002 in Chitwan, Nepal (120000/ha). Among these species, the frequency of *Murraya koenigii* was found to be highest in the community forest which was highest as compared to the study carried by KMTNC, 2003 in the Barandabhar Corridor forest (0.02%). The understory of *Murraya koenigii* and *Callicarpa macrophylla* provide shelter to the greater one-horned rhinoceros (*Rhinoceros unicornis*), the latter species being a preferred food plant of the animal during the winter (Gyawali, 1986). In

national forest, *Shorea robusta* were the most frequent species having greater coverage and IVI value followed by *Sapium insigne, Dioscoria deltoida* species.

The total density of herb stratum in national forest (175454.5/ha) was also less as compared to the value given by Rijal, 2006 (262778/ha and 210600/ha) in Shaktikhor-3 and 4, Chitwan, Nepal respectively. Among these species, *Trifolium repens* was the most dominant, frequent having greater percentage of coverage and IVI value in community forest where as in national forest, *Imperata cylindrica* was highly dominant, frequent having higher value of coverage and IVI. The habitat of community forest was considered as suitable habitat for the rhino and other wild life population. However, some percentage of *Mikania micarantha* was also reported. Amin et al. (2006) have reported that the succession of invasive alien species *Mikania micrantha* along with *Lantana camara* over natural riparian vegetation have increased risk of survival of the endangered rhino that primarily inhabit the riverine environment. So, the rhino habitat in the community forest may get degraded due to invasion of exotic species as well as by the human encroachment.

The diversity index of shrubs and herbs stratum were almost similar and higher than the tree species in the community forest. But in national forest, diversity index was higher in herb stratum than shrub stratum and trees. When diversity index of community forest was compared with national forest, the result showed that trees and shrub stratum had higher diversity in community forest than the national forest but herb stratum had almost similar diversity in both the forests.

7.3 Land use change

The land use change analysis from 1978-1992 showed that there was decrease in area of agriculture land, grass land and water bodies and increase in area of forest. Also, the new land categories were developed such as lake/pond, orchard and shrub land. Among these, there was highest loss of water bodies and gain of shrub land. The result showed loss of agriculture land by 0.64% which is opposite to that of the total buffer zone where agriculture land had increased by 1.06% (Management Plan 01-05). The forest area had increased by 12.71% in the VDC. This result is opposite to that of whole buffer zone where the forest area had highly decreased (Management plan 01-05) but similar to that of Sukranagar buffer zone VDC where forest area had increased by 27.19% from 1978-1992 from the study carried out by Neupane (2007).

7.4 Rhino related issues

In the study area, the number of rhino and its movement had declined dramatically. The cause of rhino decline was mainly due to poaching and habitat loss. However, most of the households (66%) have faced crop damaged problem by rhino and 1.4% of the household faced livestock loss problem. Generally, rhino visit crops in the evening and night more common in the winter season. Majority of the rhino damaged household lies within 1500 m distance from the buffer zone community forest. The villagers showed negative attitudes towards rhino conservation as rhino destroyed their crops, cause livestock loss and human injury.

8. CONCLUSION

The people of Argayuli buffer zone area of Chitwan National Park are predominantly dependent on agriculture and are heavily dependent on the buffer zone community forest for their sustenance. Though the economically active population were more dominant in the VDC, unemployment in the VDC had forced them to go out of the country. Most of the population had food deficit problem for which they managed through remittance. The poor and poorest cannot even think of installing alternate energy sources like biogas due to financial problem where economically better off families also want fuel wood for cooking and heating. People with a higher level of education have been reported to be more supportive of conservation, but crop damage by rhino and other wildlife showed negative attitudes of the people. Buffer zone people are not satisfied with buffer zone activities as the compensation measures for their loss are not adequate.

The people of Argayuli buffer zone VDC are extracting the forest resources from buffer zone community forest unsustainably. Still the resources available from the buffer zone community forest is not sufficient for the local people in the buffer zone VDC and thus to fulfill their demand for sustaining their livelihood, they depend on national forest which lies outside the buffer zone of same VDC as well as buffer zone community forest of adjacent Kumarworti VDC and partly on national park. Invasion of exotic species such as *Mikania micarantha* and increased rate of human encroachment into the community forest area may degrade the community forest conditions.

9. RECOMMENDATION

- Awareness regarding the importance of endangered greater one horned rhinoceros is recommended.
- Local people should be encouraged to install the alternative energy source such as biogas as it will decrease the demand of fuel wood which ultimately minimize the pressure on forest.
- Improved breed of livestock should be introduced in VDC so that it will decrease number of livestock which ultimately reduces the demand of fodder and minimize the pressure on forest.
- The benefit from the buffer zone program should be shared for the income generation activities of the landless people as well in the VDC.
- Handover of community forest is recommended as there is only proposed community forest in the VDC.
- Community forest should be opened timely so that there may be control of illegal harvesting of forest resources.

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BIOGRAPHICAL NOTES

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