Buffer Zone Resources and Socioeconomic Perspective of Conservation in Tribeni Buffer Zone Village Development Committee, Chitwan National Park, Nepal

A Thesis Submitted in Partial Fulfillment of Requirements for the Degree of Master in Science in Environmental Science

Submitted To
Central Department of Environmental Science
Tribhuvan University, Kathmandu, Nepal

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September 2009

LETTER OF RECOMMENDATION

This is to certify that Mr. **Ravindra Pandeya** has prepared this Dissertation entitled **"Buffer Zone Resources and Socioeconomic Perspective of Conservation in Tribeni Buffer Zone Village Development Committee, Chitwan National Park, Nepal"** for partial fulfillment of the requirements for the completion of Master's Degree in Environmental Science (Wildlife Management) under my supervision and guidance.

This Dissertation bears the candidate's own work, and has not submitted for other academic purposes. I, therefore, recommend this work for approval and acceptance.

……

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October 15, 2009

DECLARATION

I, Ravindra Pandeya, hereby declare that this Dissertation entitled **"Buffer Zone Resources and Socioeconomic Perspective of Conservation in Tribeni Buffer Zone Village Development Committee, Chitwan National Park, Nepal"** is original work. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been published or submitted elsewhere for any academic award.

……..

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LETTER OF APPROVAL

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ACKNOWLEDGEMENTS

First and foremost, I extend my sincere gratitude to my supervisor Dr. Dinesh Raj Bhuju for accepting to guide this study. I am deeply overwhelmed by support and guidance that I received from him, thank you very much sir. I express admiration and high respect to our wildlife management tutor Dr. Pralad Yonzon, initiator and motivator of this study program. In addition, I will never forget his ways to instruct students how to be a dedicated researcher. I am deeply indebted to Associate Prof. Kedar Rijal, HoD of Central Department of Environmental Science (CDES), Tribhuvan University (TU) for his enthusiastic review, critical comments and final arrangement of presentation. My heartfelt gratitude also goes to Prof. Dr. Umakant Roy Yadav, the then HoD of CDES, TU for being source of inspiration to carry out this work. Many thanks go to Resources Himalaya Foundation for financial support.

This study would have been incomplete or less worthy without generous support from many individuals and institutions of Triveni-Susta VDC. My deep appreciation goes to Krishna Adhikari (Secretary of Tribeni BZ CF) and Khem Bahadur Rana (Secretary of Tribeni BZ UC). It would have been incomprehensible in fieldwork if I were not supported by Mr. Top Bahadur Magar (vegetation survey) and Lok Nath Subedi "Ramu" (socioeconomic survey). I am grateful to residents of the study area who gave me their precious time to discuss about their socio-economic condition, answering the questionnaires and replying many queries. I wish to thank staff of Sub-health post of Tribeni VDC for providing the census data carried out by them.

I will never forget support that I got from my friends. I was much supported by Shiva Pd. Pokharel, during reconnaissance visit. I still remember and indebted to the diligent work done by Raju Bista and Bishnu Pandey during vegetation survey in impenetrable forest sites. My especial appreciation goes to you, Hari Datt Joshi, for your kind and humorous support during socioeconomic survey. I enjoyed the companion of Amrit P. Sharma during whole field of study. I am indebted to my seniors Bhuwan Dhakal for helping since the inception of this study and Parveen Kumar Chhetri for providing me peer-review literatures. Further, I should not fail to acknowledge library staff of CDES, TU; Central library, TU; DNPWC and Department of forest.

Finally, my most bona fide gratitude goes to my parents and family members whose support and inspiration could not be expressed in simple words.

Ravindra Pandeya

ABSTRACT

Buffer Zones were institutionalized under the framework of Integrated Conservation and Development Projects (ICDPs) as solutions for pursuing sound conservation by ensuring a ‘‘double sustainability’’, that is, the sustainability of people’s livelihood and the sustainability of biodiversity. The present study highlights two issues associated with management of Tribeni Buffer Zone community. First, it describes the socioeconomic status of community and its relationship with resource management and conservation strategies adopted by local governing body of Buffer Zone to meet their own objectives. Second, it assesses the status of natural resources especially forest resource and its demand and supply scenario. Large (19.8%) number of landless and small (37.90%) landholders reflected the poor socioeconomic condition, and hence they were forced to depend on forest resource for daily needs. Annual demand for both fodder (5,856.57 tons/yr) and fuel wood (34,854 tons/yr) outstrip the annual sustainable supply (fuel wood: 1,772.55 tons/year; fodder: 216.24 TDN in tons/year) from the forest and deficit was largely met through overharvesting BZ forest. Accordingly, the study illustrates that irrespective of buffer zone community forestry; there is still a gap between local people’s need for supplementing natural resources and their rights to satisfy them on a legal basis, which is likely to be unsustainable in the longer term. However, emerging institutions vary in the extent to which they reproduce favorable resource access conditions for few elites and benefit distribution does seem to be skewed in favor of the wealthy and higher castes, even where management practices on the surface appear fair. The complex relationship between residents and protected area continues to be an obstacle to successful conservation of buffer zone area. This calls for a thorough evaluation of current buffer zone policy how it may be improved through local participation that goes beyond the current form of buffer zone community.

Key words: Buffer Zone, Demand and Supply, Forest, ICDP, Livelihood, Natural resources

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ABBREVIATIONS

BA	Basal Area
BZ	Buffer Zone
BZ CF	Buffer Zone Community Forest
BZ UC	Buffer Zone User Committee
CCP	Crown Cover Percentage
CNP	Chitwan National Park
CS	Cut Stumps
CSD	Cut Stump Density
DBH	Diameter at Breast Height
DNPWC	Department of National Parks and Wildlife Reserves
GIS	Geographic Information System
GoN	Government of Nepal
GPS	Global Positioning System
ha	Hectare
HH	Household
ICDP	Integrated Conservation and Development Project
IVI	Important Value Index
LPG	Liquefied Petroleum Gas
LTD	Live Tree Density
LU	Livestock Unit
NGO	Non-Government Organizations
NRs.	Nepali Rupees
PCI	Per Capita Income
PPP	Park People Program
RBA	Relative Basal Area
RD	Relative Density
RF	Relative Frequency
SPSS	Statistical Program for Social Sciences
UC	User Committee
UG	User Group
UNESCO	United Nations Educational, Scientific, and Cultural Organization
VDC	Village Development Committee

Chapter: One
INTRODUCTION

1.1 Background

One of the core strategies for protecting biodiversity is the establishment of National Parks and other protected areas (Cernea & Schmidt-Soltau 2006). The outcome of this initiative is an increased trend of conserving the natural resources by designating an area as one where various types of resources are under protection. Till date, more than 100,000 designated protected areas have been listed in the World Database on protected areas which cover around 11.4 % of the Earth's land surface along with marine protected areas (Dudley *et al.* 2005). Yellowstone National Park – the first ever designated protected area in the world – led the concept of institutionalization of protected areas. While, National Parks in developing countries, particularly in Asia, were established beginning in the second quarter of 20th century (Mishra & Jefferies 1991; cited in Nepal & Weber 1993). During that period, the parks were essentially based on a biocentric approach, which mainly recognized the intrinsic values (Nepal & Weber 1993), and the objective has always been to protect wild animals and natural habitats through restricted wildlife utilization (Gibson & Marks 1995; Songorwa 1999).

Human communities, living in and around protected areas, often have important and long-standing relationships as they highly depend on the resources of these areas for their livelihood. These relationships embrace cultural identity, spirituality and subsistence practices, which frequently contribute to the maintenance of biological diversity. These relationships have too often been ignored and even destroyed by resource conservation and management initiatives. Moreover, the establishment of protected areas has often displaced rural communities from their traditional lands and policy of strict protection has also alienated the wildlife from the local people, and has frequently transformed wildlife from a valuable commodity into a threat and a nuisance (Johannesen & Skonhoft 2005).The ill-suited concepts and approaches to the needs and problems of local, often native people, led park people conflict and raised many questions on long term biodiversity conservation and protected areas.

The relationships between protected areas and human needs, and the relevancy of integrating protected areas with other major development issues were focused firstly in Third World Congress on National Parks, 1982 (Mishra & Jefferies 1991; cited in Nepal & Weber 1993), nourished and reinforced by the MAB/UNESCO Biosphere

Reserve Action Plan 1984 (Sayer 1991). Since at least the 1993 World Park Congress in Caracas, the scientific community has known and has recognized that the mostly poor local populations bear major costs of conservation, while the main benefits occur globally (Amend & Amend 1995; Wells 1992); this truth was again acknowledged, and more forcefully, by the conservation community during the 2003 World Park Congress.

Following the failure of top-down exclusionary approaches ('fortress conservation' or fences and fines or biocentric approach) to protected areas in reaching conservation objectives, the 1993 World Park Congress in Caracas recognized and acknowledged the role of local people in conservation and embraced the concept of ICDP (Integrated Conservation and Development Projects) put forward by Wells and Brandon(1993). While the core objective of these ICDP projects is protected area conservation (Brandon & Wells 1992), the aim is to achieve this by promoting economic development and by providing local people with alternative income sources that do not threaten wildlife.

Nepal, having its higher proportion of people depending upon the forest resources, institutionalized the concept of “Buffer Zone (BZ)”, outside of protected area, under the framework of Integrated Conservation and Development Projects (ICDPs) to ensure solutions for pursuing sound conservation by ensuring a ‘‘double sustainability’’: that is, the sustainability of people’s livelihood and the sustainability of biodiversity (Ebregt & Greve 2000; Cernea & Schmidt-Soltau 2006).

Though, over the last two decades Integrated Conservation and Development Projects (ICDPs) have failed to live up to their promise (Christensen 2003), integrated conservation and development with participatory approach, in Nepal, is perceived to, have made biodiversity conservation both holistic and real (Bajimaya 2005) resulting in the gradual increment of buffer zone area. They are thought to be doing well, but there has not been concrete research so as to say they are successful or not. Thus with the changing time and technologies, the core principle of buffer zone needs the assessment so as to ensure that they are living up to their promise and don’t fail in the midway.

1.2 Rationale of the study

Buffer zone programs are hailed as one of the best approaches to address the poverty of the communities surrounding protected areas (Poudel 2007). The program often combines natural resource decentralization and financial and technical support in implementing various integrated conservation and development projects (ICDP). The outcomes in general are said to have enhanced social status of local people and improved ecological condition of the area. However, seeking to address dual goal of buffer zone program namely development needs along with conservation goals, brings with it conflicting priorities as compared to nature protection pure and simple (Dobson 2000). In addition, Cambell (2005) narrated the context of development of buffer zone program in Nepal, that the aim of integrating indigenous knowledge with conservation goals is shown to be elusive when culture is seen as a resource for conservation, rather than a view on environmental relationships.

Contrastingly, some contend as Nepal's protected areas meet basic needs of communities who live in the buffer zone, the focus of biodiversity conservation has shifted more towards people (RHF 2005). Nevertheless, few more reported that integrated conservation and development with participatory approach, in Nepal, have made biodiversity conservation both holistic and real (Bajimaya 2005). Though various perspectives by various researches and scholars, success or failure of buffer zone program in Nepal is still in debate. There are quite a few questions that need to be answered to validate this conservation strategy. Does it maintain dual goal set for enhancement of livelihood and conservation in the buffer zone landscape? What are the shortcomings?

In this study, Tribeni Buffer Zone VDC of Chitwan National Park (CNP) is examined as case study to understand the role of socioeconomic status of buffer zone household and its relationship with available natural resources and community perception toward conservation hoping to avail information for better management practices for buffer zone management. The outcomes of this study could be helpful for maintaining database at local level as study on a subject matter in composite form that strives to interface the household's wellbeing, natural resources availability and their signpost for conservation strategy was scare. In addition, it is utmost important to secure the resources of the CNP to meet growing demand of both conservation and development. Moreover, this study could also bring overall ecological benefits to take up proper assessment and legislative processes to address existing disputes in the study area.

1.3 Objectives of the study

The broad objective of this study is to assess efficacy of buffer zone program in Tribeni Buffer Zone community area of Chitwan National Park in addressing the dual goal hoisted by it: Biodiversity conservation and strengthening livelihood needs of people.

Specific objectives:

1. To study socioeconomic strata and households wellbeing of Tribeni Buffer Zone area.
2. To study vegetation of Tribeni BZ forest including assessment of forest resources; household demand, annual sustainable yield and human interference on forest.
3. To scrutinize “park people conflict” and people’s perceptions on conservation and management practice adopted by buffer zone program.
4. To assess the resource utilization status of Narayani River.

1.4 Limitation of the study

This research tried to uncover intuitive information in the context of economy, ecology, and social veracity of the Tribeni Buffer Zone community. It attempted to focus on “demand and supply” scenario of natural resources and the needs of subsistence of local people, namely forest resources. However, it has some limitations.

- The main theme of research was to bare “demand and supply” picture of natural resources in community. However, it did not embrace other than fodder and fuel wood.

- Time series data on forest statistics (Population dynamics, area or biomass) could not be available for Tribeni BZ forest. Therefore, this research could not establish picture of the alteration in forest in sequential time-frame.

- Topographic map of Tribeni-Susta VDC was banned for both academic and non-academic purposes by Government of Nepal (GoN) because of long dispute on frontier between Nepal and India. Therefore, it was not possible to show land use change of study area.

Chapter: Two
LITERATURE REVIEW

2.1 Buffer zone program: Community based participatory conservation

National Parks and other forms of protected areas are the standard approach for conserving biodiversity worldwide. However, in developing countries the benefits of conservation through preservation accrue mainly to the national and global economy while the costs are often borne by local communities (Faith & Walker 1996; Wells & Brandon 1993; Christensen 2003). Budhathoki (2003) argued that conservation model based on the foundation of strict protection has been found to be insufficient as protected areas enjoy no or little public support and suggests some alternative mechanism for long-term conservation of biological resources. Hence, the newer approach of conservation "Buffer Zone" under the framework of ICDP was institutionalized for pursuing sound conservation by ensuring a ''double sustainability'': that is, the sustainability of people's livelihood and the sustainability of biodiversity (Ebregt & Greve 2000; Cernea & Schmidt-Soltau 2006). Budhathoki (2003) buttressed the introduction of the BZ program in Nepal saying it as a testimony to increase realization of the participatory approaches and emerging understanding of landscape management approaches.

Buffer zone programs are one of the most widely applied strategies to nature conservation. As a particular strategy of integrating conservation with development, buffer zones conceive protected areas as composed of layers of resources subject to different priorities; the inner zone, also called the core zone, is subjected to strict protection. The outer layer, usually called the buffer zone, is targeted for sustainable use (Poudel 2006). Buffer zones are therefore defined as peripheral zones of protected areas subjected to restricted use (Sayer 1991).

Buffer zone program have two common objectives. First, by improving the management of the natural resources in the buffer zone area, they seek to increase the supply of natural resources for local need thereby reducing the pressure on the protected area. Second, improved ecological conditions in the buffer zones are expected to provide an extended habitat for the wildlife (Poudel 2006). This opportunity to meet the multiple agenda of conservation and poverty reduction has, according to Sayer (1991), convinced the larger donors to invest in buffer zone programs. The idea of buffer zones have been so popular that almost every protected area now talks of buffer zone (Wells & Brandon 1993).

2.2 Forest resources and livelihood of the people

Forest resources play an important role in people's livelihood throughout the globe (Shackleton *et al*. 2007; Quang & Noriko 2008). Thoms (2008) also mentioned that forest products and services are important in that they provide indirect livelihood benefits for the well-being of people. Sunderlin *et al*. (2005) explained that most of the rural livelihood is maintained with diversified sources while sufficient income could not be obtained from any single occupation to survive. The reason is that farmer's livelihood systems also could not be entirely reliant on agriculture but rather should involve the forest. Livelihood opportunities are determined by various socioeconomic and development factors (Wunder 2001; Sunderlin *et al*. 2005; Shackleton *et al*. 2007), therefore, communities living in and adjacent to savannas and forests are characterized by seemingly high levels of poverty. There is always a strong relationship among the natural resources, people's livelihood and socioeconomic consequences in particular. The Millennium Development Goals (MDGs) and several other international forums have identified increasing global poverty and loss of biodiversity as the twin problems of twenty first century. These problems are perceived to be mutually reinforcing where poverty is usually seen as both cause and consequence of biodiversity loss. However, in many cases conservation initiatives themselves have induced poverty. Conservation efforts such as creation and management of protected areas exacerbate poverty by eviction, denying access to traditional resources use and loss of life, livestock and crop due to increased wildlife (Pant 2009).

2.3 Forest ecology and biodiversity loss

There have been various researches carried out by many scholars in Chitwan National Park and its buffer zone forests; assessing the general health of forest. And almost all findings of research concurred in single upshot that forests of Chitwan National Park was heavily degraded in the past and even in the present time; and more remarkably degradation took place in periphery of National Park, where the buffer zone is located (Acharya 2002; Thapa & Weber 1995).

Jnawali (1989) assessed the crop damage and human harassment by rhino in Sahaura area and suggested that the northern fringe of the park is degraded due to the livestock grazing and other human activities. He also emphasized on the people-oriented program and compensation to reduce the growing negative attitude towards park management.

Shrestha *et al*. (2000) compared the status of regenerating, natural and degraded forest of Chitrepani, Makawanpur district, and found highest tree biomass and bole volume in natural forest; however, tree and sapling density were highest in regenerating forest.

Straede *et al.* (2002) have assessed the structure and floristic composition of six-community forests established through natural regeneration of degraded Sal forests and of former riverine forest areas, which have been cleared and overgrazed in the buffer zone areas of CNP.

Shrestha *et al*. (2006) studied the plant heterogeneity of Barandabhar corridor forest of Chitwan district and enumerated 190 different species. Their findings showed no significant variation on species diversity from outer margin to inner core of forest.

2.4 Other pertinent researches

Park has become the most intensively as well as extensively studied area in South Asia (Yonzon 2000; DNPWC 2005). Further, there has been an uninterrupted history of more than 30 years of scientific studies in CNP. However, no specific study was carried out in Tribeni VDC of CNP except some inventory and survey by Park People Program (DNWC/PPP 2000). Nevertheless, there were various researches of its kind; assessing livelihood of people on behalf of resources utilization. Joshi (1999) studied the socio economic analysis of buffer zone of Chitwan National Park and found that the households having positive attitudes towards National Park are usually the one who consume higher quantity of natural resources, have lower damage from wildlife, benefit from tourism and are educated.

Salafsky and Wollenberg (2000) assessed the linkage between livelihood and conservation and concluded that ecotourism helps to maintain linkage. Stræde and Treue (2006) demonstrated the economic importance of forest product of CNP to livelihood of people in Bacchauli VDC and reveal the pressure correlated with the economic value of product. The research indicates national forest (Tikauli forest) as open access, which is more important to people of Bacchauli VDC than the park and much more important to the landless and land-poor than the CF.

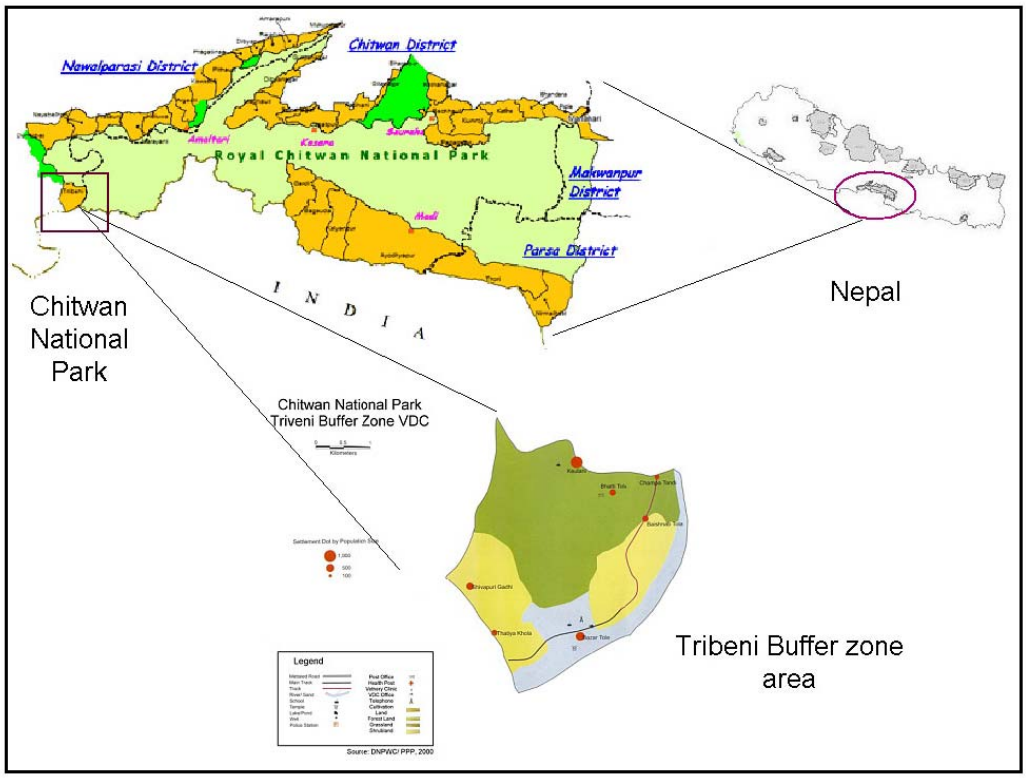
Dhakal (2007) carried out the research in Kolhuwa Buffer Zone VDC of Chitwan National Park assessing resource demand and supply scenario of local users of buffer zone, and his conclusion was that BZ programs had several shortcomings mainly because of high population relying on fewer amounts of resources driving them towards abject poverty.

Chapter: Three

MATERIALS AND METHODS

3.1 Study area

Tribeni VDC lies in the western Amaltari sector of the Chitwan National Park in Nawalparasi district, Nepal. It is the farthest BZ VDC of CNP of western sector and located at the extreme southwest point of park along the Indian border at Gandak Barrage (Map 3.1). Tribeni BZ area encompasses only five wards viz. 1, 2, 3, 7, and 8 of Tribeni-Susta VDC in the buffer zone program. Other four wards are excluded from BZ program, and lie in Susta – a substantial part of VDC, which is isolated from main land by the Narayani River. The Tribeni BZ area extends from 83^0 53' 18'' to 83^0 57' 04'' longitude and 27^0 26' 41'' to 27^0 29' 32'' latitude with altitude ranging from 97 m at Gandak barrage to highest contour point, 832 m, of the area from sea level. The BZ area of Tribeni VDC is bordered by Rupauliya VDC on the North-West; Dumkibas VDC on North; National Park on East and North-East; Kudiya VDC on West, while Balmiki Tiger Reserve of Bihar state of India adjoins on the South. The climate is of sub-tropical monsoonal type and the average annual maximum and minimum temperature were recorded as 30.56 ^{0}C and 18.58^0, respectively, while the average annual rainfall was calculated as 2323.5 mm from the data recorded from the nearest meteorological station (Dumkauli) (Annex VI).



Map 3.1: Study area

The total 1,273 ha area of Tribeni BZ was inhabited by the 4,973 people of 996 HHs (Health post record, Tribeni 2006). Population density of area was 391 per square kilometer (Field survey 2007). The population, as in the rural Terai, was densely congregated to form settlements, and was depended mainly upon subsistence farming. BZ Community Forests and Narayani River are the privileged natural resources available for locals. Tribeni Bazaar and Bhainsalotan of border town of India are the market place to commercial exchange. Tribeni is linked to East West highway at Bardaghat through graveled road.

Tribeni is a confluence of three holy rivers Narayani, Sona and Tamasha. The constellation of many Hindu temples at the bank of holy Narayani River attracts many pilgrims from Nepal and India throughout the year. Thousands of people gather and take a holy deep in the River on *Maghe Sankranti* – an annual ritual of Hindu culture (January/February). Besides Balmiki ashram, situated east of Tribeni across the Narayani River, is a sacred pilgrimage site for Hindus. The Hindu believes that this place was the hermitage of great saint Balmiki who wrote epic "The Ramayana". The place is believed to be lived by Sita, the consort of Lord Rama.

3.2 Study framework

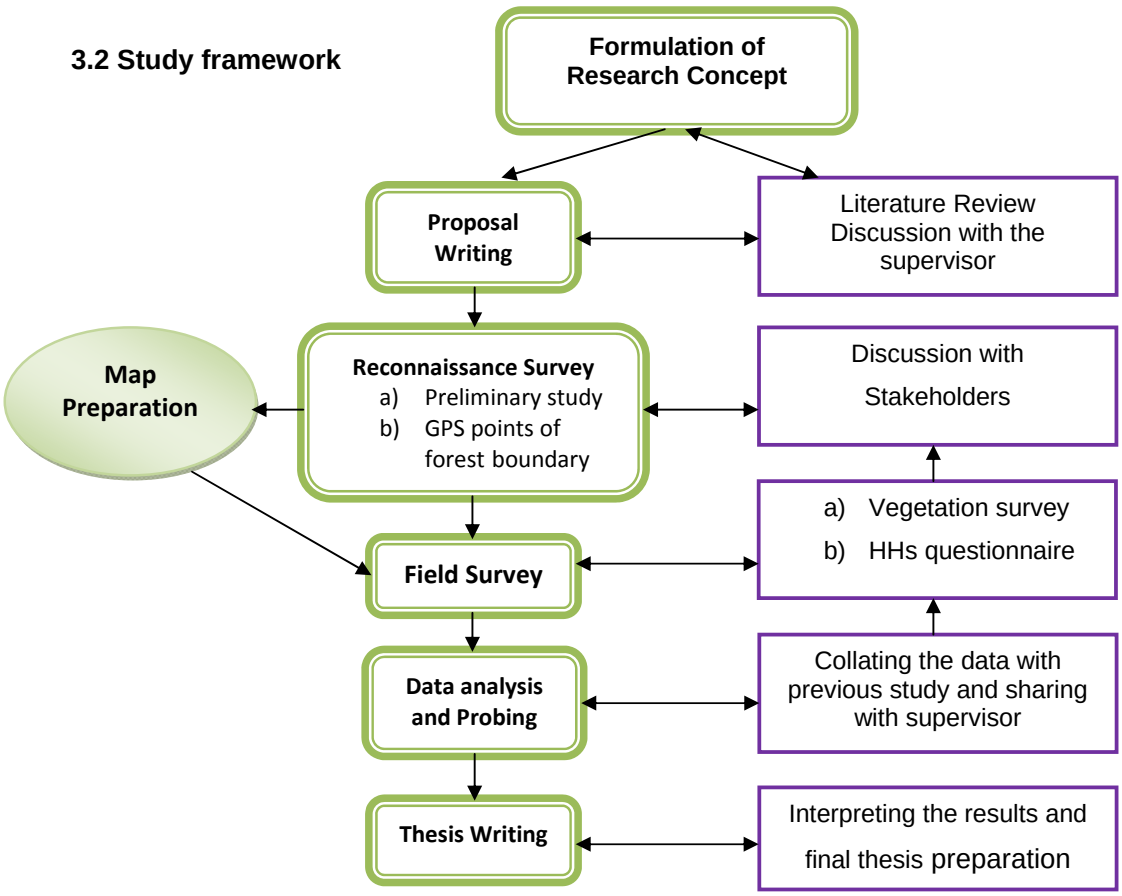


Figure 3.1: Schematic flow chart of study design

3.3 Household socio-economic survey

3.3.1 Sampling design and procedure

The sample selection was made after thorough review of available population and household statistics of Tribeni-Susta VDC. Although, census data of 2001 was most authentic and reliable source, it lacked the ward wise differentiation and further settlements were not included. Similarly, census conducted by the Tribeni sub-health post and VDC were also not updated or lacked properness. So, Population census carried out by Park People Program (DNPWC/PPP 2000) was considered for the sample size determination.

3.3.2 Sample size and sampling frame

Sample size for the households was taken to be 66, which was estimated by using statistical formula as cited by Poudyal (2000) (Annex II). Two stages of sampling were adopted for selection of households. The park buffer zone includes only five wards of Tribeni-Susta VDC namely: 1, 2, 3, 7 and 8. From these wards, all seven settlements were selected purposively during first stage of selection. From each selected settlements, households were selected applying stratified random sampling procedure by lottery box method (without replacement). The selection of household was devised with probability proportionate to sample size for all settlements with due considering land ownership (Table 3.1) by the household (DNPWC/PPP 2000). In addition, landless category was further classified to no landholding HHs and HHs with *Ailani* (landholding without legal certificate) landholders; similarly small landholders were also re-categorized into HHs with housing land only, who does not grow crop, and other small farmers who grow crops.

Table 3.1: Settlement wise sampling frame and sample size

Ward No.	Settlements	Landless	>0-0.34 ha	0.34-0.68 ha	0.68-2.72 ha	>2.72 Ha	**Total**
2	Keulani	1	2	3	1	0	**7**
2 & 3	Bhatti Tola	2	2	1	0	0	**5**
3	Champa Tandi	2	3	1	1	0	**7**
1 & 3	Baishnab Tola	2	4	1	1	0	**8**
1	Bazaar Tole	2	7	2	0	0	**11**
8	Shivpuri Gadi	2	7	3	4	2	**18**
7	Thatiya khola	2	4	2	2	0	**10**
Total		**13**	**29**	**13**	**9**	**2**	**66**

In the study site, information regarding landholding of the sample households was collected through Tribeni BZ User Committee, VDC office and the local persons.

From the list of information obtained on landholding, required number of sample size of each land categories in each settlement was selected randomly and questionnaire survey was conducted. Attempt was made to maintain ethnic ratio proportional while selecting households.

3.4 Survey methods

Both qualitative and quantitative research methods are being used in social research. However, qualitative research seldom yields precise descriptive statements about large populations. The conclusions drawn from qualitative field research are often regarded as suggestive rather than definitive (Babbie 1995). Further, use of different research techniques is a part of the triangulation process to verify the validity of research outcomes (Kane 1985). Both qualitative and quantitative social research techniques were applied for Household survey. Reconnaissance survey was carried out during the month of September 2007, during this time the questionnaires were tested. After having necessary modification of the questionnaires in the field, the final questionnaires were prepared and the survey was conducted. Field observation and vegetation inventory were executed during the month of September and October 2007. The household survey was carried out during the month of February 2008.

3.4.1 Field observation

Research activities were executed in different places like respondents' houses, farms and forests. The activities of the respondents, such as physical infrastructure development, land status, household's daily routine, their way of using natural resource, their involvement in community development works, their economic status etc. were physically observed. A field book was developed to record actual observation. This observation method was used to collate the information obtained from household survey.

3.4.2 Questionnaire survey

Structured and semi-structured questionnaires were prepared for household survey. Before conducting the formal questionnaire survey, the questionnaire was pre-tested in some houses and some modifications with issue "Narayani River as resource" was incorporated. Questionnaires were developed with three major parts (Detail in Annex I), which include information about household, buffer zone community forests with management activities and issues, and Narayani River as resource. The survey of 66 HHs was a comprehensive one having the feature that included face-to-face interview. Interview was taken from the family head member as possible, if such was not possible interview was taken from more informative member of the household.

3.4.2.1 Household information

This part mainly focuses on the household information to identify the livelihood supporting activities through occupation of respondent and family members, landholding, crop types and its production, livestock holding (including feeding types), resources need (fuel wood and fodder) and their access, energy use and consumption pattern.

3.4.2.2 Buffer zone related issues

This part was related with buffer zone community forest and buffer zone management issues. It was designed to obtain the information about condition of buffer zone forest, types of resources extraction, pressure on community forest, resources allocation system, land categorization with in community forest, problems within the community forest, suggestions/recommendation for better management and resources utilization of community forest, budget sufficiency and its transparency and household level participation in buffer zone management.

3.4.2.3 Narayani River as a resource

The section included the information on the type of resources used from the River. Further, it undertook facts about dependency of locals on River for their livelihood by their ethnicity, income level etc.

3.4.3 Secondary source review

The first step as a part of the field research was a review of literature on government policies and programs and such other documents related to buffer zone and livelihood issues. Secondary data were obtained from maps, published or unpublished documents, journals, articles, thesis etc. DNPWC provided the map of study area. Secondary information was also useful for interpretation, comparison, and triangulation of information gathered from various sources.

3.5 Data calculation and analysis

Information collected in the field was checked for the accuracy at the field following the techniques of random check. The collected data from the field were sorted as per the different categories. The local units were converted into standard units (Annex III) (Nepal & Weber 1993). The questionnaires brought from the field were coded and fed into Statistical Package for Social Science (SPSS: version-12) – a computer software. Coded questions were put into variable view and the codes obtained for the particular questions were entered in the data view of the SPSS.

All the questions were thus coded and fed into the SPSS software and were then analyzed. The output tables and charts obtained from the analysis were transferred to Microsoft Excel to change in simple and interpretable forms, which are then presented in different charts, tables and diagrams.

The analysis were primarily based on frequency, mean, percentage, correlation etc. hence to obtain characteristics of households according to caste/ethnic composition, income level etc. Further, analysis of households was carried out based on farm size accompanied by HHs as given in Table 3.2.

Table 3.2: Category of HHs as per landholding size

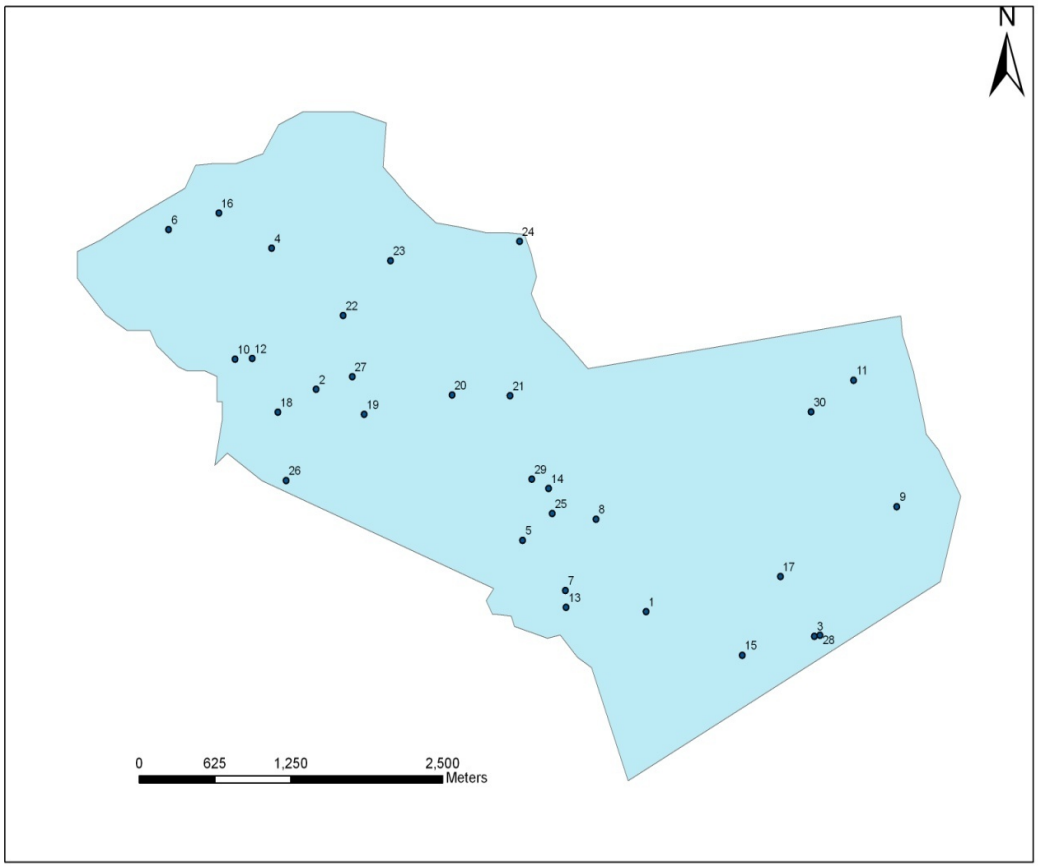
Landholding size		Land size in local unit	Land size (ha)
Landless	i. No landholding	-	-
	ii. Ailani land holders*	Not stated	Not stated
Small farm	i. Housing land only	<1 Kattha	<0.034 ha
	ii. Small farm	>1-10 Kattha	>0.034-0.34 ha
Medium farm		10-20 Kattha	0.34-0.68 ha
Large farm		1-4 Bigha	0.68-2.72 ha
Very large farm		>4 Bigha	>2.72 ha

* Landholding without legal certificate

3.6 Vegetation survey

3.6.1 Sampling

In the reconnaissance study, forest boundaries were determined by GPS (GPS model: e-trex, Garmin USA) tracking. The boundary map of the forest was prepared by using Arc-GIS and 30 random sampling plots were generated at a fixed distance (Random Sampling Method) (Map 3.2) (Annex IV). Pre-registered sampling plots, in the forest, were determined by tracking with GPS.



Map 3.2: Forest and its sampling points

3.6.2 Plot design

A total of 150 plots were laid for the vegetation survey. These included 30 plots (20x20 m^2) for tree species (DBH>10 cm), 60 each for shrubs (DBH<10 cm) and herbs (height<10 cm) with plot size 5x5 m^2 and 1x1 m^2, respectively. Design of plots was such that larger tree plot incorporated the two shrub plots in diagonally opposite direction (NE & SW), further each herbs plot laid within shrub plot (Annex IV). Irrespective to the species of plant, classification of vegetation was based on girth size and height (Table 3.3).

Table 3.3: Classification of forest strata

Category	Height (m)	DBH (cm)
Tree	Not stated	> 10 cm
Shrub	> 10 cm	< 10 cm
Herb	< 10 cm	Not stated

3.6.3 Sampling parameters and methodology

The sampling parameters, with their measurement approach, for the study were as follows (Table 3.4).

Table 3.4: Sampling parameters

Sampling Parameters	Measurement approach
No. of Tree species and individual no. of each species	Count
Tree Height of each individual tree	Brunton Compass
Tree DBH of each individual trees	DBH tape
Tree Stocking of each individual trees and whole plot	Open eye estimation
Tree Loping of each individual trees	Open eye observation
Cut stump (DBH)	DBH tape
Cut stump (height)	Measuring tape
No. of Shrub species and individual no. of each species	Count
Shrub Height of each individual	Calibrated stick
Shrub Coverage in the plot	Open eye estimation
No. of Herb species and individual no. of each species	Count
Herb Coverage in the plot	Open eye estimation

Most of the plant species were identified in the field by knowing their local names. The unidentified were tagged and preserved as herbarium and were identified in Botanical Garden, Godavari.

3.7 Quantitative analysis of vegetation

3.7.1 General parameters

The data collected in the field were calculated separately for tree, shrubs, and herbs. Different structural parameters were determined for quantitative analysis following Kent and Coker (1998), and Odum (1996) (Annex II).

3.7.2 Volume and Biomass

The calculation system called Inventory Net Volume (INV) developed by the Forest Inventory Section, Ministry of Forest and Soil Conservation; Nepal (HMG 1988a and HMG 1988b) was used for the calculation of volume and biomass of each individual tree (Annex II). The volume parameters were obtained from the study carried out by Forest Survey and Statistical Division (FSSD 1990) (Annex II).

Chapter: Four
RESULT

PART I: SOCIO-ECONOMIC FEATURES OF TRIVENI BUFFER ZONE VDC

4.1Socio-economic characteristics

4.1.1 Respondents

Overall characteristics of 66 respondents are summarized in the Table 4.1.1. Respondents and their respective households were grouped into six ethnic groups or caste categories, and this classification was taken as one important variable for further analysis to understand socio-economic strata. Moreover, other household's socio-economic data were extracted from the respondents and the validity of data could be assured as the most of them were matured age class and only one respondent was below 18 years of age.

Table 4.1.1: General characteristics of the respondents

Category	Characteristics	No. of Respondents	Percentage
Gender	Male	47	71.21
	Female	19	28.79
Age	Below 18 Years	1	1.52
	19 to 40 Years	22	33.33
	41 to 59 Years	27	40.91
	> 59 Years	16	24.24
Education	Literate	4	6.06
	Illiterate	28	42.42
	Primary schooling	14	21.21
	Secondary schooling	9	13.64
	SLC	7	10.61
	Intermediate or 10+2	1	1.52
	Graduate or above	3	4.55
Ethnic group/Caste	Bote/Majhi/Mushahar	4	9.09
	Brahmin/Chhetri/Giri/Puri	21	31.82
	Dalit	3	4.55
	Magar/Gurung/Tamang	31	46.97
	Madhesi	3	4.55
	Newar	2	3.03
Resident period	Recent settlers (<10 Years)	5	7.58
	Mid settlers (10 - 20 Years)	17	25.76
	Early settlers (>20 Years)	39	59.09
	Indigenous	4	6.06
	Don't know	1	1.52
	Agriculture	26	39.39

	Agriculture + Business	1	1.52
	Agriculture + Service	5	7.58
	Agriculture + Skilled worker	2	3.03
	Business	3	4.55
	Fishing + Boating	8	12.12
	House work	4	6.06
Occupation	Indian army	1	1.52
	Seasonal visitor to India +Wage labor	3	4.55
	Service	3	4.55
	Skilled worker	2	3.03
	Student	1	1.52
	Unskilled/Wage labors	3	4.55
	Others	4	6.06

4.2 Socio-economic status of surveyed household

4.2.1 Demography

Tables 4.1.2, 4.1.3 and 4.1.4 show the distribution of the de-facto household population by age, age composition and sex according to ethnic group and landholding class. The population size of surveyed 66 households was found to be 438 – female (50.68%) and male (49.32%). Although two groups of ethnicity, Janjati of hill and mountain (47%) and Brahmin/Chhetri/Giri/Puri (31.8%) were dominants; ethnically the community was heterogeneous. Madhesi had the highest average family size (11.33), while others did not much deviate from mean family size (6.64) of survey area.

Sex ratio (male: female) of surveyed population showed erratic fluctuation among ethnic groups; in Brahmin/Chhetri/Giri/Puri and Dalit males were higher in number with ratio 1.03 and 1.25, respectively, but in others female were dominants, while overall sex ratio was 0.97. Age structure revealed that fertility rate of study area was decreasing as large portion (63.69%) of population were between 16-59 age class and this class is also supposed to be work-strength age group. Similarly, other age class <5, 5-15 and 60+ were 10.04%, 19.17% and 7.07%, respectively; and all these classes comprise the dependable population.

Table 4.1.2: Population of Tribeni VDC BZ area as per ethnicity

Ethnic group/Caste	No. of HH	No. of Males	No. of Females	Total Population	Sex ratio (M/F)	Average family size
Bote/Majhi/Mushahar	6	16	18	34 (9.1%)	0.89	5.67
Brahmin/Chhetri/Giri/Puri	21	73	71	144 (31.8%)	1.03	6.86
Dalit	3	10	8	18 (4.5%)	1.25	6.00
Magar/Gurung/Tamang	31	98	102	200 (47.0%)	0.96	6.45
Madhesi	3	16	18	34 (4.5.0%)	0.89	11.33
Newar	2	3	5	8 (3.0%)	0.60	4.00
Total	66	216	222	438	0.97	6.64

Table 4.1.3: Age structure of population based on ethnicity

Ethnic group/Caste	<5 years	5-15 years	16-59 years	60+ years	Total
Bote/Majhi/Mushahar	9 (26.47%)	7 (20.59%)	16 (47.06%)	2 (5.88%)	34
Brahmin/Chhetri/Giri/Puri	12 (8.28%)	14 (9.66%)	106 (73.10%)	13 (8.97%)	145
Dalit	1 (5.56%)	4 (22.22%)	13 (72.22%)	0 (0.00%)	18
Magar/Gurung/Tamang	15 (7.46%)	49 (24.38%)	124 (61.69%)	13 (6.47%)	201
Madhesi	7 (20.59%)	10 (29.41%)	14 (41.18%)	3 (8.82%)	34
Newar	0 (0.00%)	0 (0.00%)	6 (100.00%)	0 (0.00%)	6
Total	44 (10.04%)	84(19.17%)	279(63.69%)	31 (7.07%)	438

Table 4.1.4: Population of Tribeni VDC BZ area as per landholding size

Category		No. of HH	No. of Males	No. of Females	Total Population	Sex Ratio (M/F)	Average Family Size
Landless	i. No landholding	5	9	14	23	0.64	4.60
	ii. Ailani land holders	8	22	23	45	0.96	5.63
Small Farm	i. Housing land only	4	22	16	38	1.38	9.50
	ii. Small farm	25	75	88	163	0.85	6.52
Medium farm		13	51	45	96	1.13	7.38
Large farm		9	29	28	57	1.04	6.33
Very Large farm		2	8	8	16	1.00	8.00
Total		66	216	222	438	0.97	6.64

4.2.2 Occupation

Table 4.1.5 outlines the major income sources of study area population through different occupations. Agriculture was key profession with other livelihood sources among the majority of households (60.61%), but households applying agriculture as absolute occupation were mere 16.67%. The study population had entertained other wide variety of occupations: Business, Service, Foreign earning, and wage labor were few examples. Besides that, Narayani River granted profession to 12.12% population – fishing and ferrying – to mostly ethnic group Bote/Majhi/Mushar.

Table 4.1.5: Family main occupation

Family main occupation	No. of HH	Percentage
Agriculture	11	16.67
Agriculture + Business	5	7.58
Agriculture + Foreign earning (Remittance)	10	15.15
Agriculture + Services	9	13.64
Agriculture + Skilled labor	3	4.55
Agriculture + Unskilled/wage labor	1	1.52
Business	1	1.52
Business + Foreign earning	2	3.03
Fishing and boating	8	12.12
Foreign earning (Remittance) + Wage labor	4	6.06
Holy Teacher + Agriculture	1	1.52
Indian Army	1	1.52
Service	2	3.03
Service + Foreign earning (Remittance)	2	3.03
Unskilled/wage labor	4	6.06
Wage labor+ Seasonal work visit to India	2	3.03
Total	66	100

4.2.3 Education

Literacy status of study population was considered only for above five years of age population. Though the literate population was 77.97%, most of them lacked higher education and among all under SLC group (46.77%) outnumbered other education level categories. Education level of Brahmin/Chhetri/Giri/Puri was higher (Table 4.1.6) than other ethnic groups and none other ethnic group attended graduate level education except Brahmin/Chhetri/Giri/Puri.

Table 4.1.6: Educational status of Tribeni BZ area as per Ethnic group

Ethnic group /Caste	Illiterate	General Literate	Under SLC	SLC	Inter or 10+2	Graduate	Total*
Bote/Majhi/Mushahar	12 (48)	5 (20)	8 (32)	0 (0)	0 (0)	0 (0)	25
Brahmin/Chhetri/Giri/Puri	15 (11.28)	24 (18.05)	47 (35.34)	22 (16.54)	16 (12.03)	9 (6.77)	133
Dalit	6 (35.29)	3 (17.65)	8 (47.06)	0 (0.00)	0 (0.00)	0 (0)	17
Magar/Gurung/Tamang	45 (24.19)	40 21.51)	87 (46.77)	9 (4.84)	5 (2.69)	0 (0)	186
Madhesi	7 (26.92)	5 (19.23)	11 (42.31)	2 (7.69)	1 (3.85)	0 (0)	26
Newar	2 (25)	1(12.50)	2 (25)	3 (37.50)	0 (0)	0 (0)	8
Total*	87 (22.03)	78 (19.74)	163 (41.26)	36 (9.11)	22 (5.57)	9 (2.27)	395

Note: *Population over five years only included (No. in parenthesis indicate percentage)

4.3.4 Landholding

Of the total surveyed households, small farm holder (>0-0.34 ha) shared the highest number, 25 (37.9%), among all. Similarly, 5 (7.6%) HHs were complete landless, 8 (12.1%) had small land (*Ailani*) but not registered, in this thesis report these HHs are also categorized as landless. Again, 4 (6.1%) HHs had their land (<0.034 ha) but not enough to grow crop and used them for housing purpose only. In addition, 13 (19.7%) had medium farm (0.34-0.68 ha), 9 (13.6%) were large (0.68-2.72 ha) landholders and 2 (3%) had their land greater than 2.72 ha. The average per capita land distribution was found to be 0.079 ha, while the mean farm size of surveyed area was 0.47 ha. Table 4.1.7 and 4.1.8 show the mean, total and per capita ownership of land by HHs in study area, by ethnicity and resident period.

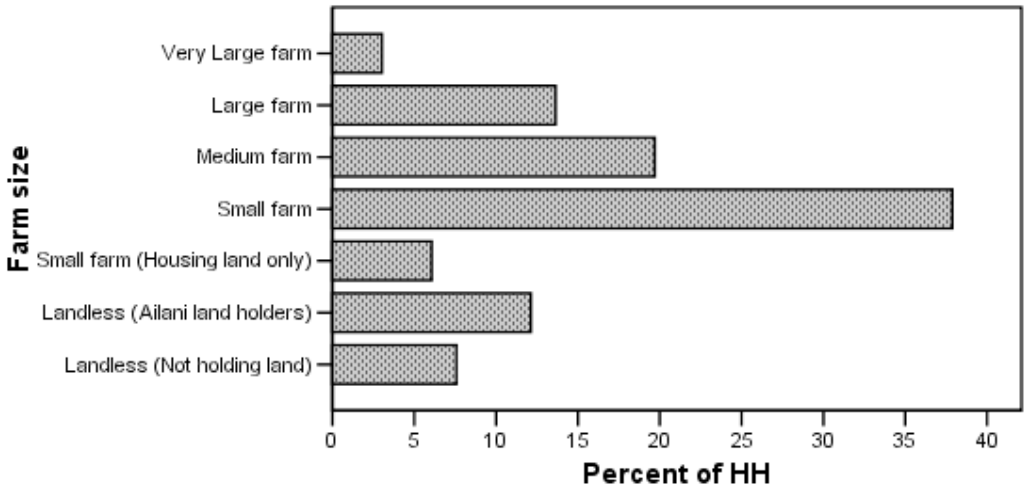


Figure 4.1.1: Land holding by HHs of Tribeni BZ area

Table 4.1.7: Landholding by ethnic group/caste

Ethnic group/Caste	Total Farm size (ha)	Mean Farm Size (ha)	Per Capita Land distribution (ha/person)	Std. Deviation	Std. Error of Mean
Bote/Majhi/Mushahar	0.41	0.07	0.01	0.07	0.03
Brahmin/Chhetri/Giri/Puri	16.58	0.79	0.13	0.94	0.20
Dalit	0.41	0.14	0.03	0.00	0.00
Magar/Gurung/Tamang	13.29	0.43	0.07	0.32	0.06
Madhesi	0.47	0.16	0.02	0.14	0.08
Newar	0.00	0.00	0.00	-	-
Total	31.15	0.47	0.079	0.61	0.076

Table 4.1.8: Landholding as per resident period

Resident period	HH* No.	Total Farm Size (ha)	Mean Farm Size (ha)	Per Capita Land distribution (ha/Person)	Std. Deviation	Std. Error of Mean
Recent Settlers (<10 Years)	5 (7.6)	1.33	0.27	0.05	0.29	0.13
Mid Settlers (10 – 20 Years)	17 (25.8)	3.38	0.20	0.05	0.20	0.05
Early Settlers (>20 Years)	40 (60.6)	26.07	0.65	0.10	0.73	0.11
Indigenous	3 (4.5)	0.36	0.12	0.02	0.08	0.04
Don't Know	1 (1.5)	0.02	0.02	0.01	-	-
Total	66	32.15	0.47	0.079	0.619	0.076

*Number in parenthesis indicate percentage

4.2.5 Crop production and deficit management

Of the total HHs, 14 (21.21%) did not have enough land or had no land to grow crop, and they had to depend on other employment opportunities for sustenance. While, rest households (52; 78.79%) were found to be growing crops mainly for subsistence, and very few (7.57%) had switched solely to cash crops. Resembling to the national scenario, rice and maize were the main food crop grown by the locals and they were cultivated by 69.23% and 86.53% of total agriculture producing (52) HHs, respectively. While only 12 (23.07%) HHs practiced growing wheat. Table 4.1.9 outlines the types of crop production of different landholding categories. Paddy, maize, and wheat shared 56.46%, 31.37%, and 12.17% of total food crops production, respectively. Mean and per capita annual food production of the studied area was 994.55 kg and 168.22 kg, respectively. Of the 66 total sampled HHs, 41 were food deficit, 8 HHs had surplus food production, and 9 HHs produced sufficient enough to balance their annual demand, while 8 HHs managed their food demand by selling other agro-products, largely sugarcane. Table 4.1.10 and 4.1.11 delineate the annual food crop production and sufficiency as per landholding category and ethnic group. Management options of food deficit HHs are shown in Figure 4.1.2.

Table 4.1.9: Types of crops production as per landholding

Landholding Category (HHs)		Types of Crops Production				Total
		Sub-sistence*	Cash Crops**	Subsistence +Cash crops	Not enough land to grow crop	
Landless	i. No holding land	0	0	0	5	5
	ii. Ailani land holders	5	1	0	2	8
Small farm	ii. Housing land only	0	0	0	4	4
	ii. Small farm	19	3	0	3	25
Medium farm		5	0	8	0	13
Large farm		2	1	6	0	9
Very large farm		0	0	2	0	2
Total		31	5	16	14	66

*General food crops and mostly include paddy, maize, wheat, oil seeds etc. ** Mostly sugarcane

Table 4.1.10: Food crop production and sufficiency as per landholding

Landholding Category		Food Crop Production*(Kg)		No. of Households			
		Mean	Per Capita Mean	Balance	Surplus	Deficit	Manage from Other Agro-product**
Landless	i. No holding land	0.00	0.00	0	0	5	0
	ii. Ailani land holders	303.75	51.29	0	0	8	0
Small farm	i. Housing land only	0.00	0.00	0	0	4	0
	ii. Small farm	692.12	101.48	2	1	21	1
Medium farm		1553.00	245.73	5	1	3	4
Large farm		1883.22	379.24	2	4	0	3
Very large farm		3887.50	709.32	0	2	0	0
Total		994.55	168.82	9	8	41	8

* Paddy + Wheat + Maize ** Selling Sugarcane

Table 4.1.11: Food crop production and sufficiency as per ethnicity

Ethnic group/Caste	Food Crop Production* (Kg)		No. of Households			
	Mean	Per Capita Income	Balance	Surplus	Deficit	Manage from cash crop**
Bote/Majhi/Mushahar	193.33	23.86	0	0	6	0
Brahmin/Chhetri/Giri/Puri	1118.48	208.93	2	4	9	6
Dalit	390.00	63.78	0	0	3	0
Magar/Gurung/Tamang	1206.19	195.04	7	4	18	2
Madhesi	478.67	68.38	0	0	3	0
Newar	0.00	0.00	0	0	2	0
Total	994.55	168.82	9	8	41	8

*Paddy+Wheat+Maize ** Selling sugarcane

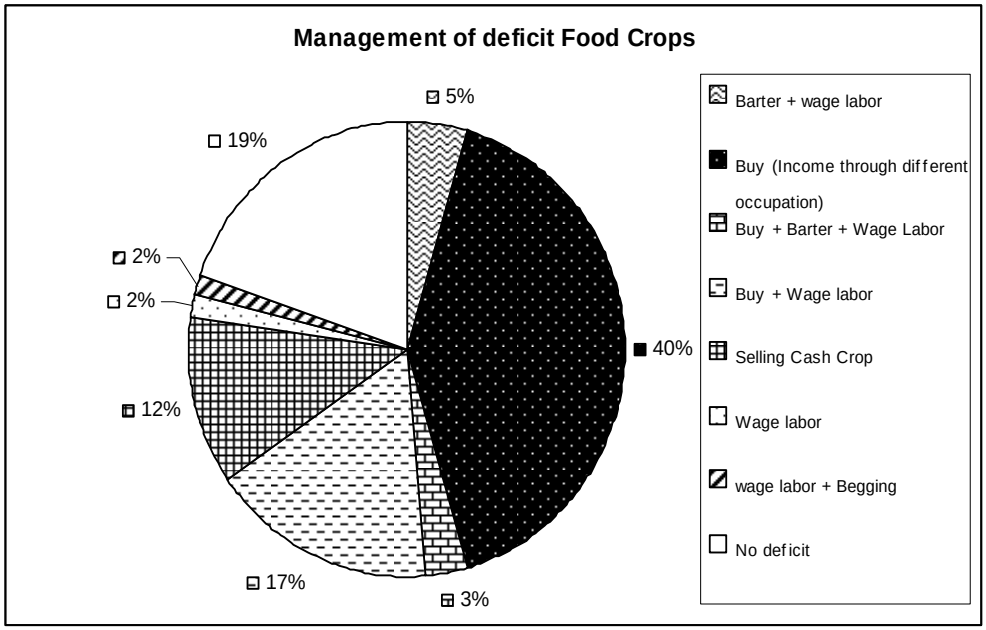


Figure 4.1.2: Management of deficit crop production

4.2.5.1 Food security

Food security result based on food supply by agro-product to demand ratio showed that only 24 (36.36%) of households were found to survive from their own agriculture production. While, rest others had to generate income through various sources to sustain for less than 3 months or even to whole 12 months (Table 4.1.12). Moreover, food security scenario was further analyzed by ethnicity and landholdings of HHs (Figure 4.1.3). For the obvious reason correlation between landholding size and food security period was found positively correlated [r = 0.605*; 0.01 significance level (2-tailed)]. Similarly, food insecurity was more pronounced to the marginalized ethnic groups; Bote/Majhi/Mushar, Dalit and Madhesi (Figure 4.1.4).

Table 4.1.12: Food security period

Food Security period	No of HH	Percent of HH
0 Month	15	22.73
<3 Months	14	21.21
3-6 Months	2	3.03
6-9 Months	6	9.09
9-12 Months	5	7.58
12 Months	24	36.36
Total	66	100

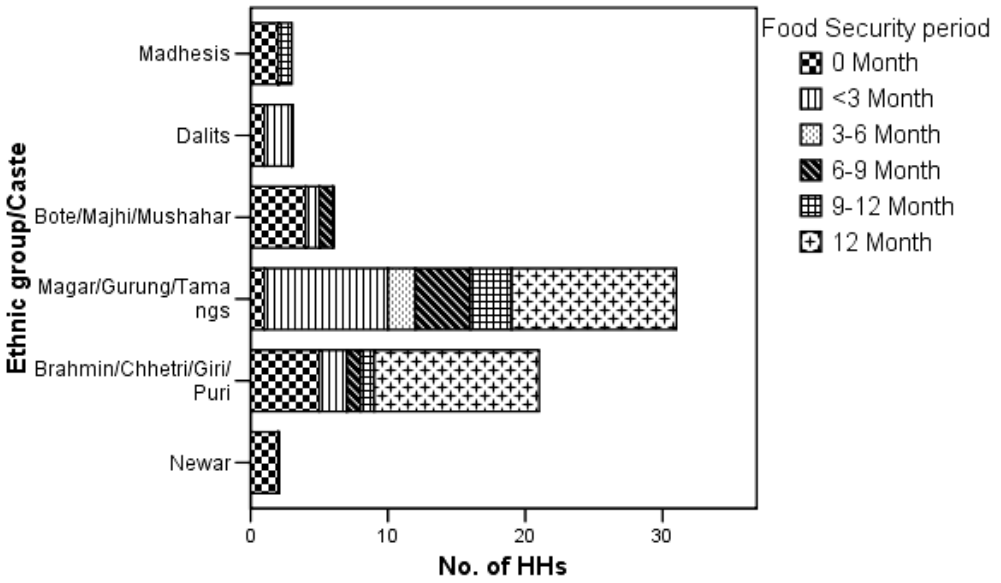


Figure 4.1.3: Food security period as per ethnicity

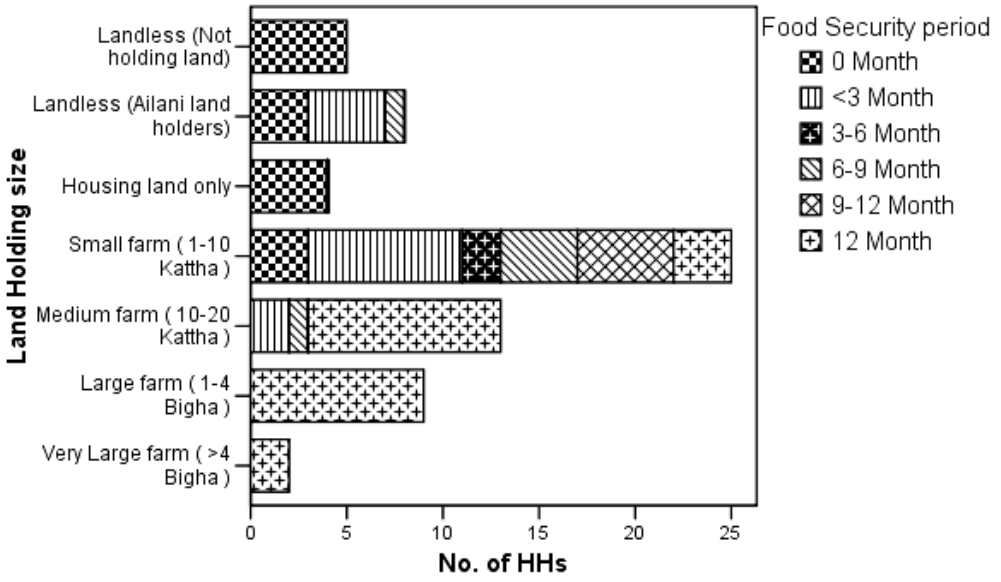


Figure 4.1.4: Food security as per landholdings of HHs

4.2.6 Livestock holding, fodder access and deficit management

Livestock holding was common off-farm employment opportunity for the locals of study area. Fifty two (78.78%) HHs were found to be rearing livestock; major livestock holding were cattle, buffalos and Goats. Number of different livestock types were synthesized in single unit called Livestock Unit (LU) (Annex III) as per Poudyal (2000) for further analysis.

Total and mean LU of studied area was found to be 120.39 and 1.82/HH, respectively. As per the landholding size, HHs with medium farm held higher portion of total LU (41.51) with mean LU 3.99 (Table 4.1.13). While small farm HHs category, having housing land only, did not hold livestock. In addition, Table 4.1.14 elucidates the triangulation of landholding size of HHs, LU hold, and fodder demand. Total fodder demand of the studied community was found as 2308.63 tons/year. Fodder demand tons/year/LU of all landholding category of HHs were drawn near to average of whole study area (21.42 tons/year/LU), while very large farm holders have much more demand (38.94 tons/year/LU) than average.

Table 4.1.13: Livestock holding as per landholding

Landholding category		Buffalo	Cow	Goat and Sheep	Total livestock unit	Mean livestock unit
Landless	i. No holding land	0 (0)	5 (1)	16 (2)	6.13	1.23
	ii. Ailani land holders	6 (4)	10 (3)	23 (4)	15.50	1.94
Small farm	i. Housing land only	0 (0)	0 (0)	0 (0)	0.00	0.00
	ii. Small farm	24 (10)	9 (6)	59 (14)	35.91	1.44
Medium farm		17 (7)	28 (12)	53 (9)	41.51	3.19
Large farm		8 (5)	13 (7)	18 (3)	18.17	2.02
Very large farm		2 (1)	1 (1)	5 (1)	3.17	1.59
Total		57 (27)	66 (30)	174 (33)	120.39	1.82

* Number in parenthesis indicate household having livestock

Table 4.1.14: Livestock distribution and Fodder demand as per landholding

Landholding category		N*	Livestock Unit		Fodder Demand (tons/year)		
			Mean LU	Total LU	Mean	Total Demand	Demand tons/yr/LU
Landless	No holding land	2	3.07	6.13	63.88	127.75	19.94
	Ailani land holders	6	2.58	15.50	45.63	273.75	18.38
Small farm		20	1.80	35.91	35.13	702.63	22.45
Medium Farm		13	3.19	41.51	58.96	766.50	19.02
Large farm		9	2.02	18.17	38.53	346.75	21.07
Very large farm		2	1.59	3.17	45.63	91.25	38.94
Total		52	Avg. Mean=2.32	120.39	Avg. Mean= 44.40	2308.63	Avg.=21.42

*Households having no livestock have been excluded

Table 4.1.15: Livestock distribution and fodder demand as per ethnicity

Ethnic group/Caste	N	Livestock Unit*		Fodder Demand (tons/year)*		
		Mean LU	Total LU	Mean	Total Demand	Demand tons/yr/LU
Bote/Majhi/Mushahar	1	0.54	0.54	18.25	18.25	33.80
Brahmin/Chhetri/Giri/Puri	18	1.70	30.65	36.50	657.00	24.54
Dalit	2	2.94	5.87	45.63	91.25	16.20
Magar/Gurung/Tamang	29	2.76	79.91	51.29	1487.38	19.82
Madhesi	1	1.26	1.26	18.25	18.25	14.48
Newar	1	2.16	2.16	36.50	36.50	16.90
Total	52	Avg. Mean =2.32	120.39	Avg. Mean = 44.40	2308.63	21.42

*Households having no livestock have been excluded

Similarly, the relationship between fodder demand, livestock holding and ethnicity of HHs is assessed in Table 4.1.15, Janjati shared the highest LU (79.91), demanding 1487.38 tons of fodder annually (Mean: 51.29 tons/year). Mean LU holding was the

highest in Dalit (2.94) and the least (0.54) was in Bote/Majhi/Mushahar (Mean of total study area 2.32).

Figure 4.1.5 portrays the various fodder access sources for fulfilling demand of fodder. Buffer zone community forest was the chief source of fodder for locals. Thirty two (61.53%) out of 52 livestock holding HHs used BZ CF, while 11 HHs were dependent absolutely on BZ CF for their daily need of fodder. Besides that, 21(40.38%) HHs used others sources like own land and wasteland in addition of BZ CF for easy access.

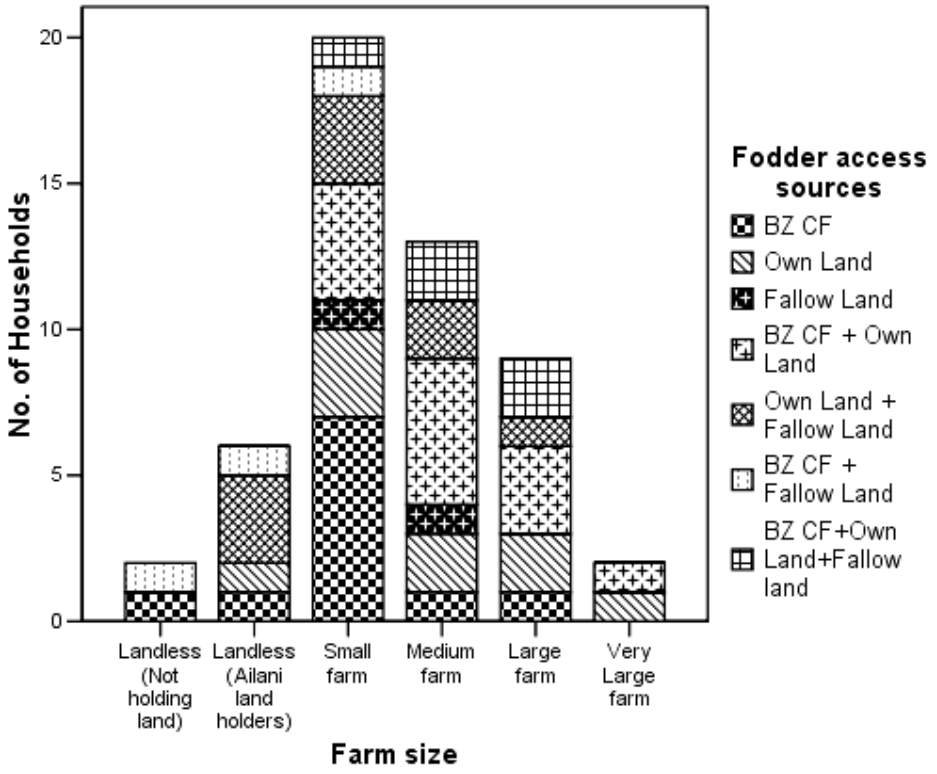


Figure 4.1.5: Sources of fodder access

Correlation analysis was performed between different fodder and livestock related variables as shown in Table 4.1.16, which demonstrated high positive association between LU and fodder demand (tons/year) as guided by correlation coefficient (r = 0.9019**). Similar analysis was also carried out between farm size versus fodder demand and LU versus farm size, but both results were insignificant while latter displayed negative correlation, suggesting lower farm size holding HHs depending more on off-farm sources of income for securing their food demand.

Table 4.1.16: Correlation between different parameter of fodder

Variables	Pearson's Correlation Coefficient (r)*
Livestock Unit Versus Farm size (ha)	-0.03180
Livestock Unit Versus Fodder demand (tons/year)	0.90192**
Farm size (ha) Versus Fodder demand (tons/year)	0.03791

**Correlation is significant at the 0.01 level (2 tailed).

4.2.7 Energy use

Kerosene and electricity were used by the locals for lighting purpose. Fuel wood was the prime source of energy for cooking which is extracted from locally available plant species. In addition, few HHs have adopted other than fuel wood energy sources namely; biogas and Liquefied Petroleum Gas (LPG) for cooking. Table 4.1.17 shows types of energy used, total per year consumed and expenditure by HHs. Kerosene was used by 98.48% HHs with mean use of 19.2 liter/year, and expending Rs 963.69 per year in average by each HHs. LPG was used by 9.09% HHs with mean cylinder use 7.94 per year and mean expenditure was Rs 8433.33. Only 6 (9.09%) HHs had installed biogas in their home. The distribution of biogas was not even among both land-holding category of HHs and ethnicity of HHs. Only medium, large, and very large farm holders from two ethnicity Brahmin/Chhetri/Giri/Puri and Janjati had installed biogas with 33.33% each of total installed (6).

Table 4.1.17: Source of energy use

Types of Energy	No. of HH (N)	%HH	Total Usage	Mean (per HH)	Mean Expenditure (NRs.)/year/HH
Kerosene (ltr/year)	65	98.48	1248	19.2	963.69
LPG(cylinder/year)	6	9.09	47.65	7.94	8433.33
Electricity	59	89.39	-	-	-
Biogas	6	9.09	-	-	-

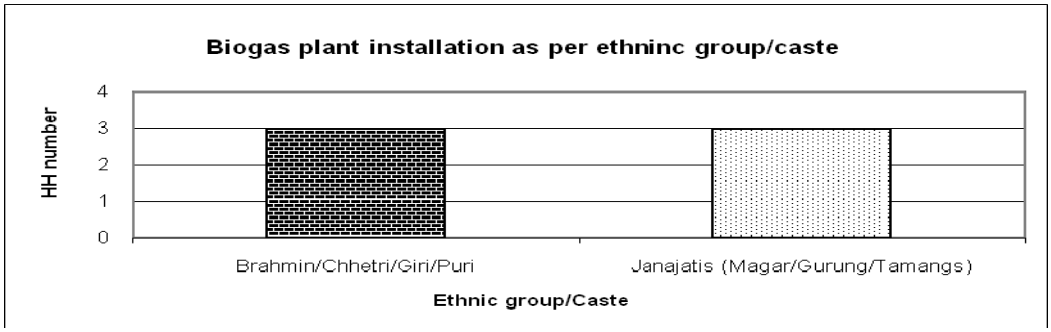


Figure 4.1.6: Biogas plant installation as per ethnicity

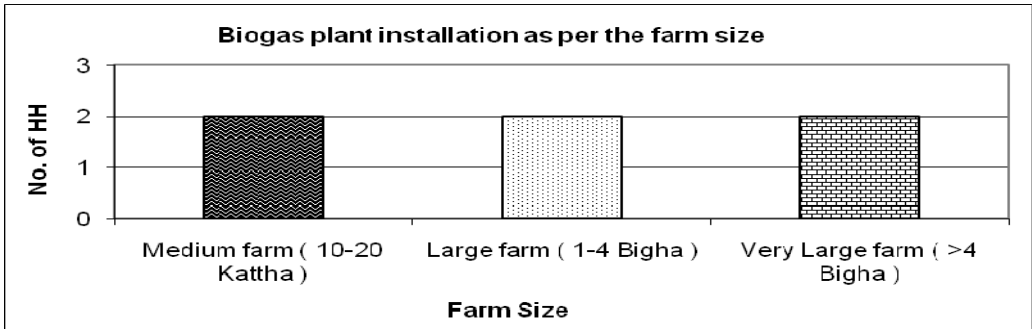


Figure 4.1.7: Biogas plant installations as per the landholding

4.2.7.1 Fuel wood

Fuel wood consumption was an essential need for local villagers; 65 (98.48%) HHs were found to be using fuel wood as their main energy resource. Although leading source for fuel wood extraction was BZ CF, HHs were also shifted towards other sources for easy access such as collecting drifted fuel wood in Narayani river or even from their own land. Moreover, locals were also largely dependent on Chitwan National Park since the park opens for seven to ten days to locals as an annual event named as *Khar Khadai*. Table 4.1.18 shows the fuel wood sources for surveyed HHs with annual amount of extraction. Similarly, Figure 4.1.8 and 4.1.9 display the sources of fuel wood as per ethnic group and farm size of HHs. Ethnic community Bote/Majhi/Mushahar had fishing and ferrying as main occupation; their principal source of fuel wood was drift wood in Narayani river.

Table 4.1.18: Sources of fuel wood and amount of extraction

Fuel wood access source	No. of HH	% of Total HH	Mean Fuel wood extraction tons/year/HH	Total Fuel wood extraction (tons/year)
BZ CF	9	13.64	3.95	35.52
Buy from BZ CF	6	9.09	5.12	30.72
Buy from BZ CF+Own land+CNP	6	9.09	4.88	29.28
Buy from Individual	1	1.52	4.80	4.80
BZ CF+CNP	3	4.55	10.24	30.72
BZ CF+CNP+FF	1	1.52	6.72	6.72
BZ CF+FF	5	7.58	5.09	25.44
BZ CF+Own land	8	12.12	6.84	54.72
BZ CF+Own Land+CNP	16	24.24	6.60	105.60
BZ CF+Own Land+CNP+FF	2	3.03	6.72	13.44
CNP+FF	2	3.03	5.76	11.52
FF	3	4.55	7.20	21.60
Fuel wood non-user	1	1.52	0.00	0.00
Own Land	3	4.55	4.80	14.40
Total	66	100	5.83	384.48

FF=Flooded fuel wood, CNP = Chitwan National Park

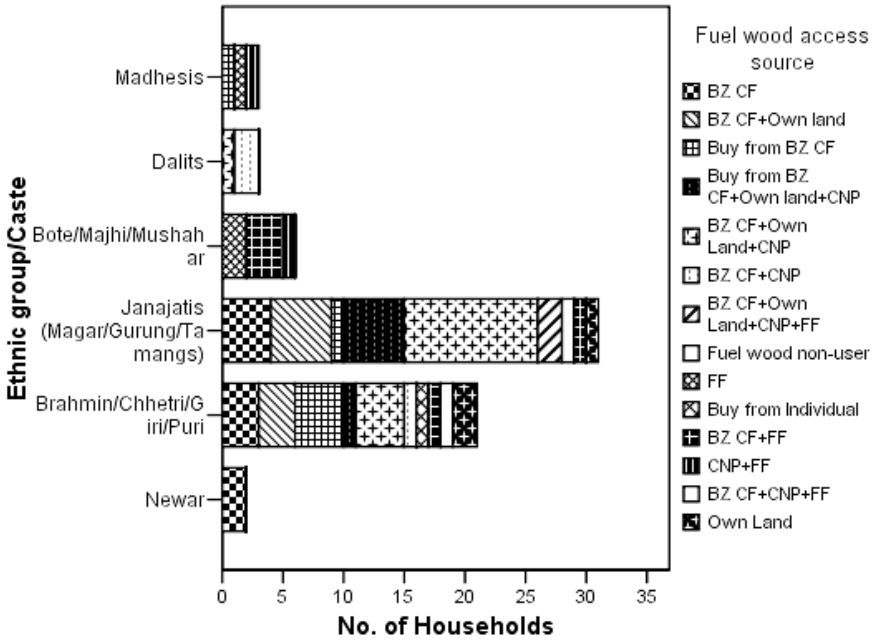


Figure 4.1.8: Sources of Fuel wood for HHs as per ethnicity

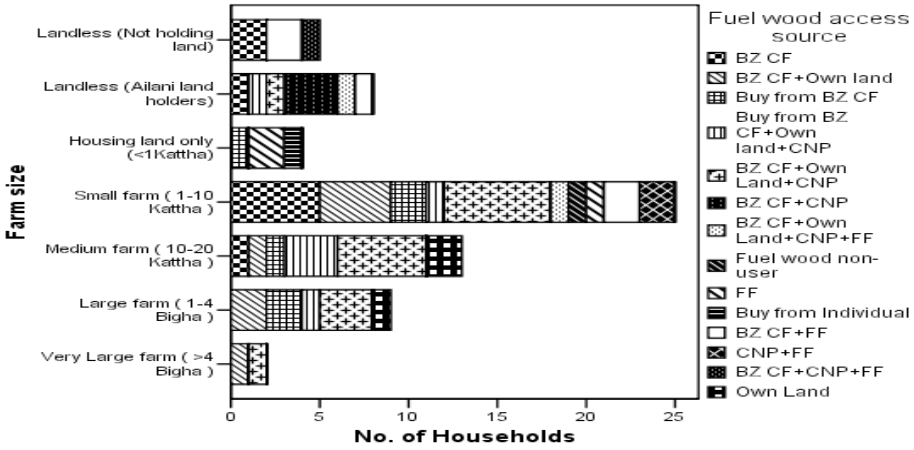


Figure 4.1.9: Sources of fuel wood as per landholding

The annual consumption of fuel wood by sampled HHs was 388.28 tons/year [mean usage = 5.97 tons/year/HH] and average per capita consumption was found as 0.94 tons/year. Per capita fuel wood usage high among the small farm (housing land only) HHs while the least (0.62 tons/year) was found in very large farm holding HHs (Table 4.1.19). Similarly, Table 4.1.20 shows the fuel wood consumption amount of HHs according to their ethnicity. The Dalit community found to be using the highest amount of fuel wood [mean: 10.24, per capita mean: 1.81] as compared to rest other

ethnic groups, the reason behind is; their traditional occupation of molding iron to manufacture agro-tools in *Aron*.

Table 4.1.19: Fuel wood usage as per landholding

Farm size		No. of HH*	Fuel wood Usage (tons/year)				
			Total Usage	Mean	Std. Deviation	Median	Per Capita Fuel wood usage
Landless	i. No holding land	5	20.16	4.03	1.72	3.84	0.89
	ii. Ailani land holders	8	57.60	7.20	3.66	5.76	1.31
Small farm	i. Housing land only	4	24.96	6.24	2.98	5.28	0.76
	ii. Small farm	24	146.84	6.12	2.47	5.76	0.92
Medium farm		13	72.96	5.61	2.46	3.84	0.77
Large farm		9	55.68	6.19	1.93	6.72	1.11
Very large farm		2	10.08	5.04	3.05	5.04	0.62
Total		65	388.28	5.97	2.56	5.76	0.94

* Fuel wood non-user households are omitted

Table 4.1.20: Fuel wood usage as per ethnicity

Ethnic group/Caste	No. of HH	Fuel wood Usage (tons/year)				
		Total Usage	Mean	Std. Deviation	Median	Per Capita Fuel wood usage
Bote/Majhi/Mushahar	6	31.68	5.28	1.66	4.80	0.98
Brahmin/Chhetri/Giri/Puri	21	110.40	5.26	2.15	4.80	0.82
Dalit	3	30.72	10.24	4.93	11.52	1.81
Magar/Gurung/Tamang	30	187.68	6.26	2.23	5.76	0.99
Madhesi	3	22.04	7.35	3.39	7.68	0.54
Newar	2	5.76	2.88	1.36	2.88	0.70
Total	65	388.28	5.97	2.56	5.76	0.94

Table 4.1.21: Correlation between different parameters of fuel wood

Variables	Pearson's Correlation Coefficient (r)*
Fuel wood demand (tons/year) Versus Family size	0.5704**
Fuel wood demand (tons/year) Versus Land own	-0.0132

******Correlation is significant at the 0.01 level (2 tailed).

Correlation analysis between fuel wood demand (tons/year) versus family size and landholding of HHs is given in Table 4.1.21. The result shows fuel demand and family size of HHs had significant mutual positive relationship (r = 0.5705**), while inverse relationship was found between fuel wood demand and landholding of HHs.

4.2.8 Income and expenditure

The economic index was constructed using household's per capita annual income. Each household's incomes through various sources were summed and per capita income of household was ranked in index stratified by range of per capita incomes (Table 4.1.22). Of the total surveyed HHs, 57.57% had poor income, 34.85% had medium income and only 7.58% HHs belonged to Good income HHs. The mean income of the sample households was found to be NRs. 81791.29 per year (Range: min Rs 12,000 and max NRs. 304,600) (Figure 4.1.10). Similarly, mean per capita income of surveyed HHs was found to be NRs. 14,054.93 per year (Range: min NRs. 2,625 max NRs. 50,766.67). Mean annual expenditure of HHs was NRs. 41,555.45 per year ranging with the highest and the lowest income by NRs. 6,040 and NRs. 127,300 respectively (Figure 4.1.11).

Table 4.1.22: Economic index of HH based on Per Capita Income

Per Capita Income Range (NRs.)	Economic Index	No. of HH	% of HH
<=12000	Poor Income Household	38	57.57
12000-36000	Medium Income Household	23	34.85
>36000	Good Income Household	5	7.58

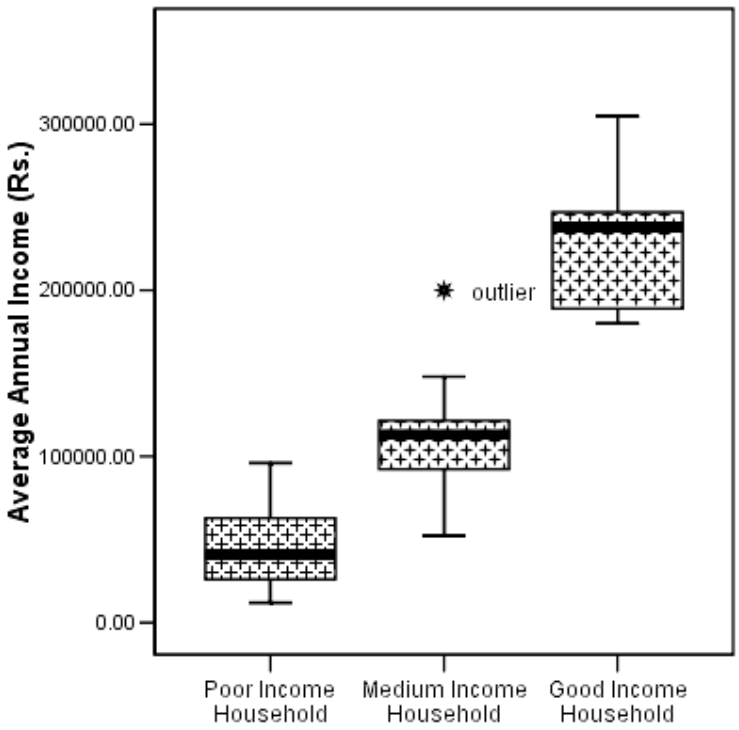


Figure 4.1.10: Annual income of HHs as per economic index

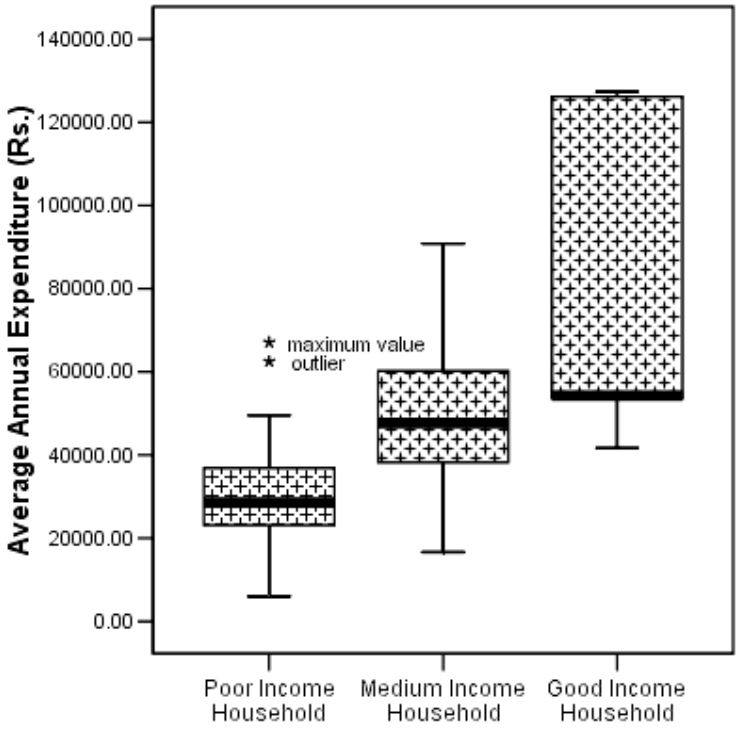


Figure 4.1.11: Annual expenditure of HHs as per economic index

Table 4.1.23 shows the economic index of the studied households, based on their ethnicity. The HHs with good income economic index belonged to only two major ethnic communities Brahmin/Chhetri/Giri/Puri (60%) and Janjati (40%). Per capita income was highest (NRs. 53591.43) in Brahmin/Chhetri/Giri/Puri HHs whereas, lowest in Dalit (NRs. 4681.48).

Table 4.1.23: Income and Expenditure as per ethnicity

Ethnic group/Caste	N	Poor/Medium/ Good Income HHs	Average Annual Income (NRs.)	Per Capita Income (NRs.)	Average Annual Expenditure (NRs.)
Newar	2	1/1/0	69,100.00	14,820.00	34,350.00
Brahmin/Chhetri/Giri/Puri	21	8/10/3	109,414.29	18,145.44	53,591.43
Magar/Gurung/Tamang	31	19/10/2	73,549.19	12,960.27	34,477.10
Bote/Majhi/Mushahar	6	6/0/0	42,133.33	7,856.02	35,125.00
Dalit	3	3/0/0	27,000.00	4,681.48	30,766.67
Madhesi	3	1/2/0	116,166.67	14,660.71	58,900.00
Total	66	38/23/5	81,791.29	13,903.41	41,555.45

Household income is crucial parameter, which influences different aspects of HHs characteristics and their possession. Table 4.1.24 presents information on the distribution of economic resources, utilization of forest products and the de jure HHs

income and expenditure scenario by their economic Index. Landholding among the poor, medium and good income show the linear association and justify that higher landholding tracked for better income. Moreover, correlation analysis between land own versus net income, and land own versus per capita income both were positively significant with correlation coefficient (r) 0.3488* (0.01 significance level) and 0.266* (0.05 significance level), respectively. Livestock holding was high (2.13 LU/HH) among poor income HHs, and then was in medium income HHs (1.46 LU/HH) and least among good income (1.20 LU/HH): showing inverse relationship between income and livestock possession. Similar inverse relationship was also observed in utilization of forest resources by poor, medium and good income HHs (Table 4.1.25).

Table 4.1.24: HHs characteristics of Tribeni BZ area

Variables	Poor Income HH	Medium Income HH	Good Income HH	Total Average
Landholding (Ha)	0.38	0.47	1.20	0.47
Avg. annual income (NRs.)	45292.76	109500.00	231720.00	81791.29
Avg. annual expenditure (NRs.)	31065.39	50398.91	80600.00	41555.45
Net income (saving) (NRs.)	14227.37	59101.09	151120.00	40235.83
Per capita income (NRs.)	6579.73	19359.22	44466.67	13903.41
Livestock Unit	2.13	1.46	1.20	1.82
Avg. food crops production(Kg)	988.24	694.04	2226.00	979.48
Avg. fodder usage (tons/year)	41.30	27.38	25.55	35.26
Avg. fuel wood usage (tons/year)	6.83	4.92	3.07	5.88

Table 4.1.25: Correlation between parameters of income and landholding

Variable	Pearson's correlation coefficient (r)
Land own (ha) versus Net income (average savings)	0.3488*
Land own (ha) versus Per capita income	0.266**

*Correlation is significant at the 0.01 level (2-tailed) **Correlation is significant at the 0.05 level (2-tailed).

4.3 Buffer zone program and community forestry

Buffer zone program in Tribeni was started since the commencement of program in 1997. Buffer zone management committee of CNP had ranked Tribeni Buffer Zone VDC in grade B; CNP assigns grading to buffer zone area for budget allotment. Altogether, 34 user groups (UG) were formed under the Tribeni Buffer Zone User Committee (UC). There were three buffer zone community forests within the Tribeni buffer zone area namely: Tribeni BZ CF, Shanti BZ CF and Kaddar Baba BZ CF. However, none of them had been handed over to the users by the buffer zone

program of CNP. Tribeni BZ CF seemed to be more operational in comparison to two others and submitted its operational plan to CNP authority. Other two had been formed by the locals on the scenario of dispute in resource utilization among users. Since the inception, there was continuous conflict on the boundary of buffer zone area, and even on the boundaries between community forests within buffer zone area in Tribeni VDC. The buffer zone forest resources were shared by 996 HHs of ward number 1, 2, 3, 7, and 8 of Tribeni-Susta VDC; and ward no. 4, 5, 6, and 9 were not included in the buffer zone program due to isolated and far away from buffer zone area.

4.3.1 Household participation in buffer zone program

Of the total surveyed HHs, 69.70% had been involved in buffer zone activities. The result visualized that participation in buffer zone management was varied according to landholding, ethnicity and income level of HHs. Higher land owners were more interested in buffer zone activities and involvement ratio were high. Very large farm holding HHs were cent-percent involved, while involvement of *Ailani* landholders were mere 25%.

Participation in buffer zone program among ethnic groups show higher involvement from Brahmin/Chhetri/Giri/Puri (76.19%) and Janjati (74.19%), moreover none other ethnic community had involved in governing body of User Committee except Brahmin/Chhetri/Giri/Puri and Janjati. Similarly, linear relationship was found in involvement in BZ program and income level. Higher income level HHs were found to be taking part in BZ activities in higher proportion.

4.3.2 Perception on budget allotment by CNP

Most of respondents found this question vague because they were unaware about amount of budget disbursed to their BZ by CNP. Result showed that 48.5% respondents did not know about budget allocation system of BZ program, 43.9% said budget was insufficient and only 7.6% were satisfied by amount of budget (Figure 4.1.12).

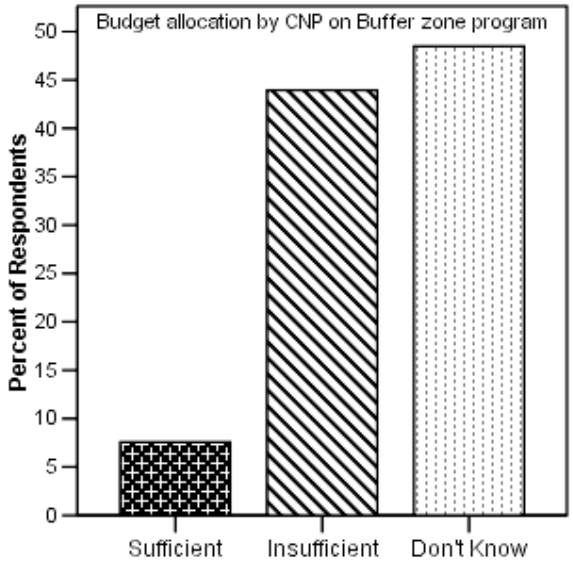


Figure 4.1.12: Respondents perception on Budget allocation on BZ program

4.3.3 Community forestry and resources issues

Community forestry was the major source of natural resources for locals of Tribeni BZ area. Fodder, Fuel wood, Timber, Medicinal Plants, *Khar* and *Khadai* were the listed resources that have been extracting by users in study area from community forestry. When asked about types of resource utilization from CF, response was most common for fodder (75% of HHs) and fuel wood (80.30% of HHs), while 9.09 % HHs were non-user of CF resources. Table 4.1.26 shows the combined utilization of resources from community forest by users.

Table 4.1.26: Types of resources usage from BZ CF

Resources usage from BZ CF	No. of HH	%HH
Fodder + Fuel wood	26	39.39
Fodder+Fuel wood+Timber+Khar and Khadai	14	21.21
Fuel wood	8	12.12
Fodder	6	9.09
Fodder + Fuel wood + Timber	4	6.06
Timber	1	1.52
Fuel wood + Timber	1	1.52
None	6	9.09
Total	66	100

4.3.4 Status of community forest

Perception on buffer zone community forest is visualized in Figure 4.1.13. Of the total respondents, 10.6% of respondents perceived that present status of forest was in very good condition, 37.9% response was in favor of option good; 27.3% and 19.7%

respondents told that condition of forest was satisfactory and bad, respectively, while 4.5% were unaware about forest status. When asked to compare present status of forest to past time, larger proportions of respondents (39.4%) went for option worse. Similarly, majority of respondents (53%) said that their demand for forest resources were not fulfilling by the BZ CF.

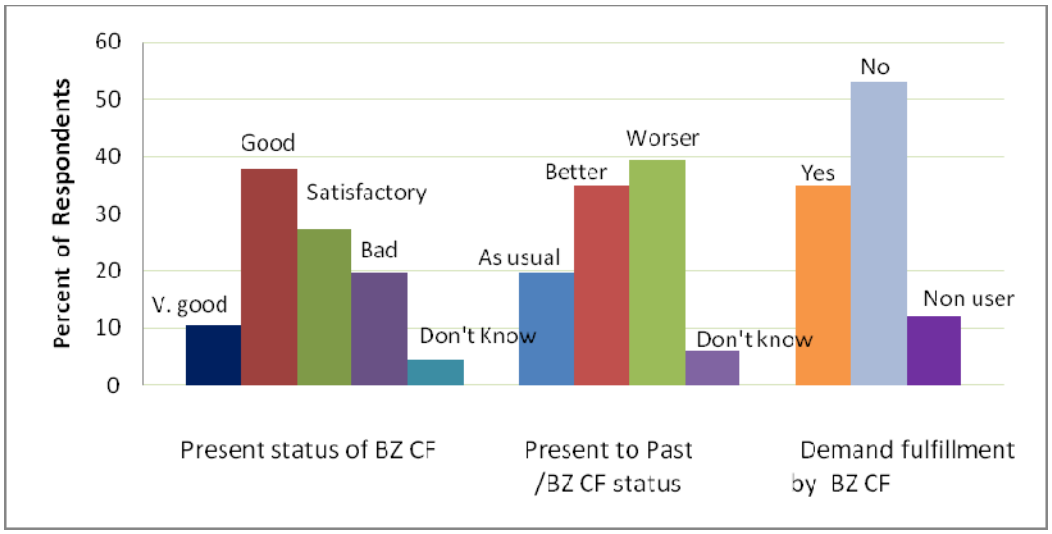


Figure 4.1.13: Perception of respondents on BZ CF

4.3.5 Problem in BZ CF

The problem that the users were facing in their respective BZ CF had been identified by respondents and is presented in Table 4.1.27. Altogether, seven kinds of problem were listed by 44 respondents; while, 16 respondents were unknown about problem that they faced from their community forest and six of all found no problem in BZ CF.

Table 4.1.27: Problem identified by respondent in BZ CF

Problem in BZ CF	Frequency Response	Percent
Crop depredation from wildlife	2	3.03
Deforestation	10	15.15
Encroachment from outsider	10	15.15
Improper management practice	8	12.12
No fencing	3	4.55
Proper boundary	5	7.58
Timber is inaccessible	6	9.09
No problem	6	9.09
Don't know	16	24.24
Total	66	100

4.3.6 Suggestion

When asked for suggestion for betterment of BZ CF, the highest percentage (31.82%) did not replied the question and other responses enumerated nine preference for improvement of BZ CF. Of all, 22.73% said that awareness among users would guide betterment, while 4.55% each suggested for afforestation and fair distribution of compensation for CF linked losses (Table 4.1.28).

Table 4.1.28: Suggestion of respondents on betterment of BZ CF

Managerial suggestion for betterment for BZ CF	Frequency Response	Percent
Plantation of fodder plant	1	1.52
Formation of strong management team of UC	2	3.03
Preventing encroachment from outsiders	2	3.03
Afforestation	3	4.55
Fair distribution of compensation	3	4.55
New installment of biogas	5	7.58
Proper boundary between CFs	7	10.61
Pro-poor governance	7	10.61
Awareness	15	22.73
No Idea	21	31.82
Total	66	100

4.4 Wildlife, crop depredation problem and compensation

Depredation due to wildlife on crop and livestock is a serious threat for causing park people conflict, so was the case in the Tribeni BZ and raising problematic issue for settlements near to forest boundary. Though human casualty was yet to record, crop damage and livestock loss was frequent phenomena in the studied area. Table 4.1.29 enumerates the crop and livestock depredating wildlife. Tribeni Buffer Zone was rather outreach site for rhino, and surveyed respondents identified no local occurrence of rhino. However, locals reported that one rhino appeared some five/six years ago but it was brought by flood of Narayani River.

Table 4.1.29: Animals causing crop damage and livestock depredation

S.N.	Common Name	Scientific Name	Family
1	Nilgai (Ghodgadha)	*Boselaphus tragocamelus*	Bovidae
2	Langur Bandar	*Semnopthicus entellus*	Cercopithecidae
3	Dumshi	*Hystrix indica*	Hystricidae
4	Bandel	*Sus scrofa*	Suidae
5	Chittal	*Axis axis*	Cervidae
6	Bhalu**	*Ursus ursinus*	Ursidae
7	Chituwa*	*Panthera pardus*	Felidae
8	Bagh*	*Panthera tigris*	Felidae

* Livestock depredating ** both livestock and crop depredating

Figure 4.1.14 visualizes the number of HHs facing problem of crop depredation and their measures to tackle the problem. Fifty percent of HHs, in one way or other, were facing the problem of hunting by wildlife on their field or livestock. While, 28.8% did not have to confront with the problem and 13.6% did not face the problem because they had no land to grow crop or not held livestock. To deal with problem, 12.5% respondent had shifted their crop types – to sugarcane, three percentages abandoned their field and 23% did not apply any measures (Figure 4.1.15).

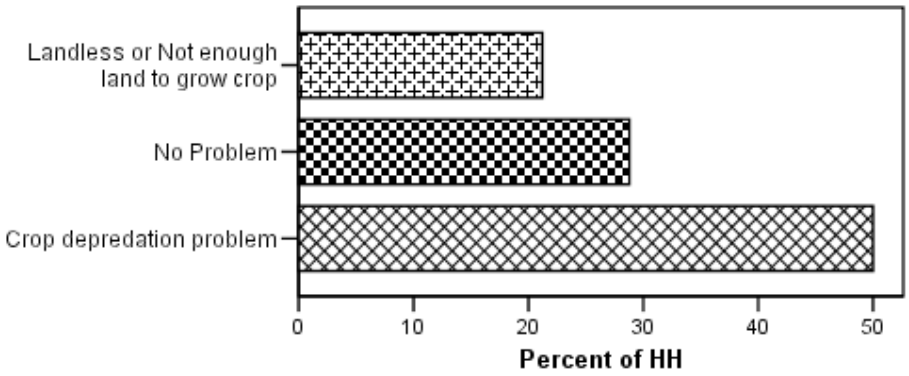


Figure 4.1.14: Crop depredation problem

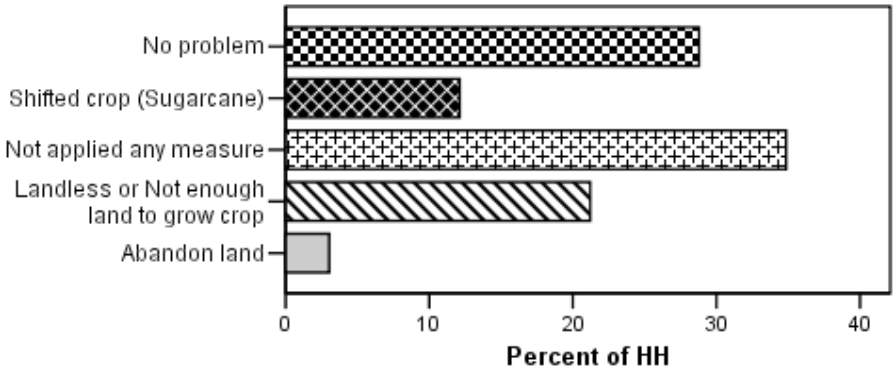


Figure 4.1.15: Measures for crop depredation problem

Following Tables 4.1.30, 4.1.31 and 4.1.32 show the volume of crop losses by victim householders by their land percentage and compensation receipt histories. There were 15.15% HHs that had lost nominal crops accounting less than 10% of their land. Similarly, HHs with crop loss 10-25%, 25-50% and greater than 50% of their land were 13.64%, 15.15% and 6.06%, respectively. In contrast, there were few HHs which had got compensation from buffer zone program; only 24.25% sufferer got compensation, while 45.45 did not get reparation of damages and further 30.30% did not said to authority about damage.

Table 4.1.30: Amount of crop damage in land percentage

Annual crop damage by the Wildlife (Land %)	No. o HH	%HH
No damage	19	28.79
<10%	10	15.15
10-25%	9	13.64
25-50%	10	15.15
>50%	4	6.06
Landless or not enough land to grow crop	14	21.21
Total	66	100

Table 4.1.31: Compensation of crop damage

Compensation of damaged crop*	No. of HH	%HH
Got compensation	8	24.25
Didn't get	15	45.45
Didn't tell to authority	10	30.30
Total	33	100

* Only Crop depredated HH are entertained

All together 10 (15.15%) HHs suffered livestock loss from wildlife in their lifetime. 3.03% of each HHs had their livestock loss within last year and within surveyed month. Moreover, during survey period I found one HH, which had lost two goats the day before the interviewed day. Only one victim HH had succeeded to get compensation of their livestock loss.

Table 4.1.32: Time of loss of livestock

When did you loss Livestock?	No. of HHs	%HH
This month	2* (No Compensation)	3.03
Within last year	2* (1 got the compensation)	3.03
Years before	6	9.09
Till date no loss	51	77.27
Not held livestock	5	7.58
Total	66	100

Figures 4.1.16 displays the respondents' perception on wildlife population. Majority of respondents (54.5%) said that wildlife population in buffer zone forest was decreasing and some important reasons reported by them were habitat loss, human interference, natural death and poaching. While, 19.7% of respondents thought population was increasing; 18.2% said no change in population, and again 7.6% were unaware about inhabited wildlife.

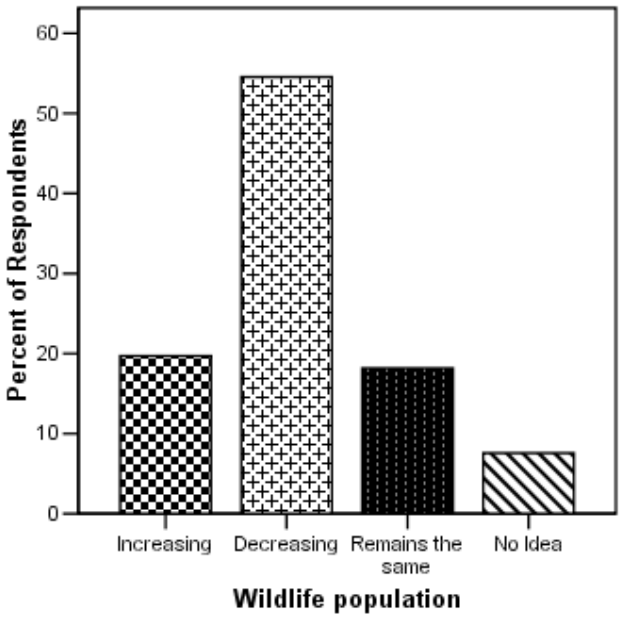


Figure 4.1.16: Respondents perception on wild animal population

When asked about poaching consequences of wildlife, none of the respondents were interested to express their understanding at first, but later on some 22.73% agreed that poaching was the problem for wildlife and about one out of four said poaching was prevalent only in past (Table 4.1.33). Eight respondents perceived that poaching was matter of recreation, 11 respondents said poaching was easy way to earn money for poachers, while 12 respondents said poachers were compelled to do poaching for their sustenance (Table 4.1.34).

Table 4.1.33: Perception on poaching

Have you notice poaching of wild animals?	No. of Respondents	Percent
Yes	15	22.73
No	19	28.79
Don't know	15	22.73
Yes but in past	17	25.76
Total	66	100

Table 4.1.34: Reasons of poaching

Reason of poaching	No. of Respondents	Percent
As a recreation	8	12.12
To earn money	11	16.67
To sustain their life	12	18.18
Don't know	16	24.24
No poaching	19	28.79
Total	66	100

4.5 Narayani River as resource

The Narayani River, flowing Southern east boundary of Tribeni Buffer Zone area, had set up wide range of opportunities for locals. More than 95% local residents thought Narayani River as resource. Many locals, mostly ethnic group Bote/Majhi/Mushar got their basic means of support from Narayani River. Out of total, 16.66% HHs had been earning their lives from Narayani River through seasonal or fulltime professions like fishing, ferrying, collecting construction materials etc. Table 4.1.35 and 4.1.36 delineate resource utilization status and dependency on Narayani River by ethnicity, respectively.

Table 4.1.35: Types of resources use form Narayani River

Resources usage from Narayani River	No. of HH	Percent
Constructional material	1	1.52
Fisheries	2	3.03
Flooded fuel wood	3	4.55
Water+ Fisheries+ Fuel wood	10	15.15
Water+ Flooded fuel wood+ Constructional material	2	3.03
Water+ Fuel wood+ Fisheries+ Constructional material	2	3.03
Non-user	46	69.70
Total	66	100

Table 4.1.36: Ethnic group depending on Narayani River for livelihood

Ethnic group/Caste* (profession using Narayani river)	Frequency	Frequency%	Total
Brahmin/Chhetri/Giri/Puri	1	4.76	21
Janjati (Magar/Gurung/Tamang)	3	9.68	31
Bote/Majhi/Mushahar	6	100.00	6
Madhesi	1	33.33	3
Total	11	18.03	61

*Ethnic group involve in using Narayani river's resources as seasonal or fulltime profession is enlisted.

PART II: VEGETATION ANALYSIS OF TRIVENI VDC BUFFER ZONE FOREST

4.6 Status of forest strata

4.6.1 Tree stratum

Vegetation analysis revealed that there were altogether 29 tree species belonging to 16 different families in the study area. The Tribeni Buffer Zone forest harbored two types of forest – Sal forest species and Terai (Tropical) mixed hardwood species – major tree species belonging to Sal forest were predominant-*Shorea robusta;* and *Terminalia alata*, *Adina cordifolia*, *Anogeissus latifolius* etc the associated tree species in the canopy cover. Similarly, *Syzygium spp*, *Phyllanthus emblica*, *Adina cordifolia*, *Acacia catechu*, *Lagerstroemia parviflora* etc comprised the species of Terai mixed hard wood forest. Table 4.2.1 shows Important Value Index (IVI) of the tree species. *Shorea robust* got the highest IVI, while there were three trees namely; *Carey aborea*, *Lannea coromandelica* and Chanichui, which were occurred singly in only one plot out of total 30 studied plots.

Table 4.2.1: Density, Frequency, Dominancy and IVI of tree stratum (Detail in Annex VIII)

Plant Name	No.	D/ha	RD%	F%	RF%	Dom.	R. Dom%	IVI
Shorea robusta	99	82.50	25.127	40.00	9.23	0.06314	44.113	78.471
Anogeissus latifolius	65	54.17	16.497	66.67	15.38	0.02722	19.016	50.898
Lagerstroemia parviflora	58	48.33	14.721	63.33	14.62	0.02167	15.141	44.477
Terminalia alata	58	48.33	14.721	56.67	13.08	0.02167	15.141	42.939
Wendlandia puberula	31	25.83	7.868	26.67	6.15	0.00619	4.325	18.347
Semecarpus anacardium	13	10.83	3.299	20.00	4.62	0.00109	0.761	8.676
Mallotus phillippensis	10	8.33	2.538	16.67	3.85	0.00064	0.450	6.834
Physalis divaricata	6	5.00	1.523	13.33	3.08	0.00023	0.162	4.762
Ziziphus incurve	6	5.00	1.523	13.33	3.08	0.00023	0.162	4.762
Adina cordifolia	4	3.33	1.015	13.33	3.08	0.00010	0.072	4.164
.....								
Total no. of species 29	394	328.33	100	433.33	100	0.14312	100	300

The basal area of trees per unit area is mainly governed by the size and density of trees. In addition, the DBH and height of tree gives the size of tree. The calculated value of total basal area, relative basal area, and basal area per hectare is presented in Table 4.2.2. Moreover, total basal area per hectare of all species was found to be 16.8 m^2ha^{-1} and highest relative basal area was of *Shorea robusta* (30.67%).

Table 4.2.2: Basal area of Tree species (Detail on Annex VIII)

Species Name	Mean Height (m)	Mean DBH (cm)	Std. Deviation of Mean DBH	TBA (m^2)	RBA%	BA/ha
Shorea robusta	15.87	21.40	18.46	6.1864	30.676	5.1553
Anogeissus latifolius	16.53	26.04	14.25	4.4836	22.233	3.7363
Terminalia alata	17.60	23.97	17.28	3.9556	19.615	3.2964
Lagerstroemia parviflora	11.88	17.15	8.07	1.6320	8.093	1.3600
Semecarpus anacardium	10.47	21.92	8.77	0.5635	2.794	0.4696
Wendlandia puberula	8.54	14.45	3.68	0.5402	2.679	0.4502
Dellenai pentagyna	15.54	47.00	36.77	0.4534	2.248	0.3778
Acacia catechu	10.70	34.75	8.37	0.3960	1.964	0.3300
Diospyros tomentosa	11.94	20.06	6.20	0.2742	1.359	0.2285
Clestocalyx operculatus	18.42	38.00	0.00	0.2269	1.125	0.1891
……						
Total no. of species 29	13.84	21.13	14.33	20.1665	100	16.8054

It was observed from stand size classification that larger proportions of trees were of pole class (50.5%). Similarly, sapling, small saw timber and large saw timber were 28.2%, 15.5% and 5.6%, respectively. Meanwhile, height classification of trees showed that higher percentage (55.6%) trees were of intermediate height class i.e. in the range of >10 m to 20 m.

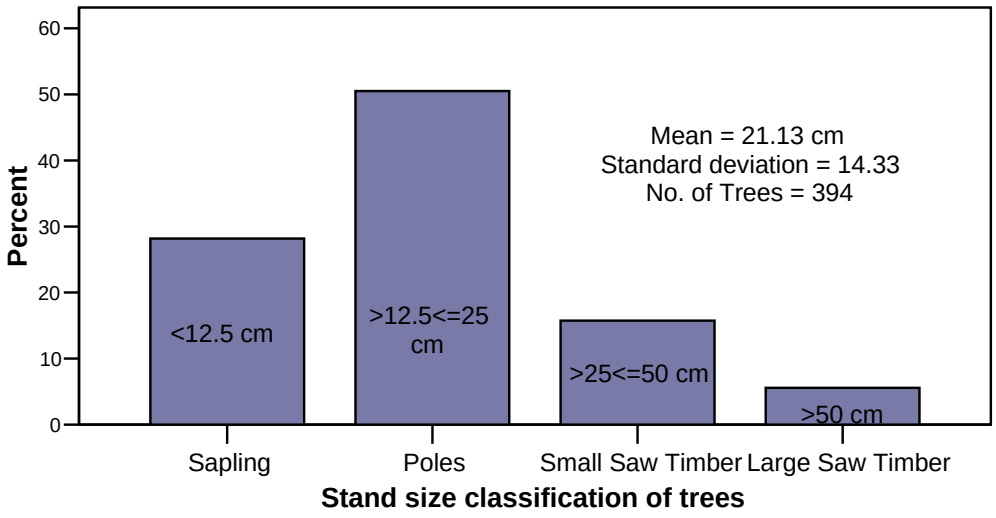


Figure 4.2.1: Stand size classification

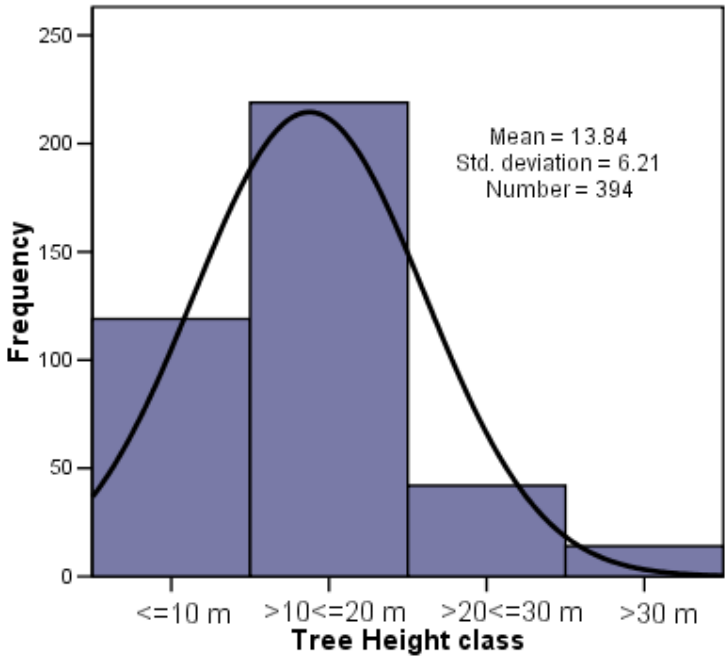


Figure 4.2.2: Stand height classification

Figure 4.2.3 visualizes the distribution of height of each tree according to their standing size (DBH) class. Sapling, pole, small saw timber and large saw timber were distributed in ascending range of height class accordingly.

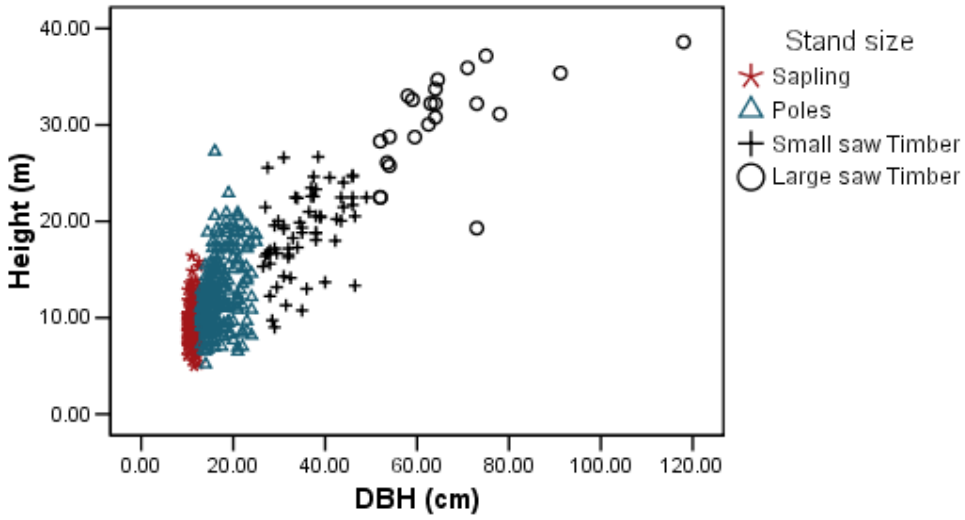


Figure 4.2.3: DBH of trees as per height of trees

Stocking of forest was studied on the basis of percent crown coverage by trees on each plot. Of the 30 studied plots, 14 had the medium stocked crown cover. While, seven each had poor and well stocked forest, and two plots were categorized as “no stocking” as these plots had coverage less than 10%.

Table 4.2.3: Stocking of the forest

Stocking	Crown cover %	No. of Plots	Area (m^2)	Percent
No stocking	-	2*	800	6.67
Poorly stocked	10-39	7	2,800	23.33
Medium stocked	40-69	14	5,600	46.67
Well stocked	70 or more	7	2,800	23.33

* Less than 10% crown closure

4.6.2 Shrub stratum

The study on shrub plot documented a total of 4,324 individual middle storey plants from 96 species, of them four species were unidentified. Table 4.2.4 (Detail in Annex VIII) presents the density, frequency, dominancy and IVI of encountered species in shrub plot. No any species showed the single dominancy, however most of index values were higher for *Terminalia alata* [Density: 2,800 no./ha, Relative Frequency%: 5.70, Relative Dominancy%: 20.19 and IVI: 35.61] and was followed by *Shorea robusta* [Density: 2,886.67 no./ha, Relative Frequency%: 4.04, Relative Dominancy%: 21.46 and IVI: 35.48]. The total density of species in shrub plot was 28,826.67 no./ha.

Table 4.2.4: Density, Frequency, Dominancy and IVI of plant species at shrub stratum (Detail in Annex VIII)

Species name	No.	D/ha	RD	F%	RF%	Dom.	R. Dom%	IVI
Terminalia alata	420	2,800.00	9.713	78.33	5.70	0.009437	20.19605	35.613
Shorea robusta	433	2,886.67	10.014	55.00	4.00	0.010028	21.46563	35.484
Leea macrophylla	304	2,026.67	7.031	41.67	3.03	0.004948	10.58072	20.645
Kuraini lahara	286	1,906.67	6.614	40.00	2.91	0.004378	9.36483	18.892
Khatte*	246	1,640.00	5.689	66.67	4.85	0.003237	6.92848	17.472
Sporobolus diander	276	1,840.00	6.383	26.67	1.94	0.004072	8.72140	17.046
Anogeissus latifolius	191	1,273.33	4.417	53.33	3.88	0.001952	4.17671	12.477
Bauhinia vahlii	144	960.00	3.330	48.33	3.52	0.001101	2.37407	9.224
Woodfordia fruticosa	140	933.33	3.238	45.00	3.28	0.001043	2.24401	8.758
Nilkantha jhar (hudeshi)*	166	1,106.67	3.839	23.33	1.70	0.001478	3.15489	8.693
……								
Total No. of Species 96	434	28,826.7	100.000	1373.33	100.00	0.04675	100.00000	300.000

***Local name**

4.6.3 Ground Vegetation

A total of 1,074 individuals from 56 different species were found in the 60 herb plots. Table 4.2.5 presents the density, frequency, dominancy and IVI of herb species. The total density of ground vegetation was found to be 179,000 no./ha. Most dominant

species was *Imperata cylindrica* with density, relative frequency%, relative dominancy% and IVI as 27,500 no./ha, 3.59, 44.92 and 63.88, respectively.

Table 4.2.5: Density, Frequency, Dominancy, and IVI of plant species at herb stratum (Detail in Annex VIII)

Species name	No.	D/ha	RD%	F%	RF%	Dom.	R. Dom%	IVI
Imperata cylindrica	165	27,500.00	15.36	16.67	3.60	0.023603	44.926	63.886
Cynodon dactylon	85	14,166.67	7.91	6.67	1.44	0.006264	11.922	21.276
Dogshoe khar*	72	12,000.00	6.70	18.33	3.96	0.004494	8.554	19.215
Carex daltonii Boott.	51	8,500.00	4.75	25.00	5.40	0.002255	4.292	14.436
Nilkantha (hudeshi)*	51	8,500.00	4.75	23.33	5.04	0.002255	4.292	14.077
Cyperus rotundus	54	9,000.00	5.03	18.33	3.96	0.002528	4.812	13.797
Cheilanthes anceps	56	9,333.33	5.21	10.00	2.16	0.002719	5.175	12.547
Sporobolus diander	37	6,166.67	3.45	21.67	4.68	0.001187	2.259	10.380
Ohioglossum vulgatum	37	6,166.67	3.45	16.67	3.60	0.001187	2.259	9.301
Cyperus compressus	34	5,666.67	3.17	13.33	2.88	0.001002	1.908	7.951
……								
Total no. of sps. 56	1074	179,000.00	100	463.33	100	0.052537	100	300

***Local name**

4.7 Forest status

4.7.1 Biodiversity

The study area had natural forest, which has been protected since the establishment of CNP. Grazing on outer zone of forest and collection of fallen branches for fuel wood were frequent, while cut stem found on the plots indicated timber collection practice were also prevalent. Status of forest was analyzed by computing different index of plant distribution and is presented in Table 4.2.6 and Figure 4.2.4.

Table 4.2.6: Diversity index at tree, shrub and herb strata

Parameters	Tree stratum	Shrub stratum	Herb stratum
No. of species	29	96	56
Total no. of individual	394	4,324	1,074
Index of dominancy	0.1431	0.0467	0.0525
Shannon Index of diversity	1.0180	1.5323	1.4856
Index of evenness	0.0351	0.0160	0.8498
Species richness	10.7879	26.1284	18.1458
Area studied (m^2)	12,000	1,500	60

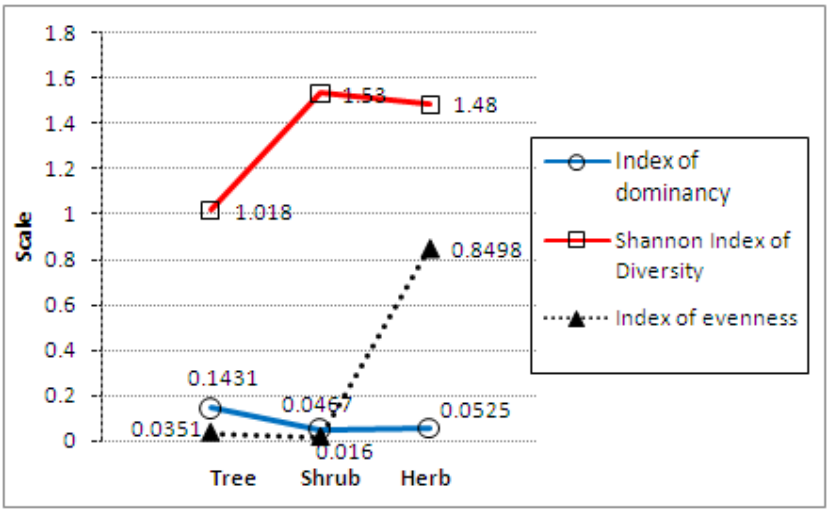


Figure 4.2.4: Diversity indices

4.7.2 Regeneration

Altogether 37 tree species were observed in the regeneration stage (<10 cm) in the shrub plots. The density of regenerating species with their height class is presented in Table 4.2.7. The total density of regenerating tree species was 13,060 no./ha. *Shorea robusta* had the highest density among regenerating species. Density of regenerating species gradually decreased as the height class increased (Table 4.2.8).

Table 4.2.7: Regenerating tree species

Species	Density (No./ha) of regenerating tree species according to their height class				Total No.	Total Density (No./ha)
	<1 m	1-3 m	>3-5 m	>5 m		
Shorea robusta	2233.33	606.67	46.67	0.00	433	2886.67
Terminalia alata	2146.67	540.00	33.33	80.00	420	2800.00
Anogeissus latifolius	926.67	246.67	66.67	26.67	190	1266.67
Woodfordia fruticosa	233.33	366.67	306.67	26.67	140	933.33
Xeromphis spinosa	600.00	226.67	26.67	0.00	128	853.33
Mallotus phillippensis	533.33	240.00	6.67	13.33	119	793.33
Physalis divaricata	340.00	206.67	6.67	0.00	83	553.33
Wendlandia puberula	226.67	40.00	26.67	6.67	45	300.00
Acacia catechu	293.33	0.00	0.00	0.00	44	293.33
Lagerstroemia parviflora	80.00	180.00	0.00	20.00	42	280.00
Dalbergia latifolia	193.33	86.67	0.00	0.00	42	280.00
Zyziphus incurve	220.00	53.33	0.00	0.00	41	273.33
Sterculia villosa	120.00	53.33	0.00	0.00	26	173.33
Desmodium oojeinense	80.00	73.33	0.00	0.00	23	153.33

Semecarpus anacardium	66.67	33.33	40.00	0.00	21	140.00
Phyllanthus embelica	113.33	0.00	0.00	0.00	17	113.33
Mallotus nepalensis	100.00	13.33	0.00	0.00	17	113.33
Garuga pinnata	86.67	13.33	0.00	0.00	15	100.00
Cassia fistula	53.33	33.33	6.67	0.00	14	93.33
Bridelia retusa	26.67	60.00	0.00	0.00	13	86.67
Schleichera oleosa	73.33	0.00	0.00	0.00	11	73.33
Ficus nerrifolia	26.67	40.00	0.00	0.00	10	66.67
Stereospermum chelonoides	40.00	20.00	0.00	0.00	9	60.00
Trichilia connaroides	46.67	6.67	0.00	0.00	8	53.33
Syzygium cumini	46.67	0.00	0.00	0.00	7	46.67
Bauhinia purpurea	33.33	13.33	0.00	0.00	7	46.67
Syzygium cerasoides	33.33	0.00	0.00	0.00	5	33.33
Holarrhena pubescens	26.67	6.67	0.00	0.00	5	33.33
Ficus religiosa	26.67	0.00	0.00	0.00	4	26.67
Wendlandia tinctoria	6.67	6.67	6.67	6.67	4	26.67
Dellenia pentagyna	26.67	0.00	0.00	0.00	4	26.67
Psidium guajave	20.00	0.00	0.00	0.00	3	20.00
Diospyros tomentosa	0.00	0.00	13.33	0.00	2	13.33
Adina cordifolia	13.33	0.00	0.00	0.00	2	13.33
Rukha bel*	13.33	0.00	0.00	0.00	2	13.33
Sano padali*	13.33	0.00	0.00	0.00	2	13.33
Bombax ceiba	6.67	0.00	0.00	0.00	1	6.67
Total No. of Species 37	9126.67	3166.67	586.67	180.00	1959	13060.00

***Local name**

Table 4.2.8: Height class and density of regenerating species

Height Class	No.	Density (No./ha)	Relative Density
<1 m	1369	9126.67	69.88
1-3 m	475	3166.67	24.25
>3-5 m	88	586.67	4.49
>5 m	27	180.00	1.38
Total	1959	13060	100

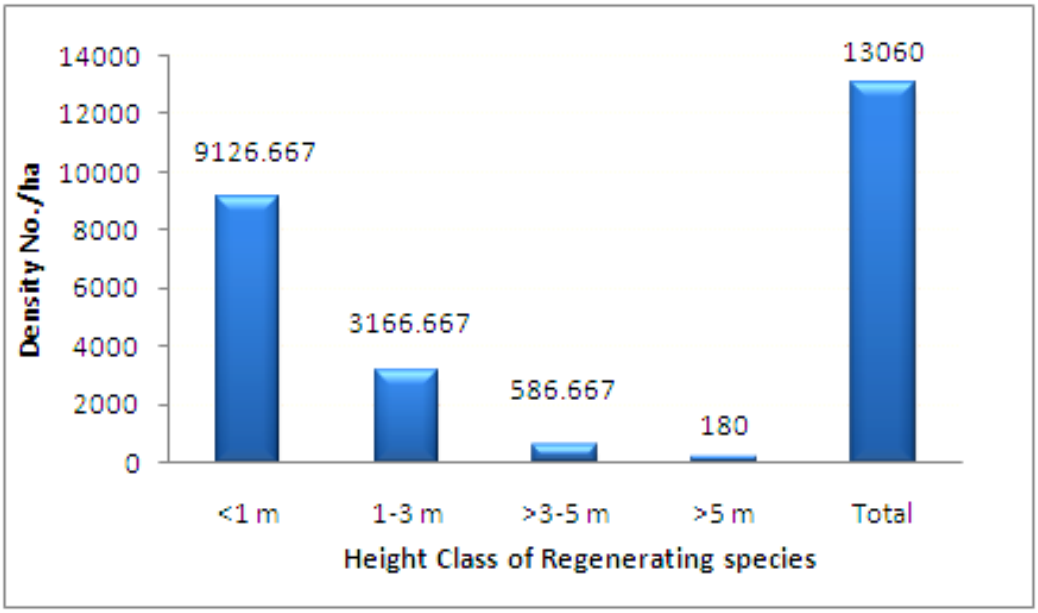


Figure 4.2.5: Density of regenerating species according to height class

4.7.3 Cut stumps

A total of 43 cut stumps of 11 different species were recorded in 19 plots out of 30 sampling plots for trees (Table 4.2.9). *Anogeissus latifolius* had the highest Cut Stump Density (CSD: 8.33 no./ha), and followed by *Shorea robusta* and *Terminalia alata* with each 6.67 no./ha. When CSD was compared with Live Tree Density (LTD), it was found that Ficus hederacea had 100% CSD to LTD, similarly,50% each for *Adina cordifolia* and *Zyziphus incurva*. Altogether, 13.78% of live tree had been cut to remain stumps.

Table 4.2.9: Cut stump density

Species	N	CSD (No./ha)	LTD (No./ha)*	% of Cut stump compared to Live tree
Anogeissus latifolius	10	8.33	54.17	15.38
Terminalia alata	8	6.67	48.33	13.79
Shorea robusta	8	6.67	82.50	8.08
Lagerstroemia parviflora	5	4.17	48.33	8.62
Zyziphus incurve	3	2.50	5	50.00
Ficus hederacea	2	1.67	1.67	100
Adina cordifolia	2	1.67	3.33	50.05
Dalbergia latifolia	2	1.67	5	33.33
Diospyros tomentosa	1	0.83	6.67	12.49
Desmodium oojeinense	1	0.83	2.50	33.33
Mallotus nepalensis	1	0.83	2.50	33.33
Total	43	35.83	260	13.78

* Density of those species whose cut stump found were considered

It was found that trees with girth size 12.5 – 25cm (CSD: 25 no./ha) were most commonly chosen by timber harvester (Table 4.2.10).

Table 4.2.10: Girth classification of cut stump

Species	Density (No./ha) of cut stump by DBH Class				Total No.	Total density (No./ha)
	<12.5 cm	12.5-25 cm	>25-50 cm	>50 cm		
Anogeissus latifolius	1.67	5.83	0.83	-	10	8.33
Terminalia alata	3.33	1.67	1.67	-	8	6.67
Shorea robusta	1.67	5.00	-	-	8	6.67
Lagerstroemia parviflora	0.83	3.33	-	-	5	4.17
Zyziphus incurve	-	2.50	-		3	2.50
Ficus hederacea	-	1.67	-	-	2	1.67
Adina cordifolia	-	0.83	-	0.83	2	1.67
Dalbergia latifolia	-	1.67	-	-	2	1.67
Diospyros tomentosa	-	0.83	-	-	1	0.83
Desmodium oojeinense	-	0.83	-	-	1	0.83
Mallotus nepalensis	-	0.83	-	-	1	0.83
Total	7.5	25.00	2.5	0.83	43	35.83

4.7.4 Lopping

Lopping was common phenomena as the most of tree species were fodder plant. Altogether 22 species of trees were found to be lopped from minimum to severe intensity. Species wise density of different lopping % class is given in Table 4.2.12.

Table 4.2.11: Lopping intensity of tree species

Lopping class	Frequency	Percent	Density (no./ha)
No damage	177	44.92	147.5
Least damage (25%)	62	15.74	51.67
Medium damage (25-<50%)	89	22.59	74.17
High damage (50-<75%)	43	10.91	35.83
Very High (=>75%)	23	5.84	19.17
Total	394	100	328.33

Table 4.2.12: Density of tree species as per lopping intensity

Species Name	Density based on Lopping % damage					Total lopped density (no./ha)	Total density (no./ha)
	No damage	Least	Medium	High	Very High		
Lagerstroemia parviflora	14.17	11.67	12.50	9.17	0.83	34.17	48.33
Shorea robusta	49.17	5.83	16.67	9.17	1.67	33.33	82.50
Anogeissus latifolius	22.50	11.67	14.17	4.17	1.67	31.67	54.17
Terminalia alata	20.00	12.50	12.50	2.50	0.83	28.33	48.33
Wendlandia puberula	14.17	3.33	3.33	1.67	3.33	11.67	25.83
Semecarpus anacardium	4.17	0.83	4.17	1.67	-	6.67	10.83
Mallotus phillippensis	1.67	0.83	3.33	2.50	-	6.67	8.33
Ziziphus incurva	-	-	0.83	-	4.17	5.00	5.00
Adina cordifolia	-	2.50	-	-	0.83	3.33	3.33
Acacia catechu	0.83	-	0.83	1.67	-	2.50	3.33
Mallotus nepalensis	-	-	-	-	2.50	2.50	2.50
Woodfordia fruticosa	-	-	0.83	-	0.83	1.67	1.67
Ficus Hederacea	-	0.83	0.83	-	-	1.67	1.67
Syzygium cumini	-	-	0.83	0.83	-	1.67	1.67
Diospyros tomentosa	5.00	-	-	1.67	-	1.67	6.67
Dalbergia latifolia	-	-	0.83	-	0.83	1.67	1.67
Wendlandia tinctorea	-	-	0.83	-	0.83	1.67	1.67
Dellenai pentagyna	-	0.83	0.83	-	-	1.67	1.67
Symplocos ramosissima	0.83	0.83	-	-	-	0.83	1.67
Careya arborea	-	-	-	-	0.83	0.83	0.83
Morjyak*	0.83	-	-	0.83	-	0.83	1.67
Physalis divaricata	4.17	-	0.83	-	-	0.83	5.00
Phyllanthus emblica	1.67	-	-	-	-	-	1.67
Chainchui*	0.83	-	-	-	-	-	0.83
Garuga pinnata	0.83	-	-	-	-	-	0.83
Lannea coromandelica	0.83	-	-	-	-	-	0.83
Clestocalyx operculatus	1.67	-	-	-	-	-	1.67
Desmodium oojeinense	2.50	-	-	-	-	-	2.50
Cassia fistula	1.67	-	-	-	-	-	1.67
Total	147.50	51.67	74.17	35.83	19.17	180.83	328.33

***Local name

4.8 Annual and sustainable yield

4.8.1 Volume and biomass of tree

The standing volume of tree species in the sample plots was found to be 36.17 m^3/ha, while total biomass accumulation on tree was 43,499.74 Kg/ha (Table: 4.2.13). Similarly, the annual sustainable fuel wood, timber and fodder supply from Tribeni Buffer Zone forest were found to be 1,772.55 Kg/ha/year, 231.51 Kg/ha/year and 92.78 Kg/ha/year, respectively (Table, 4.2.14).

Table 4.2.13: Volume and biomass of tree species

Species	Standing Volume (m^3/ha)	Total Biomass (Kg/ha	Total Stem Biomass (Kg/ha)	Total Branch Biomass (Kg/ha)	Total Leaf Biomass (Kg/ha)	Total Volume %	Total Biomass %
Anogeissus latifolius	10.6377	13065.25	9573.95	2840.27	651.03	29.41	30.04
Shorea robusta	9.4898	11447.23	8351.05	2543.55	552.63	26.24	26.32
Terminalia alata	7.0771	9174.96	6723.23	1994.56	457.18	19.57	21.09
Lagerstroemia parviflora	3.3422	3876.84	2840.87	842.79	193.18	9.24	8.91
Acacia catechu	0.7527	986.14	722.63	214.38	49.14	2.08	2.27
Dellenia pentagyna	0.7773	763.75	559.66	166.03	38.06	2.15	1.76
Semecarpus anacardium	0.7549	741.69	543.49	161.24	36.96	2.09	1.71
Wendlandia puberula	0.6200	609.17	446.39	132.43	30.35	1.71	1.40
Diospyros tomentosa	0.4478	513.27	376.12	111.58	25.58	1.24	1.18
Cleistocalyx operculatus	0.4347	456.81	334.74	99.31	22.76	1.20	1.05
Careya arborea	0.2562	251.74	184.47	54.73	12.54	0.71	0.58
Desmodium oojeinense	0.2255	221.53	162.33	48.16	11.04	0.62	0.51
Morjyak*	0.1808	177.65	130.18	38.62	8.85	0.50	0.41
Mallotus phillippensis	0.1493	146.69	107.49	31.89	7.31	0.41	0.34
Lannea coromandelica	0.1415	139.03	101.88	30.22	6.93	0.39	0.32
Physalis divaricata	0.1338	131.50	96.36	28.59	6.55	0.37	0.30
Phyllanthus emblica	0.0772	119.96	67.77	43.71	8.47	0.21	0.28
Ziziphus incurva	0.1254	123.17	90.26	26.78	6.14	0.35	0.28
Dalbergia latifolia	0.0865	106.60	75.94	25.49	5.16	0.24	0.25
Adina cordifolia	0.1029	94.05	68.92	20.45	4.69	0.28	0.22
Mallotus nepalensis	0.0966	94.96	69.58	20.64	4.73	0.27	0.22
Ficus Hederacea	0.0727	71.44	52.35	15.53	3.56	0.20	0.16
Symplocos ramosissima	0.0501	49.21	36.06	10.70	2.45	0.14	0.11
Cassia fistula	0.0415	40.79	29.89	8.87	2.03	0.11	0.09
Garuga pinnata	0.0256	25.14	18.42	5.46	1.25	0.07	0.06
Wendlandia tinctoria	0.0263	25.82	18.92	5.61	1.29	0.07	0.06
Syzygium cumini	0.0169	17.73	13.00	3.86	0.88	0.05	0.04
Chainchui*	0.0132	12.94	9.48	2.81	0.64	0.04	0.03
Woodfordia fruticosa	0.0149	14.68	10.76	3.19	0.73	0.04	0.03
Total	36.17	43499.74	31816.18	9531.44	2152.12	100	100

***Local name**

4.8.2 Sustainable yield from Tribeni BZ forest.

Table 4.2.14: Sustainable yield from the forest

Species	Annual stem yield (Kg/ha/yr)	Annual Branch yield (Kg/ha/yr)	Annual foliage yield (Kg/ha/hr)	Sustainable fuel wood yield (Kg/ha/yr)	Sustainable timber yield (Kg/ha/yr)	Sustainable fodder yield (Kg/ha/yr)
Anogeissus latifolius	516.04	152.52	34.76	532.04	69.66	28.16
Shorea robusta	450.12	136.59	29.51	467.27	60.77	23.90
Terminalia alata	362.38	107.11	24.41	373.62	48.92	19.77
Lagerstroemia parviflora	153.12	45.26	10.32	157.87	20.67	8.36
Acacia catechu	38.95	11.51	2.62	40.16	5.26	2.13
Dellenia pentagyna	30.17	8.92	2.03	31.10	4.07	1.65
Semecarpus anacardium	29.29	8.66	1.97	30.20	3.95	1.60
Wendlandia puberula	24.06	7.11	1.62	24.81	3.25	1.31
Diospyros tomentosa	20.27	5.99	1.37	20.90	2.74	1.11
Cleistocalyx operculatus	18.04	5.33	1.22	18.60	2.44	0.98
Careya arborea	9.94	2.94	2.94	10.25	1.34	0.23
Desmodium oojeinense	8.75	2.59	0.59	9.02	1.18	0.48
Morjyak*	7.02	2.07	0.47	7.23	0.95	0.38
Mallotus nepalensis	5.79	1.71	0.39	3.87	0.51	0.20
Mallotus phillippensis	5.79	1.71	0.39	5.97	0.78	0.32
Lannea coromandelica	5.49	1.62	0.37	5.66	0.74	0.30
Physalis divaricata	5.19	1.54	0.35	5.35	0.70	0.28
Ziziphus incurva	4.86	1.44	0.33	5.02	0.66	0.27
Dalbergia latifolia	4.09	1.37	0.28	4.36	0.55	0.22
Adina cordifolia	3.71	1.10	0.25	3.83	0.50	0.20
Phyllanthus emblica	3.65	2.35	0.45	4.91	0.49	0.37
Ficus Hederacea	2.82	0.83	0.19	2.91	0.38	0.15
Symplocos ramosissima	1.94	0.57	0.13	2.00	0.26	0.11
Cassia fistula	1.61	0.48	0.11	1.66	0.22	0.09
Wendlandia tinctoria	1.02	0.30	0.07	1.05	0.14	0.06
Garuga pinnata	0.99	0.29	0.07	1.02	0.13	0.05
Syzygium cumini	0.70	0.21	0.05	0.72	0.09	0.04
Woodfordia fruticosa	0.58	0.17	0.04	0.60	0.08	0.03
Chainchui*	0.51	0.15	0.03	0.53	0.07	0.03
Total	1,716.94	512.44	117.33	1,772.55	231.51	92.78

***Local name**

4.8.3 Annual Yield of green fodder in Tribeni BZ area

Table 4.2.15: Annual yield of green fodder in Tribeni BZ area

Land use category	TDN Yield Factor	Area (ha)	Annual TDN yield (tons/year)
Hardwood forest	0.34	636	216.24

4.9 Supply and deficit of resources in Tribeni BZ area.

Table 4.2.1.16 shows the estimated sustainable resource yield and demand of people residing in buffer zone area. The estimation of demand and supply situation in Tribeni Buffer Zone area revealed that both major resources fuel wood and fodder were short supplied from the forest.

Table 4.2.16: Resources supply and deficit in Tribeni BZ area

Parameters	Value
Forest area (ha)	636
Total no. of HHs in Tribeni BZ area	996
Total Population in Tribeni BZ area	4,973
Estimated no. of HHs using fuel wood	981 (98.48%)
Estimated no. of HHs using fodder	785 (78.79%)
Total demand of fuel wood by BZ forest users (tons/year)	5,856.57
Sustainable fuel wood yield from BZ forest (tons/year)	1,772.55
Deficit fuel wood (tons/year)	**- 4,084.02**
Total demand of fodder in BZ area (tons/year)	34854
Sustainable fodder yield from BZ forest (TDN in tons/year)	216.24
Deficit fodder (tons/year)	**- 34,637.76**

Chapter: Five
DISCUSSION

5.1 Demographic characteristics and education status

Chitwan National Park is surrounded by a large number of poor farmers, landless people, and indigenous communities (Poudel 2007). These vast numbers of congregation is mostly due to rapid in-migration of hill and mountain people after the eradication of malaria in Terai (Sharma 1991; Ghimire 1992). Such in-migration is the main demographic issue confronting in protected areas of developing countries (Sherbinin & Freudenberger 1998). Findings of this thesis report showed that population distribution was markedly higher in Tribeni Buffer Zone area with population density 391 per sq. kilometer (Field survey 2007), which is more than double of national average. Moreover, it is composed of mostly by income poor (57.57%) and land poor (63.64%) people (Table 4.1.22 & Figure 4.1.1)

The average family size in the sample HHs (6.64/HH) was higher compared to both district (5.72/HH) and national (5.45/HH) average (DNPWC/PPP 2001; CBS 2006). While, similar study conducted by Dhakal (2007) in Kolhuwa Buffer Zone VDC of Nawalparasi found further higher (7.10/HH) average family size. Family size is an important demographic parameter, which greatly shapes the dynamics of population of an area. Average family size may vary according to tradition, ethnicity, income level, education level, occupation etc. Among ethnic group of sample households Madhesi had the highest average family size (11.33/HH) and the least was observed in Newar (4/HH).

The sex ratio – the number of male per 100 females – of studied households was found to be 0.97, closer to national sex ratio obtained in the 2001 census. Sex ratio differs by residence (GoN 2006) and affects by the migration pattern. Age structure of population shows the nature of growth pattern, pyramid shaped age structure generally is the outcome of Nepal's age structure because of relatively high fertility in the past (GoN 2006), however, age structure of studied HHs revealed that large proportion (63.69%) of population were between 16-59 age class and population below 15 years age (29.17%) was comparatively less. DNPWC/PPP (2001) reported 41.5% of population under 15 years of age in the whole buffer zone area of CNP.

Education status of studied population reflects the general state of affairs of Nepal. Education and poverty is complementary to each other in the contextual scenario of Nepal, since most of the marginalized poor live in rural area; they have less access

to education and are trapped in a vicious circle of poverty (ADB 2005). Although the literate population (77.97%) was greater than whole buffer zone area (59%), most of them lacked higher education and only 16.95% had attended SLC or more level of education. Besides that, none of other ethnic group attended graduate or above level education except Brahmin/Chhetri/Giri/Puri ethnic group. This may be due to the better economic condition in those households and groups (Table 4.1.23).

5.2 Land ownership, food security, livelihood sources, and income distribution: Reflection of wellbeing

Land is the predominant source of income, security, and social prestige (Shrestha & Conway 1966; Karki 2002; cited in Poudel 2007). However, land distribution throughout the country is highly skewed and thousands of people do not have enough land to cultivate, and the situation is even worse in and around the Chitwan National Park (Poudel 2007). Similar perspective could be found in the Tribeni BZ area where most of land cover was held by few elites and so called superior caste and ethnic groups.

Mean landholding of the Tribeni BZ residents was mere 0.47 ha/HH, while average family size was 6.64/HH; in one study, Joshi (1999) claims that a family of 7 members requires 2 ha (per capita need: 0.286 ha) of land to provide enough food, construing that high proportion of food insecure HHs in the Tribeni BZ area. The land distribution was highest in Brahmin/Chhetri/Giri/Puri with mean land own 0.79 ha/HH, Janjati came second on holding land (mean: 0.43 ha/HH), while other ethnic communities – Bote/Majhi/Mushar, Dalit, Madhesi and Newar – land ownership was scare and their per HH landholding started at nil and ended at 0.16 ha. Hence, these land-poor households had to rely on other source of income, especially on buffer zone forest resources for drawing their livelihood.

Shortage of land is often one of the main causes of poverty, while it is more likely to be a problem in rural area, resulting an exacerbated food security problem (Panta 2009). In this analysis, it was observed that only 36.36% HHs, mostly land rich, had sufficient production from their land to feed their family round the year. Survey on 2001 by DNPWC/PPP found 43.1% HHs with complete food secured and no HHs with food security period less than 3 months (complete food insecure); however, current findings revealed that complete food insecure (12 months) HHs were 22.73% (Table 4.1.12), suggesting enormous increment of food insecure HHs in Tribeni BZ area.

It was observed that most of the villagers had multiple livelihood sources and basically reliant on the agriculture based occupation such as food crops, livestock farming. Moreover, to cope with chronic shortage of food, food insecure HHs switched to many off-farm employment opportunities like wage labor, fishing and ferrying in Narayani River, seasonal work visit to India etc. Study found that livelihood sources were also markedly associated with ethnicity; all six sampled HHs of Bote/Majhi/Mushahar were drawing their livelihood by fishing and ferrying in Narayani River, Madhesi were engaged in business, and Dalit earned their living basically by molding agriculture tools. However, Brahmin/Chhetri/Giri/Puri and Janjati were connected to many diverse fields for their income such as services, remittance, business, agriculture etc.

The distribution pattern of the income level in the sample HHs was largely governed by the landholding of respective HHs. Landholding among the poor (0.38 ha/HH), medium (0.47 ha/HH) and good (1.20 ha/HH) income HHs show the linear association and justify that higher landholding HHs tracked for better income. Moreover, correlation analysis between land own versus net income and per capita income (Table 4.1.25) further justifies the above assumption as both analysis were positive and significant.

5.3 Dependency on forest resources: Demand, access and consumption

Since the subsistence agriculture and livestock rearing was the prominent reliance to rural livelihood of Tribeni BZ population; the inter-dependency of agriculture, livestock and forestry was conspicuous (HMG/N 2000). Of the total, about three fifth HHs were engaged in agriculture, about 80% HHs reared livestock, and almost all of HHs had their main source of energy as fuel wood; these facts clearly indicate value of forest resources to locals. However, it was observed that the availability of forest products, were perceived by respondents, to have sharply declined over the past decades.

Fuel wood, fodder, timber, thatch grass, and medicinal plants were resources that had been extracting by locals from the BZ forests. Firewood was the basic product that people of Tribeni heavily rely on BZ CFs; however, large requirement for fuel wood could not fulfilled by the BZ forest hence the people have adopted different strategies to meet their firewood needs in areas of shortages. A substantial portion of their firewood demand is met illegally by taking firewood from the park during the annual grass-cutting season (Lehmkuhl *et al*. 1986) and during other times of the year. Besides, drifted wood in the Narayani River during rainy season contributed good sum of fuel wood to locals' especially to ethnic community Bote/Majhi/Mushar.

While taking to consumption scenario of fuel wood, it was found inverse relationship between demand of fuel wood and landholding of HHs. This was because of the adoption of alternatives of fuel wood by higher landholding HHs; all biogas plant were installed in HHs with medium to large farm holdings, in addition household size was also contributing factor as average family size was smaller in larger land holders.

5.4 Crop damage and livestock depredation: Implication of park people conflict

Damage of agricultural crop, human harassment, injuries and death, and livestock depredation are the common causes of ill relationship between park and people inhabiting nearby park (Jnawali 1989; Heinen 1993; Shrestha 1994; Studsord & Wegge 1995; Sharma 1996). In Tribeni BZ area, depredation due to wildlife had escalating effect on park and people rapport. Of the total HHs, half of them, particularly HHs near forest boundary reported problem of either loss of livestock or crop damage by wild animals.

The study conducted by Shrestha (2007) in Kumroj BZ VDC found same result with 50% HHs reporting depredation problem from wild animals. In addition, Bhattarai (1999) also reported that about half of HHs in the four VDCs of Madi valley of CNP had problem of depredation due to wild animals. Respondents reported eight different wild animals (Table 4.1.29) which were found to be raiding crop or lifting livestock. Crop damage was more pronounced in the Tribeni BZ area and 13.64% HHs had lost crop grown in more than 50% of land. However, compensation program was ill functional and prejudice and was in favor to HHs with member of BZ council and their relatives; only about 25% of people succeed to get reparation of their loss. Furthermore, majority of respondent expressed dissatisfaction on compensation program of Tribeni BZ committee.

This study found 10 cases of livestock lifting in Tribeni BZ area. However, DNPWC/PPP (2000) reported no case of registered wildlife related human injuries and livestock loss. This may be due to low reporting of cases to authority, also in this study about 30% of HHs did not reported their cases of loss.

5.5 Vegetation ecology and human interference

Tribeni Buffer Zone forest was extended to area 636 ha, mainly on rugged lower Churia hills while smaller portion continued on gentle slope. The elevation of area ranged from about 97m at bank of Narayani River to the highest contour point, 832m, of topography of Tribeni VDC. The area comprised two types of forests: Sal forests on well-drained upland as well as on the gentle slope of lower belt and Terai mixed

hardwoods on bottomlands along streams (HMG/N 1988b). This study identified altogether 133 plant species of trees, shrubs, climbers and herbs in the Tribeni Buffer Zone forest (Annex VII).

5.5.1 Population dynamics

5.5.1.1 Trees stratum

The average density of tree species was 328.33 trees/ha. Singh (1998) reported 152.52 trees/ha in the CNP forest. Shrestha *et al.* (2006) in their study in Barandhabhar corridor forest of CNP found the average density ranged from 150 to 290 trees/ha, they had computed density based on distance from the boundary of forest. This suggests that canopy layer plants of Tribeni BZ forest were denser in comparison to both CNP as a whole and Barandhabar corridor forest. However, different factors as altitude, aspects, soil and climatic condition in general are also responsible for the distribution pattern of plants (Brooks 1969). Study carried out by Bhuju and Yonzon (2004) in Churiya of central Nepal including Chitwan area found total 774 tree per hectare and basal area 33 m^2/ha.

Furthermore, *Shorea robusta* was the dominant species among all tree species with density 82.50/ha [RD: 25.127%, RBA: 30.676%]. Dhakal (2007) reported the density of dominant *Shorea robusta* as 45.83/ha in Kolhuwa Buffer Zone forest of Nawalparasi district. Webb and Shah (2003) found the density of *Shorea robusta* in natural Sal forest of Central Terai to be 253.5/ha. The study conducted by Shrestha *et al*. (2000) in natural forest of Chitrepani found 141 *Shorea robusta* trees per hector. Aryal *et al*. (1999) have reported 152 trees of *Shorea robusta* per hector in the then Royal Bardia National Park (now Bardia National Park) of Nepal. Although the *Shorea robusta* being dominant species in the Tribeni BZ forest, the forest is not sole Sal forest and hence the density of *Shorea robusta* is relatively less than natural Sal forest of Chitrepani, Bardia and central Nepal as a whole. Similarly, Bhuju and Yonzon (2004) reported RBA 48.8% and RD 42.0% of dominant Shorea robusta in Central Churia hill region, which included Chitwan National Park. Other species with significant contribution on stand count for trees were *Terminalia alata* with density (48.33/ha), *Anogeissus latifolius* (54.17/ha), *Lagerstroemia parviflora* (48.33/ha) and *Wendlandia puberula* (25.83/ha).

Important Value Index (IVI) index provides a quantitative basis for the classification of community (Sigdel 2008). IVI of any species in community ranges between 0-300 and the sum of IVI of all species is 300. In studied forest, the highest IVI was recorded for *Shorea robusta* (78.471) followed by *Anogeissus latifolius* (50.89),

Lagerstroemia parviflora (44.47) and *Terminalia alata* (42.93) (see Annex VII for IVI of all spp.). It means these species are ecologically important to maintain the existing ecosystem.

5.5.1.2 Shrub stratum

Altogether, 96 different species were reported in middle layer canopy of forest with a density 28,826.67/ha. Shrestha *et al*. (2006) reported density of shrubs in Barandhabhar corridor forest ranging from 19,300 to 26,900 plants/ha. While Dhakal (2007), in his study in Kolhuwa BZ forest of CNP, found 32,786.67/ha. Comparing to above two studies conducted in adjacent areas of Tribeni BZ forest, the shrubs were in intermediate condition on the stand count. However, Straede *et al*. (2002) found the density of shrubs 120,000/ha, which is massive greater than the present study. Seasonal variance is the prominent factors for fluctuation of density of shrubs and herbs. Of all the plant species in shrub stratum, *Terminalia alata* and *Shorea robusta* were found to be dominant with IVI 35.613 and 35.484, respectively; other followers were *Leea macrophylla* (20.645), Kuraini lahara (18.892), and Khatte (17.472). Moreover, of the total plant encountered in shrub plots, 37 were the sapling and seedlings of the tree species; adding 12 more tree species, which were not represented in tree strata.

5.5.1.3 Herbs stratum

There were 56 plant species representing ground vegetation with average density 179,000 plants/ha. It included all species of herbs, grasses and seedlings of shrubs and tree species. Population of grasses family namely *Imperata cylindrica* with IVI (63.89), *Cynodon dactylon* (21.28) were responsible for such higher population density (Shrestha 2003). Shrestha *et al*. (2006) reported herbs population density ranging from 1,197,000 to 2,804,900 plants/ha in Barandabhar corridor forest in Chitwan. Chhetri (1997) recorded 172,000 plants/ha of the Sal seedlings only, in Chitwan. Generally, the density of herbs is higher in the areas with lower canopy coverage (less woody species) because they get better light condition, higher nutrient availability and lower degree of competition (Shrestha *et al*. 2006)

5.5.2 Forest status

Tribeni BZ forest was the sole source of natural resources throughout the year for 4,973 people of 996 HHs in Tribeni BZ area. The people depend on forests for fuel wood, timber, fodder, medicinal plants and other forest resources necessary for subsistence. Forests are used also for grazing livestock and collection manure for (Sharma 1991). However, they were also found to accumulate ample amount of

thatch grass and fuel wood during the annual *Khar-khadai* harvest (Poudel 2007). The level of human dependence on the natural recourses was very high and people did not have alternatives to solve the problems; these facts were leading the forest on high stress and adverse condition. Density of lopped trees and cut stump substantiated the evidence of anthropogenic pressure on forests. It was found that the total density of lopped trees to be 180.83/ha, of which severely lopped trees were 19.17 plants per hector. Similarly, the study found that about 13.78% of live trees had been cut to remain as stump. *Anogeissu latifolius* was highly preferred tree species by locals to cut; its cut stump density was the highest (8.33/ha) to others. Majority of cut stump were in girth size 12.5-25cm (CSD: 25/ha), this is because of usage of these stand size trees in house building purpose. The result of regeneration analysis showed that there was bloom of seedlings and immature (<10 cm DBH) tree species in the forest. The density of regenerating species of trees species was 13,060/ha, and which was about 40 times greater than tree density. However, there was subsequent decrease of density as the height class of regenerating species increased; regenerating plants in height class above 5 m had density 180 plants per hector even less than the tree density. This is because of harvesting trend of locals mostly on shrubs and sapling of trees as fodder and fuel wood.

The study revealed that pole sized tree (50.5%) were dominant and subsequent poor representation from higher DBH Class. The typical of stable population is characterized by non-linear reduction in stem densities with increasing diameter class, showing typical “reverse-J shape” (Hartshorn 1978; Webb & Sah 2003; cited in Dhakal 2007). Representation of tree in stand size classification confirms the reverse-J shape appearance (Figure 4.2.1), indicating forest in typical stable state. Forest biodiversity depends on good age class distribution, presence of various tree species and proper distribution of these species in the forest stand (HMG/N 2002). Diversity index of Shrubs was highest and followed by ground vegetation and canopy layers, respectively. Since the seedlings of trees were also counted in the shrub and herb plots, diversity index was relatively higher for them. Human interferences and variation in plant population could not bring any significant changes in species diversity of the plants in different strata. The Shannon-weinner index of diversity (1.018) for the tree was found to be higher than Nawalpur Saraswoti CF (1.010), while lower than Chakradevi CF (1.28) of Makawanpur, Central Terai Nepal as reported by Acharya *et al.* (2006). Species diversity is the combination of species richness and species evenness. Species evenness is the distribution of individuals among the species (Sigdel 2008). Among three strata, ground vegetation was found

to be evenly distributed (Table 4.2.6). Species richness is the reflection of diversity index and followed the similar trend, shrub with highest value than other two strata.

Calculation of forest annual yield shows that the forest was not storing enough biomass and volume as expected for given forest types. The total standing volume and biomass were found as 36.17 m^3/ha and 43.5 tons/ha, respectively. Pradhan (2002) reported volume of 141.1 m^3/ha and biomass of 165.9 tons/ha in mixed hardwood forest of BZ forest of Bardia National Park. Shrestha *et al*. (2000) found volume and biomass of natural Sal forest in Chitrepani of Makawanpur district to be 467 m^3/ha and 807 tons/ha, respectively, and which were greatly higher compare to present study. Similarly, average biomass as reported by HMG/N (1988a) of CDR (148.87 tons/ha) was higher to accumulate biomass in Tribeni BZ forest. The depredating nature of Tribeni BZ forest may be outcome of excessive lopping especially of wet, green branches, which have adverse effects on the growth potentials of existing trees, their resistance to natural calamities, and the regeneration capacity of the forest stock. Lopping starts at the lowest branches and proceeds upwards, so that severely lopped 'pole-stage' trees in the forest, standing tall with only the top crown of branches and a naked trunk below, were very common. An ailing forest subject to intensive and fairly regular firewood pressures of this nature can degenerate beyond recovery particularly since hardwood species take nearly 80 years to attain full growth (Baland *et al.* 2007). Furthermore, it was found that forest was on high stress as the locals were harvesting more than the annual sustainable yield for both fuel wood (1772.55 tons/year) and fodder (216.24 TDN in tons/year).It was estimated that annual deficit of 4084.02 tons fuel wood and 34,637 tons of green fodder was leading cause for users dependency on drift wood in Narayani River and over collection of fuel wood during annual *Khar-khardai*.

5.6 Buffer zone management

Tribeni Buffer Zone area being farthest among all BZ of CNP, it seemed, isolated from mainstream program of park. Although 69.70% HHs found to be involved in BZ activities, majority of respondent's perception on BZ activities was rather dreary. Buffer zone leaders, who are represented in Councils, UCs, and UGs, are often members of better-off groups and 'upper caste' males who often control local social and political institutions (Budhathoki 2003; Paudel 2005). Participation in BZ program was greatly skewed by the two dominating ethnic groups Brahmin/Chhetri/Giri/Puri and Janjati of Hill and mountain. Moreover, none of the other ethnic groups except Brahmin/Chhetri/Giri/Puri and Janjati had been enrolled in the governing body of

User Committee. Buffer zone non-members were mostly the marginalized land poor Dalit and Bote/Bote/Mushar. Although there were 34 user groups registered in BZ UC, hardly few of them were running properly. Moreover, BZ UC had launched different income generation program in collaboration with management council since the inception of program in Tribeni such as installation of machine for making *Tapari (*leaf plates) and Rope; however, all these programs were found dysfunctional. Besides, education and information about BZ program and conservation issues was found minimal in respondents as most of respondents had no idea about the problem in their buffer zone and many of them could not suggest for better way of management of local resources. Hence, the effectiveness of conservation education to users in Tribeni is questionable. There was conflict on rights to resource in different settlements of Tribeni BZ. In early phase of BZ program in Tribeni there was single CF, Tribeni BZ CF, but due to dispute on resource utilization users set up two other CFs– Shanti BZ CF and Kaddarbaba BZ CF, however none of them had been legitimated by CNP authority.

To run the life for small farm holder and landless in Tribeni BZ was challenging task, further, it was aggravated by the low productive land. Therefore, the forest and Narayani River resources were single privilege to helpless. Although, the exclusion of the poor and marginalized, who should be the primary target, is being gradually realized by CNP labeling them Specially Target Group (STG) (Poudel *el al.* 2007), there was no such program running in Tribeni. Much to them, BZ users committee restricted locals for daily collection of fuel wood and decided to open in each Saturday. It seemed sound approach for conservation of forest; however, it created hardship for poor landless people who run their livelihood through collecting and selling fuel wood. Poudel (2005) argued that in order to achieve socially favorable and ecological sound conservation it is imperative to address local livelihood needs. However, since the environmental concerns have often overshadowed the local livelihood rights, there are several restrictions on community forest management, collection of driftwood and establishment of forest-based enterprises (Poudel *et al*. 2007)

Chapter: Six

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Socioeconomic condition of communities in Tribeni Buffer Zone is the potential driving force for shaping the conservation and management issue; one major goal set by the buffer zone program. As in the rural setting, subsistence agriculture economy is foremost basis for governing the structure and function of local community of Tribeni. Majority of the households largely depend on agriculture and livestock husbandry, while animal rearing was either through stall feeding or grazing into the BZ forests. Household landholding is decisive element for stratification in socioeconomic status of community. Household having large farm-land have better access to strengthen overall livelihood condition. Moreover, land ownership is a provision for food security to the locals. The pressing problems are evident in landless, small landholders and marginalized ethnic communities as they are deprived of livelihood support system, further their affliction escalated by the interrupted access to forest resource on which they mostly depend for living.

At household level, high consumption and extraction of forest products found to be an indispensable means of survival, leading to profound stress on BZ forest. Annual demand for both fodder and fuel wood outstrip the annual sustainable supply from the forest, and deficit was largely met through over harvesting BZ forest as there were no alternatives except private land and annual opening of park for *Khar khadai.* Much to that, inappropriate management practice and disproportionate representation in buffer zone management is leading the sacred goals set by buffer zone program in letdown state from Tribeni Buffer Zone community. Nevertheless, this is not an end and if local management of buffer zone is rescaled with some amendment, it may tackle the impending jeopardy to biodiversity conservation and lead prosperous livelihood for locals.

6.2 Recommendation

1. Providing alternative livelihood strategies especially for marginalized and poor households who are nearby forest frontiers. Once they have alternative ways of living, their over dependency on forest resources would be gradually reduced.

2. Tribeni BZ community is potential site for biogas installation since the most of household reared livestock; hence including biogas other alternative energy promotion program cutback over dependency from forest and would enhance conservation of biodiversity.

3. Capability enhancement of local human resources and reframing of local management unit to ensure good governance.

4. Periodic assessment of socioeconomic status on behalf of available natural resource to review supply and demand condition of local resources.

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Annex I

QUESTIONNAIRE FOR THE SOCIO-ECONOMIC ANALYSIS OF TRIBENI BUFFER ZONE COMMUNITY OF CHITWAN NATIONAL PARK (2008)

Name of Data Collector: Date:

HOUSEHOLD SURVEY

A. Household Information

GPS Position : a) Long: b) Lat:

Respondent's name : .....

Caste/Ethnic group : .....

Sex : .....

Age : .....

Education : .....

Occupation : .....

Current address

(VDC/Ward) : .....

Residence period:

Family structure: a) Nuclear b) Joint

B. Family Members

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

C. Sanitation facility

a) Open/indiscriminate b) Simple latrine c) Pour flushes latrine d) Septic tank

D. Solid waste disposal

a) Open/indiscriminate b) Open dump c) Bury in yard d) others (specify)

E. Farm size/production

Ownership	Area			Irrigation type	Land type
Own	Bigha	Kattha	Dhur		Party/Ailani
Shared tenant					Party/Ailani

1.What type of crop do you grow?

Food crop		Area			Production		Consumption Kg	Surplus Kg	Deficit Kg	Deficit Period
		Bigha	Kattha	Dhur	Muri	Kg				
Food crops	Wheat									
	Paddy									
	Maize									
Pulses										
Cash crops	Vegetables									
	Oil seeds									
	Others									

2. How will you manage for the deficit months?

   Buy/Burrow/Barter/Wage Labor/Others (specify).....

3. If surplus what do you do with the surplus crops?

   Store/Sale/Others (specify)…....

F. Livestock type and holding

Types of Animal	Numbers	Stall Feeding	Grazing Both

1. Nutritional status of livestock's (observed) using Rinney's Index

Livestock Type	Number	Observation	Remark
		Body Line Round	Good
		Body Line Angular	Intermediate
		Body Line Angular, Rib Cage Visible	Poor

E. Fodder/Fuel Wood/ Timber

Season	**Fodder**		
	Species	Quantity	Access
	Fuel wood		
	Timber		

F. Alternative energy

Fill in the information on use of fuel and how it is obtained (Record use for each month, liter of kerosene, no. of cylinder for gas and Bhari for firewood) (one Bhari = …..... Kg)

Type of Energy used	Amount	Expenditure (Rs.)	Season	Source
Kerosene				
Electricity				
Solar				
LP Gas				
Battery				
Other				

1. Do you have biogas plant in your house?

a) Yes b) No

1.1 If Yes,

Installed Date	Biogas	
	Capacity (cb.m)	Expenditure

1.2 Have you installed plant on your own or did you receive any support from others?

a)Myself b) Supported by NGO c) Supported by BZ office d) other

1.3 How much Livestock are needed to operate your biogas plant?

……

1.4 How much fodder is required for livestock?

……

1.5 If you don't have biogas plants, what is the reason behind it?

……

1.6 Do you have any plans to install biogas plants?

a) Yes b) No

G. Buffer zone community forest, household participation and Issues

1. Have you been involved in BZ management?

a) Yes b) No

2. If yes, what is/was your status (position) Buffer Zone Management Council, UC, UG?

Date	Group	Status	If any member of Family (relation with respondent)

3. Which BZ CF do you use?.....……..

4. What type of resources do you bring from your BZ CF?

……

5. What do you say about your BZ CF status?

a) Very good b) Good c) Satisfactory d) Bad

6. What was the condition of your BZ CF in the past/present?

a) Better than past b) Worser than past c) No change

7. Are available resources in your community forest fulfilling your demand?

a) Yes b) No

Resources	Demand (Bhari/Kg)	Supplied (Bhari/Kg)	Deficit (Bhari/Kg)

8. If No, How do you manage your demand?

a) Buy from BZ CF b) Buy from other CF c) From CNP d) Others (Specify).....

9. Are there any kinds of resources allocation system in your BZ CF?

a) Yes b) No

10. If Yes, on what basis?

a) Well Being b) Population c) No. of Livestock d) Profession e) Others.....

11. Are there any land categorizations for different purpose in your BZ CF?

a) Yes b) No

12. If yes, a) Pasture Land b) Recreation c) habitat management d) Fodder

e) Fuel wood f) others (specify) .....

13. What sort of problems do you find in your CF? ……

14. What needs to be done for better management of your CF resources utilization and conservation? Any suggestions / recommendations?

……..

15. Is budget allocated by CNP for BZ is enough? a) Yes b) No

H. Crop depredation, livestock loss, and human casualties by wildlife

1. Crop damage by wildlife (Current year)

Wildlife	Crops	Time of crop damage			% of Land damage	Compensation (Rs.)
		Morning	Day	Night		

2. Livestock loss by wild animals.

Wild animal	Livestock type	Number of loss	Time (year/month)	Compensation Rs.

3. Frequency of human casualty and injuries.

Wild animal	Date/Time	Killed	Injury	Compensation (Rs.)

4. Are you satisfied with compensation measures for loss made by wild animals?

a) Yes b) No

5. In No, what do you think it should be?

……

6. What are the wild animals found in this locality?

……

7. Have you seen Rhino in this area?

a) Yes b) No

8. What do you know about wildlife population of this locality?

a) Increasing b) Decreasing c) Remains same d) Don't know

9. If no, reasons for decreasing.

a) Natural death b) Habitat loss c) Killing (Poaching) c) Translocation d) Others……

10. Do you know when and where wild animals were killed?

Name of Wild animals	Date	Place

11. Do you know what types of people are involved in poaching?

a) Poor/Medium/Rich b) Educated/Uneducated

Name	Address	Involved date

12. What do you think, why they are killing wild animals (in any particular animals)?

……..

13. Would any opportunity to poachers help to help stop killing?

a) Yes b) No c) Don't Know

If yes, what.....…….....

14. What kind of activities are/were done by BZCF/BZ UC/Park management to stop wild animal poaching?

……..

15. Do you think existing activities/policies/conservation practices have helped to conserve wild life?

a) Yes b) No c) Don't know

16. If No, what do you think what kind of activities/policies/conservation practices will help to conserve wild animals?

……..

I. "Narayani River" as resource and its issues

1. Do you think Narayani River as resource?

a) Yes b) No c) Don't know

2. If yes, what kind of resource material are you extracting from it?

a) Water b) Drifted fuel wood c) Fisheries d) constructing material e) others……

<u>Drifted (flooded) fuel wood</u>

1. What do you do with collected driftwood?

a) Use myself b) Sell to BZ office c) Sell in market d) Others…….....

2. How much driftwood do you collect in one year?

……..

Fisheries and Boating

1. How much fish do you collect?

Fish accumulation	Amount (Kg.)	Market price (Rs.)
General one day accumulation		
General monthly accumulation		

2. In which season do you collect more fishes?

a) Spring b) Rainy c) Autumn d) Winter

3. What is the frequency of catching fish comparing to past?

a) Increasing b) Decreasing c) As usual

4. How many boats do you have?

a) Large …….. b) Small ……..

5. In which season do you earn maximum by boating?

a) Spring b) Rainy c) Autumn d) Winter

J. Annual Income and Expenditure

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

Source	Amount (Rs.)	
	Calculated	Rectified
Agriculture		
Service		
Livestock		
Tourism		
Off farm employment		
Business		
Others		
Total		

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

Items	Amount (Rs.)	
	Calculated	Rectified
Education		
Health		
Maintenance		
Agriculture		
Livestock and poultry maintenance		
Loss of livestock loss		
Loss of crops		
Total		

Remarks:

From the above tables the saved amount becomes Rs…… Do you save this much annually? ……..

Annex II

FORMULAE

1. Sample size determination

The sample size (n) of the household, to represent the study area, was determined by using following formula (Atkins and Colton, 1963) at 95 % confidence level.

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

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)

2. Vegetation analysis

a) Population dynamics and diversity

Density/ha $= \frac{\text{No of Individual of species}}{\text{Size of the plot x Total no. of plots sampled}} \text{x}10000$

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

Frequency (%) $= \frac{\text{Total no. of plots in which species occurred}}{\text{Total no. of plots sampled}} \text{x}100$

Relative frequency (%) $= \frac{\text{Frequency of a species}}{\text{Sum of frequency of all the species}} \text{x}100$

Dominance $= \left[\frac{ni}{N}\right]^2$

Relative Dominance (%) $= \frac{\text{Dominance of species}}{\text{Sum of dominance of all the species}} \text{x}100$

Importance Value Index (IVI) $= \sum(RD + RF + R.Dom)$

Basal area (BA) $= \frac{\pi d^2}{4}$ Where, d= diameter of a tree at breast height

Total Basal area/ha = Density of all species x Average basal area

Relative Basal Area $= \frac{\text{Basal area of a species}}{\text{Total basal area of all species}} \text{x}100$

Basal area/ha (of a species) $= \frac{\text{TBA x RBA of a species}}{100}$

Index of Dominance (c) $= \sum\left(\frac{ni}{N}\right)^2$ Where, ni = importance value of each species

N = total importance value of all species

Shannon Index of Diversity $= -\sum\left(\frac{ni}{N}\right) x \log\left(\frac{ni}{N}\right)$

Species richness (d_1) $= \frac{S-1}{\log N}$ Where, S= No. of species; N= No. of species

b) Biomass and Volume

The computer based system of estimating total volume of the whole stems is given by following formula:

$$Ln(V) = a + b x ln(d) + c x ln(h) \Rightarrow V = e^{a+b x ln(d)+c x ln(h)}$$

Where,

ln ($\log_e$) = Natural logarithmic value

V = Total stem volume with Bark (m^3/ha)

D = Diameter of tree at breast height (meter)

h = Tree height in meter

a, b, and c are volume parameters, which are constant for each species but different between species. The volume parameters were obtained from the study carried out by Forest Survey and Statistical Division (FSSD, 1990).

Table: Volume parameters for different Terai tree species

Scientific name	**a**	**b**	**c**
Acacia catechu (L.f.) Wild.	-2.3256	1.6476	1.0552
Adina cordifolia (Wild.ex Roxb.) Benth and Hook.	-2.5626	1.8598	0.8783
Anogeissus latifolius (Roxb. Ex DC.) Bedd.	-2.272	1.7499	0.9174
Lagerstroemia parviflora Roxb.	-2.3411	1.7246	0.9702
Shorea robusta Gaertn.	-2.4554	1.9026	0.8352
Syzygium cumini (L.) Skeels	-2.5693	1.8816	0.8498
Terminalia alata Heyne ex Roth.	-2.4616	1.8497	0.88
Miscellaneous in Terai (Avg. wt.)	-2.3993	1.7836	0.9546

[Source: (FSSD, 1990)]

Biomass calculation procedures:

Stem Biomass = Stem Volume x Wood Density

Branch Biomass = Stem Biomass x Ratio of Branch to Stem Biomass

Foliage Biomass = Stem Biomass x Ratio of Branch to Stem Biomass

Table: Wood density of tree species of Terai forest

Type of forest	Species	Rel. wt.	Density (Kg/m3)	Wt.avg. density	Uses
Sal forest	*Shorea robusta*	0.9	880	**878**	T, F, Fdr
	Terminalia tomentosa	0.02	950		T, F, Fdr
	Adina cordifolia	0.01	670		T, F, Fdr
	Anogeissus latifolia	0.02	900		T, F, Fdr
	Lagerstroemia parvifolia	0.05	850		T,F
Terai (Tropical) mixed hard wood	*Myrica esculenta*	0.05	750	**720**	-
	Daphniphyllum himalense	0.05	640		F
	Eugenia/Syzygium spp	0.05	770		T, F, Fdr
	Diosyros spp	0.02	840		Fdr
	Shorea robusta	0.03	880		T, F, Fdr
	Castonopsis indica	0.35	700		T, F, Fdr
	Schima wallichii	0.45	690		F

T= Timber, F= Fuel wood, Fdr= Fodder [Source: MPFS (HMG, 1988a)]

Table: Ratio factor to calculate biomass of stem, branch and foliage of tree.

Forest type	Species	Rel. wt.	Branch biomass/Stem biomass			Foliage Biomass/Stem biomass		
			Repr/ Poles	Small Timber	Large Timber	Repr/ Poles	Small Timber	Large Timber
Sal	*Shorea robusta*	0.9	0.055	0.341	0.357	0.062	0.067	0.067
	P. embliica	0.1	0.645	0.725	0.75	0.125	0.079	0.067
	WT. AVG.	**1**	**0.114**	**0.38**	**0.396**	**0.069**	**0.068**	**0.067**
Terai mixed hard wood	*P. emblica*	0.1	0.645	0.725	0.75	0.125	0.079	0.067
	S. robusta	0.1	0.055	0.341	0.357	0.062	0.067	0.067
	C. indica	0.35	0.398	0.915	1.496	0.053	0.048	0.042
	S. wallichii	0.45	0.52	0.186	0.168	0.064	0.035	0.033
	WT. AVG.	**1**	**0.443**	**0.511**	**0.71**	**0.066**	**0.047**	**0.043**

[Source: MPFS (HMG, 1988a)]

C). Annual and Sustainable Yield

Stem Annual Yield = Stem Biomass x % yield

Branch Annual Yield = Branch Biomass x % yield

Foliage Annual Yield = Leaf Biomass x % yield

Where, % Yield was obtained from the MPFS, 1988a

Table: Growing and Annual yield (tons/yr) in the natural forest of Terai region of Western Development Region, Nepal.

Forest type	**Forest Biomass**			**Annual Yield**			**Percent Yield**		
	Stem	Branch	Leaf	Stem	Branch	Leaf	Stem	Branch	Leaf
Sal and Terai - mixed hardwood	80.32	30.90	5.43	4.33	1.66	0.29	5.39	5.37	5.34

(Source: HMG/N, 1988a)

Sustainable Fuel wood Yield = 85% of Sustainable Stem supply + Sustainable Branch supply

Where,

Sustainable Stem Supply = 90% of Stem Annual Yield

Sustainable Branch Supply = 90% of Branch Annual Yield

Sustainable Foliage Supply = 90% of Foliage Annual Yield

Fodder Yield from Buffer Zone forest was calculated based on Total Digestible Nutrient (TDN) yields for various categories of land as follows (HMG, 1988b)

Table: Fodder yield from various land categories

Land Category	TDN yield (tons)
Hardwood forest, grazing	0.34
Mixed forest, grazing	0.15-0.20
Conifer forest , grazing	0.1
Forest plantation, hand cutting	1.44
Shrub/burnt forest, grazing	0.77
Waste land/Over grazed land, grazing	0.24
Flatland, grazing	0.58

[source: MPFS (HMG/N, 1988b)]

Annex III

UNIT CONVERSION

Table: Unit conversion for crop products

Particulars	Local unit Un-milled (Muri)	Standard Unit (Kg)
Paddy	1	50
Maize	1	60
Wheat	1	69

(Source: Nepal & Weber, 1993)

Table: Unit conversion for forest resources

Particulars	Local unit Bhari (fagot)	Standard Unit (Kg)
Fuel wood	1 Bhari	40
Fodder	1 Bhari	50

(Source: Nepal & Weber, 1993)

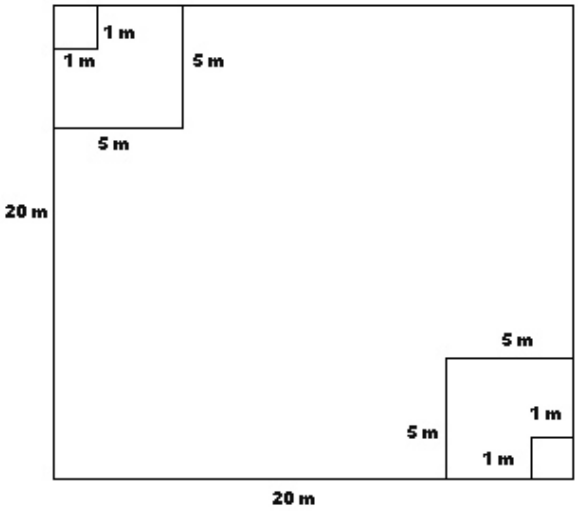
Table: Livestock unit conversion

Livestock	Livestock unit value
Cattle	0.65
Goat and ship	0.18
Buffalo	0.81

(source: Poudyal, 2000)

Annex IV

VEGETATION SURVEY - PLOT DESIGN



Annex V

GPS POINTS OF VEGETATION SAMPLE PLOTS

Forest type: Sal and Terai mixed hardwoods

Plot ID	Longitude	Latitude
1	83.91909	27.46510
2	83.89464	27.48026
3	83.93157	27.46342
4	83.89133	27.48987
5	83.90994	27.46997
6	83.88371	27.49115
7	83.91310	27.46655
8	83.91538	27.47141
9	83.93768	27.47226
10	83.88863	27.48230
11	83.93448	27.48088
12	83.88989	27.48235
13	83.91317	27.46539
14	83.91188	27.47349
15	83.92622	27.46213
16	83.88742	27.49226
17	83.92905	27.46749
18	83.89180	27.47870
19	83.89820	27.47854
20	83.90471	27.47987
21	83.90902	27.47981
22	83.89664	27.48528
23	83.90015	27.48904
24	83.90971	27.49034
25	83.91214	27.47178
26	83.89240	27.47405
27	83.89731	27.48111
28	83.93200	27.46348
29	83.91062	27.47413
30	83.93133	27.47872

Annex VI

CLIMATE DATA

Base meteorological station: Dumkauli, Nawalparasi Duration of year: 1976 to 2007
Latitude: 27^0 41' Longitude: 84^0 13' Elevation: 154 m

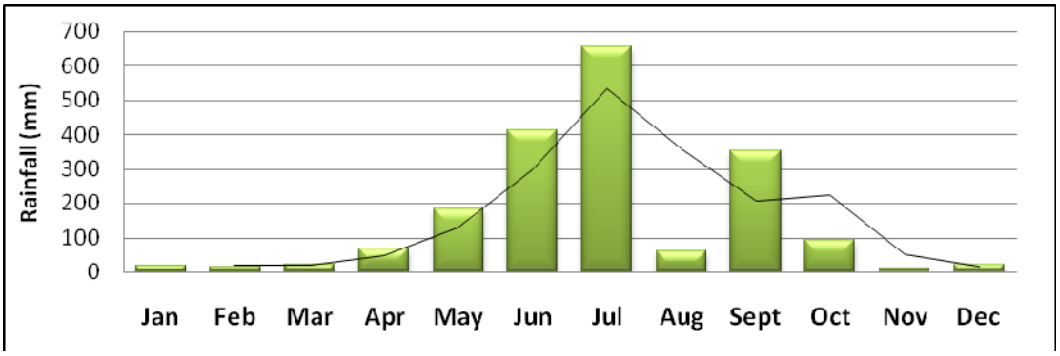


Figure: Mean monthly rainfall of Study area

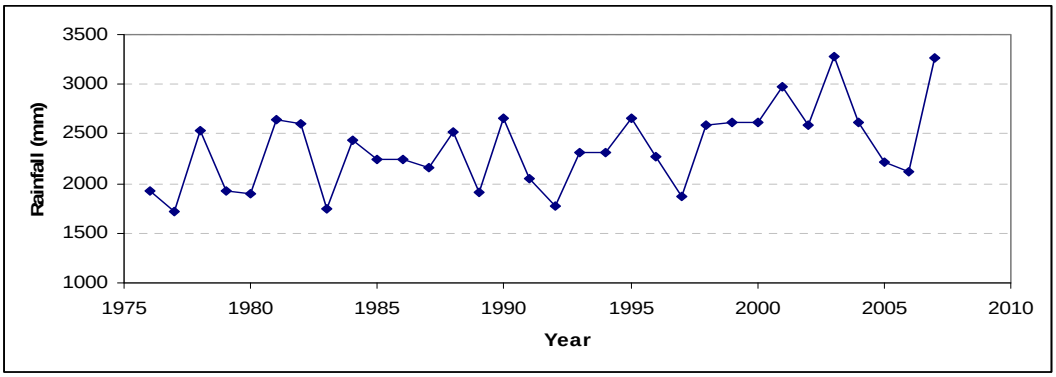


Figure: average annual rainfall of study area

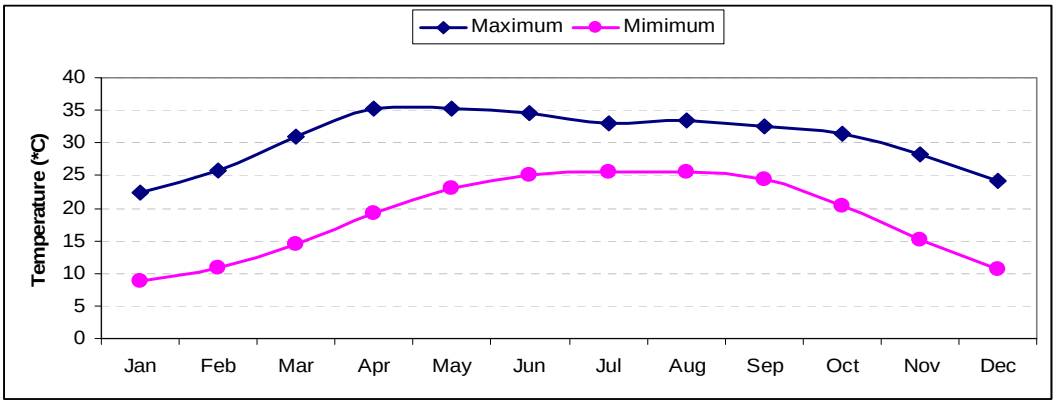


Figure: Mean monthly maximum and minimum Temperature of study area

Annex VII

LIST OF SPECIES RECORDED IN THE SAMPLING PLOTS IN TRIBENI VDC BZ FOREST

S.N.	Scientific name	Local name	Habit	Family
1	*Abrus precatorius L.*	Ratigedi Lahara	Climber	Leguminosae
2	*Acacia catechu (L.f.) Wild.*	Khayar	Tree	Leguminosae
3	*Acacia pennata (L.) Wild.*	Araili	Shrub	Leguminosae
4	*Adina cordifolia (Wild.ex Roxb.) Benth and Hook.*	Karma (Haldu)	Tree	Rubiaceae
5	*Aegle marmelos (L.) Correa.*	Bel	Shrub	Rutaceae
6	*Ageratum conyzoides L.*	Gandhe Jhar	Herb	Compositae
7	*Anaphalis busua (Buch.-Ham. Ex Don) DC.*	Seto ghans	Grass	Compositae
8	*Anogeissus latifolius (Roxb. Ex DC.) Bedd.*	Banjhi	Tree	Combretacteae
9	*Antidesma bunius (L.)Spreng.*	Archale	Herb	Euphorbiaceae
10	*Apluda mutica L.*	Danthe Khar	Grass	Poaceae
11	*Asparagus racemosus Wild.*	Kurilo	Herb	Asparagaceae
12	Banbhawan*		Shrub	
13	Bankali Bhata*		Shrub	
14	*Bauhinia purpurea L.*	Tanki	Tree	Leguminosae
15	*Bauhinia vahlii Wight and V Am.*	Vorla Lahara	Climber	Leguminosae
16	Bharke (Gaujo)*		Shrub	
17	Bhuse kuro*		Grass	
18	Boke jamun*		Shrub	
19	*Bombax ceiba L.*	Simal	Tree	Bombacaceae
20	*Breea arvensis (L.) Less.*	Thakauli		Compositae
21	*Bridelia retusa (L.) Spreng.*	Gaay	Tree	Euphorbiaceae
22	*Carex daltonii Boott.*	Seto khar (Likhekhar)	Grass	Cyperaceae
23	*Careya arborea Roxb.*	Kumbhi	Tree	Lecythidaceae
24	*Cassia fistula L.*	Rajbriksh	Tree	Leguminosae
25	Chainchui*		Tree	
26	Chariamilo (Birgan-Magar)*		Herb	
27	*Cheilanthes anceps Blanford.*	Rani sinka	Grass	Pteridaceae
28	*Cissampelos pareira L.*			Penispermaceae
29	*Cissus repens Lam.*	Charchare Lahara	Climber	Vitaceae
30	*Cleistocalyx operculatus (Syzygium operculatum)*	Kyamuno	Tree	Myrtaceae
31	*Clerodendrum viscosum Vent.*	Ghatusaro	Herb	Labiatae
32	*Colebrookea oppositifolia Sm.*	Dhursilo	Shrub	Lamiaceae
33	*Crinum amoenum Roxb. Ex Ker-Gawler*	Ban pyaj	Herb	Amaryllidaceae
34	*Curcuma zeodaria Rosc.*	Ban Hardi	Herb	Zingiberaceae
35	*Cymbopogon citratus (DC.) Stap.f.*	Lemon Grass	Grass	Gramineae
36	*Cynodon dactylon (L.) Pers.*	Dubo	Grass	Gramineae
37	*Cyperus compressus L.*	Ban Mothe	Grass	Cyperaceae
38	*Cyperus rotundus L.*	Mothe	Grass	Cyperaceae
39	*Dalbergia latifolia Roxb.*	Satisal	Tree	Leguminosae
40	*Dellenia pentagyna Roxb.*	Tantari	Tree	Delleniaceae
41	*Desmodium gangeticum (L.) DC.*	Ban Gahat	Herb	Leguminosae
42	*Desmodium oojeinense (Roxb) H. Ohashi*	Panan (Halesadhan)	Tree	Leguminosae
43	*Didymocarpus aromaticus Wall. Ex D. Don*	Kumkum Dhup	Herb	Gesneriaceae
44	*Dioscorea alata L.*	Kukur Tarul	Climber	Dioscoreaceae
45	*Dioscorea bulbifera L.*	Ban Tarul/Gittha	Climber	Dioscoreaceae
46	*Dioscorea deltoidea Wall. Ex Griseb.*	Bhyakur	Climber	Dioscoreaceae
47	*Diospyros malabarica (Desr.) Kostel.*	Khallu		Ebenaceae

48	*Diospyros tomentosa Roxb. Or Diospyros melanxylon*	Kyanu	Tree	Ebenaceae
49	Dogshu khar*		Grass	
50	*Elephantopus scaber L.*	Phuli jhar	Herb	Compositae
51	*Eulaliopsis binata (Retz.) C.E. Hubb*	Babiyo	Grass	Gramineae
52	*Eupatorium odoratum L.*	Banmara	Herb	Compositae
53	*Ficus Hederacea Roxb.*	Dudhe	Tree	Moraceae
54	*Ficus religiosa L.*	Pipal (puja Garne)	Tree	Moraceae
55	*Garuga pinnata Roxb.*	Dabdabe	Tree	Burseraceae
56	Ghudeso*			
57	*Glycyrrhiza glabra L.*	Jethi Madhu	Herb	Leguminosae
58	*Gramineae family*		Grass	
59	*Grewia sclerophylla Roxb. Ex G. Don*	Fosre	Tree	Tiliaceae
60	*Holarrhena pubescens (Buch.-Ham.) Wall.ex G.Don*	Madheshi Kharseto	Tree	Apocynaceae
61	*Imperata cylindrica L.*	Siru ghans	Grass	Gramineae
62	Jhulo*		Herb	
63	Jhuse khar*		Grass	
64	Kali Ghurra*		Shrub	
65	Kali Ghurra Lahara*		Climber	
66	Kali lahara*		Climber	
67	Kharkhachha*		Shrub	
68	Khasre Ghans*		Herb	
69	Khatte*		Shrub	
70	Kuraini Lahara*		Climber	
71	*Lactiporus sulphureus (Fr.) Murr.*	Rato chyau		
72	*Lagerstroemia parviflora Roxb.*	Bot Dhayaro	Tree	Lythraceae
73	*Lannea coromandelica (Houtt.) Merr.*	Jinggat	Tree	Anacardiaceae
74	Latte Kuro*			
75	*Leea macrophylla Roxb. Ex Hornem.*	Goleni	Shrub	Leeaceae
76	Lichens	Jhyau (jhar)	Lichen	
77	*Lippia nodiflora (L.) Rich.*	Kurkure		Verbenaceae
78	*Litsea monopetala (Roxb.) Pers.*	Kutmiro	Tree	Lauraceae
79	*Mallotus nepalensis Mull.-Arg.*	Rani Karam (Phirphire)	Tree	Euphorbiaceae
80	*Mallotus phillippensis (Lam) Muell-Arg.*	Roinee	Tree	Euphorbiaceae
81	*Marsdenia tinctoria R. Br.*	Kalilahara	Climber	Asclepiadaceae
82	*Mitragyna parviflora L.*	Tikuli	Shrub	Rubiaceae
83	Money plant*		Climber	
84	Morjyak (Ratokath)*		Tree	
85	*Murraya koenigii (L.) Jack.*	Latikath	Shrub	Rutaceae
86	*Musa balbisiana Colla.*	Jangali kera	Banana	Musaceae
87	Mushe Khar*		Grass	
88	*Myrsine semiserrata Wall.*	Kalikath	Shrub	Myrsinaceae
89	Nilkantha (Hudeshi)*		Herb	
90	*Ohioglossum vulgatum L.*	Jibre sag	Herb	
91	*Oxalis corniculata L.*		Herb	Oxalidaceae
92	Patahi *		Shrub	
93	*Phoenix humilis Royle ex Baccari and Hook.f.,*	Thakal	Shrub	Arecaceae
94	*Phyllanthus emblica L.*	Amala	Tree	Euphorbiaceae
95	*Physalis divaricata D. Don*	PatPate	Tree	Solanaceae
96	*Pogonatherum paniceum (Lamk.)*	Mushe Khari Ghans (Khari Banso)	Grass	Gramineae
97	*Pogostemon benghalensis (Burm.f.) Kuntz.*	Rudilo	Shrub	Lamiaceae
98	*Premna integrifolia L.*	Gindheri	Shrub	Verbenaceae

99	*Psidium guajava L.*	Belauti	Tree	Myrtaceae
100	*Rambhorla* (Bungmari, Magar)*		Climber	
101	*Rauvolfia serpentina (L.) Benth.Hook.f.*	Sarpgandha	Herb	Apocynaceae
102	Rukha Bel*		Tree	
103	Sano Padali*		Tree	
104	*Schleichera oleosa (Lour.)*	Kusum	Tree	Sapindaceae
105	*Semecarpus anacardium L.f.*	Bhalayo	Tree	Anacardiaceae
106	*Shorea robusta Gaertn.*	Sal	Tree	Deptercarpaceae
107	Sida rhombifolia L.	Balu jhar	Herb	Malvaceae
108	Sinke Lahara*		Climber	
109	*Smilax aspera L.*	Kukur daino	Climber	Smilacaceae
110	*Smilax orthoptera A.DC.*			Smilacaceae
111	*Sonchus wightianus DC.*	Mulapate	Herb	Compositae
112	*Sporobolus diander (Retz.) P. Beauv.*	Ghode ghans	Grass	Gramineae
113	*Stephania elegans Hook.f. and Thoms.*	Badalpate	Climber	Menispermaceae
114	*Sterculia villosa Roxb. Ex Smith.*	Mudalo/Odal	Tree	Sterculiaceae
115	*Stereospermum chelonoides (L.f.) DC.*	Padali (Padari)	Tree	Bignoniaceae
116	*Symplocos ramosissima Wall. Ex G. Don*	Kharane	Shrub	Symplocaceae
117	*Syzygium cerasoides*		Tree	Myrtaceae
118	*Syzygium cumini (L.) Skeels*	Jamun	Tree	Myrtaceae
119	*Terminalia alata Heyne ex Roth*	Saaj	Tree	Combretacteae
120	*Thespesia lampas (Cav.) Dalz. Et Gibs.*	Ban kapash	Shrub	Malvaceae
121	Unknown (29b)			
122	Unknown 4b			
123	Unknown TR shrub a			
124	Unkwon 21b			
125	Unkwon RG5			
126	*Uraria picta (Jacq.) Desv. Ex DC.*	Tinpate Lahara	Climber	Leguminosae
127	*Wendlandia puberula DC.*	Kenyu	Tree	Rubiaceae
128	*Wendlandia tinctoria (Roxb.) DC.*	Seto tilka	Tree	Rubiaceae
129	*Woodfordia fruticosa (L.) Kurtz.*	Dhayaro	Tree	Lythraceae
130	*Xeromphis spinosa (Thunb.) Keay.*	Mainkanda	Shrub	Rubiaceae
131	*Zingiber cassumunar Roxb.*	Ban aduwa	Herb	Zingiberaceae
132	*Ziziphus incurva Roxb.*	Rajukanda	Tree	Rhamnaceae
133	*Zizyphus mauritiana Lam.*	Ban bayar	Shrub	Rhamnaceae

*Local name

Annex VIII

CALCULATION

Table: Density, Frequency, Dominancy, and IVI of plant species at herb stratum

Species name	No.	D/ha	RD%	F%	RF%	Dom.	R. Dom%	IVI
Imperata cylindrica	165	27,500.00	15.36	16.67	3.60	0.023603	44.926	63.886
Cynodon dactylon	85	14,166.67	7.91	6.67	1.44	0.006264	11.922	21.276
Dogshoe khar*	72	12,000.00	6.70	18.33	3.96	0.004494	8.554	19.215
Carex daltonii Boott.	51	8,500.00	4.75	25.00	5.40	0.002255	4.292	14.436
Nilkantha*	51	8,500.00	4.75	23.33	5.04	0.002255	4.292	14.077
Cyperus rotundus	54	9,000.00	5.03	18.33	3.96	0.002528	4.812	13.797
Cheilanthes anceps	56	9,333.33	5.21	10.00	2.16	0.002719	5.175	12.547
Sporobolus diander	37	6,166.67	3.45	21.67	4.68	0.001187	2.259	10.380
Ohioglossum vulgatum	37	6,166.67	3.45	16.67	3.60	0.001187	2.259	9.301
Cyperus compressus	34	5,666.67	3.17	13.33	2.88	0.001002	1.908	7.951
Khatte	21	3,500.00	1.96	16.67	3.60	0.000382	0.728	6.280
Cissus repens	17	2,833.33	1.58	16.67	3.60	0.000251	0.477	5.657
Mushe khari*	23	3,833.33	2.14	11.67	2.52	0.000459	0.873	5.532
Zingiber cassumunar	17	2,833.33	1.58	11.67	2.52	0.000251	0.477	4.578
Dioscorea bulbifera	14	2,333.33	1.30	13.33	2.88	0.000170	0.323	4.505
Marsdenia tinctoria	21	3,500.00	1.96	8.33	1.80	0.000382	0.728	4.482
Sonchus wightianus	12	2,000.00	1.12	13.33	2.88	0.000125	0.238	4.233
Desmodium gangeticum	17	2,833.33	1.58	10.00	2.16	0.000251	0.477	4.218
Bhuse kuro	23	3,833.33	2.14	5.00	1.08	0.000459	0.873	4.094
Oxalis corniculata	18	3,000.00	1.68	5.00	1.08	0.000281	0.535	3.290
Gramineae family	11	1,833.33	1.02	8.33	1.80	0.000105	0.200	3.022
Kali gurra*	16	2,666.67	1.49	5.00	1.08	0.000222	0.422	2.991
Sida rhombifolia	13	2,166.67	1.21	6.67	1.44	0.000147	0.279	2.928
Glycyrrhiza glabra	13	2,166.67	1.21	6.67	1.44	0.000147	0.279	2.928
Stephania elegans	12	2,000.00	1.12	6.67	1.44	0.000125	0.238	2.794
Woodfordia fruticosa	9	1,500.00	0.84	8.33	1.80	0.000070	0.134	2.770
Jhuse khar*	14	2,333.33	1.30	5.00	1.08	0.000170	0.323	2.706
Eulaliopsis binata	11	1,833.33	1.02	6.67	1.44	0.000105	0.200	2.663
Leea macrophylla	8	1,333.33	0.74	8.33	1.80	0.000055	0.106	2.649
Kuraini *	8	1,333.33	0.74	8.33	1.80	0.000055	0.106	2.649
Pogonatherum paniceum	15	2,500.00	1.40	3.33	0.72	0.000195	0.371	2.487
Smilax aspera	9	1,500.00	0.84	6.67	1.44	0.000070	0.134	2.411
Thespesia lampas	8	1,333.33	0.74	6.67	1.44	0.000055	0.106	2.289
Cymbopogon citratus	8	1,333.33	0.74	6.67	1.44	0.000055	0.106	2.289
Dioscorea alata	7	1,166.67	0.65	6.67	1.44	0.000042	0.081	2.171
Terminalia alata	7	1,166.67	0.65	6.67	1.44	0.000042	0.081	2.171
Shorea robusta	7	1,166.67	0.65	6.67	1.44	0.000042	0.081	2.171
Breea arvensis	7	1,166.67	0.65	6.67	1.44	0.000042	0.081	2.171
Ageratum conyzoides	9	1,500.00	0.84	5.00	1.08	0.000070	0.134	2.051
Anogeissus latifolius	5	833.33	0.47	6.67	1.44	0.000022	0.041	1.946
Syzygium cumini	5	833.33	0.47	6.67	1.44	0.000022	0.041	1.946
Xeromphis spinosa	6	1,000.00	0.56	5.00	1.08	0.000031	0.059	1.697
Dioscorea deltoidea	5	833.33	0.47	5.00	1.08	0.000022	0.041	1.586
Garuga pinnata	3	500.00	0.28	5.00	1.08	0.000008	0.015	1.373
Elephantopus scaber	8	1,333.33	0.74	1.67	0.36	0.000055	0.106	1.210
Zyziphus incurve	4	666.67	0.37	3.33	0.72	0.000014	0.026	1.118
Boke jamun*	3	500.00	0.28	3.33	0.72	0.000008	0.015	1.014
Lichens	3	500.00	0.28	3.33	0.72	0.000008	0.015	1.014
Dalbergia latifolia	3	500.00	0.28	3.33	0.72	0.000008	0.015	1.014

Crinum amoenum	2	333.33	0.19	3.33	0.72	0.000003	0.007	0.912
Lactiporus sulphureus	2	333.33	0.19	1.67	0.36	0.000003	0.007	0.553
Anaphalis busua	2	333.33	0.19	1.67	0.36	0.000003	0.007	0.553
Curcuma zeodaria	1	166.67	0.09	1.67	0.36	0.000001	0.002	0.454
Lippia nodiflora	1	166.67	0.09	1.67	0.36	0.000001	0.002	0.454
Money plant*	1	166.67	0.09	1.67	0.36	0.000001	0.002	0.454
Unknown RG5	3	500.00	0.28	1.67	0.36	0.000008	0.015	0.654
Total number of species=56	1074	179,000.00	100	463.33	100	0.052537	100	300

**Local name*

Table: Density, Frequency, Dominancy and IVI of plant species at shrub stratum

Species name	No.	D/ha	RD	F%	RF%	Dom.	R. Dom%	IVI
Terminalia alata	420	2,800.00	9.713	78.33	5.70	0.009437	20.19605	35.613
Shorea robusta	433	2,886.67	10.014	55.00	4.00	0.010028	21.46563	35.484
Leea macrophylla	304	2,026.67	7.031	41.67	3.03	0.004948	10.58072	20.645
Kuraini lahara	286	1,906.67	6.614	40.00	2.91	0.004378	9.36483	18.892
Khatte*	246	1,640.00	5.689	66.67	4.85	0.003237	6.92848	17.472
Sporobolus diander	276	1,840.00	6.383	26.67	1.94	0.004072	8.72140	17.046
Anogeissus latifolius	191	1,273.33	4.417	53.33	3.88	0.001952	4.17671	12.477
Bauhinia vahlii	144	960.00	3.330	48.33	3.52	0.001101	2.37407	9.224
Woodfordia fruticosa	140	933.33	3.238	45.00	3.28	0.001043	2.24401	8.758
Nilkantha jhar (hudeshi)*	166	1,106.67	3.839	23.33	1.70	0.001478	3.15489	8.693
Xeromphis spinosa	128	853.33	2.960	45.00	3.28	0.000873	1.87581	8.113
Mallotus phillippensis	119	793.33	2.752	36.67	2.67	0.000754	1.62129	7.043
Boke jamun	116	773.33	2.683	38.33	2.79	0.000717	1.54058	7.015
Physalis divaricata	83	553.33	1.920	50.00	3.64	0.000365	0.78872	6.349
Dalbergia latifolia	42	280.00	0.971	41.67	3.03	0.000093	0.20196	4.207
Bharke (Gaujo)*	79	526.67	1.827	15.00	1.09	0.000338	0.71453	3.634
Breea arvensis	59	393.33	1.364	25.00	1.82	0.000182	0.39854	3.583
Ziziphus incurva	41	273.33	0.948	31.67	2.31	0.000089	0.19246	3.446
Lagerstroemia parviflora	42	280.00	0.971	30.00	2.18	0.000093	0.20196	3.358
Wendlandia puberula	45	300.00	1.041	26.67	1.94	0.000103	0.23184	3.214
Cissus repens	43	286.67	0.994	21.67	1.58	0.000099	0.21169	2.784
Latte kuro*	27	180.00	0.624	28.33	2.06	0.000030	0.08346	2.771
Kali lahara*	45	300.00	1.041	16.67	1.21	0.000103	0.23184	2.486
Clerodendrum viscosum	57	380.00	1.318	10.00	0.73	0.000178	0.37198	2.418
Kali gurra lahara*	34	226.67	0.786	20.00	1.46	0.000068	0.13235	2.375
Eupatorium odoratum	45	300.00	1.041	15.00	1.09	0.000103	0.23184	2.365
Desmodium gangeticum	56	373.33	1.295	6.67	0.49	0.000167	0.35904	2.140
Desmodium oojeinense	23	153.33	0.532	20.00	1.46	0.000023	0.06057	2.049
Semecarpus anacardium	21	140.00	0.486	16.67	1.21	0.000026	0.05049	1.750
Acacia catechu	44	293.33	1.018	6.67	0.49	0.000105	0.22165	1.725
Grewia sclerophylla	15	100.00	0.347	18.33	1.33	0.000010	0.02576	1.708
Zizyphus mauritiana	27	180.00	0.624	11.67	0.85	0.000030	0.08346	1.557
Curcuma zeodaria	31	206.67	0.717	10.00	0.73	0.000054	0.11002	1.555
Dioscorea bulbifera	38	253.33	0.879	6.67	0.49	0.000072	0.16532	1.530
Sterculia villosa	26	173.33	0.601	11.67	0.85	0.000032	0.07740	1.528
Cassia fistula	14	93.33	0.324	15.00	1.09	0.000015	0.02244	1.438
Mallotus nepalensis	17	113.33	0.393	13.33	0.97	0.000015	0.03309	1.397
Lippia nodiflora	13	86.67	0.301	13.33	0.97	0.000000	0.01935	1.291
Pogostemon benghalensis	25	166.67	0.578	8.33	0.61	0.000034	0.07156	1.257
Garuga pinnata	15	100.00	0.347	11.67	0.85	0.000010	0.02576	1.222

Antidesma bunius	19	126.67	0.439	10.00	0.73	0.000013	0.04133	1.209
Asparagus racemosus	18	120.00	0.416	10.00	0.73	0.000013	0.03709	1.182
Bridelia retusa	13	86.67	0.301	11.67	0.85	0.000000	0.01935	1.170
Thespesia lampas	15	100.00	0.347	10.00	0.73	0.000010	0.02576	1.101
Phyllanthus emblica	17	113.33	0.393	8.33	0.61	0.000015	0.03309	1.033
Schleichera oleosa	11	73.33	0.254	10.00	0.73	0.000005	0.01385	0.996
Stereospermum chelonoides	9	60.00	0.208	10.00	0.73	0.000003	0.00927	0.946
Myrsine semiserrata	18	120.00	0.416	6.67	0.49	0.000013	0.03709	0.939
Colebrookea oppositifolia	13	86.67	0.301	8.33	0.61	0.000000	0.01935	0.927
Lannea coromandelica	8	53.33	0.185	10.00	0.73	0.000004	0.00733	0.920
Dioscorea alata	11	73.33	0.254	8.33	0.61	0.000005	0.01385	0.875
Phoenix humilis	11	73.33	0.254	8.33	0.61	0.000005	0.01385	0.875
Khasre ghans*	6	40.00	0.139	10.00	0.73	0.000009	0.00412	0.871
Ficus Hederacea	10	66.67	0.231	8.33	0.61	0.000003	0.01145	0.850
Sida rhombifolia	22	146.67	0.509	3.33	0.24	0.000029	0.05541	0.807
Jhulo*	12	80.00	0.278	6.67	0.49	0.000007	0.01649	0.779
Bauhinia purpurea	7	46.67	0.162	8.33	0.61	0.000006	0.00561	0.774
Patahi*	8	53.33	0.185	6.67	0.49	0.000004	0.00733	0.678
Syzygium cerasoides	5	33.33	0.116	6.67	0.49	0.000003	0.00286	0.604
Cissampelos pareira	4	26.67	0.093	6.67	0.49	0.000009	0.00183	0.580
Kharkhacchha*	8	53.33	0.185	5.00	0.36	0.000004	0.00733	0.556
Syzygium cumini	7	46.67	0.162	5.00	0.36	0.000006	0.00561	0.532
Musa balbisiana	10	66.67	0.231	3.33	0.24	0.000003	0.01145	0.485
Banbhawan*	8	53.33	0.185	3.33	0.24	0.000004	0.00733	0.435
Psidium guajave	3	20.00	0.069	5.00	0.36	0.000005	0.00103	0.434
Chariamilo (Birgan)	3	20.00	0.069	5.00	0.36	0.000005	0.00103	0.434
Holarrhena pubescens	5	33.33	0.116	3.33	0.24	0.000003	0.00286	0.361
Bankalibhata*	4	26.67	0.093	3.33	0.24	0.000009	0.00183	0.337
Ghudeso*	4	26.67	0.093	3.33	0.24	0.000009	0.00183	0.337
Smilax orthoptera	4	26.67	0.093	3.33	0.24	0.000009	0.00183	0.337
Ficus religiosa	4	26.67	0.093	3.33	0.24	0.000009	0.00183	0.337
Dellenia pentagyna	4	26.67	0.093	3.33	0.24	0.000009	0.00183	0.337
Aegle marmelos	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Diospyros tomentosa	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Premna integrifolia	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Adina cordifolia	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Didymocarus aromaticus	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Ram bhorla*	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Rukha bel*	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Sano padali*	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Sinke lahara*	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Murraya koenigii	6	40.00	0.139	1.67	0.12	0.000009	0.00412	0.264
Wendlandia tinctoria	4	26.67	0.093	1.67	0.12	0.000009	0.00183	0.216
Acacia pennata	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Apluda mutica	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Diospyros malabarica	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Litsea monopetala	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Abrus precatorius	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Rauvolfia serpentiana	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Bombax ceiba	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Mitragyna parviflora	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Uraria picta	1	6.67	0.023	1.67	0.12	0.000001	0.00011	0.145
Unknown 29b	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289
Unknown 4b	2	13.33	0.046	3.33	0.24	0.000002	0.00046	0.289

Unknown 21 b	2	13.33	0.046	1.67	0.12	0.000002	0.00046	0.168
Unknown TR shrub a	4	26.67	0.093	1.67	0.12	0.000009	0.00183	0.216
Total No. of Species 96	434	28,826.7	100.000	1373.33	100.00	0.04675	100.00000	300.000

**Local name*

Table: Density, Frequency, Dominancy and IVI of tree stratum

Plant Name	No.	D/ha	RD%	F%	RF%	Dom.	R. Dom%	IVI
Shorea robusta	99	82.50	25.127	40.00	9.23	0.06314	44.113	78.471
Anogeissus latifolius	65	54.17	16.497	66.67	15.38	0.02722	19.016	50.898
Lagerstroemia parviflora	58	48.33	14.721	63.33	14.62	0.02167	15.141	44.477
Terminalia alata	58	48.33	14.721	56.67	13.08	0.02167	15.141	42.939
Wendlandia puberula	31	25.83	7.868	26.67	6.15	0.00619	4.325	18.347
Semecarpus anacardium	13	10.83	3.299	20.00	4.62	0.00109	0.761	8.676
Mallotus phillippensis	10	8.33	2.538	16.67	3.85	0.00064	0.450	6.834
Physalis divaricata	6	5.00	1.523	13.33	3.08	0.00023	0.162	4.762
Ziziphus incurve	6	5.00	1.523	13.33	3.08	0.00023	0.162	4.762
Adina cordifolia	4	3.33	1.015	13.33	3.08	0.00010	0.072	4.164
Acacia catechu	4	3.33	1.015	10.00	2.31	0.00010	0.072	3.395
Desmodium oojeinense	3	2.50	0.761	10.00	2.31	0.00006	0.041	3.110
Mallotus nepalensis	3	2.50	0.761	10.00	2.31	0.00006	0.041	3.110
Diospyros tomentosa	8	6.67	2.030	3.33	0.77	0.00041	0.288	3.088
Syzygium cumini	2	1.67	0.508	6.67	1.54	0.00003	0.018	2.064
Clestocalyx operculatus	2	1.67	0.508	6.67	1.54	0.00003	0.018	2.064
Cassia fistula	2	1.67	0.508	6.67	1.54	0.00003	0.018	2.064
Dalbergia latifolia	2	1.67	0.508	6.67	1.54	0.00003	0.018	2.064
Wendlandia tinctorea	2	1.67	0.508	6.67	1.54	0.00003	0.018	2.064
Dellenai pentagyna	2	1.67	0.508	6.67	1.54	0.00003	0.018	2.064
Phyllanthus emblica	2	1.67	0.508	3.33	0.77	0.00003	0.018	1.295
Woodfordia fruticosa	2	1.67	0.508	3.33	0.77	0.00003	0.018	1.295
Ficus Hederacea	2	1.67	0.508	3.33	0.77	0.00003	0.018	1.295
Symplocos ramosissima	2	1.67	0.508	3.33	0.77	0.00003	0.018	1.295
Morjyak*	2	1.67	0.508	3.33	0.77	0.00003	0.018	1.295
Chainchui*	1	0.83	0.254	3.33	0.77	0.00001	0.005	1.028
Garuga pinnata	1	0.83	0.254	3.33	0.77	0.00001	0.005	1.028
Lannea coromandelica	1	0.83	0.254	3.33	0.77	0.00001	0.005	1.028
Careya arborea	1	0.83	0.254	3.33	0.77	0.00001	0.005	1.028
Total Species =29	394	328.33	100	433.33	100	0.14312	100	300

*****Local name

Table: Basal area of Tree species

Species Name	Mean Height (m)	Mean DBH (cm)	Std. Deviation of Mean DBH	TBA (m2)	RBA%	BA/ha
Shorea robusta	15.87	21.40	18.46	6.1864	30.676	5.1553
Anogeissus latifolius	16.53	26.04	14.25	4.4836	22.233	3.7363
Terminalia alata	17.60	23.97	17.28	3.9556	19.615	3.2964
Lagerstroemia parviflora	11.88	17.15	8.07	1.6320	8.093	1.3600
Semecarpus anacardium	10.47	21.92	8.77	0.5635	2.794	0.4696
Wendlandia puberula	8.54	14.45	3.68	0.5402	2.679	0.4502
Dellenai pentagyna	15.54	47.00	36.77	0.4534	2.248	0.3778
Acacia catechu	10.70	34.75	8.37	0.3960	1.964	0.3300
Diospyros tomentosa	11.94	20.06	6.20	0.2742	1.359	0.2285
Clestocalyx operculatus	18.42	38.00	0.00	0.2269	1.125	0.1891
Mallotus phillippensis	7.54	13.37	2.73	0.1457	0.723	0.1215
Ziziphus incurve	7.07	16.73	5.05	0.1420	0.704	0.1184
Careya arborea	17.99	42.20	.	0.1399	0.694	0.1166
Desmodium oojeinense	12.19	22.00	10.54	0.1315	0.652	0.1096
Adina cordifolia	9.82	18.63	7.97	0.1240	0.615	0.1033
Physalis divaricata	9.06	15.00	3.54	0.1110	0.550	0.0925
Morjyak*	12.55	23.20	15.27	0.1029	0.510	0.0858
Lannea coromandelica	13.00	36.00	.	0.1018	0.505	0.0849
Mallotus nepalensis	8.93	18.17	5.11	0.0819	0.406	0.0682
Ficus Hederacea	8.12	21.50	2.12	0.0730	0.362	0.0608
Phyllanthus emblica	9.38	20.50	3.54	0.0670	0.332	0.0559
Dalbergia latifolia	12.38	18.75	3.89	0.0564	0.280	0.0470
Symplocos ramosissima	8.40	16.80	3.11	0.0451	0.224	0.0376
Syzygium cumini	6.04	15.00	1.41	0.0355	0.176	0.0296
Cassia fistula	11.66	13.00	0.71	0.0266	0.132	0.0222
Garuga pinnata	9.41	16.40	.	0.0211	0.105	0.0176
Woodfordia fruticosa	5.25	11.25	0.35	0.0199	0.099	0.0166
Wendlandia tinctorea	9.88	11.00	1.41	0.0192	0.095	0.0160
Chainchui*	9.41	11.30	.	0.0100	0.050	0.0084
Total	13.84	21.13	14.33	20.1665	100	16.8054

**Local name*

Annex IX

DATA SHEET FOR HERBS AND SHRUBS PLOTS

Plot no.	: …….. (NE/SW)	Date	: ……..
Forest Name	: ……..	Forest type	: ……..
Latitude	: ……..	Longitude	: ……..
Slope	: ……..	Aspect	: ……..
Interference	: ……..	Status	: ……..
Grazing	: …….. (%)	Coverage	: …….. (%)

Species	Height	No.	Remark

Note:
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DATA SHEET FOR TREE STUDY PLOTS

Plot no. : ……..
Forest name : ……..
Latitude ……..
Elevation : ……..
Aspect : ……..
Status : ……..
Soil type : ……..

Date : ……..
Forest type : ……..
Longitude : ……..
Slope : ……..
Interference : ……..
Coverage : …….. (%)

Species	DBH (cm)	Angle	BD (m)	No	No. of Branch	Lp %	CS (no.)	Remarks

DBH: Diameter at breast height (1.37m), Lp: Lopping percent, CS: Cut stump

Note:
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