Drivers of Land Use Change : A Study from Sundarijal Catchment, Shivapuri Nagarjun National Park

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Protected areas (PAs) throughout the world is increasingly being recognized for their ecosystem services such as watershed protection, water purification, carbon sequestration, flood control, biodiversity conservation, soil conservation, cultural functions, landscape beauty etc. Reflection on such global trends is also found in Shivapuri Nagarjun National Park (SNNP) of Nepal, which is important water source of drinking water to Kathmandu residents. However, water is collected and used for free and those benefits are remained to be identified by upstream people and decision makers. In this scenario, the conservation efforts in SNNP can be strengthened through the incentive mechanisms like Payment for Environmental Services (PES).

With this view, this research aimed to assess the land use and land use change during 1990, 2000 and 2010 of Sundarijal VDC/catchment of SNNP with its implication on key ecosystem services, drivers of land use change and required actions to improve the ecosystem service of SNNP. For that, land use and land use change were analysed with Arc GIS 9.3. Similarly, the field study was accompanied by reconnaissance survey, focus group discussions (FGD), field observation, informal interview, household survey and key informant interview (KII). The perception of respondents was measured by using index of relative ranking (IRR).

From the GIS analysis, the obtained results showed that forest land and bare land declined by 6.71 ha (0.19%) and 18.8 ha (0.53%) respectively from 1990 to 2010. However, agricultural land raised by 25.5 ha (0.72%) at the same period. Hence, overall forest land conversion from 1990 to 2010 were found to be 0.02 percent per annum, bare land decreased by 0.05 percent per annum and agricultural land expanded by 0.07 percent per annum. According to local preference, adverse effects on ecosystem service are ranked as water quantity, water quality, soil erosion and biodiversity loss. Similarly, reported key drivers of these land use are ranked as overharvesting of fuel wood, timber, alcohol production and government policy. Similarly, majority of the respondents believed that before implementing any policy, villagers must be consulted for the conservation activities. Due to limited livelihood options, people inside SNNP are involved in extraction of tree for alcohol production. So, they believed that alternative livelihood options should be provided to them to halt such activities. Hence, this study strongly emphasised the need of PES inside SNNP to foster both conservation and improve the livelihood of people. As PES scheme provides economic incentives to the resource managers to adopt conservation friendly behaviours and to ensure the generation of the environmental services. For guideline, this study has referred the PES framework of ICIMOD (2011).

Key words: Land Use Change, Payment for Environmental Services (PES), Sundarijal Catchment, Shivapuri Nagarjun National Park (SNNP)

DEDICATION

This dissertation is dedicated to Mr. Laxmi Bhakta Shrestha, my father, Mrs. Sushila Shrestha, my mother, Eng. Suraj Shrestha, my elder brother, Mrs. Shobha Manandhar Shrestha, my sister in law and Ms Sumita Shrestha, my younger sister who has been the source of continuous love, support and inspiration throughout my life.

DECLARATION

I hereby declare that this dissertation has not been submitted for candidature for any other degree.

I understand that my dissertation will become part of the permanent collection of Kathmandu University Library. My signature below authorizes release of my dissertation to any reader upon request.

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Sujata Shrestha Date

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ABBREVIATIONS AND ACRONYMS

BZ	Buffer zone
CBS	Central Bureau of Statistics
CISIEN	Centre for International Earth Science Information Network
CREEW	Centre of Research for Environment Energy and Water
DNPWC	Department of National Park and Wildlife Conservation
DoF	Department of Forest
DoS	Department of Survey
EIA	Environmental Impact Assessments
FAO	Food and Agriculture Organization of the United States
FGD	Focus Group Discussion
GIS	Geographic Information System
ha	Hector
HH	Household
IEE	Initial Environmental Examinations
KII	Key Information Interview
KUKL	Kathmandu Upyatayaka Khanepani Limited
LPG	Liquid Petroleum Gas
OBIA	Object based Analysis
HH	Household Survey
ICIMOD	Integrated Centre for International Mountain Development
IIDS	Institute for Integrated Development Studies
IUCN	World Conservation Union
IRR	Index of Relative Ranking
Kg	Kilogram
KU	Kathmandu University

MENRIS	Mountain Environment and Natural Resources Information System
MFSC	Ministry of Forest and Soil Conservation
NETIF	Nepal Environmental Tourism Initiative Foundation
NFI	National Forest Inventory
NPR	Nepalese Rupee
NP	National Park
NPWC	Nepal Protected area and Wildlife Conservation
NTNC	National Trust for Nature Conservation
PAs	Protected Area
PES	Payment for Environmental Services
RS	Remote Sensing
SNNP	Shivapuri Nagarjun National Park
SPSS	Statistical Package for Social Science
SETDS	Sundarijal Environmental Tourism Development Society
UNDP	United Nations Development Program
UNFCCC	United Nations Framework for Climate Change Conventions
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat

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CHAPTER ONE

INTRODUCTION

1.1 Background

The term land use describes any activity, arrangement or use that occurs directly on the land or immediate actions modifying or converting land cover. It includes broad categories of human settlements, protected area, agricultural area, industrial zone, residential zone etc. Land cover refers to the observed bio-physical cover on the earth surface that characterizes a particular area. Examples of broad land cover includes forest, grassland, etc. (Briassoulis, 2006; CIESIN, 2002; FAO, 2000 and 2005; Lamichhane, 2008). Hence, there is an established direct link between land use and land cover and action of people in environment may lead to the land cover change (Phong, 2004; Lamichhane, 2008).

Land use is the major factor through which human beings are playing dominant role to influence the environment (Lambin et. al., 2001; Lamichhane, 2008), as land use and land cover have direct relationship to many of earth's fundamental characteristics and process like productivity of land, biodiversity, biochemical and hydrological cycle (CIESIN, 2002). Indeed, land use is the key for providing food, fibre, shelter and environmental services essential for human sustenance and well-being (DeFries et. al., 2007). Land use system such as range land, wetland, water bodies, agricultural land and protected areas provide multi spectral range of ecosystem services (ICIMOD, 2011). Growing number of literature suggest that PAs throughout the world is increasingly being recognized for their potential to protect various ecosystem services. It is well established that PAs offer immense recreational and tourism services and other ecosystem services

such as watershed protection, water purification, carbon sequestration, flood control, biodiversity conservation, soil conservation, cultural functions, landscape beauty etc (Georieva et. al., 2003; Maskey, 2008).

As establishing PAs is an effective approach to conserving biodiversity and natural ecosystems, many developing countries have declared more than 10 percent of their land as protected areas such as in Bhutan, Nepal, Thailand, Chile, Zimbabwe and Togo (Ghimire, 1994). However, these services from PA nevertheless are often affected by human and/or natural alteration of land use leading to regional and global environmental system changes (Vitousek et. al. 1997). In fact, humans are increasingly recognized as a dominant force in land use change (CISEIN, 2002; Lamichhane, 2008). Such changes have considerable negative consequences on environment such as soil erosion, water quality, microclimate, methane and carbon emission (Awasthi, 2004; Lamichhane, 2008), which results in increasing vulnerability of places and people to climatic, economic and socio-political problems. Clearly, all of these impacts eventually affect human society. Some of these changes are short but exploitative and while others are long term and stable. Concerns regarding land use in protected area have risen sharply, as land use change of protected area brings visible adverse effects in regional and global level and again impact of these regional and global changes on society (CISEN, 2002).

Land use change is occurring inside Shivapuri Nagarjun National Park (SNNP) which is focus area of this study. SNNP is located in north east of Kathmandu valley and is an important water source providing 40 percent of drinking water to Kathmandu residents (Maskey, 2008; NTNC, 2004). Within NP particularly Sundarijal catchment provides up to one-third of pipe water in the Kathmandu Valley. In addition, SNNP contributes water to over 4,000 ha of agricultural farms. Water from Sundarijal sub-catchment is collected into a reservoir and channelled to hydropower plant located in Sundarijal that generates about 4,231,000 KW per hour of electricity a year (Karna, 2008). This water is processed and transferred to the city for distribution to domestic consumers through Kathmandu Upatyaka Khanepani Limited (KUKL) that distributes about 33.3 million cubic meter of water per year (Karna, 2008). Water is also used by

mineral water companies in the downstream. Hence, the water from SNNP generates significant financial revenue and economic benefits for downstream communities. The net financial value added across different water uses is around NPR 306 million (US$ 7.6 million) a year (Karna, 2008; Kunwar, 2008). This NP is also considered as one of the important site for both national and international visitors.

However, the local people living inside and around the national park, since well before the declaration of the protected area, are an important stakeholder group in forest protection, but who remain ignored so far in terms of financial incentives such as compensation for wildlife damage on crops and livestock, restricted access to forest products, and access to markets as road construction is not allowed in the park. Lack of alternative income source and alternative energy have led to local people cutting down trees inside the national park for firewood for domestic use and also to produce alcohol that is sold in Kathmandu. Several researches have shown that local people mainly those living inside the park are a major cause for deforestation and ecosystem degradation inside SNNP.

This dual role of people in both contributing to causes and experiencing the effect of global change process emphasizes the need for better understanding of the interaction between human activities and environment process (CISEN, 2002). The understanding of such problem has been increasingly recognized in recent years, leading to the development of new schemes for effective preservation of land use for ecosystem services by controlling human behaviour through incentive mechanisms, often referred to as Payment of Environmental or Ecosystem Services (PES).

1.1.1 Payment for Environmental Services (PES) Concept

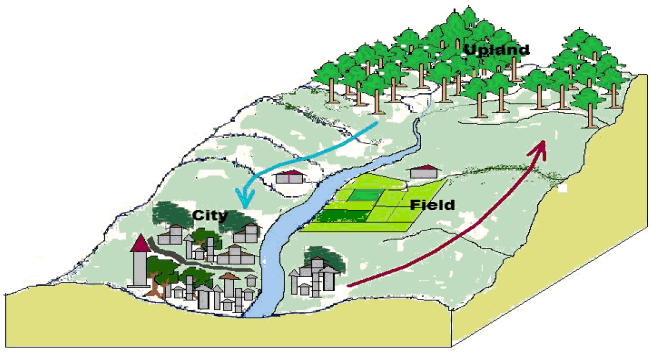
Payment for Environmental Services (PES) represents a new more direct way to promote conservation of ecological services (Wunder, 2007). PES simply is a voluntary, conditional agreement between at least one “seller” and one “buyer” over a well defined environmental services or a land use presumed to produce those services (Wunder, 2005 and 2007). The core idea of PES is that external beneficiaries of environmental services make direct contractual payments to local land owners and land managers in return for

adopting land and resource uses that secure ecosystem conservation and restoration in order to produce ecosystem services that are essential for the external beneficiaries.

Many conservationists believe that the success of national parks and protected areas depends upon the extent of support and positive attitudes of local people towards such establishment. The conservation efforts in SNNP can be strengthened through an appropriate incentive mechanism like PES. The economic logic of PES schemes dealing with the promotion of particular land use changes in PAs is simple by means of establishing market transactions between downstream and upstream economic agents, the downstream effects are taken into account (Niraula, 2007). In this way, land users would have direct incentive to include these services in their land use decisions, resulting in optimal land uses. This study examines land use types and activities inside the park boundary in Sundarijal sub-catchment, their impact on the natural forest in order to develop some recommendations to foster a co-existence of local livelihoods and ecosystem conservation of the protected area.

Figure 1.1:

Land Use System and PES



Source: ICIMOD, 2011

1.2 Statement of the Problem

Human population growth, land intensification, changing public attitude and demand regarding forest resources underscore the importance to assessment of land use and land use change (Alig, 2006; Sawathvong, 2003 and 2005; Wiens, 2007). As demography is major contributor to the land use change pattern (Wiens, 2007), with

continuous population growth, local people occupy the forest land or deforest and harvest forest products legally or illegally. The same phenomenon has accelerated in the SNNP due to intense dependency on fuel wood and resources use from forest whereas problems like livestock depredation and crop damage are risk to the local communities from wildlife (Maskey, 2008; Pandey, 2009; Purkait and Chalise, 2010; Kunwar, 2008). As a result, there always exist park-people conflict between SNNP management authorities and local communities (Maskey, 2008; Pandey, 2009). In addition, SNNP received about NRS. 62.8 million fund for their management and army annually (Kunwar, 2008). However, local communities do not receive any compensation or reward for their opportunity cost as limiting land use option to protect ecosystem services of SNNP. Furthermore, various researches revealed that due to restrictive NP policy, local people are deprived from economic opportunities and other basic requirements and lack of alternative sources and technologies have compelled them to use the forest resources inside SNNP. Local communities have no interest in upland conservation as they do not receive compensation or reward but the upland watershed conservation has significant economic and financial value to the downstream people. However, the land use and ecosystem services of the upper catchment improved significantly, while the local people status has worsened with many households living in poverty and more people are marginalized (Kunwar, 2008).

In a long run, there is a high probability that due to lack of incentive or reward mechanism and continued drudgery of people living inside and around the park will result in further degradation of forest especially in those areas proximate to the local village as distance is less between SNNP and surrounding landscape. Moreover, major concerns include effect on upland watershed deterioration in SNNP where improper land use practices in upstream consequently degrade water quality and quantity on adjoining lowland (Singh, 2007). As environmental changes in the watershed appear to closely couple with changes in land use within watershed, all the activities of local people in and around the SNNP are significant drivers of land use change because of severity and permanence of the land use change pose by the local people (Wiens, 2007).

Thereby, there are challenges to maintain the both ecological functions in SNNP and human land use option including preserving crucial habitats and reducing dependence of local human population on protected area resources. It is also important to evaluate the socioeconomic dynamics that determine current and future land use option for the local communities.

1.3 Rationale of the Study

The problem faced by SNNP include socio-economic factor affecting communities in and around the SNNP such as poverty (Pandey, 2009), land tenure and equity (Alig, 2006; Sawathvong, 2003 and 2005). There are serious issues in SNNP to balance conservation against the need to exploit natural resources to sustain livelihood and foster economic development. So, various studies on investigating environmental and economical services and need of PES mechanism on Sundarijal of SNNP have been conducted (IUCN, 2006; Panta and Rasul, 2008). In addition to that, feasibility, challenges and oppotunies of PES with identification of stakeholder have also found in various literature (Karna, 2008; Kunwar, 2008). The previous studies showed that water supplies of Sundarijal watershed yield significant financial and economical benefits for downstream users. Moreover, valuation of cost benefit analysis and contingent valuation of willingness to pay from beneficiaries of water services of Sundarijal catchment such as local people, organizations and institutions (hydropower and KUKL etc) to environmental service provider have been conducted (Maskey, 2008; Niurala, 2007). However, those benefit need to be identified and valued properly to convince the decision makers about the importance of managing upper watershed as a part of water supply infrastructure.

Previous studies have showed that under the conservation strategy, protection efforts of watershed are found to be linked with land use system. PES mechanism has gained attention in land use system as it is linked with production and consumption in agriculture and forestry within the defined geographical area (Sawathvong, 2005). So, information on land use change is quite necessary to apply PES mechanism in Sundarijal watershed of SNNP. However, up to date information on land use change, its key driver and impact on ecological environment of Sundarijal catchment is still found to be

lacking. Along with identifying these gaps, this study focuses land use change between 1990, 2000 and 2010 in the Sundarijal VDC/watershed of SNNP with its key drivers and impact of land use change. Similarly, local perception on status of land use change was also analysed. As socioeconomic activities of people inside the SNNP plays major role in land use change of SNNP. Therefore, this study also analyze possible application of PES is needed to be explored, as a potential solution to address both ecosystem and local livelihoods..

1.4 Objective

The main objective of this study is to assess land use and land use change in Sundarijal catchment inside the SNNP.

1.4.1 Specific Objectives:

1. To assess land use and land use change from 1990, 2000 and 2010 of Sundarijal VDC/catchment.
2. To assess the implications of land use change on key ecosystem services of Sundarijal VDC/catchment.
3. To identify key drivers of land use change inside SNNP of Sundarijal VDC/catchment.
4. To study perceptions of local communities regarding land use change inside of Sundarijal VDC/catchment.
5. To explore what action may be required for enhancing ecosystem services in Sundarijal VDC/catchment.

1.4.2 Research Questions:

1. What are the land use dynamics of Sundarijal VDC/watershed area?
2. What are the persisting impacts due to land use dynamics in the forest resources and its ecological services?
3. What are the key drivers of land use change inside SNNP?
4. What are the perceptions of local communities regarding land use change of forest land inside the park?
5. What are the suggestions and recommendations of local communities to the park authorities relating to improving the ecosystem services in Sundarijal catchment?

1.5 Limitations of the Study

1. This study has been carried out only for study purpose, the opinions are personal and it is not necessarily reflect official authority.
2. Unable to make more interaction with concerned stakeholders due to lack of time.
3. Increased load shedding schedule and assistance of expert in the study causes delay.

1.6 Study Area

SNNP is the nearest National Park from Kathmandu covering an area of 159 sq. Km. It encompasses two separate forest patches viz. Shivapuri and Nagarjun. Further information of the study area such as geographic location, study area location, watershed value, history, management and flora and fauna are briefly described below.

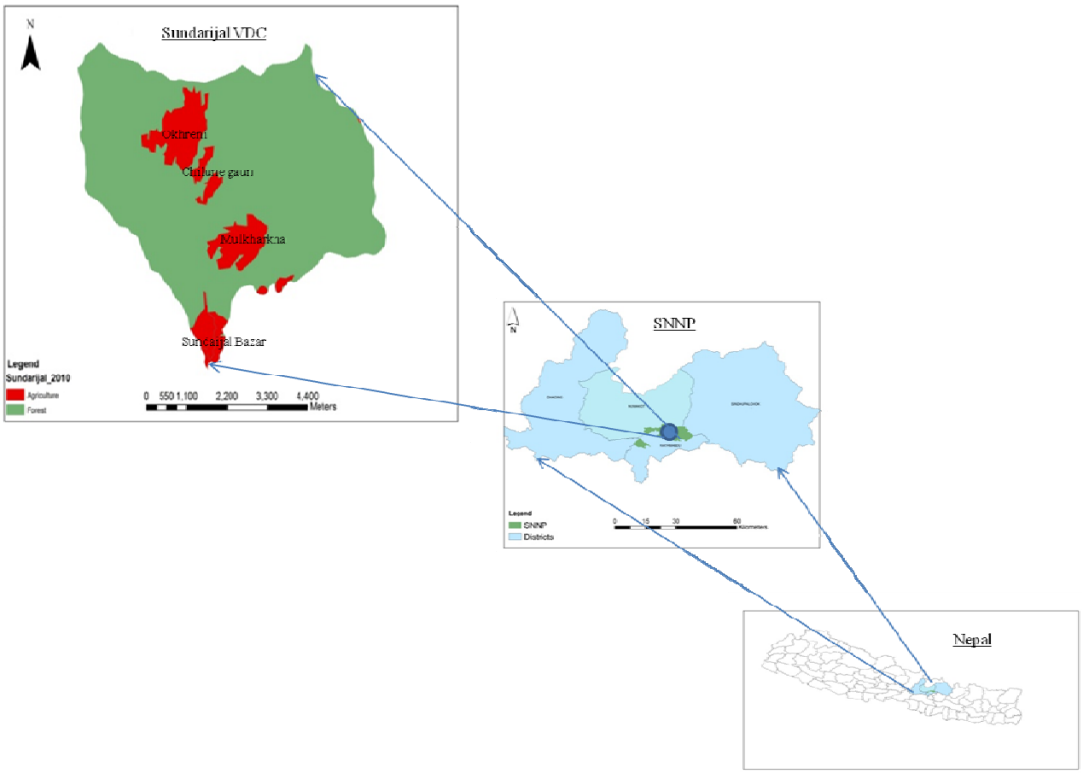
1.6.2 Geographic Location

Geographically, Shivapuri is located between 27°45' to 27° 52' north latitude and 85° 16' to 85° 45' east longitude whereas Nagarjun is located between 27° 43' to 27° 46' north latitude and 85° 13' to 85° 18' east longitude. It is spread over Kathmandu, Nuwakot, Dhading and Sindhupalchwok districts of central Nepal. The elevation ranges from 1350m to 2732m and its boundary is demarcated by a 111 km long boundary wall and 95 km long ring road. It is the true representation of the mid hills in the protected area system of Nepal.

1.6.2 Location

Figure 1.2:

SNPP and Sundarijal VDC Map



Source: Author, 2012

1.6.3 Watershed Value

Shivapuri Nagarjun National Park is situated in the north of Kathmandu which is one of the primary sources of freshwater for Kathmandu valley. The park is bestowed with an abundance of streams/streamlets. The park provides over 40 percent of the drinking water to the Kathmandu valley. About 30 million litres of water per day is tapped from the *Bagmai, Syalmai, Bishnumai, Nagmai, Sangla, Mahadeva* and *Tusal Khola*. There are reservoirs at *Sundarijal, Panimuhan, Tokha, Alle, Dhakalchaur* and *Panchmane* to supply water to the Kathmandu Valley. *Bagmati*, *Bishnumai* and

Yashomai rivers originate in the Shivapuri ridge. This explains why this area is the lifeline of the capital city.

1.6.4 History

Up to early 1970, natural slope on the southern slope of now Shivapuri Nagarjun National Park suffered rapid and wide spread degradation, mainly as a result of conversion to agriculture logging and exploitation of fuel wood. In recognition of area's important ecosystem goods and services, and in response to these threats, Shivapuri National park was declared as protected area in 1973. Three years later, the management of status of Shivapuri National park was raised to Watershed Reserve. In 1983, the area's management status was again upgraded to Wildlife Reserve, and in 2002 Shivapuri National Park was gazetted. To provide extended habitat for wildlife population and its representation on of intact mid hill, 15 square kilometre area was extended to the National Park along the west in 2009.

1.6.5 Management

SNNP has been managed by the Department of National Park and Wildlife conservation (DNPCW)/ Ministry of Forests and Soil Conservation (MFSC), with the support of army, who has 6 military posts around the park.

1.6.6 Flora and Fauna

The park lies in the transit zone between sub-tropical and temperate regions. There are more than 1250 species of floras. About 129 species of mushrooms have been described from the park. Schima-Castanopsis, Pines, Oaks, and Rhododendron are the dominant vegetation in the park. The vegetation in the park can be categorized into four types: (i) Lower mixed hardwood forests (Schima - Castanopsis) between 1350m and 1500m, (ii) Chirpine forests between 1350m and 1600m, (iii Oak forests between 2300 and 2732 m, and (iv) Upper mixed hardwood forests between 1500 and 2732 m. The major tree species are *Schima walichii, Castanopsis indica, Alnus nepalensis, Pinus roxburghii, Myrica esculanta, Pyrus pasia, Quescus semicarpifolia, Rhododendron arboreum, Juglan regea* etc.

Corresponding to rich floral diversity, SNNP supports rich faunal diversity with a number of protected, threatened and endemic species. It is an abode of a wide range of vertebrates. There are more than 22 species of mammals, out of which 5 species are in protected list Clouded leopard (*Pardofelis nebulosa*), Indian Pangoli (*Manis spp.*), Chinese Pangolin (*Manis spp.*), Leopard cat (*Prionailurus bengalensis*), Asamese Monkey (NPWC Act, 2029). Furthermore, other mammal species include Common leopard (*Panthera pardus*), Ghoral (*Naemorhedu goral*), Himalayan Black Beer (*Ursus thibetanus*), Jungle Cat (*Felis chaus*), Barking Deer (*Muniacus munijak*), Samba Deer, Rhesus Monkey (*Macaca mulata*), Marin, Large India Civet, Masked Palm Civet, Jackal, Wild pig (*Sus scrofa*), India Porcupine (*Hystrix indica*), Hare Flying Squirrel, Mongoose, Bats etc are also harbouring in this park.

1.6.7 A Case of Sundarijal Catchment of SNNP

The focus of assessment is Sundarijal catchment within SNNP which is the major source of drinking water to Kathmandu Valley. The park feeds the two major rivers in the valley – *Bagmati* and *Bishnumati*, and contributes to the drinking water supplied through the Kathmandu Valley Drinking Water Limited (KUKL), the only water supply company to the city. Sundarijal catchment that lies inside the Sundarijal VDC of the SNNP is particularly important because it is the origin of the city's largest river, the *Bagmati* and its two rivulets, *Nagmati* and *Shyalmati*. Thereby, here in study area of Sundarijal VDC is regarded as Sundarijal catchment.

Within the national park, under Sundarijal catchment, there are three villages; *Mulkharkha, Chilaune gaun* and *Okhreni* with 323 households (Sundarijal VDC, 2008/09). In these villages, most economically vulnerable groups exist in upstream area. Moreover, these households largely depend upon resources of the PAs for agriculture, fuel-wood, timber and fodder. As a consequence, socioeconomic activities of villagers directly or indirectly affect on the land use and vegetation of SNNP.

1.6.7 Rationale of Selecting Study Site

The Sundarijal catchment was selected for the research for two principle reasons. Firstly, many conservation activities have been carried out by the authorities for conservation of ecosystem in this area despite the life supporting activities of villagers

are still responsible for the depletion of ecological resources in this area. Therefore, result of this study are expected to provide information about land use dynamics in SNNP, key drivers of land use change and its implications to ecological service particularly water of SNNP. Secondly, the fact that hydrological services provided by this catchment has benefited downstream valley. Hence, a new economic environmental instrument PES is expected to be developed in order to support livelihood of upstream inhabitants. This can motivate them to stop depleting activities related to their life supporting behaviours or carry out conserving activities to establish sustainable and managed catchments.

In this regard, this study is conducted to analyse land use dynamics in Sundarijal catchment to develop PES scheme which can foster the livelihood of communities inside SNNP and conservation of environmental services from park.

1.7 Organization of Dissertation

This paper is organized into six chapters including this chapter one- introduction. Chapter one sets out the background of the study and concept of PES. It also provides statement of problem, rationale of the study, and objectives with highlighting limitation of the study and information of the study area. Chapter two- literature review covers the concept of land use and land cover, global trend of land use change and land use change in PAs. It also provides overview of the concept of PES, national and international trend of PES practices, research gap and brief legislative arrangement relative to land use and PES. Chapter three-methods and materials present research design, sources of data, bio-physical data collection technique and data analysis process. Chapter four- results includes the main finding of the study through GIS analysis, household survey , focus group discussion and key informant interview. Chapter five- provides the consolidate discussion of results via key points such as land use and land use change, general socioeconomic condition, major forest product and their use, implication of land use change on key ecosystem services, key drivers of land use change and attitude of local people toward the SNNP management and authority. Finally chapter six- conclusion and recommendation provides conclusion of study to develop of PES scheme and draws recommendation for the further action and research in this field.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Land Use and Land Cover Change

It is generally agreed that land supports all the human activities, providing goods (resources) and services (regulations) (Turner II et. al., 2007; Gonzales, 2009) and also receiving disposal (Gonzales, 2009). Similarly, many studies reported that from various aspects land use is being dynamically shaped under the influence and interaction of two broad sets of forces, human needs and environmental features and processes (Briassoulis, 2006; Gonzales, 2009). Such change in the use of land is occurring at various spatial and temporal levels (Agrawal et. al., 2002). These changes pose at certain times beneficial and at other times detrimental impacts (Briassoulis, 2006), the later being the main cause affecting the structure and functioning of ecosystem and ultimately earth system as well as the human well being (Turner II et. al., 2007; Gonzales 2009).

Land cover and land use change means changes in structure and function (qualitative) and change in the area extent (quantitative) of given type of land use or cover. Two types of change land use change can be distinguished (Turner II et. al., 1995; Briassoulis, 2006; Gonzales, 2009). First one is conversion, which means a change from one cover type to another and another one is modification, which means alteration of structure or function without a complete change from one type to another, it could involve change in productivity, biomass (Briassoulis, 2006; Gonzales, 2009). Moreover, land cover change occurs as a result of natural process such as climatic variation, volcanic eruption, changes in the river channel or sea level, etc. However, most of the land cover changes of the present and recent past are due to human actions i.e., to use the land for production or settlement (Turner II et. al., 1995; Briassoulis, 2006; Gonzales 2009). This view is supported by various researchers with evidence that human caused

land use change has been occurring at accelerating rate and posing effects immeasurably in the greater proportion on earth's land area (Jianchu, 2008; Lamichhane, 2008). Therefore, growing number of researchers emphasise on relatively arguably more urgent issue as land use and land use change (Lambin et. al., 2001; Wiens, 2007).

However, local level land use change may not produce significant local land cover change and consequently no significant environmental impact. However, there may accumulate across and /or over time and produce significant land cover change at higher (e.g. regional, national or global). Land degradation, desertification, biodiversity loss, deforestation and wetland drainage have all accompanied by significant alteration of land cover change involved (Briassoulis 2006). So, growing literatures have been highlighted the fact that land use and land cover change is the most important attribute of global change affecting ecological system and with an impact on environment (Meyer and Turner II, 1991; Lambin et. al., 2001; Lamichhane, 2008; Vitousek, 1994). With this view, scholars have claimed that such changes have been leading to important consequences on natural resources and significantly key aspects of earth system functioning and also poses vulnerability to the places and humans regarding climatic, economic, and socio-political perturbations (CISIEN, 2002; Lamichhane, 2008, Jianchu, 2008).

Similarly, the assessment of land use change revolves around two central and interrelated questions regarding drivers of land use and environmental and socioeconomic impacts of land use change (Briassoulis, 2006; Gonzales, 2009). The widely accepted two categories of drivers of land use change are biophysical and socio-economic (Briassoulis, 2006). Biophysical drivers include characteristics process of natural environment such as climatic variation, landform and geomorphic process, plant succession, soil types and process, drainage pattern etc. The socio-economic drivers comprise demographic, social, economic, technological, market, governmental and institutional factors and their process (CISEN, 2002; Briassoulis, 2006; Gonzales 2009). Such changes in land use have enabled humans to appropriate an increasing share of planet's resources but they also potentially undermine the capacity of ecosystems (Defreis et.al., 2007).

The impact of land use change is broadly categorized into environmental and socio-economical but these two are closely interrelated. The former causes the later which feedback to the former again, potentially causing succession of round (Briassoulis 2006; Gonzales 2009). As land use change is the result of a complex web interaction between bio-physical and socio-economic forces over space and time (Briassoulis, 2006; Gonzales, 2009).

2.1.1 Global and National Land Use Change: Deforestation Rate

The growing researchers also revealed that conversion and modification of forest land use and land cover to other land i.e., deforestation and degradation are regarded as major concern that not only leads to transitions between land use categories but that significantly affects productivity.

With rising concern the recent study of FAO (2010) indicated that world deforestation; mainly conversion of tropical forest to agricultural land has decreased over the past ten years but continues at an alarming rate in many countries. Global Forest Resources Assessment, 2010 conducted by FAO reported that world's total forest area is just over 4 billion hectares which corresponds to 31 percent of total land area. The study showed that around 13 million hectares of forest were converted to other uses of lost through natural cause each year in last decade compared with 16 million hectares per year in 1990s. It is because large scale of afforestation and natural expansion of forest in some countries and regions have reduced the net loss of forest significantly at the global level. The net change in forest are in the period 2000 to 2010 is estimated at -5.2 million hectares per year (an area about the size of Costa Rica), down from -8.3 million hectares per year in the period 1990-2000. Similarly, the legally established PAs has increased by 19 million hectares since 1990, which is 13 percent of the world's forest.

According to UNFCCC (2007), Nepal is on the 7th position out of 10 countries with the highest deforestation rate in the world. Nepal experienced an annual deforestation rate of 1.6 percent of the forest area during the period (1979-1994). Nepal has total 4.2 million ha (29%) of forest area and an additional 1.6 million ha (10.6%) shrub land which accounts to approximately 40 percent of the land covered by forest.

The National Forest Inventory (NFI, 1999) indicates that national annual rate of change (deforestation) is about 1.7 percent per year (Adhikari, 2011; Lamichhane, 2008).

There is lack of recent study on such issues in Nepal, however forest cover change analysis of the 20 Terai districts was conducted by MFSC/DoF (DoF, 2005), using two satellite images (Landsat image data from 1991 and 2001). This study showed that annual rate of deforestation was the highest in the Terai i.e., 0.27 percent compared with 1.6 percent during the previous decade. Nevertheless, the same study showed that increase in forest cover in PAs by rate of 0.01 percent (DoF, 2005).

2.3 Land Use Change in PAs

Changing pattern of the land use are the heart of many environmental service regarding PAs, more concerns of land use rise sharply as land use of PAs leads to the reduction in land availability for other purpose such as residential use, agriculture use, and so on (Pfeffer et. al., 2001). Such conservation practice like PAs takes land to restore in natural condition and sets boundaries and restricted access as a means of preservation. Thereby, transferring tenure system creates condition of relative scarcity and uncertainty about future access of resources (Pfeffer et.al. 2001). Furthermore, researcher revealed that increasing population growth leading to the greater demand of livelihood untimely lead to the conversion of forest land to agricultural land (UNEP, 2001). As a result, land of PAs encroached by people which leads to offset the balance of ecosystem service such as water filtration, biodiversity protection, carbon storage. Major rising concerns are on effects of forest loss on water quality and quantity (Alig, 2006; Awasthi, 2004). Researchers also revealed that communities inside and outside of PAs are facing problem related to socio-economic factors in and around PAs are poverty (Pandey, 2009), land tenure and equity (Alig, 2006; Sawathvong, 2003 and 2005).

PAs are essential for the conservation of biological diversity and meeting a range of community objectives, because PAs are important natural habitats, which must be conserved. There are many land use types included in the PAs namely forest, wetlands which improve water quality, provide flood control, mitigate climate change, and assist groundwater recharge (Jensen et. al., 1993; Muniyati, 2000). Therefore, worldwide, there is current growth in PAs both number of sites and the area under protection have

substantially increased in recent decades (Davey, 1998). The value of protected area ranges from retention of representative samples of natural region and preservation of biological diversity to the maintenance of environmental stability of surrounding regions. However, there is challenge to conserve and promote the land use of PAs due to changes in different land use may significantly affect the ecosystem process and services in the PAs.

2.3.1 Ecosystem Services of PAs

The term “ecosystem services” or “environmental services” refers to the conditions and processes through which natural ecosystem sustain and fulfil the needs of human life (Gonzales 2009). These services are result from ecosystem functions, the physical, chemical and biological processes that the ecosystem does for maintenance. Ecosystems are generally divided into four categories: Provisional services such as food, fresh water, fuel, wood, genetic resources; Regulating services such as climate regulation, pest and disease regulation, hazard mitigation, control of soil erosion and sedimentation, and water quality regulation; cultural and amenity services such as spiritual, recreation, aesthetic, inspiration, educational; Supporting Services which represents the ecological process that underlie the functioning of the ecosystem or those needed for the other services such as wildlife habitat, soil formation nutrient cycling, primary production (MEA, 2005). Since PAs are conserved and human prohibited, land use system of PAs provide all ecosystem services required by the society.

These ecosystems such as forests, grasslands, wetlands, etc located inside the PAs provide ‘watershed services’. The water services from PAs benefits local, national or regional level. A study on PAs found that a third of world’s largest cities depend on protected areas for drinking water supply and unfortunately a billion people who live in these cities live without access to clean and adequate water (Georieva et. al., 2003).

PAs are also regarded as global goods as number of benefit reach to the global community, for example carbon storage for mitigating climate change through reduced carbon dioxide level in the atmosphere (ICIMOD, 2011). However, conservation and promotion of PAs have face challenges.

2.3.2 Challenges and Constraints of PAs

Land use change often can alter ecosystem and reduce their capacity to provide broad range services. It is found that, globally, about 60 per cent of all ecosystem services are being degraded, overexploited or used unsustainably and particularly the provision for fresh water has depleted far beyond the level required to sustain current demands (MEA, 2005). If current trend continues, there is likely to be further rapid degradation of ecosystem services which may pose several environmental risks. The case of PAs is not exceptional.

Most people living inside or outside of PAs depend on resources from these areas for their livelihood. But, once an area is declared as PA, the local communities are denied access (ICIMOD, 2011). This can result conflict between park authorities and local communities. Different research studies have also revealed the fact that a restriction on use or harvesting forest resources from traditional land of poor people is the main cause of park people conflict. With the exhaustion and restriction of forest resources, people will tend to extract as much as possible from PAs in order to satisfy their immediate needs, without considering benefit to be gained from longer environment security (Shrestha and Conway, 1996). As a consequence, a vicious cycle the level of impoverishment in rural village increases and further environmental deterioration occurs (Ghimire, 1994). Due to population pressure and poverty in developing countries, conservation strategies need to address local people's need.

Encroachment inside PA, conflict with local people, illegal hunting and harvesting of forest resources, deforestation and forest degradation are found to be some common challenges and constraint of PA (ICIMOD, 2011).

2.4 PES Concept

PES mechanism can be effective in PA management to contribute livelihood and wellbeing of local communities. Over the past few decades, various conservation approaches have been adopted to solve the problem of improving natural ecosystem. Recognition of this problem has led to effort to develop reward or compensation mechanism for enhancing both conservation and livelihood of local people in and around PAs. Hence, PES will likely become one among several valid conservation approaches.

Conceptually, PES provides economic incentives to the resource managers to adopt conservation friendly behaviours to ensure the generation of the ES (Engel et. al., 2008, Danish Institute for International Studies, 2007; Wunder, 2005 and 2007). PES is also referred as a market based approach to conservation. It is based on two principles that those who benefit from environmental services should pay for environmental services and that those who generate services should be compensated for providing them (Wunder, 2005; Pagiola, 2002 and 2008; Pagiola et. al., 2007; Pagiola et. al., 2010). The PES approach seeks to create mechanisms to arrange transaction between service users and service providers by internalizing externality (Pagiola et.al. 2007; Pagiola et. al., 2010). Hence, PES also could either provide additional funding for PAs by paying inside or outside land for such services.

Until now, mainly four types of environ-mental services have been traded (1) carbon sequestration and storage (2) biodiversity protection (3) watershed protection (4) protection of landscape beauty (Wunder, 2007).

Although a variety of terms describe the PES concept can be found in the literature, according to Wunder A. PES refers to:

"a voluntary transaction where a well defined environmental services is being ' bought' by a (minimum one) environmental Service Buyer from a (minimum one) Environment Service Provider if and only if the environmental Service provider secures environmental service provisions (conditionality) (Wunder, 2005)".

The PES approach is increasingly attractive (Pagiola et. al., 2007; Pagiola et al., 2010) because;

I) It generates new financing, which would not otherwise be available for conservation,

II) It is likely to be sustainable, as it depends on the mutual self-interest of service users and providers and not on the whims of governmental or donor funding and

III) It is likely be efficient, in that it conserves services whose benefits exceed the cost of providing them and does not conserve services when opposite is true.

2.4.1 International Trends of PES Practices

The PES concept developed during the 1990s. Although it is hard to locate the exact origin of the concept, many associate PES with Latin America and particularly to Costa Rica. Many researchers believed that Costa Rica had pioneered the use of PES in the developing country by establishing a formal country wide program of payment. In the beginning of 1997, Costa Rica developed an elaborated PES program by encoding PES in Forest Law No. 7575. This law defines the environmental services as those provided by forest and forest plantation and which have a direct effect upon the protection and improvement of the environment (Singh, 2007; Pagiola, 2008). Under the 1997 Forestry Law, land users can receive payments for specified land uses, including new plantations, sustainable logging and conservation natural forests. This program is financed in a variety of ways, including revenues from a fossil fuel sales tax, sales of carbon emissions reduction credits, and payments from private water users and is now being supported by a World Bank and GEF. World Bank is working with several countries (Costa Rica, Columbia- Costa Rica - and Nicaragua, Guatemala, Mexico, Dominican Republic- Ecuador- and El Salvador, Venezuela and South Africa) to develop PES mechanism (Pagiola et. al., 2003).

Though PES scheme is new, some PES is a success to provide incentive for regulating environmental services. In most cases, PES is assumed to contribute to poverty reduction which is found to be mainly land users. Such assumption can be seen most explicitly in Rewarding the Upland Poor for Ecosystem Services (RUPES) (Pagiola, et. al., 2003). Similarly, many developing countries around globe; Mexico, China, Philippines, Indonesia and India are also benefiting from PES programs (Karna, 2008; Singh, 2007, Pagiola et. al., 2003).

A private hydroelectricity company and the Costa Rican Government fund make the payment to upstream forest and land owners for regularity of water flow to generate the hydroelectricity (Singh, 2007).

2.4.1.1 Catskill Water Supply System New York, USA

Before it became overwhelmed by agricultural and sewage runoff, the watershed of the Catskill Mountains provided New York City (US) with water ranked among the

best in the country. When the water fell below quality standards, the City investigated what it would cost to install an artificial filtration plant. The estimated price tag for this new facility was six to eight billion dollars a high price to pay for what once was free. New York City decided instead to invest a fraction of that cost ($660) in restoring the natural capital it had in the Catskill's watershed. In 1997, the City raised an Environmental Bond Issue and is currently using the funds to purchase land and halt development in the watershed to compensate property owners for development restrictions on their land and to subsidize the improvement of septic systems. Water users pay a small fee, as part of the water bill as a PES.

2.4.1.2 Vittel Mineral Water Company, North-eastern France

In France, a private water bottling company- Vittel (Nestle Waters) has invested 980 euro ha/yr to protect the quality of its water by paying farmers to adoption of land-management practices to reduce nitrates in the water source. Practices adopted include adopting extensive cattle ranching, and pasture management (switching from maize to hay and alfalfa), compost animal waste and give up agrochemicals. Farmers receive on average, about 200 euro/ha/year over five years. Of the 24.25 million invested in the first seven years,9.14 million euro were spent on land acquisition, 3.81 million on investments in farm equipment and 11.3 million in farm financial compensation.

2.4.2 National Trends of PES Practices

Reflection on such international trends can also be made in Nepal. In Nepal, the concept of PES was introduced in 2003 as a pilot project of the World Agro forestry Centre (ICRAF) to compensate and reward upstream community of the Kulekhani watershed. It has been perceived as an additional source of money to implement watershed management programs in the area and to foster both ecosystem conservation and improvement of livelihoods at the local level. The Kulekhani watershed became a pioneer in adopting the concept when a revenue-sharing mechanism was devised between the Kulekhani hydroelectricity project and the communities residing in the upstream part of the watershed (Khatri, 2009).

2.4.2 .1 Kulekhani Watershed

Kulekhani watershed, source of Kulekhani reservoir was built in 1970s. It has 12,500 ha watershed that consists of settlements and mosaic of land uses. Among the total area, 53 percent of land surface was covered by forest with more than 45,000 number of population. The study of RUPES found that the land use pattern in the upstream area directly affects the water storage capacity of the reservoir. Sedimentation caused by intensive agriculture and land disturbance is the main problem faced by Kulekhani Hydropower Plant. Other problems including high sedimentation in the rivers is low dry season flow. Programs (watershed conservation included community forestry, conservation education, terrace improvement and fruit plantations) were implemented to enhance the awareness about environmental services among local communities and other stakeholders and to promote conservation farming in the uplands. PES scheme was developed. A portion of the hydropower royalty paid by the Kulekhani hydropower to central government is now allocated for development in Kulekhani watershed in recognition of hydrological services, the communities provide. The Environmental Services Management Special Fund (EMSF) was established. The EMSF distributed and allocated the royalty budget for the KHP-affected villages and that fund was invested in conservation and development in and around the watershed.

The study showed that analysis of land use pattern forest cover were declined between 1978 to 1992, however after implementation of PES mechanism forest cover were found to be increased. The analysis of sedimentation of pattern also indicated that rate of sedimentation to the Kulekhani reservoir had declined greatly by 1990.The decline in rate of sedimentation corresponds to the increase forest cover. Analysis of dry season water flow also indicated that water flow to the reservoir also increased as the forest cover increased according to RUPES.

2.4.2.2 Dhulikhel Drinking Water Supply System

With support of GTZ (now GIZ), the PES mechanism were implemented in Dhulikhel Drinking water supply system. Due to rapidly increasing population, there was increased demand for water in the city. A good and regular supply of water was urgently required and hence, alternative sources of water were explored. Forest above

Bhumidanda Village, about 14 km from Dhulikhel, was identified as a potential source of water. Negotiations with the village communities led to an agreement that Dhulikhel water users will provide financial support (based on annual negotiation) for forest protection and other development activities in Bhumidanda village. In return, the village will protect the forest to ensure the water catchment remains intact. The infrastructure for water piping was completed in 1991. The water from the village is filtered at a filtration plant just above Dhulikhel and distributed to households through pipes. Part of the payment from water users is used to pay for forest protection and other development activities.

Some of the very recent studies are more focused to economic valuation of natural resources and generating information on feasibility to set up PES mechanism in Nepal. A very recent one on economic valuation has highlighted the importance of Churia hills resources for locals and communities and the importance of Churia watersheds for hydrological benefit to downstream people and generated much needed background information for setting up PES Scheme (Singh, 2007). Buffer zone program area management are others example of PES of biodiversity conservation and management.

PES approach is new in Nepal and the study and research regarding PES is found to be lacking. Similarly, Nepal has no experience PES in PA context.

2.4.3 Case Study of SNNP in the Perspective of Land Use and PES

Several literatures on SNNP have provided background information on PES its feasibility, challenges and opportunities for implementation in SNNP (Karna, 2008; Kunwar, 2008). Maskey, 2008 has conducted contingent valuation of willingness to pay from beneficiaries which is found to be 1% of their average monthly income (US $300/month). IUCN's three policy brief, 2006 of Forestry Research Program stated that between 1988 and 2001 in Shivapuri National Park (ShNP), forest area were found to be increased by more than six fold of that area. The remote sensing data showed that degraded forest is decreased by almost 85 percent (IUCN, 2006) because most of this forest restoration took place were found in ShNP. However, at the same time, fringe encroachment, conversion of forestland to agricultural land was observed at the boundaries of the park, and around the three villages' settlements inside it. The policy brief also found that improving forest cover has led to the more steady water flow in the

downstream area. This view is supported by the study of Panta and Rasul, 2008 as the study found a positive relationship between watershed conservation upstream and water yield downstream in SNNP i.e. conservation of upstream watershed increases water yield in downstream areas though there is some gestation period. However, the economic study of watershed services of Sundarijal catchment showed that local inhabitants incur opportunity cost of water resources (Niurala, 2007).

On the basis of hydrological, livelihood and economical cost and benefit of alternative land use and resource management option, the IUCN report analyses on modelled three management options for the ShNP area which are; continuation of status quo, where park management is based largely on the exclusion of human and sustainable resources use, resettlement of the park resident population and continued conservation, and de-gazettment of park and cessation of conservation activities. Similarly, the third option of co-management was found to be best management option (Karna, 2008). As overall scenario of co-management benefits local communities and allow some level of sustainable use. So, IUCN study emphasis to investigate mechanism for ensuring motivates or rewards to the upstream land managers or villagers inside NP to conserve the ecosystem services of NP including particularly water services. Similarly, Panta and Rasul, 2008 suggested that by rewarding upland farmers for setting their farmland aside for conservation can provide higher water yield downstream at the same time increasing the income of upstream farmers. Hence, the study recommended the PES considering suitable option that is widely considered to compensate people, living in or near protected areas that provide the services, for their losses through payment for ecosystem services (Niurala, 2007).

2.4.3.2 A Pilot Program in Sundarijal Watershed of SNNP

With the perception that PES is a means of creating a market in environmental services (Wunder, 2007) that would enhance the watershed services in upstream as well as incentive or reward to the park management and local communities, the consortium of three organizations, NETIF, Forest Action and ICIMOD has been actively involved in feasibility study of PES scheme on the perspective of Sundarijal watershed. Discussions,

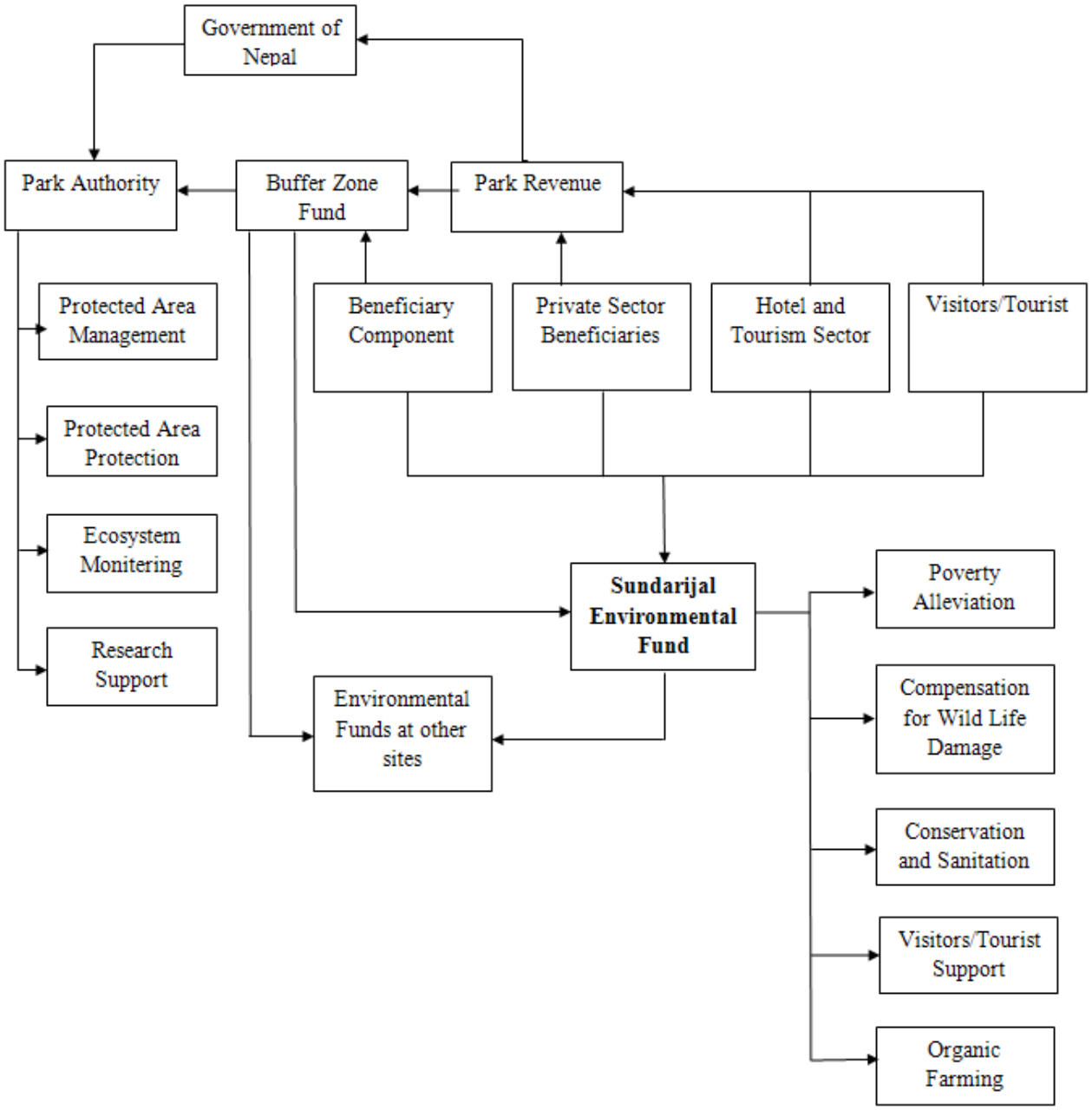
PES awareness program and capacities enhancement are actively ongoing activities to generate understanding of PES among all the stakeholders.

The feasibility study of pilot program in Sundarijal catchment indicated that people living inside the villages have been suffering intense park people conflict. As they are suffering economically with little livelihood options, they are compelled to involve in alcohol production using fuel wood from PAs (both activities are prohibited by law). The study also estimated that value of the water services of Sundarijal catchment (all revenue minus expenses for water distribution and electricity generation) at US$ 870 per hectare per year. The cost of damage to crops and livestock by wild life was estimated as US$ 498 per house hold per year. Similarly, the annual cost to the park authority for managing and guarding was US$ 5 (ICIMOD, 2011).

The given economic value poses potential for PES mechanism in Sundarijal catchment inside SNNP. Hence, the study propose a PES scheme which would collect payment from water distributed companies, hydropower companies, tourism sector, downstream industries, and paddy farmers that use water from catchment. The benefit of such scheme would include economic incentives to local people to assist in conservation and park management. The detail framework for PES scheme is as follows:

Figure 2.1:

Framework of PES Scheme for Sundarijal Catchment at SNNP



Source: ICIMOD, 2011

2.5 Research Gap

Data alone are insufficient for improved understanding and projections of future land use trend. They must be matched by enhanced understanding of the causes and of land use change as well impact of such changes. In addition to that, understanding of land cover and land use change and its implications are coupled with ecosystem functioning and its services. But, the research on land use and land cover change of forest area is poorly studied in Nepal with its influence of geomorphologic character on watershed quality in the design of PES mechanism (Awasthi, 2000; IUCN, 2008).

The data and information regarding the watershed conservation from Sundarijal watershed is well known. However, up to date information on status of forest land, particularly in the vicinity of human settlement is not available. There is also lack of scientific evidence of land use change analysis and its impact on key ecosystem though; there are lots of emphases on watershed management (Karna, 2008). The further study is needed focusing on impact of land use change. Similarly, there is lack of awareness about PES concept among people, resource managers and policy makers and thus, lacks recognition in national policies (Karna, 2008).

Therefore, an assessment of current land use and land use change with implication on ecosystem services was conducted. Local people's perception towards the change, its causes and future prediction was also assessed as it is essential in PES negotiation and future planning including the development of PES scheme.

2.6 Legislative Arrangements of Nepal

The Ministry of Land Reforms and Management has finalized the draft of National Land Policy, 2012 with an aim to manage, classify and put them to proper long term use. Land is classified in six categories- agricultural area, residential area, forest area commercial area, industrial area and public and other necessity area with provisions to preserve at least 40 percent of the total land area for forestry. According to the policy, government will implement 'Land Use Plan' in phases over several years (Republica, 2012).

Till date, Nepal has no national policy and legal framework regarding PES. However, some legislative arrangements on PAs and environment with its linkage with land use and or PES summarized briefly in Table 2.1 below:

Table 2.1:

Environmental and Protection Legislative Arrangements of Nepal

Act	Summary	Linkage with land use and /or PES
1. National Parks and Wildlife Conservation Act, 1973	The act is commitment to conservation. Under the fourth amendment of the National Parks and Wildlife Conservation Act 1973, DNPWC introduced buffer zone policy in 1993 and buffer zone regulations in 1996, which has made provision to plough back 30 to 50 percent of the park revenue to the community development of the buffer zone areas.	No linkage with land use. However, buffer zone programme and conservation area management are relevant examples of Payment of environment services of conservation and management communities for the sake of socio-economic development and livelihoods support.
2. Forest Act, 1993	This act has focus on conservation and development of forest and the proper utilization of the forest products this act has been established. It has emphasized the preparation of action plan for the management forest.	For the conservation and development of forest, analysis of land use change can give scenario of state of forest land use and land cover. This may lead to develop appropriate action plan for the forest management. Similarly, scheme of PES can be include in preparation of action plan to foster the wellbeing of people and which lead to motivate local communities to conservation activities of forest and forest product.

3. National Conservation Strategy, 1988	It has emphasized the sustainable use of natural resources and compatible land use. It also envisages forestry as a contributor to gross domestic product as a source of off-farm employment opportunities. The plan has stated that meeting people's basic needs for forestry production is a prerequisite to reduce park/people conflict.	Compatible land use can be identified by land use change assessment. For the sustainable use of natural resources, PES scheme can be included in long term conservation strategy for motivating local people to conserve by fulfilling their needs.
4. Environment Protection Act, 1996 and Environment Protection Regulations, 1997	This act has made have made Initial Environmental Examinations (IEE) or Environmental Impact Assessments (EIA) mandatory to prevent the adverse impact on forest and biodiversity components due to the development proposals.	IEE and EIA could help to plan proper land use to prevent adverse impact on forest resources.
5. Nepal Biodiversity Strategy, 2002	The act has recognized the need for the comprehensive approach that will aim to conserve forest, soil, water and biological diversity while at the same time meeting the basic needs of the people who are dependent on these resources for the livelihood.	Appropriate land use planning can lead to integrated conservation approach. For both conservation and improvement of livelihood of local people, PES tool can be implemented.
6. Three Years Interim Plan (TYIP) (2064/65-2066/67)	Ministry of Forests and Soil Conservation has mentioned the necessity of effective and efficient diplomatic efforts for the Payment for Environment Services (PES).	Detail institutional PES mechanism policy or law could be formulated.

CHAPTER THREE

METHODS AND MATERIALS

This chapter describes how the research was conducted, the methods used for data collection, the technique used for data analysis and all materials that have been used for this research work.

3.1 Research Design

The research has been initiated with depth literature review. It helps to develop concept of the research by defining and formulating research problem, objectives, research questions and identifying study area.

Subsequently, it was followed by desk study/data collection of RS and GIS data and other socioeconomic and required data from related organization and field study. As existing data on RS, GIS and socioeconomic conditions could be readily available and additional information can be supplied from primary sources. This approach helps to maximum resources utilization under finite time.

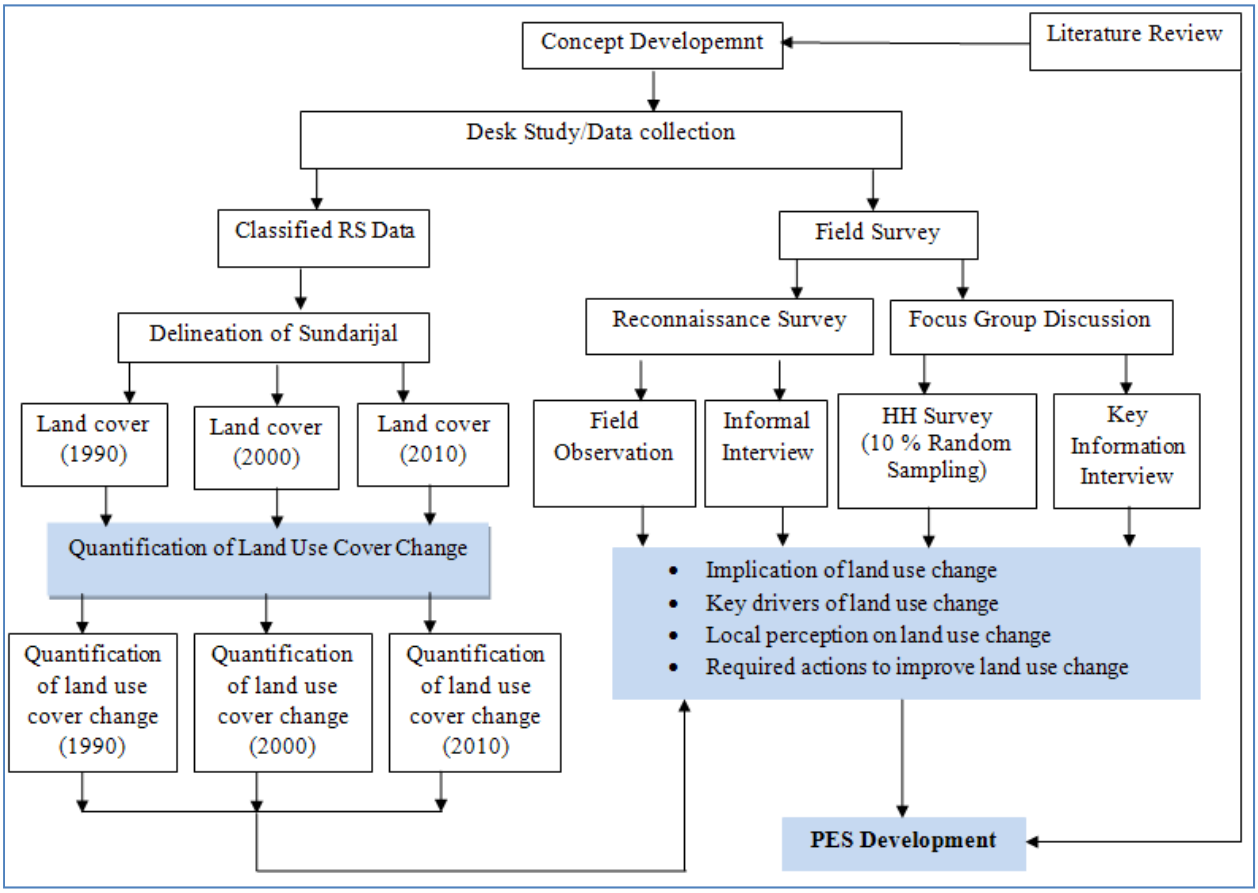
The collected classified RS data from 1990, 2000 and 2010 delineated to study area and land use and land cover of all data from three periods were quantified using GIS and subsequently analysed.

Field study was accompanied by reconnaissance survey, focus group discussions (FGD), field observation, informal interview, household survey and key informant interview (KII) extracting the information from field such as implication of land use change, key drivers of land use change, local perception on land use change and required actions to improve land use change in the study area.

Finally, on the basis of inference on land analysis of data of 1990, 2000 and 2010, outcome of field work along with consistence literature review PES concept was developed. The detail process of research design is illustrated in 3.1.

Figure 3.1:

Research Design



Source: Author, 2012

3.2 Sources of data

Both primary and secondary data were collected for the study. Primary data was collected from field survey on study site while secondary data were gathered from aerial photographs, GIS maps, topographic maps, published and unpublished documents relevant to the research from different sources such as ICIMOD, IUCN, NTNC, DNPCW, CBS, VDC, FAO, DoS, WWF etc.

3.2.1 Data Collection

The secondary data of RS and GIS data, topographic map and socio-economic data were collected from above mentioned organizations. Similarly, primary bio-physical and socio-economic data of study area were collected from field survey such as reconnaissance survey, FGD, household survey, field observation, informal talk and KII.

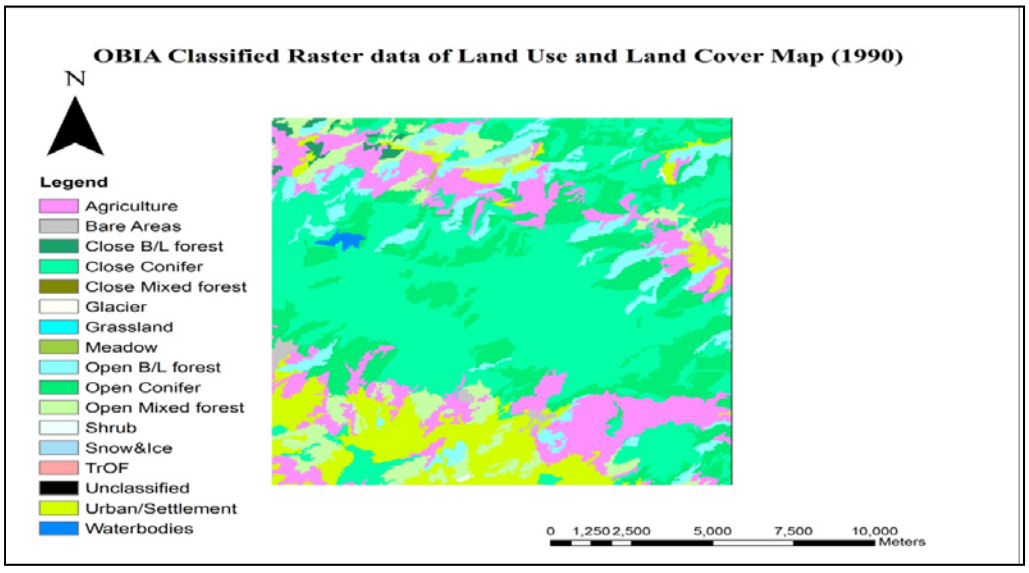
3.2.2 Satellite Image and GIS Data

Assessment of land use and land use change pattern was conducted by Geographic Information System (GIS) and Remote Sensing Analysis (RS). Time series data of 1990, 2000 and 2010 were used for quantification of land cover of Sundarijal VDC. All data were collected from ICIMOD (MENRIS department), which comprised of the Landsat TM of 30 m spatial resolution of raster data and classified by OBIA (object-based image analysis) technique.

The classification of OBIA is based on information from a set of similar pixels called objects or image objects. More specifically, image objects are groups of pixels that are similar to one another based on a measure of spectral properties (i.e., colour), size, shape, and texture, as well as context from a neighbourhood surrounding the pixels.

Figure 3.2:

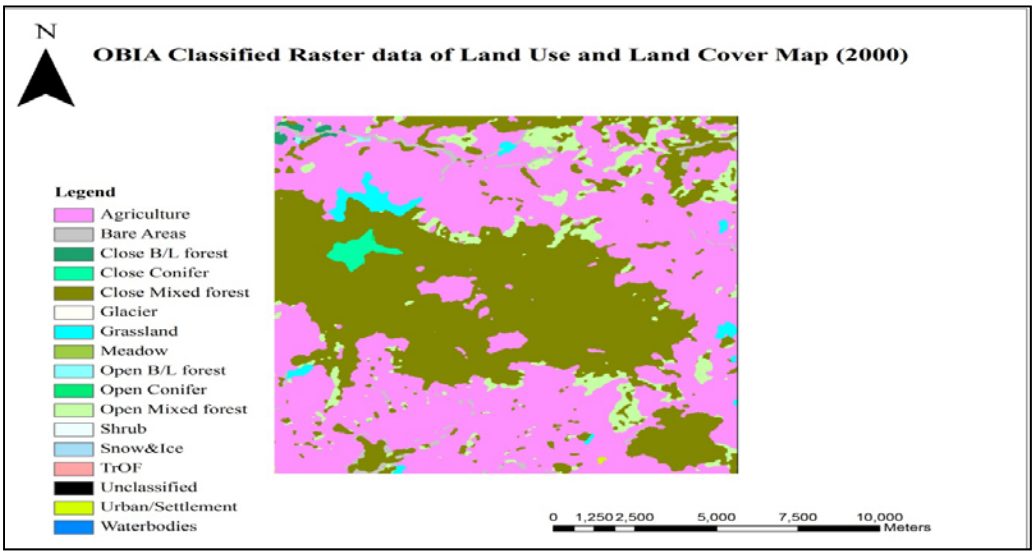
Raw data of Sundarijal VDC (1990)



Source: ICIMOD, 2011

Figure 3.3:

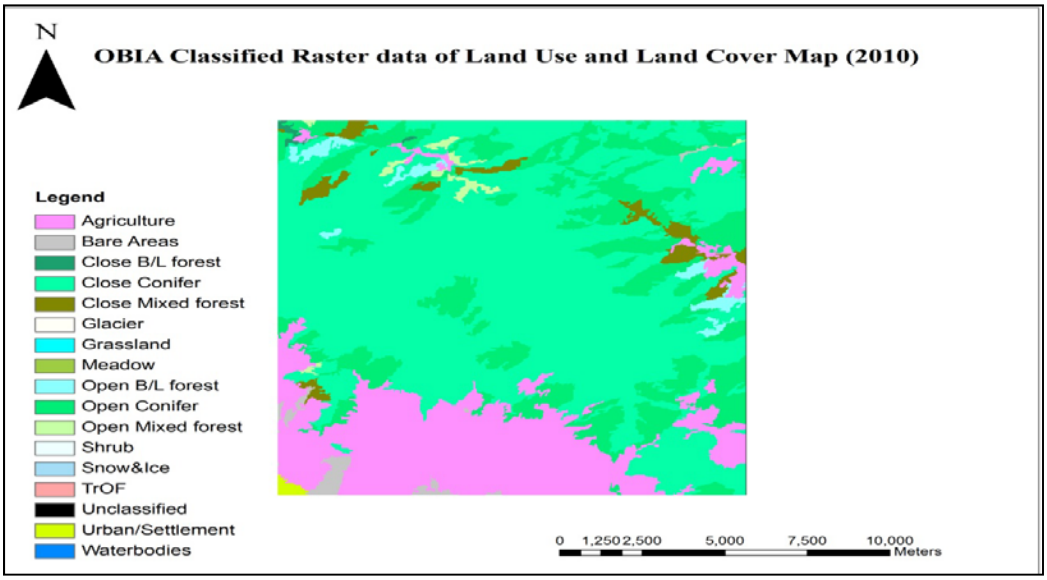
Raw Data of Sundarijal VDC (2000)



Source: ICIMOD, 2011

Figure 3.3:

Raw data of Sundaijal (2010)



Source: ICIMOD, 2011

3.2.3 Limitation of Landsat TM

However, there are still certain limitations with remote sensing technology when used for assessment of land cover. According to FAO, some of the major ones are listed below:

1. Since resolution of data from Landsat image is 30 m, the linear strips of forest cover along roads, canals, bunds and rails of width less than the resolution are generally not captured.
2. Young plantations and species having less chlorophyll contents in their crown do not give proper reflectance and as a result are difficult to be interpreted correctly.
3. Considerable details on ground may be obscured in areas having clouds and shadows. It is difficult to interpret such areas without the help of collateral data.
4. Variation in spectral reflectance during leafless period poses problem in interpretation.
5. Gregarious occurrence of bushy vegetation and certain agricultural crops such as lantana, sugarcane, cotton, etc. often pose problems in delineation of forest cover as their reflectance is similar to that of tree canopy.
6. There is drastic difference in texture (Colour pattern) in 1990, 2000 and 2010 collected data from ICIMOD. However, these three are temporal satellite images of the same location, i.e. are they represent the same area and location.

3.2.4 Topographic Map

Digital Topographical Map on shape file of scale 1:25000 of the SNNP was collected from Department of Survey (DoS), Kathmandu. The research area, Sundarijal VDC was extracted from that topographic map by clipping tool of Arc GIS 9.3.

3.3 Bio-physical and Socioeconomic Data Collection

The required bio-physical data were collected through reconnaissance survey along with socioeconomic assessment were conducted by different approach such as Focus Group Discussion (FGD), Household Survey, Informal Interview, Field Observation and Key Informant Interview (KII), which were briefly described in following sub sections.

3.3.1 Reconnaissance Survey

A reconnaissance survey was carried out on the month of September 2011 to get the general understanding of land use and land cover status of the study area before starting the fieldwork. During the reconnaissance survey, a series of informal meetings were conducted with key persons associated with environmental organizations, local people and park authorities. The survey provided a broad picture of the study area.

3.3.2 Focus Group Discussion (FGD)

After reconnaissance survey, three group discussions, i.e., one group discussion in each three village (Mulkharkha, Chilaune gaun and Okhreni) were conducted with the women group. In a single group discussion, 5 to 13 people were participated. As women role was more associated with forest products, women groups were selected. A checklist was developed to document the local perception on issues regarding land use change inside SNNP, drivers of land use change, impact of land use change, linkages between land use and livelihood of local people and actions required to improve the livelihood of local people and conservation in SNNP.

With the help of FGD, key issues of Sundarijal watershed were identified and questionnaire of household survey was designed.

3.3.3 Household Survey

For household survey, systematic random sampling method was applied. The questionnaire survey was carried out in month of December 2011. Out of 9 wards in Sundarijal VDC, 6 wards were selected for the study. The selection of ward was on the basis of three villages; Mulkharkha, Chilaune gaun and Okhreni which lie entirely inside the SNNP.

Table 3.1:

Village and their Ward Details

Village	Ward	No of HH	Population
Okhreni	1,2	150	749
Chilaune gaun	3	51	247
Mulkharkha	4,5,6	119	671
	Total	320	1667

Source: Sundarijal VDC, 2008/09

Ten percent (10%) was taken as sampling ratio for the sample size determination based on four basic rules as set by social researcher to determine sample size (Baker, 1999). All three villages are dominant with *Tamang* group with similar socio-economic character and same settlement was observed during focus group discussion and reconnaissance survey in these villages. Out of 323 households, 32 households were sampled from the study area.

Table 3.2:

Sample Size Determination

Village	Ward	No of HH	Sample Size
Okhreni	1	30	3
	2	120	12
Chilaune gaun	3	51	5
Mulkharkha	4	47	8
	5	41	4
	6	31	3
	Total	320	32

Source: Sundarijal VDC, 2008/09

Systematic random sampling technique without replacement was used for the respondents with equal probability of selection (Unbiased Sample). At the field, each sample was drawn with lottery method.

The survey was conducted through direct interview with household member using structured and semi structured questionnaire. Before conducting the formal questionnaire survey, the questionnaires were pre-tested in some households in and around the Sundarijal bus park and some necessary modifications were made. The purpose of pre-testing was to identify any ambiguity or errors in the questions. Before conducting formal survey, discussions on supervisor on subject matter were done. Interview was conducted with the family head member as far as possible and in absence of family head, interview was made with representative and knowledgeable member of the household.

The household survey schedule was prepared incorporating household size information, socio-economic condition, dependency on forest resources, and their perception on status of forest, key drivers of land use change, impact of land use change within the study area and their suggestion and recommendations.

3.3.4 Informal Interview

The informal interview was carried with local people regarding the land use dynamic of 1990, 2000 and 2010 along with possible causes, its implication on ecological services and socio-economic status of village which helps in triangulation of collected data by different technique.

3.3.5 Key Informant Interview (KII)

In order to triangulate the collected data from household survey and focus group discussions, few key informant interviews were conducted. The information regarding assessment of land use change, implication on key ecosystem services particularly water services, forest dependency were conducted with Principle of school, President of SETDS, members of school management committee, president of Sundarijal VDC and Assistant warden of SNNP.

3.3.6 Field Observation

All study areas were visited with one local assistant from Mulkharkha to gain insight of knowledge. Field observation was carried out continuously throughout the data collection period in the field. The current land use practices, forest along with their existing condition and pattern (cultivation, land types, sources of resources, etc), pressure over the forest (fodder, firewood and timber collection, leaf letter collection etc.) was also observed in the field to validate the statements of the participants of the group discussion, household survey and key informant interview by comparing them with actual activities in the field.

Photographs of such activities were also taken for the visual interpretation.

3.3.7 Limitations

1. A person whose culture emphasizes collectivism or interdependence is more likely to be influenced by the presence of others leading to response errors.
2. The study was based on the subjective analysis, thus it was difficult to get exact result as in numerical analysis.
3. Time series analysis of 1990, 2000 and 2010 of land use dynamics and socio-economic information has been collected mainly from memory recall of the respondents through questionnaire.
4. Interview was made with the family head as far as possible, if such was not possible; interview was taken from the next knowledgeable member of the house.
5. Due to the poor record keeping, it was difficult to collect the baseline information and data related on this study from VDC offices .
6. As people are living inside the SNNP, restrictiveness may influence the truthiness of answer.

3.4 Secondary Data Sources

The population was analyzed with secondary data from VDC data of 2007 and census data from Centre Bureau of Statistics (CBS) of 1990 and 2001. In order to have the insight knowledge on the subject matter and policies, extensive desk study was done from the policy briefs, documented literatures and available international literatures of the

relevant publications of international and national organizations, journals, newsletters, factsheets and research papers.

3.5 Data Analysis

Both qualitative and quantitative data were analysed using different computer software programs. ARC GIS 9.3 was used for analysis and interpretation of satellite images and GIS data. Similarly, all the household data was entered and analyze using Statistical Package for Social Science (SPSS version 15) using different statistics such as percent, mean, frequency, chart, bar diagram and graph, both qualitative and quantitative data were interpreted. The analysis and interpretation of SPSS was also performed on Microsoft Excel.

Likewise, statistical analysis of linear correlation was also performed to test the significance of two variables i.e amount of collected firewood with time required to walk from house to place of firewood collection, day spent to collect firewood to forest, amount of firewood used for alcohol production and amount of alcohol produced in three different time periods (2010, 2000 and 1990) respectively.

In addition, the ranking of impact on ecosystem services due to forest deforestation and key drivers of land use in SNNP by local people was analysed through the Index of Relative Ranking (IRR). Miller (1986) stated that IRR can be calculated by following formula:

$$IRR = \frac{R_1S_1 + R_2S_2 + \cdots + R_nS_n}{n\,r}$$

Where, IRR =Index of Relative Ranking

R_1= Rank of first order (No. of observation on first order)

S_1= Score of highest rank (6)

R_n=Rank of last order (No. of observation on last order)

S_n= Score of lowest rank (1)

n = Number of observation

r = Total rank given to particular attribute

The perception of ranking regarding the key drivers of land use change was rank from 1 to 7, where it is measured by card system where rank 1=Most important, 2= slightly less important, 3= less important; and so forth.

3.5.1 Data Calculation

In GIS analysis, the measurement of land cover was carried out in hectare. In socio-economic analysis, net household income was determined by annual income with different sources like agriculture, livestock, wage labour, alcohol business, business service, handicraft, and remittance and others. Proportion percentage of dependency on these livelihood activities was reported.

The local units for alcohol production and fuel wood were converted into accepted metrics by weighing the samples. Production of alcohol was measured in *pathi* and converted to standard unit litre (l). Likely, collection of fuel wood was measured in *bhari* and converted in to standard unit kilogram (Kg).

- 1 *pathi* = app. 4 litre
- 1 *bhari* = app. 50 kg

3.5.2 Land Cover Classification:

In this study, land cover is classified into different classes and regrouped to the following three major groups. The main classified groups are as follows;

1. Forest land
2. Agricultural land
3. Bare land

3.5.3 Description of Land Cover Classification:

The descriptions of above classified land cover group are given below:

1. **Forest Land**: Forest cover is defined as an area more than 1 ha in extent and having tree canopy density of 10 percent and above. All species of trees (including bamboos, fruits or palms, etc.) and all types of lands (forest, private, community or institutional) satisfying the basic criteria of canopy density of more than 10 percent have been delineated as forest cover while interpreting satellite

data. The minimum area of 1 ha for forest cover has been kept because this is the smallest area that can be delineated on a map at 1:50,000 scale (FAO, 2000).

2. **Agricultural Land**: The land primarily used for food and fibre are classified as agricultural land.

3. **Bare Land**: The fallow land without vegetation cover as well as gravel covered stream bank is classified as barren land. Barren land, sand and gravel are classified on the same class because both of these have similar reflectance value.

3.5.4 Land Use and Land Cover Change Detection and Analysis

The collected data in Landsat TM of 1990, 2000 and 2010 were OBIA classified raster data. These were converted to vector (ESRI shape file) on Arc GIS 9.3 by using raster to vector conversion tool. With the help of previously extracted Sundarijal VDC shape file from digital topographic map, study area was extracted from all three maps of 1990, 2000 and 2010 by using clipping tool. These vector shape file were classified into three classes i.e., forest land, agriculture land and bare land to observe the changes in the land use and land cover of Sundarijal VDC by different contrast colour. Colours like green, red and white colour were used to distinguish forest, agriculture and bare land respectively.

Change on Land Use and Land Cover of Sundarijal VDC in three different period 1990, 2000 and 2010 were calculated by using geometric calculator. The analysis and interpretation of different aspects of the numeric data of land use dynamic was performed on Microsoft Excel. The result was presented easily in understandable tabular form by area and percentage.

CHAPTER FOUR

RESULTS

The results are presented in three parts. The first part presents GIS data analysis of land use and land cover change of Sundarijal VDC. It is followed by findings from household survey. It comprises of socio-economic background of respondents, major use of forest product, key drivers of land use change, implication of land use change and attitude of local people towards SNNP management and authority. The final part presents the summary of focus group discussion and key informant interview which include key issues of land use and land change inside three villages of SNNP.

4.1 GIS Data Analysis

The assessment of land use and land cover of Sundarijal VDC of 1990, 2000 and 2010 were conducted by Arc GIS 9.3 software which is described in following sub-sections.

4.1.1 Land Use and Land Cover

Land use and land cover classification was conducted in Landsat TM of 1990, 2000 and 2010. The images were classified into three classes, i.e., forest land, agriculture land and bare land to observe the changes in the land use and land cover of Sundarijal VDC. The Sundarijal VDC occupies 3524.74 ha.

From the GIS analysis, the obtained results showed that in 1990 forest was the major land use covering 3110.88 ha (88.26%) of the total VDC which was followed by agricultural land with 395.07 ha (11.21%) and bare land 18.80 ha (0.53%). Similarly, in 2000, even though the forest cover was increased to 3176.89 ha (90.13%), the agricultural land and bare land were found to be decreased to 334.83 ha (9.50%) and 13.01 ha (0.37%) respectively. In 2010, the forest area found to be decreased and reached 3104.17 ha (88.07%). However, in span of 10 years, the agricultural land was found to be

increased with 420.57 ha (11.93%) and bare land totally disappeared. The land use and cover in different periods during 1990, 2000 and 2010 is shown in the following Table 4.1.

Table 2.1:

Land Use and Land Cover in Different Periods (1990, 2000 and 2010)

	Class	1990		2000		2010	
		Area in ha	%	Area in ha	%	Area in ha	%
1	Forest	3110.88	88.26	3176.89	90.13	3104.17	88.07
2	Agricultural land	395.07	11.21	334.83	9.50	420.57	11.93
3	Bare land	18.80	0.53	13.01	0.37	0	0
	Total	3524.74	100	3524.74	100	3524.74	100

Source: Author, 2012

4.1.2 Land Use and Land Cover Change

The study showed detection of change in land use and land cover of Sundarijal VDC. During the period 1990 to 2000, the forest land was increased by 66.01 ha (1.87%). On the contrast, in the same period, the area of agricultural land and bare land was found to be decreased by 60.24 ha (1.71 %) and 5.79 ha (0.16%) respectively. However, the opposite trend i.e., decrease in forest land by 72.72 ha (2.06%) and increase in agricultural land by 85.74 ha (2.43%) was observed from 2000 to 2010. Bare land was found to be further decreased by 13.01 ha (0.37%). Similarly, overall change from 1990 to 2010 showed that forest land was declined by 6.71 ha (0.19%). Likewise, bare land was also found to be decreased by 18.8 ha (0.53%) during same period. However, agricultural land was increased by 25.5 ha (0.72%) during that period. The Table 4.2 below shows the land use change from 1990 to 2000, 2000 to 2010 and 1990 to 2010.

Table 4.2:

Land Use and Land Cover Change From 1990 to 2010

	Class	1990 – 2000		2000 – 2010		1990-2010	
		Change in ha	Change in %	Change in ha	Change in %	Change in ha	Change in %
1	Forest	66.01	1.87	-72.72	-2.06	-6.71	-0.19
2	Agricultural land	-60.24	-1.71	85.74	2.43	25.5	0.72
3	Bare land	-5.79	-0.16	-13.01	-0.37	-18.8	-0.53

Source: Author, 2012

4.1.3 Annual Land Use Change

The study revealed that forest area was increasing at the rate of 0.18 percent per annum during 1990 to 2000 in Sundarijal VDC whereas agricultural land was decreasing at the rate of 0.17 per annum at the same period. Furthermore, bare land was found to be decreasing by 0.02 percent per year. However, from 2000 to 2010 forests decreased by 0.21 percent and agricultural land increasing at the rate of 0.24 percent whereas bare land was found to be declined at very less rate by 0.04 percent. Hence, overall forest land conversion from 1990 to 2010 was found to be 0.02 percent per annum and agricultural land expanded by 0.07 percent per annum. Likewise, bare land was found to be in decreasing trend by 0.05 percent per annum. Hence, Table 4.3 shows that forest land is converting to agricultural land.

Table 4.3:

Annual Land Use Change Percent from 1990 to 2010

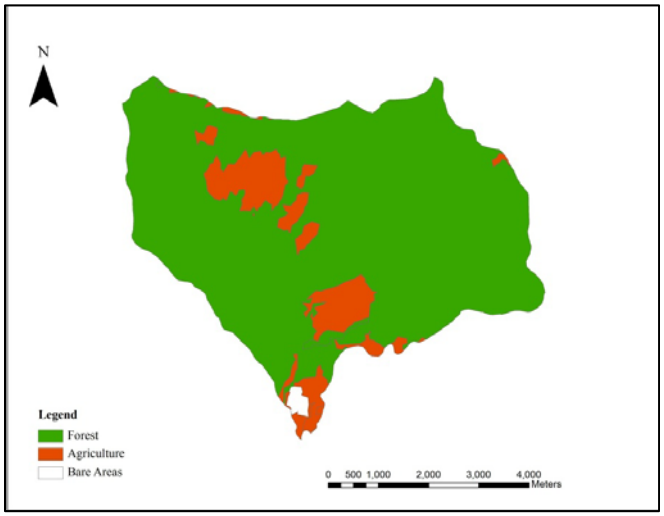
	Class	1990-2000	2000-2010	1990-2010
		Annual change %	Annual change %	Annual change %
1	Forest	0.18	-0.21	-0.02
2	Agricultural land	-0.17	0.24	0.07
3	Bare land	-0.02	-0.04	-0.05

Source: Author, 2012

The classified image was converted to vector ESRI shape file which gave the land use and land cover map of the study area for 1990, 2000 and 2010 as shown in Figure 4.1, Figure 4.2, Figure 4.3.

Figure 4.1:

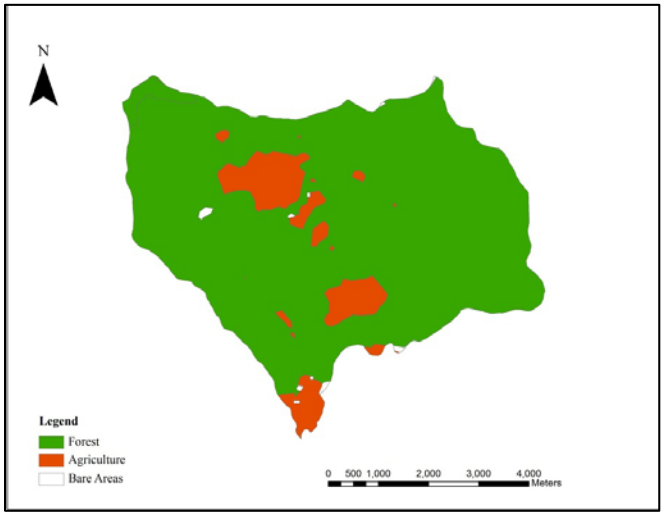
Land Use and Land Cover Map of Sundarijal VDC (1990)



Source: Author, 2012

Figure 4.2:

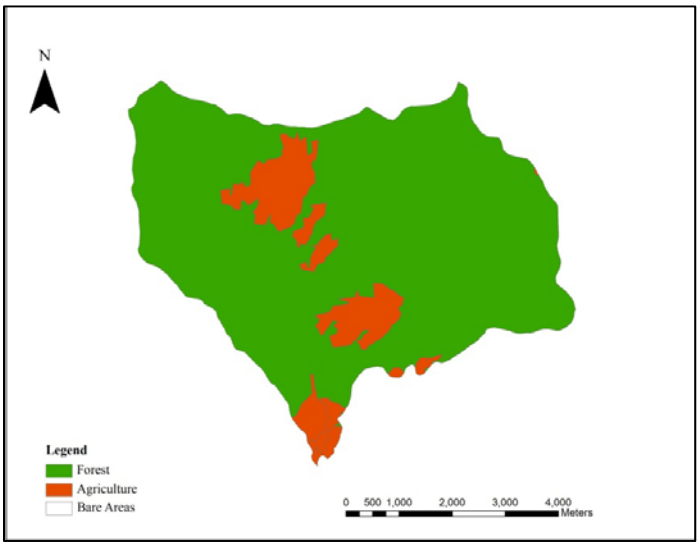
Land Use and Land Cover Map of Sundarijal VDC (2000)



Source: Author, 2012

Figure 4.3:

Land Use and Land Cover Map of Sundarijal VDC (2010)



Source: Author, 2012

4.2 Household Survey

The assessment of socio-economic condition, local perception on implication of land use change on key ecosystem services, local perception regarding key drivers of land use change and local attitude and recommendation to improve the livelihood of local people as well as conservation of SNNP were conducted through household survey in three villages i.e., Mulkharkha, Chilaune gaun and Okhreni.

4.2.1 Assessment of Socio-economic Condition

The assessment of socio-economic conditions included general information of respondents, household family size, and economic activities of three villages.

4.2.1.1 General Information of Respondents

The distribution of sample household of the study area according to sex, age group, main occupation, education and house roof type are summarized in Table 4.4. The percentage of male and female respondents was equal in Mulkharkha i.e. 50 percent male and 50 percent female. However, percentage of male and female Chilaune gaun were found to be 20 percent and 80 percent respectively and in case of Okhreni the percentage of male and female was 67 percent and 33 percent respectively. The age of respondents

ranges from 20 to 69 years with more than two third of respondents range from 20 to 59 years of age. The main occupation of majority of respondents was agriculture in three villages. In total, 67 percent respondents from Mulkharkha, 80 percent from Chilaune gaun and 100 percent from Okhreni depended on agriculture. Similarly, 17 percent, 8 percent, and 8 percent respondents from Mulkharkha depended on service, labour and livestock rearing respectively whereas 20 percent of respondents from Chilaune gaun depended on business.

The overall literacy of study area was found to be 40 percent which was less than national literacy rate of 54.1 percent (CBS, 2007). Similarly, most of respondents have galvanized tin as type of house roof.

Table 4.4:

General Information of Respondents

Category		Mulkharkha (n=12)	Chilaune gaun (n=5)	Okhreni (n=15)
		%	%	%
Sex	Male	50	20	66.7
	Female	50	80	33.3
Age Group	18-59	83.3	20	86.7
	> 60	16.7	80	13.3
Main Income Sources	Agriculture	66.7	80	100
	Service	16.7	0	0
	Labour	8.33	0	0
	Livestock rearing	8.3	0	0
	Business	0	20	0
Education	Literate	25	40	13.3
	High School	33.3	0	6.7
	College	16.7	0	6.7
	Illiterate	25	60	73.3
House Roof Type	Thatched	8.3	0	6.7
	Tin	0	0	0
	Galvanized tin	91.7	100	93.3
	Concrete	0	0	0

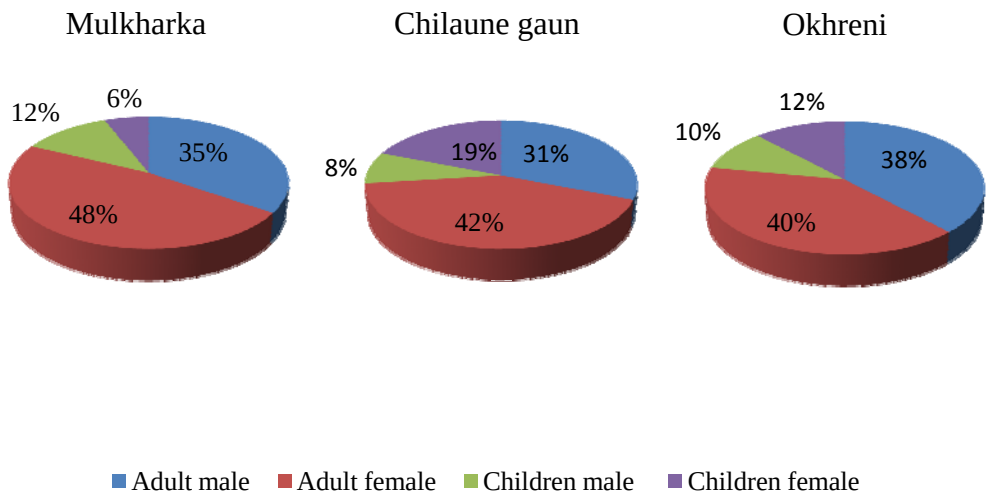
Source: Field, 2012

4.2.1.2 Household family size

Out of total population of sample household, male and female living inside the village was found greater than male and female living outside the village. The average family size was 5.75 per HH in Mulkharkha, 5.2 per HH in Chilaune gaun and 5.93 per HH in Okhreni. Similarly, the average number people living outside in all three villages were found to be less than zero. Moreover, the household family size percent living inside the village and household family living outside the village are shown in Figure 4.4 and Figure 4.5 respectively.

Figure 4.4:

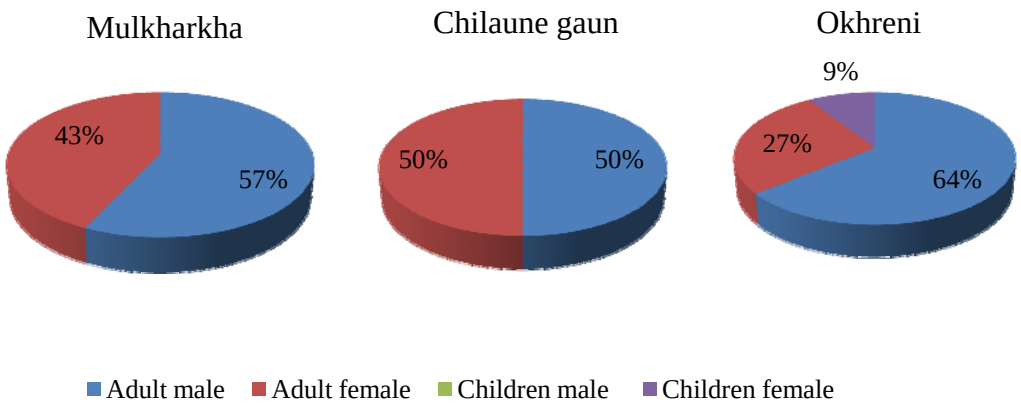
Household Family Size Percent Living Inside Villages



Source: Field, 2012

Figure 4.5:

Household Family Size Percent Living Outside Villages



Source: Field, 2012

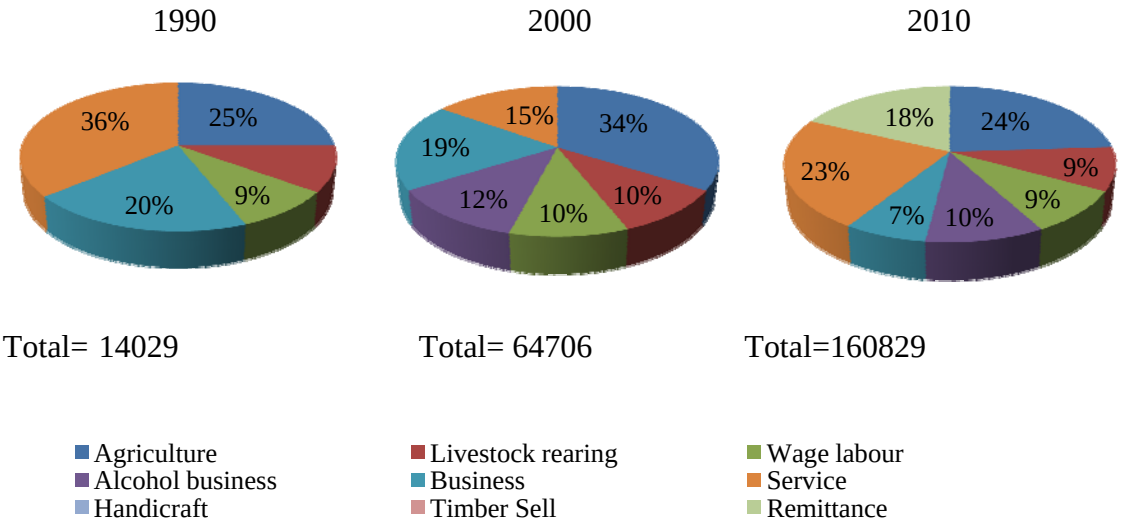
4.2. 1.3 Economic Activity

Major economic activities of three village were analyzed in three time period; present (2010), 10 years ago (2000) and 20 years ago (1990). In this study, the dependency in agriculture was also analyzed in terms of income. Households living inside Sundarijal VDC depend on a wide range of activities for their livelihoods such as agriculture, livestock rearing, wage labour, alcohol production, business, service and remittance. These income sources of three villages in three different periods were found to have shifting trend, which is shown in Figure 4.6, Figure 4.7 and Figure 4.8.

The study reported that in Mulkharkha dependency on agriculture (25%, 34% and 24%) was found to be major source of livelihood during 1990, 2000 and 2010 respectively. However, dominancy of service (36% and 26%) was found during 1990 and 2010. Subsequently business (20% and 19%) was found be during 1990 and 2000. Remittance (18%) was second dominant source of income during 2010. It was followed by livestock rearing (10%) and wage labour (9%) in all three time periods. Furthermore, alcohol business (12% and 12 %) was also prevalent during 2000 and 2010.

Figure 4.6:

Proportional Percent of Household Income in Mulkharkha in Different Periods (NRs.)

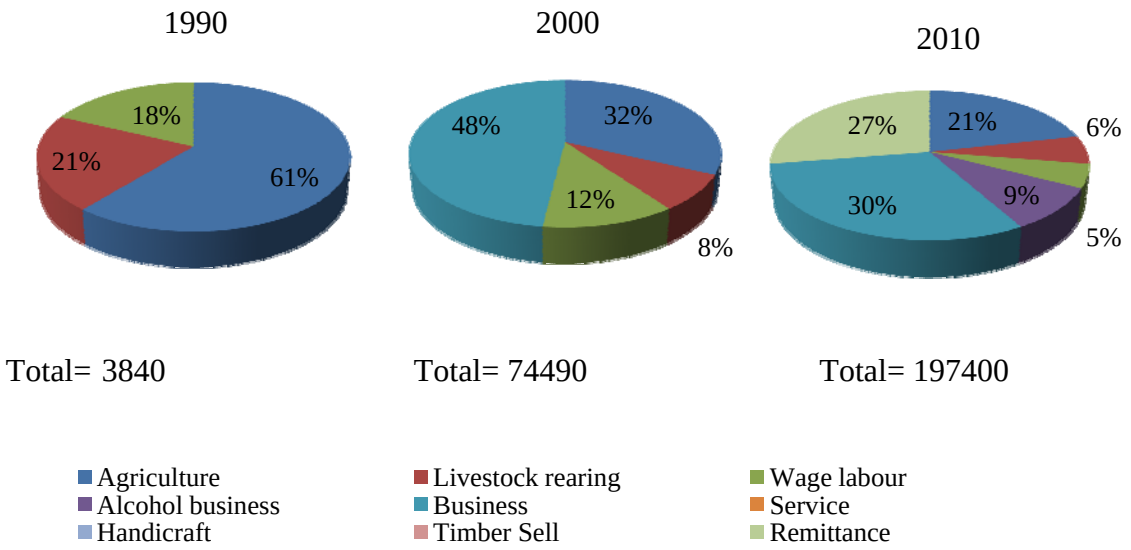


Source: Field, 2012

In Chilaune gaun, only agriculture (61%), livestock rearing (21%) and service (18%) were found in 1990 whereas business (48%) occupied large percentage during 2000. It was followed by agriculture (32%), wage labour (12%) and livestock rearing (18%). Likewise, business (30%) was found to be dominating during 2010. Subsequently, it was followed by remittance (27%); agriculture (21%), alcohol business (9%), livestock rearing (6%) and wage labour (6%).

Figure 4.7:

Proportional Percent of Household Income of Chilaune gaun in Different Periods (NRs.)

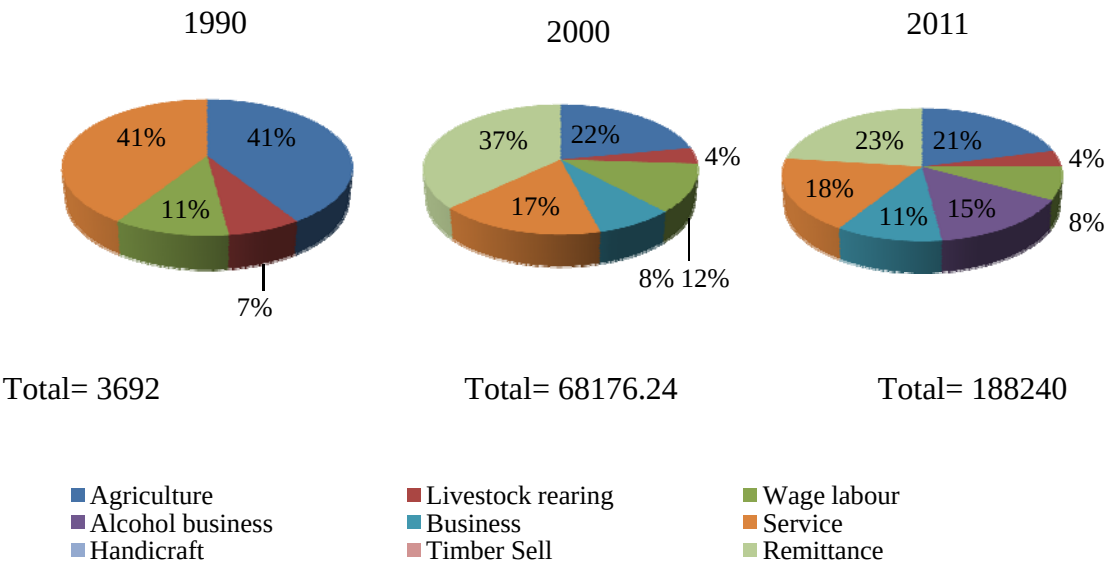


Source: Field, 2012

The study showed that in Okhreni major income sources were agriculture (41%), service (41%), wage labour (11%) and livestock rearing (7%) during 1990. Later, in 2000, local people were also involved in remittance (37%) and business (8%). Similarly, other proportion percentage of other income sources was found to be agriculture (22%), service (17%), wage labour (12%) and livestock (4%). Likewise in earlier case, alcohol business (15%) added in livelihood activity of local people and other sources were agriculture (21%), remittance (23%), service (18%), wage labour (8%) and livestock rearing (4%).

Figure 4.8:

Proportional Percentage of Household Income of Okhreni in Different Periods (NRs.)



Source: Field, 2012

4.2.2 Dependency on forest resources

The household dependency on forest resources was analysed here in terms of household energy consumption, forest product use, relationship between amount of fuel collection and time required to reach the forest and average annual production of alcohol production in those villages.

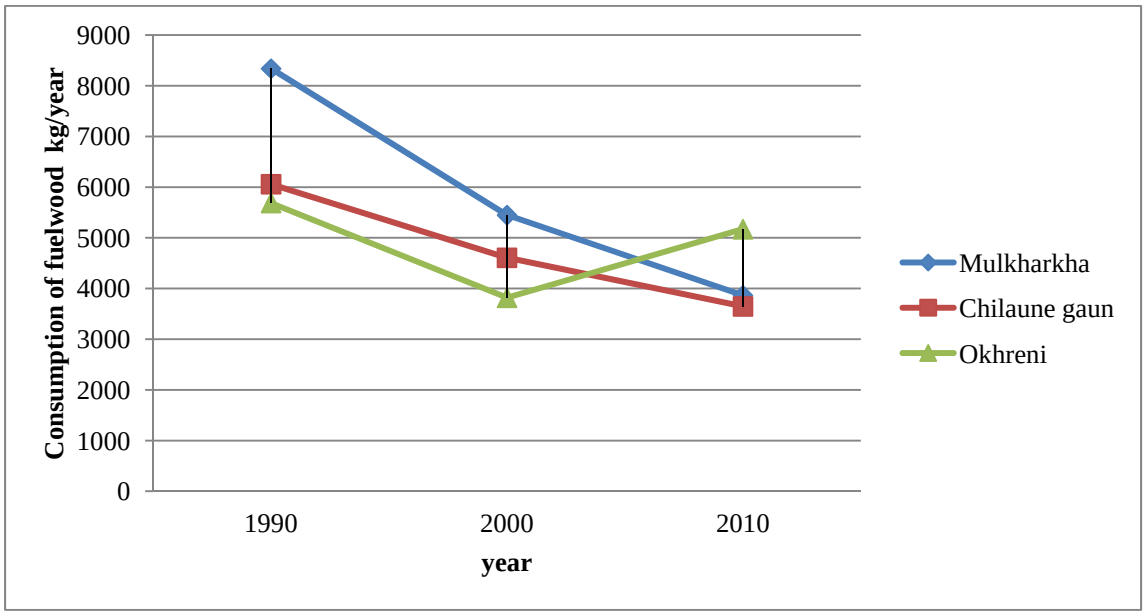
4.2.2.1 Household Energy consumption

The major energy sources such as fire wood, bio-gas, electricity and LPG were used in these villages. However, the primary sources of energy of all three villages was found to be fire wood. Hence, only annual average consumption of firewood was analyzed in three periods. The annual average consumption of firewood was found to be high during 1990 with average consumption 4800kg, 1800kg and 1000 kg of Chilaune gaun, Mulkharkha and Okhreni respectively. In 2000, consumption of fire wood was found to be decreased. The average annual firewood was found to be 600kg, 800kg and

300kg of Mulkharkha, Chilaune gaun and Okhreni respectively. Least consumption was found in present time i.e. 400kg, 300kg and 450 kg in Mulkharkha, Chilaune gaun and Okhreni respectively. The Figure 4.9 below shows the annual consumption of firewood.

Figure 4.9:

Annual Consumption of Firewood



Source: Field, 2012

4.2.3 Forest product use

Most of respondents of surveyed households use firewood, timber, wild fruits and vegetable, medicinal plants and wild animal/birds. By using index of relative ranking these forest products were ranked according to their consumption. The rank of forest products used by respondents which is received from NP as perceived by the local people of Mulkharkha, Chilaune gaun and Okhreni are shown in Table 4.5.

Table 4.5:

Use of Forest Resources

Forest Resources	Frequency (n=32)	Sum of Score	IRR	Ranks
Firewood	31	159	5	1
Wild Fruit and Vegetables	15	102	3.2	2
Timber and Pole	19	93	2.9	3
Medicinal herbs	5	19	0.6	4
Wild animal/ birds	0	0	0	0

Source: Field, 2012

4.2.4 Correlation Analysis of distance for firewood collection

Relationship among different variables such as amount of firewood collected in whole year, time required to walk from house to place of firewood collection, days spent to collect firewood from forest, amount of firewood used for alcohol production and amount of alcohol produced in three different time periods of 2010, 2000 and 1990 were analyzed by bi-variate correlation analysis. The correlation established between amount firewood collected and other respective variables are illustrated in Table 4.6.

The analysis showed that during all three periods of 2010, 2000 and 1990, there were no significant relation between amount of collected firewood and time required to walk from house to place of firewood collection. On contrary, during those periods, correlation with all other variables; days spent to collect firewood to forest, amount of firewood used for alcohol production and amount of alcohol produced was found to be significant. During the period of 2010, correlation with variable; day spent to collect firewood to forest and amount of firewood used for alcohol production were found to be higher than the period of 2000 and 1990. This represents local people spent more days to collect firewood and produce more alcohol than ten years ago and twenty years ago. However, in all three periods, correlation with amount of alcohol production was found to be more or less similar. As alcohol production is prohibited by law, real data of alcohol production may not be collected by this report.

Table 4.6:

Correlation Table for Periods (2010, 2000 and 1990)

		Three different time periods (2010, 2000 and 1990)				
		Amount of firewood Collected (kg)	Time required to walk from house to place of firewood collection (m)	Day spent to collect fire wood from the house to forest (day)	Amount of firewood used for alcohol production (kg)	Amount of alcohol produced (l)
Amount of firewood Collected (2010 /(kg)	Pearson Correlation	1	-.032	.796(**)	.903(**)	.435(*)
	Sig. (2-tailed)		.861	.000	.000	.016
	N	32	32	28	30	30
Amount of firewood Collected (2000) /(kg)	Pearson Correlation	1	-.096	.389(*)	.545(**)	.596(**)
	Sig. (2-tailed)		.606	.034	.002	.000
	N	32	31	30	31	31
Amount of firewood Collected (1990) /(kg)	Pearson Correlation	1	-.001	.619(**)	.382(*)	.404(*)
	Sig. (2-tailed)		.996	.001	.041	.030
	N	31	29	26	29	29

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

Source: Field, 2012

As shown in table 4.6, there are no significant relation between amount of collected firewood and time required to walk from house to place of firewood collection,. Further analysis of time required for walking from house to place of firewood collection in all three periods in terms of Mean, Median, Maximum and Minimum was carried out and shown in Table 4.7. This shows that during all three periods, time consumption was found to higher at Okhreni which is followed by Chilaune gaun and Mulkharkha. The

analysis also showed that in 2010, time consumption was found to increased in Okhreni and Chilaune gaun as compared to the 2000 and 1990. However, it was found to be decreasing than 2000 and 1990 in Mulkharkha .

Table 4.7:

Time Required of Walking Distance for Firewood Collection

Village	Time period	Average Time (m)	Median (m)	Minimum (m)	Maximum (m)
Mulkharkha	1990	71	60	1	180
	2000	44.58	30	10	120
	2010	36.67	30	15	75
Chilaune gaun	1990	75	45	30	180
	2000	48	30	30	90
	2010	63	30	15	180
Okhreni	1990	85.71	60	30	180
	2000	83.57	60	30	180
	2010	90	60	30	180

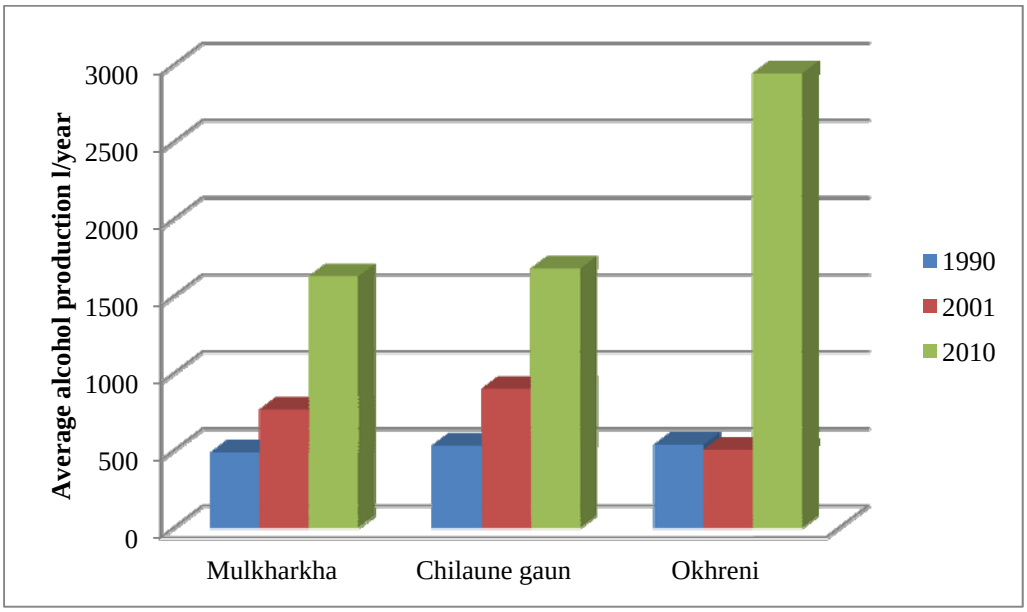
Source: Field, 2012

4.2.6 Alcohol Production

All the respondents in all three villages were dominated by Tamang ethnic group. So, as an indigenous activity, most of them were involved in alcohol production activity. The trend of alcohol production in these three villages at 3 different period of 1990, 2000 and 2010 are shown in Figure 4.10. At present, production of alcohol was found to be highest in all three villages with average 1700 l, 1800 l and 3000 l in Mulkharkha, Chilaune gaun and Okhreni respectively. In 2000, the scenario was found less as compared to present production with average value 700 l, 900 l and 600 l from Mulkharkha, Chilaune gaun and Okhreni respectively. It could be due to heavy involvement of people in the alcohol business since 10 years in all 3 villages. In case of 1990, alcohol production was found to be less with average value 500 l, 600 l and 600l. Hence, the alcohol production shows increasing trend in three time periods.

Figure 4.10:

Production of Alcohol



Source: Field, 2012

4.2.7 Local perception on land use change

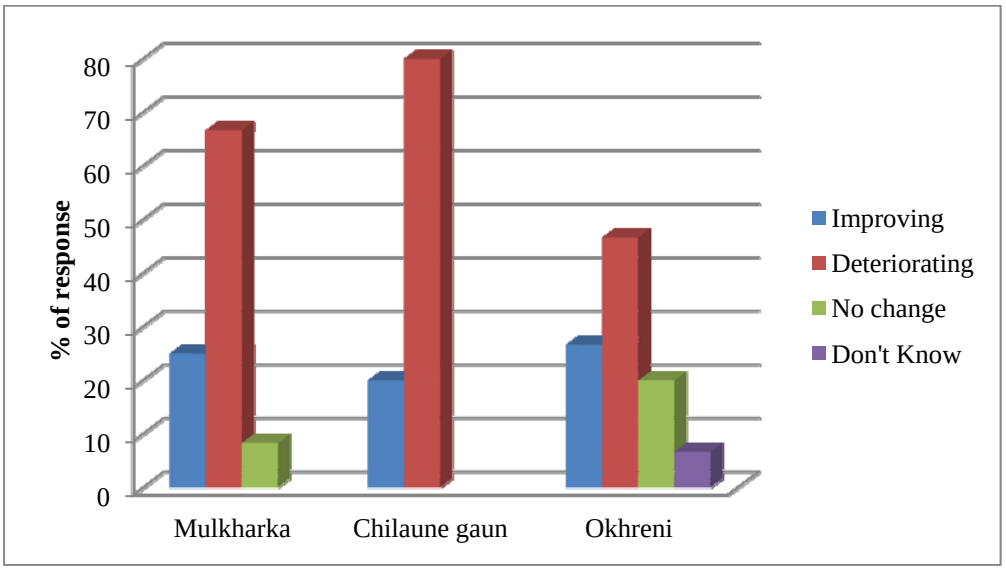
Along with GIS data analysis, local perception was also referred to assess the land use change and land degradation of forest near and far forest from village.

4.2.7.1 Status of near forest

The perception of majority of respondents regarding status of near forest over last 10 year was found to be highly deteriorating in Chilaune gaun and Okhreni with average value of 88 percent and 32 percent respectively. According to them, it is due to intense cutting of firewood near village forest where as 18 percent respondents from Chilaune gaun and 12 percent respondents from Okhreni believed that forest near village is deteriorating. Nevertheless, 11 percent of respondents from Okhreni don't know the status of near forest. Figure 4.11presented below illustrated the perception of local people for status of near forest over the years.

Figure 4.11:

Status of Near Forest over Year



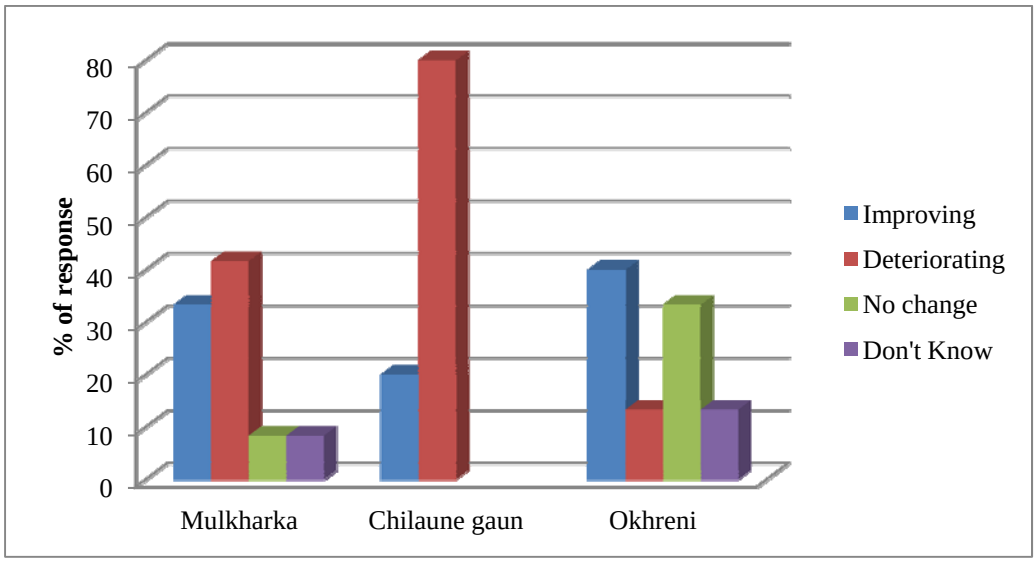
Source: Field, 2012

4.2.7.2 Status of forest far from village

Majority of respondents from all three villages perceived that the status of forest far from village was found to be deteriorating with 48 percent, 78 percent and 32 percent from Mulkharkha, Chilaune gaun and Okhreni respectively. It was followed by 30 percent, 18 percent and 12 percent respondents from Mulkharkha, Chilaune gaun and Okhreni who agreed on improving condition of forest far from village. Few people also reported that they don't know and no change was perceived. The different perceptions of local people for the status of forest far from the village over the year are given in Figure 4.12.

Figure 4.12:

Status of Forest Far from Village Over Year



Source: Field, 2012

4.2.8 Impact of land use change on key ecosystem services

Local perception was also referred to assess the implication of land use change on key ecosystem services.

4.2.8.1 Impact on ecosystem services due to forest deterioration

The local respondents perceived that due to land use change; i.e., conversion of forest land into agricultural land leads to negative impacts on ecosystem services. With the help of IRR, negative phenomenon of forest deterioration were ranked as water quantity, quality, soil erosion, biodiversity, landscape beauty and religious or touristic value as first, second, third, fourth, fifth and sixth. The findings are as shown in Table 4.8.

Table 4.8:

Impact on Ecosystem Services due to Forest Deterioration

Impact on Ecosystem services	Sum of Score	IRR	Rank
Water Quantity	104	4.72	1
Water Quality	94	4.27	2
Soil Erosion	88	4	3
Biodiversity loss	68	3.09	4
Landscape beauty	65	2.95	5
Religious/ touristic	35	1.6	6

Source: Field, 2012

*Among 32 respondents, 10 respondents perceived that there were no negative impacts on environmental services inside SNNP.

4.2.9 Key drivers of land use change

By using IRR, the ranking of key drivers of land use change are found to be firewood overharvesting, timber overharvesting, economic activities of alcohol production, population growth and governmental policy as first, second, third, fourth, fifth, sixth, seventh and seventh rank respectively. The value of respective IRR is shown in Table 4.9 below:

Table 4.9:

Key Drivers of Land Use Change

Key drivers of land use change	Sum of Score	IRR	Rank
Firewood over harvesting	138	6.3	1
Timber over harvesting	124	5.7	2
Economic activities (alcohol production)	107	4.7	3
Population increase in the villages	84	3.9	4
Government Policy	81	3.7	5
Hotels and tourists	41	1.9	6
Infrastructure development	26	1.2	7

Source: Field, 2012

*Among 32 responses, 10 responses perceived that there were no negative impacts on environmental services inside SNNP.

4.3 Attitude of local people towards the SNNP management and authorities

Attitude of local people towards the SNNP management and authorities were incorporated here. This includes benefit of national park to local people, risk from national park and suggestion and recommendation to SNNP to improve the livelihood of local people and ultimately conservation of SNNP.

4 3.1 Benefits from National park

Benefits received from NP as perceived by the respondents of all three villages are shown in Table 4.10. The highest acceptance of the statement was found to be easy availability of fodder in Mulkharkha. Similarly, highest percentage of acceptance of Chilaune gaun was found to be good water quality and consistent water supply. Likewise, the statement decrease in intensity in landslide was highly accepted in Chilaune gaun.

Table 4.10:

Benefits from National Park

Benefits received from National Park	Mulkharkha (n=12)	Chilaune gaun (n=5)	Okhreni (n=15)
	Percent of acceptance	Percent of acceptance	Percent of acceptance
Easy availability of firewood	11.11	8	8.87
Easy availability of fodder	14.29	12	11.39
Good water quality	14.29	20	16.45
Consistent supply of water	11.11	20	16.45
Toilets and sanitation improvements	12.69	12	10.13
Economic opportunities	11.11	0	1.27
Conservation education and awareness	12.69	16	15.19
Decrease in intensity and frequency of landslides	11.11	12	18.99

Source: Field, 2012

4.3.2 Risk from conservation

Perceptions regarding risk resulting from conservation initiatives were almost similar in three villages. The accepted statements were found to be restriction on harvesting of forest product, frequent intervention by park authority, fine punishment and harassment, restriction on infrastructure development and lack of grazing land for domestic livestock. Least accepted statement were crop damage or livestock depredation by wildlife and human causalities from wildlife. The percent of acceptance of risk from conservation of NP is shown in Table 4.11.

Table 4.11:

Risk from Conservation

Risk from Conservation of National Park	Mulkharkha (n=12)	Chilaune gaun (n=5)	Okhreni (n=15)
	% of acceptance	% of acceptance	% of acceptance
Restriction on harvesting forest products	16.22	13.79	15.46
Lack of grazing land for domestic livestock	14.87	17.24	14.43
Crop damage or livestock predation by wildlife	13.51	0	15.46
Human causalities due to wildlife	6.76	17.24	11.34
Frequent intervention by the park authority	16.21	17.24	14.43
Fine punishment and harassment	16.21	17.24	14.43
Restriction on infrastructure development	16.21	17.24	14.43

Source: Field, 2012

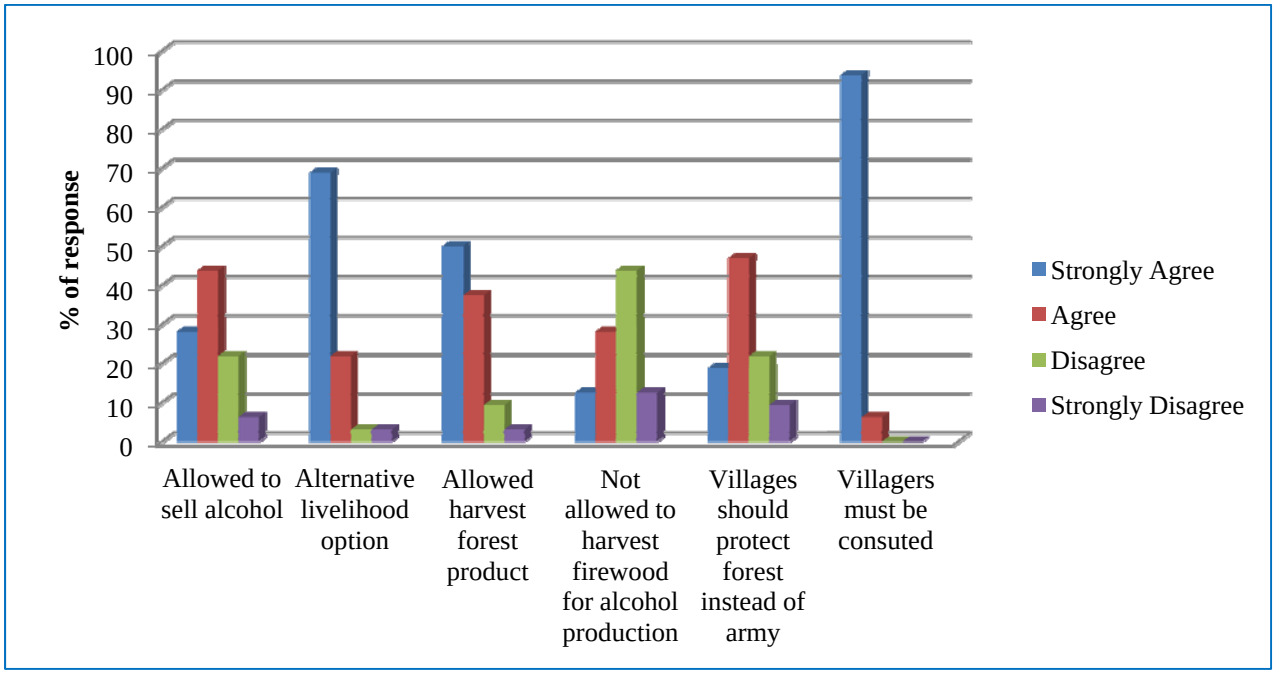
4.3.3 Recommended actions for management authorities

A large percentage (94 percent) of the respondents from the survey strongly agreed the statement that villagers must be consulted with for the conservation activities. It was followed by the statement alternative livelihood option should be provided to the villagers. Subsequently, 29 percent of respondents also strongly agreed that alcohol

should be allowed to sell, 18 percent of respondents strongly agreed that villagers should protect forest instead of army and only 12.5 percent of respondents strongly agreed that forest products should not be harvested by villagers. Similarly, 46 percent respondents agreed that villagers should protect forest instead of army. Then, 44 percent of respondents agreed that alcohol should be allowed to sell. Similarly, other recommendations include forest products should be allowed to harvest by villagers and forest products should not be allowed to villagers. The percent of responses of recommended actions for management and authorities were given in Figure 4.13.

Figure 4.13:

Recommended Actions for Management Authorities



Source: Field, 2012

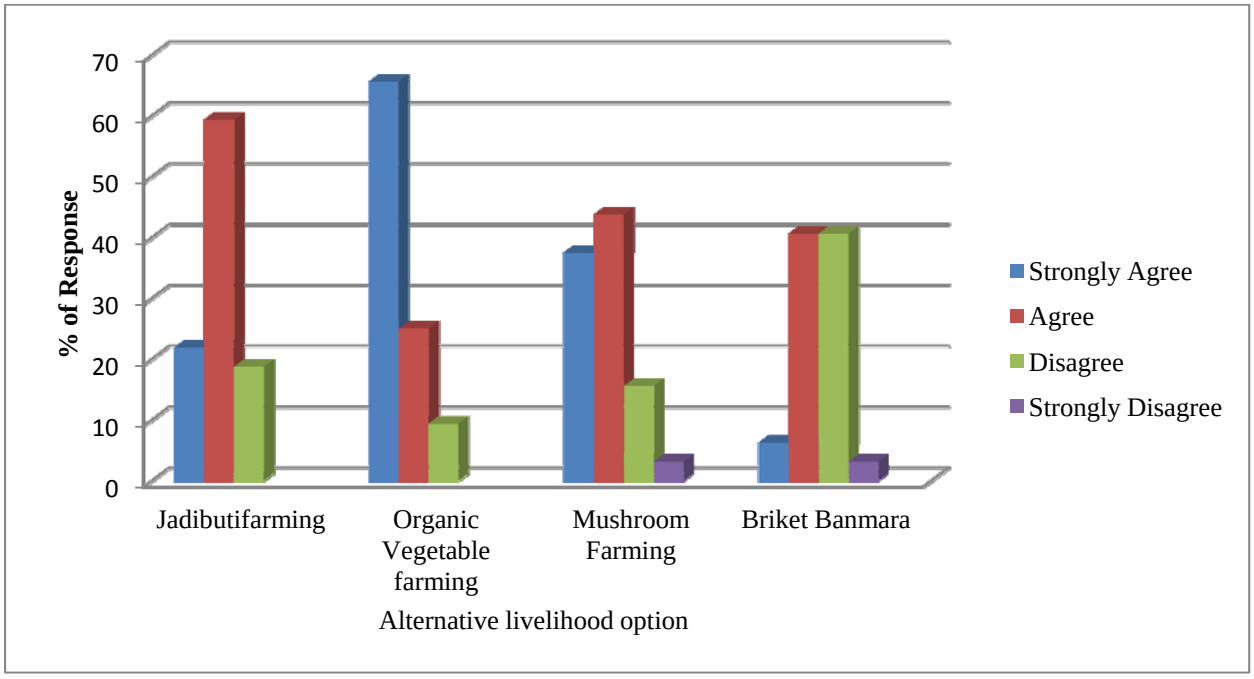
4.3.4 Recommended actions for alternative livelihood options

Majority of respondents (67%) from all three villages strongly agreed on organic vegetable farming. It was followed by medicinal plants farming, mushroom farming and briquette from *banamara* with 38 percent, 22 percent and 5 percent respectively. Similarly, 50 percent people agreed on medicinal plants farming. Likewise, 43 percent,

41 percent and 25 percent of respondents agreed on mushroom farming, organic farming and briquette from *banamara* respectively. 40 percent, 19 percent, 17 percent and 10 percent of respondents disagreed on briquette from *banamara*, medicinal plants farming, mushroom farming and organic farming respectively. Only 2 percent respondents strongly disagreed on mushroom farming and briquette production. The percent of response for recommended actions for alternative livelihood options were illustrated in Figure 4.14.

Figure 4.14:

Recommended Action for Alternative Livelihood Option



Source: Author, 2012

4.4 Focus Group Discussion and Key Interview Information

The finding of focus group discussion (FGD) and key information interview (KII) were moreover similar in all three villages. Hence, finding of FGD and KII are summarized here as follows:

4.4.1 Local People Perception on Land Use Dynamics in Sundarijal Catchment of SNNP

Majority of participants of FGD from three villages and KII reported that land of the Sundarijal catchment was used as forest land and agricultural land in all three periods of 1990, 2000 and 2010. They also believed that during 1990, forest cover was less compared to time period of 2000.During 2000 forest cover was good but again forest cover is in decreasing trend during 2010.

During 1990, forest land was under Shivapuri Watershed and Wildlife Reserve. At that period, people had open access to the forest resources as a consequence the forest was highly exploited and degraded. As local people from village and people from other places like *Bhaktapur*, *Thimi*, Airport area, *Gokarna*, *Gaushala*, *Naibadi* etc daily collected firewood and timber as possible as they could to sell it in the market (Kathmandu). As a result, the deforestation rate was very high. Due to high deforestation rate, slopes near the village were bare and naked and hazards like landslide, flash flood and soil loss were some major problems at that time.

After declaration of National Park in 2002, the deforestation was controlled. As a result, both forest cover and density of forest was increased and hazards like landslide, soil erosion and flood was controlled to some extent.

Deforestation near the village vicinity and inside the forest has been started. As local people from village and people from other places like Airport, *Gokarna* etc heavily extracted firewood for alcohol production from the forest. They were illegally involved to cut down trees for the production of alcohol. As a result, deforestation and degradation rate are once again following increasing trend.

4.4.2 Impact of Land Use Change on Key Ecosystem Services

During 1990, due to deforestation and degradation of forest resources, the key ecosystem services were also adversely affected. They also reported that as a result of deforestation, the number of trees decreased which ultimately affect biodiversity of the area. Landslide, flood and soil erosion were the major problems during that time.

The declaration of National Park posed the strict rules and regulation to the villagers. As a result, forest was protected including key ecosystem services.

However, degrading trend renewed due to local activities endangering key ecosystem services. They also informed that landslide, flood and soil erosion are some problems that have been occurring in village premises now.

4.4.3 Key Drivers of Land Use Change inside the National Park

The key drivers of land use change are ranked here according to their importance as per the information obtained during FGD.

- ***Over Harvesting of Forest Products***

Majority of the participants informed that villagers heavily depended on forest products. During 1990, the villagers used to extract timber for selling purpose. Due to less agricultural production and limited livelihood options, villagers used to cut trees as much as they can so that they can sell to meet the high timber demand in Kathmandu. As a result, forest area declined and highly degraded. Later, Shivapuri National Park was gazetted, the armies were mobilized to conserve the forest resources and the deforestation was significantly controlled. However, due to restriction of National Park, local residents inside the village were deprived from economic opportunities and other basic requirements. The quality of life declined sharply due to lack of alternative resources. Majority of people inside the village are involved in alcohol production to fulfil basic requirements. This resulted in the high pressure on forest for firewood.

- ***Economic Activity***

The participants reported that the main economic activity of most of the local residents was alcohol production. They were not reluctant to report that almost 90 percent of villagers are involved in alcohol production. As alcohol manufactured from millet is highly demanded in market (Kathmandu), the locals preferred this business. In addition, they also informed that the alcohol production have high return value in less time.

- ***Population Growth***

Majority of participants believed that population growth is main cause of land use change inside the Sundarijal watershed area. According to Women's group opinion,

population inside the village is in increasing trend. With population growth, the demands of people are also increasing but villagers are deprived from economic opportunities and other basic requirements. As a result, villagers are compelled to be involved in deforestation activities for firewood and alcohol business to support their livelihood which are the major causes of forest land use change.

- ***Government Policy***

Majority of women participants agreed that government policy is the major contributor to the land use change. They perceived that with changing governing policy, their livelihood pattern and options also change. As their major demand is fulfilled by the forest land, they believed that the government policy is not in their favour. That's why, they are compelled to be involved in illegal activities like forest cutting and alcohol production business.

- ***Infrastructure***

It was reported that local people cut down the trees to construct houses. They are highly dependent on forest resources for their infrastructure which is one factor of forest land use change.

- ***Technology***

Majority of people gave less priority to the technology for the land use change. Due to National Park policy, modern technologies are not developed yet. Still ox is used to plough the land.

4.3.4 Sources of Income

People are involved in various activities for better livelihood. Following are the main sources of income which have been arranged according to proportion of income:

- ***Alcohol Production***

The participants reported that alcohol production is major source of income for more than 90 percent of villagers in all three villages. Almost all participants reported that they are involved in alcohol production for both sale and religious activities.

- ***Agriculture and Livestock Rearing***

All the participants and KII reported that most of the villagers are involved in farming and livestock rearing. Most the villagers have their own farm and livestock.

- ***Business***

As the *Mulkharkha* village lies in the *Chisapani, Gosaikunda* trekking route and there is flow of internal and international tourist, people have been also engaged in grocery shop, tea shop etc. Only few people of *Okhreni* and *Chilaune* gaun were involved in business.

- ***Government Service***

KII suggested that very few villagers are involved in government service in Mulkharkha. However, no participant's family members from Okhreni and Chilaune gaun were involved in any service.

- ***Remittance***

Both participants of FGD and KII reported that emigration to gulf countries is increasing in villages. As there is high risk on alcohol production, those people who can save money around 300 to 400 thousand rupees, they are more likely to migrate abroad.

- ***Others***

Participants of FGD and KII reported that they do not have any skills such as handicraft, sewing, kneading etc. They also reported that due to less economic opportunities, most of villagers have high rate of loan and they are compelled to do illegal work like extraction of firewood as well as business of alcohol.

4.3.5 Dependency on Forest Resource

The dependency on forest resources are given below according to proportion of use:

- ***Traditional Energy System***

Majority of villagers are dependent on forest resources for fire wood and alcohol production. However, majority of villagers widely use LPG gas for cooking.

Furthermore, only 4 households have biogas plants which they only use for cooking but only firewood is used for the alcohol production in the village.

- ***Timber***

Inside the village, timber is harvested from the forest for the construction of home. Trees like *Katus*, *Chilaune*, *Phalad* etc are highly used for door, window etc.

- ***Livestock***

Fodders are extracted from forest to fulfil the fodder demand of cattle. Buffalo and goat are common livestock inside the village.

- ***Medicinal Plants***

Local villagers have been using chiraito as a medicinal plant to cure fever. They don't recognize other medicinal plants. So, there is no any pressure on forest for medicinal plants.

4.3.6 Local people's Perception on Present Ecosystem Services

The summary of local perception on present ecosystem is as follows:

1. There are no changes on recreational and touristic value as both internal and international tourist flows are increasing in Mulkharkha.
2. There is no change on water quality as water is clean in the Sundarijal VDC.
3. There is change on water quantity as water is scarce in dry season in the area too.

4.3.7 Impact on Ecosystem Services:

Most of participants believed that due to intense deforestation, they are facing some impacts on ecosystem services. Most of the participants reported that they have observed landslides and floods. Similarly, they have also experienced the problem in water accessibility especially during dry season.

4.3.8 Prediction/ Vulnerability Context in Future Due to Land Use Change:

Majority of participants believed that if the present process continues in same way, the impact on ecosystem might be severe on future. They predicted that the land would be converted in the bare land very soon.

4.3.9 Alternative Options to Improve the Livelihood of Local People

Majority of participants of FGD and KII were aware about the negative consequences of the alcohol production and their high risk in alcohol business. So, majority of people are ready for other alternative livelihood options. If training is given to them, they are interested in following activities:

- ***Organic Farming***

Organic farming like *Jadibuti kheti*, *Chiraito kheti* etc and mushroom farming are feasible in this area. For this purpose, irrigation facilities should be provided to facilitate water supply in fields.

- ***Briquette from Banamara (Eupatorium adenophorum)***

Locals believed that if roads are permitted, mobility of people, services and resources become easier. As a result, various livelihood opportunities will be opened to them. One major advantage can be the production and logistics of briquette produced from *banamara* plants to the areas where the demand is higher. This will also help to improve the living standard of local people.

4.3.10 Recommendation from Local People to Improve the SNNP Management

These are the major recommendations given by the meeting;

1. Strong punishment should be given to those who are involved in illegal activities but villagers must be allowed to collect fuel wood as they collect fuel wood from old branches of tree, small shrubs etc.
2. Before implementation of any rules from government level, discussion and dialogues should be performed at local level. Participatory approach is favoured by them.
3. People from outer communities are more responsible for deforestation of the forest which should be controlled.
4. Livelihood of village people should be improved by providing them alternative options.

5. The responsibility of conservation should be given to the local community as they will give more effort for protection. They reported that they can conserve better than current protection practices.

4.3.11 Other Issues

Some ongoing important issues in these villages which were not incorporated by FGD and KII checklist but widely discussed during the meeting and interview are:

- ***Buffer Zone:***

According to locals, if buffer zone is declared, that it will be better for them. They want to share the conservation monetary resources to compensate the villagers for loss incurred by park-people conflict and the village development activities.

- ***Risk Factor***

The villagers are frequently facing various fines from National Park authorities to control their activities. They paid up to Rs 16000 to Rs 77000 for Rs 800 alcohol (market price). However, due to less economic opportunities and high rate of loan, people are compelled to be involved in alcohol business.

Similarly, different kinds of punishment are also given to villages, if they are caught by police or army at forest. The police and army have made their own rules on their wish. So, the punishment differs from person to person. The member of meeting reported that people from village had fine up to Rs. 28000 for timber (*chiso daaura*) and up to Rs. 500 for firewood, fodder, grass and branches of old tree. There was also an incidence that people were soaked in water whole night as a punishment.

- ***Park-People Conflict***

Since the declaration of national park, there have always been conflicts between SNNP management authorities and local communities. Without the support of local community, the conservation of national park is tedious task. Some mechanisms need to be initiated to foster the communication between SNPP and local community.

CHAPTER FIVE

DISCUSSIONS OF RESULTS

5.1 Land Use and Land Cover Change

Land use system of PAs provides multiple goods and service required by the society (ICIMOD, 2011). So, with overarching goal of sustainable development as well as biodiversity conservation to secure the benefits for present and future generations, PAs are established (Pandey, 2009). With this aim , most countries and regions legally established PAs in which PAs cover more than 10 percent area whereas 31 percent of total land area is forest cover globally (FAO, 2010). Similarly, in the context of Nepal, forests cover about 29 percent of total area of Nepal and 15 percent of forests lie within the Protected Area System (FAO, 2010).

Globally the pressure on land is ever increasing leading to the conversion of forest land into non forest land (FA0, 2005). However, there is lack of scientific data on reducing forest in Nepal, the past available data showed clear fact that forest is being disappeared at the alarming rate in Nepal. It is estimated that the overall deforestation rate of Nepal from 1978/79 to 1994 was 1.7 percent per year and from 1991/92 to 2001/ was increased to 2.7 percent per year (Dhital, 2009; MFSC, 2008 and 2011; CBS, 2008), which is well above the Asian average (1%) and the global average (1.3%) (Dhital, 2009; FAO, 2005). However, globally deforestation has decreased at a rate of 0.4 percent annually over the last ten years (FA0, 2010).

Nevertheless, the study shows control in deforestation in SNNP as forest increase in Sundarijal VDC from 1990 to 2000 at the rate 0.18 percent per annum. However, forest decreases slightly from 2000 to 2010 at the rate of 0.21 percent per annum. Moreover, overall deforestation rate over 20 years was 0.02 percent per annum and the

conversion of forest to agricultural land was prevalent. At the same period, fringe encroachment observed at the boundary villages inside the SNNP (IUCN, 2008). Here, deforestation rate of Sundarijal VDC was found to be less than national and global deforestation rate. However, a forest cover change analysis of the *Terai* from 1991 to 2001 presents the forest cover of PAs in Terai increases at the rate 0.01 percent per annum (DoF, 2005). Hence, it is clear from study that conversion of forest into agricultural land is higher rate in SNNP than NP's of Terai. Local perception also supported the fact of higher deforestation activity for fuel wood and timber during 1990 to 2001.However, deforestation was controlled by patrolling the army after establishment of Shivapuri National park. At present, such activity for fuel wood has been in an accelerating trend. Hence, through both GIS study and local perception, it was reported that the forest land of Sundarijal VDC/catchment is converting from forest land to agricultural land i.e, forest land is decreasing and agricultural land is increasing. Similarly, modification of forest land is also reported by the local people as they observe decrease in tree number.

Even the deforestation rate of Sundarijal VDC is found to be comparatively less than Asian average deforestation level and global average deforestation level, it is indicating there is high risk of increase of deforestation in future. The socio-economic activities of three villages are directly related with the forest resources, which are further discussed in following section.

It is well known fact that deforestation lead to the consequences of negative relation with environmental services and possible catastrophe and hazard. So, higher increase in percent of deforestation in Sundarijal VDC and SNNP shows the clear picture of insecurity in the sustainable conservation and development. The detail of key drivers of deforestation and implications on ecosystem services particularly on water service are analysed in preceding sections.

5.2 General Socio-economic Condition

Social researchers argue that land use of PAs restricted access to the forest resources and thereby creates condition of relative scarcity and uncertainty about forest resources (Pfeffer at.al., 2001), thus leading to negative and unjust impacts on the social

and economic welfare of neighbouring .This negative impact causes the harm on protected area conservation objectives as PAs cannot succeed without the support of local communities.

In this study, the linkages between household socio-economic activities of three villages i.e., Mulkharkha, Chilaune gaun and Okhreni and forest resources extraction has been playing major role in the forest land use change in Sundarijal VDC of SNNP. Within all three villages, Tamang were the dominating ethnic group. Education status gives clear information regarding level of awareness of individuals. Majority of respondents from all villages were illiterate but the literacy and education level of Mulkharkha was higher than Chilaune gaun and Okhreni. Thus, respondents of Mulkharkha were found to be more aware on PES concept for both conservation and improvement of livelihood of local people. Due to the absence of road facilities, majority of houses located in the slope upland were constructed with clay, brick and galvanized tin or straw. Only some houses of Mulkharkha have relatively better transportation facilities, houses were constructed with brick and cement. This showed that although these villages were located in the neighbourhood of Kathmandu city, transportation is still a problem.

The average family inside the village size were found to be 5.7 per HH, 5.2 per HH and 5.93 per HH of Mulkharkha, Chilaune gaun and Okhreni respectively which was more or less similar to the average national family size 5.6 per HH (UNDP, 2001) and 5.4 per HH for rural area of Nepal (CBS, 2005). However, the average number of people living outside in all three villages was found to be less than zero. As the family size inside village was found greater, this obviously demanded greater amount of forest resources from forest of SNNP.

Most of the household income depends on subsistence agriculture in rural Nepal and similar is the case in the study area. In most of the households, crop and vegetable farming were limited for home consumption, however no commercial vegetable farming was observed. Majority of respondents reported that there was food insecurity as production of agriculture was not enough for them. Moreover, household more than a quarter suffer recurrent food shortages for 4-10 months of the year (IUCN, 2008). Livestock rearing is an integral part of Nepalese farming system. It is the second major

sector contributing 28 percent total agricultural production of the country (Tiwari, 1993). Crop and livestock mixed farming system were common in all three villages. In addition, people were also involved in wage labour as subsistence agriculture and livestock were no enough for their livelihood. Majority of people from Mulkharkha and some households from Chilaune gaun and Okhreni were also involved in service and business, whereas some young generation prefer migration to traditional activities. As these conventional activities give limited livelihood support, respondents of all three villages were involved in an alcohol business. Among these three villages, study showed that people of Okhreni were highly involved in alcohol business. It may be because controlling of army has been less here and people can easily collect fuel wood for alcohol production.

5.3 Major Forest Products and Their Use

Most of the rural population of Nepal rely on locally available forest resources for their subsistence needs such as fuel wood and fodder. Dependency on forests for energy in rural Nepal is very high i.e., 70 percent is estimated to be forest dependent (MFSC, 2008). According to WECS (2006), in 2006/07 fuel wood derived from forest constituted 84 percent of the total of energy source in Nepal. Most of the rural households depend upon fuel wood for cooking and heating purposes particularly in the hills and mountains.

In all three villages, the energy consumption for domestic sector was dominated by traditional forms of energy such as fuel wood from the forest and private land and agricultural residue. All sampled households used fuel wood for cooking purpose. Other forms of energy such as kerosene, LPG and electricity used by household were very little compared to fuel wood. Data from the field showed that the annual average consumption of firewood was found to be high during 1990 with average consumption 4800kg, 1800kg and 1000 kg of Chilaune gaun, Mulkharkha and Okhreni respectively. It showed that no alternative energy was developed during that period. During 2000, consumption of fire wood was found to be decreased with the average annual firewood was found to be 600kg, 800kg and 300kg of Mulkharkha, Chilaune gaun and Okhreni respectively. At that period, transmission line reached villages and electricity was available for cooking purpose. Least consumption was found in present time i.e., 400kg, 300kg and 45 kg of

Mulkharkha, Chilaune gaun and Okhreni respectively with availability of LPG and bio-gas. Four biogas plants were observed in Mulkharkha during field visit. However, alternative energy sources such as biogas and solar panels were not widespread in other two villages. The result of socio-economic status such as education, economy and dependency on agriculture and livestock and travelling distance is consistent with higher fuel consumption in Okhreni. Furthermore, the study showed people also harvested timber, wild fruits and vegetable and fodder and forage. As people are residing inside the NP, majority of them reported that they are involved in harvesting of medicinal herbs and hunting of wild animals/ bird. Most of the respondents reported that they did not recognize the medicinal plants. Nevertheless, key informants revealed that there is high rate of illegal harvesting of medicinal herbs as well as hunting of animals/birds. In principle, any kind of product harvest including fuel wood and livestock grazing in the forest of national parks is illegal and the users either loggers, herb collectors or the rural households have to take written permission to harvest products (Forest Act 1993, Forest Regulation 1995). The forest rules prescribe penalties, however, rules and regulations are seldom followed and the villagers, who have been customarily using the forest for years, continue to use them for household purpose fuel wood collection, grazing etc.

Likewise, the study showed that the high rate of consumption of fuel wood can be linked with the decline level of forest which was also observed by the GIS analysis where the forest proximate to village were converted in to agricultural land. However, the study showed the distance was not significant to collect the fuel wood. The correlation in all three time period showed the there is no relationship between amount of collected fuel wood and distance from house to forest. It is because of the fact that fuel wood is a basic necessity of villagers and they do not have enough land to grow tree. So, irrespective of distance people collect fuel wood from forest of SNNP. Another reason is that alternative sources of energy are either unavailable or are costly for the people. In addition, as all three villages lie inside the SNNP and presence of restrictive policy, when they enter to the forest they collect as much they could. Furthermore, alcohol business also demands high rate of fuel wood. So, people are compelled to collect the fuel wood from the national park forest.

As reported in Shivapuri National Park Management Plan (NTNC, 2004), ethnically Tamang communities inside the SNNP were relatively deprived of productive land as they hold mostly small patches of fragile and steep slope upland (Bari). Hence, in the absence of adequate agricultural land and other alternatives for living, most of the households of Tamang communities were found to be involved in alcohol production. The study showed that during 1990 alcohol was consumed only within themselves for their traditional and cultural activities. Since 2000, people were involved in the alcohol business because of limited livelihood and high demand from market (Kathmandu). So, alcohol business is in increasing trend in all three villages. The study found that among these three villages, the households of Okhreni involved in alcohol production was relatively higher than in Chilaune gaun and Mulkharkha. This might also be one of the reasons for higher average household demand of fuel wood in Okhreni VDC.

5.4 Implication of Land Use Change on Key Ecosystem

The conversion forest land use to other land use leads to the deforestation (FAO, 2005), where deforestation is regarded as primary cause of soil erosion or impoverishment where soils tend to be thin and nutrient poor. It is linked with habitat loss leading to species endangerment and biodiversity loss, it affects the hydrological cycle through changes in evapo-transpiration and run off and it releases stored carbon and therefore contributes to climate change (CISIEN, 2002).

Detail scientific data are lacking on the implication of land use change on SNNP. However, study of IUCN (2008) showed that fifth of inflow was depleted in Sundarijal sub-catchment, whereas 30 percent depleted in the Bagmati Watershed (Karna, 2008). As scientific method was not implemented to study impact on water, perception of local people was referred for this purpose. The study revealed that perception of local people was similar to the finding of GIS analysis i.e., declining of forest land inside the SNNP.

Similarly, local respondents were found to be aware of adverse effects in environmental process and function. As majority of respondents reported that they observed severe and adverse effects on key ecosystem services such as decline in water volume and quality of water, soil loss and biodiversity loss. Similarly, a study of Panta and Rasul (2008) reported that there is a positive relationship between watershed

conservation upstream and water yield downstream i.e., forest land is decreasing and so is water yield in downstream. In addition, study revealed the increasing shortage of drinking water in the Kathmandu, while demand for water has been increased considerably over the past few decades. The supply has been dwindling due to poor management and degradation of adjacent watershed of SNNP. However, the demand of water in the city is about 270 million litres daily but KUKL is supplying only 100 litres. The shortage of water has affected the lives of 1.5 million people in Kathmandu and made adverse impact on their health and environment. Moreover, degradation of watershed has affected the quality of water in Kathmandu causing increased waterborne diseases and affecting public health (Pant and Rasul, 2008). Moreover, degradation of watershed has affected the quality of water in Kathmandu causing increased waterborne diseases and affecting public health. Similarly, the study conducted by Bhattarai, Shrestha and Lekhak (2008) on water quality on Sundarijal reservoir and its feeding streams in Kathmandu also claimed the similar fact that physio-chemical characters were within the standard of World Health Organization (WHO) and European Commission (EU) of its stream water. However, the coliform bacteria were found high and water was not safe to consume without intense treatment and disinfection. Also most of respondents do not use toilet. There is lack of awareness on sanitation and hygiene, which is one of the major causes of Coliform bacteria in water. Majority of villagers of all three villages depend on agriculture. So, people are using fertilizers and pesticides along with compost for higher production which affect the water quality. Similarly, haphazard road construction inside the three villages also poses the serious problem of soil erosion, landslide and siltation on reservoir.

In terms of water status, this study found that steadily decreasing forest cover inside the SNNP has led to declining rate of water flow in downstream and quality of water is also degrading. As per the local perceptions impact of ecosystem services are also found in soil erosion, landslide, biodiversity loss, landscape beauty and religious or touristic number.

5.5 Key Drivers of Land Use Change

Loggings, shifting cultivation, agricultural expansion, encroachment and urbanization /industrialization are the key drivers of global forest land use change to other land use in general (Dhital, 2009). However, in Nepal, government's resettlement program, unauthorized settlements, illegal clearing of forest for agriculture and illicit felling of timber for smuggling across the border are drivers. Other causes of deforestation in the country are expansion of agricultural land for food production, extraction of fuel wood for cooking and domestic heating, forage gathering and livestock grazing, inadequate management regulations (MFSC, 2008).

In case of SNNP, the study showed that major drivers of land use change are various socio-economic activities which are ranked as fire wood overharvesting, timber harvesting, economic activities like alcohol production, demographic change and government policy. As majority of households were found to be heavily depended on firewood as a primary source of energy than other sources of energy, fire wood harvesting is ranked as first. Similarly, local villages only depend on timber from forest for all the construction activities inside village and hence timber is ranked as second. Due to limited livelihood opportunities, most of the villagers are compelled to be involved in alcohol production business that requires higher amount of firewood. So, it is ranked three. Demand of firewood for alcohol production is higher than demand of firewood for food making. There is higher extraction of firewood for alcohol business, which is found to be key driver of deforestation and degradation of SNNP. Most of the respondents observed that population has increased compared to previous year leading to greater demand of forest resources and ranked at four. Policies for conservation of SNNP were found to be changing. However, local people can't adopt in changing policies and legislative act regarding conservation. This changing policies and legislative acts regarding conservation, it has been ranked five. Most of the respondents observed that population is increased compared to previous year and tourists are also in increasing trend which leads to greater demand of forest resources.

Hence, different activities like agriculture practices, heavy dependency on firewood and alcohol business and tourism activity of villagers inside the SNNP causing

adverse effects on water services of SNNP which affects both upstream and downstream people.

5.6 Attitude of Local People towards the SNNP Management and Authority

Most of the people of all three villages have appreciated that the conservation initiatives of SNNP as it has effectively protected forest and its wild animals. However, majority of respondents perceived that conservation initiatives have created more risk to them. Towards the benefits received from NP, highly acceptance was statement of easy availability of fodder in Mulkharkha and good water quality and consistent water supply in Chilaune gaun and Okhreni. The least accepted statement in all three villages was increasing economic opportunity. The major difficulty faced by all three villages after the establishment of NP was restriction of the forest resources which are needed in daily basis. Furthermore, lack of grazing land, frequent intervention by the park authority, fine punishment and harassment and restriction of infrastructure development were major risk to them.

Majority of the respondents from the study believed that before implementing any policy, villagers must be consulted for the conservation activities. It was followed by the statement alternative livelihood options should be provided to the villagers. Subsequently, respondents demand on permission of alcohol sell. Likewise, they disagreed on the statement of villagers should not allowed to harvest firewood for alcohol production. As above discussion, it is cleared that because of limited livelihood opportunities, people are involved in alcohol business. So, most of respondents recommended that they need alternative livelihood options. If road infrastructure is well developed and market is available, most of the respondents are ready for organic farming. Furthermore, they are also positive toward medicinal plants (jadibuti) farming and mushroom farming. However, most of the respondents disliked the briquette production. It may be due to lack of knowledge regarding briquette production.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From the study, it was determined that the forest land declined by 0.19 percent accounting an area of about 3104.17 ha during the 20 years time from 1990 to 2010. Similarly, bare land was also found to be decreased by 10.53 percent and disappeared during same period. On the contrary, the agricultural land augmented by 0.72 percent covering 420.57 ha during the same period. As a whole, overall forest land conversion from 1990 to 2010 was found to be at the rate of 0.02 percent % per annum and agricultural land expanded by 0.07 percent per annum. Likewise, bare land was found to be in decreasing trend by 0.05 percent per annum. However, available deforestation rate of PAs in Nepal is at the rate of 0.01 percent per annum. Hence, the deforestation is found to be higher inside the SNNP especially at the proximities to the three villages i.e., *Mulkharkha*, *Chilaune gaun* and *Okhreni*. Hence, the GIS analysis results showed the change in land use and land cover in Sundarijal VDC.

The study showed that key drivers of such pattern of the land use change were found to be overharvesting of fuel wood, timber, economic activities like alcohol production and inappropriate governmental policies which are the primary causes of excessive extraction of firewood from the forest. These are leading to deforestation and degradation of forest of SNNP.

The study also found that the implications of such activities are leading to deterioration of water quality, deterioration of water quantity and soil erosion which are the most hazardous impacts on the ecosystem services of forest of SNNP. Ultimately, such phenomenons are also leading to biodiversity loss, effects on landscape beauty and tourism etc which are other adverse impacts on the ecosystem services.

The locals residing inside the park have also perceived the land use change of NP and emphasized on need of strong action which is required to conserve the ecosystem of SNNP. These people also strongly agreed that they should be consulted for the conservation activities in the park. Similarly, they believed that they should be provided with the alternative livelihood options in order to reduce the pressure on forests for firewood and timbers. Majority of respondents reported that the alternatives should be provided for livelihood options like organic vegetable farming, medicinal plants farming, mushroom farming and briquette from *Banamara* etc. in order to enhance the conservation efforts and ecosystem services. To enhance such activities, there is need for development of Payment for Environmental Scheme (PES) in Sundarijal watershed area inside the SNNP.

6.2 Development of PES Scheme

The entire study cleared the fact that extensive modification of land use may affect natural ecosystem and reduce their capacity to generate services for future as different services are interlinked and interdependent. The land use of forest of PAs coupled with vulnerability is suffering from pressure. Since, people inside the SNNP are devoid of adequate economic alternatives; their survival strategies are likely to threaten resources inside the PA. So, realisation is increasing for effective land management and enhancement of ecosystem services. For this, systems are needed which provide incentives to upstream villagers. The primarily intention is to encourage upstream villagers to maintain practices that ensure and improve environmental services. Hence, this study is conducted to analyse the applicability of PES considering suitable option that is widely considered to compensate people, living in or near protected areas that provide the services, for their losses through payment for ecosystem services. In this context, PES could be appropriate conservation tool for SNNP with fostering of the local livelihood as it is win-win opportunities for human activities within environmental way exist.

In order to develop PES scheme, this research refers the PES framework of ICIMOD 2011 which has been illustrated in literature review. Though various studies regarding PES have been conducted in SNNP, the PES mechanism is not clear. However,

framework of ICIMOD has provided detail guidelines for PES scheme. Hence, this study recommends the guideline of PES scheme from ICIMOD.

Currently, park revenue is collected by park authority which directly goes to the governmental account. Furthermore, GoN provides fund to manage the administration and other expenses such as PAs management, PAs protection, ecosystem monitoring and research support for the park authority. However, there is no environmental fund for compensating mechanism for the local people loss since the buffer zone (BZ) is not established in SNNP.

In this context, the PES scheme provides guideline that compensation should be collected from beneficiaries such as private companies like KUKL, Sundarijal hydropower, mineral bottle factories, hotel and tourism sector, visitors/tourist etc and for such purpose separate environmental fund can be established. This fund can be utilized as an incentive to the people of three villages inside the SNNP. The structure of incentive can be varied according to need of villagers like poverty alleviation, compensation for wildlife damage, conservation and sanitation, visitors/tourist and alternative livelihood options like organic farming.

Since the conventional conservation approaches have been facing challenges and constraints, this study concluded that participatory approach of SNNP management and authority with local upstream service providers and downstream beneficiaries are necessary. The local people should be engaged in SNNP conservation activities. It can be achieved by establishing good relationship through trust building activities such as responding the need of local people, it may not necessarily related to conservation management but community development activities such as education, health, sanitation etc. In addition, eco-friendly practices such as organic farming can be conducted. Likewise, local people can be hired for park protection or extension staffs. Such staffs can be used for educating the communities about the NP and multispectral services. Similarly, staff can work on educating upstream people about clear demarcation of SNNP boundary as demarcation of SNNP boundary is not cleared to upstream people.

In the same way, downstream people should be aware of watershed value of SNNP to participate in the conservation activities. However, research study showed the downstream people are willing to pay to conserve the SNNP. Furthermore, other stakeholder likes KUKL, hydropower, mineral water companies should have regulatory mechanism to compensate to upstream people. The estimation of compensation amount could be next study.

6.3 Recommendations

As study shows that forest of Sundarijal Catchment of SNNP is converting into agricultural land. So, at first conversion of forest land to agriculture land should be controlled to continue sustainability of conservation. Whereas various study revealed that the convention approach of command and control is not a success to conserve the forest as the means of natural services and goods. Instead, participatory approach of SNNP management and authority, upstream and downstream people could better manage the PAs and its services. For the participatory method for conservation of Sundarijal Catchment of SNNP following recommendations are made:

5.3.1 Recommendation for Action

- Economic activities like alcohol business etc should be controlled. Similarly, before implementing any new policy, local people should be consulted and engaged for better management and conservation of NP.
- The policy should integrate consideration of ecosystem services and conservative tools like PES. New regulation can be made so that beneficiaries pay compensation to upstream people of particular type of service use.
- The institution can be developed to regulate interaction between market and ecosystem.
- Both upstream and downstream people should be made aware about the importance about the environmental services and PES mechanism. It can be conducted with communicating and educating people by different means such as newspaper, magazine, radio, TV etc.

- Empowerment of groups particularly dependent on forest resources, women and young group could be conducted since such activities could decrease dependency on forest resources.
- As exploitation is the main cause of deforestation, technology changes like promotion of alternative energy such bio gas, briquette, improve stove, solar could be conducted. Moreover, subsidies on gas, kerosene and electricity could be given to local people.

6.3.2 Recommendation for Students

Further research in Sundarijal catchment is needed on detail study of land use linkages on various environmental factors (Water, Biodiversity, Carbon, Landscape etc) as this study could not give detail scientific data on implication of land use change on key ecosystem services. In the same way, estimation of compensation of beneficiaries could be conducted which can be implemented during negotiation between stakeholders of PES scheme. To implement PES, valuation of ecosystem services of SNNP will help to assess importance of SNNP resources. Another interesting topic could be study on siltation, soil erosion, landslide caused by haphazard road construction inside the SNNP as such process could hamper ecosystem services and goods in future. To increase SNNP revenue and improve livelihood of local people further recreational (hunting, fishing and boating) and tourism activity (home stay) can be explored inside the national park.

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Annexes

Annex-1: Pictorial Highlights

Field Observation

Woman Carrying Firewood

Key Informant Interview

FGD in Mulkharkha

Household Survey

Collection of Firewood

Annex-2: Checklist for focus group discussion

Name of Area:
Location:
Name of the organization:
No. of participants:
Date:

1. Land use dynamics within Sundarijal catchment of SNNP. (20 years ago, ten years ago and current)
2. Local people's perception of forest degradation and deforestation. (try to get a sense of how far they had to walk to collect firewood – 20 years ago, ten years ago and now)
3. Impact of land use change on key ecosystem system services and livelihood of local people inside SNNP.
4. Key drivers of land use change (try to have the drivers ranked or prioritized according to importance)
   - Over-harvesting of forest products
   - Population growth (separate between local growth and in-migration)
   - Government Policy
   - Economic Activity
   - Infrastructure
   - Technology (including agriculture intensification)
   - Other
5. Historical forest status
   Forest management, deforestation
6. Relationship between land use change and livelihood of local people (this may be better to repeat during individual interview – also use to validate the information from two methods)
   - Major source of income (Trend of 20 years)- Farming, Government Service, Private Service, Migration, Other
   - Livelihood analysis
7. Dependency on forest resource and their proportion (this may be better for individual interview)
   - Energy
   - Livestock
   - Timber
   - Medicinal plant
   - Other
8. Distance travelled for extraction of forest resources(this may be better for individual interview)
   - Time spend to collect
   - How frequent they visit the forest?
   - How much they collected per visit
   - Areas with intense forest resource extraction
9. Local people's perception on present ecosystem services, impact on ecosystem services and prediction/ Vulnerability context in future due to land use change.
10. Local people's perception on impact on livelihood of local people due to land use change.
11. Indigenous knowledge regarding land use and Conservation strategy
12. Alternative options to improve the livelihood of local people / Valuation of their perception toward alternative options
13. Recommendations from local people to improve the management of SNNP.
14. Other

Annex-3: Household Questionnaire Survey Form

Date of Interview: Questionnaire no:

Interviewer's Name: Village/Ward:

1. Demographic Information of the respondent
    a) Name:
    b) Age:
    c) Gender: Male ( ) Female ( )
    d) Main Occupation:
    e) Education: Literate ( ) High School ( ) Campus ( )
    f) Type of house roof:

2. Household Information of the respondents

	Male	Female
Adult (living in village)		
Children (living in village)		
Family living outside village		

3. Income of each household member
    a) Sources of income of each household member:

Sources of Income	Now		10 years ago		20 years ago	
	Tick mark	Proportion of Income	Tick mark	Proportion of Income	Tick mark	Proportion of Income
Agriculture crops						
Livestock rearing						
Wage labour						
Alcohol Production						

Business						
Service						
Handicraft						
Timber/firewood sell						
Remittance						
Other (specify)						

b) Estimated total Income

Annual Income	Now	10 years ago	20 years ago

4. Household Energy Consumption

5. Source and quantify of energy used per month?

Source of Energy	Unit	Now	10 years ago	20 years ago
Fuel Wood	Bhari			
|Bio gas				
Electricity	Unit			
Kerosine	Litres			
LPG	Cyclinders			
Other specify				

6. Forest products used by the family? Rank them according to the priority (for this year only).

	Rank	Now	10 years ago	20 years ago
Firewood (bhari)				
Poles/bamboo (number of poles)				
Timber (cubic feet)				
Wild fruits and vegetables				
Medicinal herbs				
Wild animals/birds				
Others (specify)				

7. Distance travelled for extraction of firewood.

	Now	10 years ago	20 years ago
Days spent (in one year) to collect fire wood from the forest			
How many times do they visit the forest (in one year)?			
Time required to walk from house to place of firewood collection			
Amount collected in whole year (bhari)			
Of total amount, how much firewood is used for alcohol production (bhari)			
Amount of alcohol produced (pathi)			

Alcohol: a. Self consumption b. Sale			

8. Over the last 10 years, the status of forest around the village is…

a. Improving b. Deteriorating c. No change d. don't know

How do you know this is happening: (indicators)

a. ……..
b. ……..
c. ……..
d. ……..
e. …….

9. If the answer to previous question is “deteriorating”, then ask “Why do you think the forest status is changing in Sundarijal watershed area of Sundarijal (Rank them according to their importance)

	Tick if relevant	Rank (1 for most important)
Firewood (over)harvesting		
Timber (over)harvesting		
Population increase in the villages		
Government Policy		
Economic activities (alcohol production)		
Hotels and tourists		
Infrastructure development (road, schools, etc)		
Technology (intensive farming)		
Other (Specify)		

Note: Rank 1=Most important; 2 slightly less important; 3 less important; and so forth)

10. Over the last 10 years, the status of forest far away from the village is…

a. Improving b. Deteriorating c. No change d. don't know

11. Did you observe any change on ecosystem services due to land use change?

Ecosystem Services	Tick if relevant	Rank
Biodiversity loss		
Soil erosion		
Water quantity		
Water quality		
Landscape beauty		
Religious/ touristic		
Other		

12. What are the benefits you receive from the National Park? (Please pick a number from the scale to show how much you agree or disagree and write in the space to the right of the option.)

(Scale: 1= Strongly agree 2=Agree 3=Neutral 4=Disagree 5=Strongly disagree)

a. Easy availability of firewood
b. Easy availability of fodder
c. Effective protection of forest and wildlife
d. Good quality water
e. Consistent supply of water
f. Toilets and sanitation improvement
g. Economic opportunities (e.g. tourism)
h. Conservation education and awareness
i. Decrease in intensity and frequency of landslides
j. Other (specify)……..

13. What are the risk factors resulting from the conservation initiatives?

(Please pick a number from the scale to show how much you agree or disagree and write in the space to the right of the option.)

(Scale: 1= Strongly agree 2=Agree 3=Disagree 4=Strongly disagree)

a. Restriction on harvesting forest products
b. Lack of grazing land for domestic livestock
c. Crop damage or livestock predation by wildlife
d. Human causalities due to wildlife
e. Frequent intervention by the park authority
f. Fine, punishment and harassment
g. Restriction on infrastructure development

14. What recommendations do you want to give to the park management?

(Please pick a number from the scale to show how much you agree or disagree and jot in the space to the right of the option.)

(Scale: 1= strongly agree 2=Agree 3=Disagree 4=Strongly disagree)

a. Local people should be allowed to produce and sell alcohol.
b. Alternative livelihood options to alcohol production should be provided.
c. Local people should be allowed to harvest firewood and other products freely (without restriction).
d. Local people should NOT be allowed to harvest firewood for alcohol production.
e. If allowed, villagers can better protect the forest instead of army.
   Before implementing any government rule inside the national park, local villagers must be consulted.

15. Alternative option

What are the appropriate alternative livelihood options for you?

(Please pick a number from the scale to show how much you agree or disagree and jot in the space to the right of the option.)

(Scale: 1= Strongly agree 2=Agree 3=Disagree 4=Strongly disagree)

a. Jadibuti farming
b. Organic vegetable farming
c. Mushroom Farming
d. Brikket from Banmara
e. Tourism (hotels/shops/guides for tourists)

f. Others (specify)…..

Thank you so much for your kind cooperation. If you like to add anything more……..

Annex-4: Checklist for Key Informant Interview (KII)

Date:

Name:

Position:

Organization:

1. What are the types of land use people practice around the national park?
2. Major forest resources and their uses by the local people
3. Spatial distribution of deforestation activity (how far people go to collect resources)
4. Historical forest status, forest management, deforestation status
5. Drivers of land use change
6. Major disturbance to the forest and their causes, impact
7. Area with severe forest use
8. Official records of removal of trees/ illegal activity (trading of alcohol)
9. What are the management problems and their underlying causes?
10. Impact on livelihood
11. Alternative options to improve their livelihood
12. Programmes implemented or proposed to check deforestation and degradation
13. Other comments