IMPACT ANALYSIS OF LANDSCAPE LEVEL CONSERVATION AND DEVELOPMENT OF METHODOLOGIES: A CASE STUDY OF TERAI ARC LANDSCAPE PROGRAMME, NEPAL

A DISSERTATION

SUBMITTED FOR THE

PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

THE DOCTOR OF PHILOSOPHY (Ph.D.) DEGREE

IN ENVIRONMENTAL SCIENCE

BY

RAM PRASAD LAMSAL

DEPARTMENT OF ENVIRONMENTAL SCIENCE AND ENGINEERING

SCHOOL OF SCIENCE

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DEDICATION

Dedicated to late father Mr. Khimkarna Uppadhaya and late elder brother Mr. Gopal Lamsal

CERTIFICATION

This dissertation entitled **Impact Analysis of Landscape Level Conservation and Development of Methodologies: A Case Study of Terai Arc Landscape Programme, Nepal** by "*Ram Prasad Lamsal*", under the supervision of *Professor Dr. Sanjay Nath Khanal, Department of Environmental Science and Engineering (DESE)*, Kathmandu University, Dhulikhel, Nepal, and co-supervision of *Dr. Keshav Raj Kanel,* Kathmandu, is hereby submitted for the partial fulfilment of the Ph.D Degree in "*Environmental Science*". This dissertation has not been submitted in any other university or institution previously for the award of a degree.

APPROVED BY:

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Date:	Date:
Professor Dr. Sanjay Nath Khanal	External Examiner
DESE	(*Name, title*)
Kathmandu University	*Institution*

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Date:	Date:
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DECLARATION

I, *Ram Prasad Lamsal,* hereby declare that the work presented herein is genuine work done originally by me and has not been published or submitted elsewhere for the requirement of a degree programme. Any literature, data or works done by others and cited within this dissertation has been given due acknowledgement and listed in the reference section.

Signature

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Ram Prasad Lamsal

Date:

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ABSTRACT

Appreciation of the multiple benefits of conservation is incomplete without a comprehensive understanding of their impacts on biodiversity, livelihood and climate change. This study aimed to identify impacts and develop methodologies for monitoring and impact analysis (M&IA) of landscape level conservation (LLC). Four corridors and three bottleneck areas of the Terai Arc Landscape (TAL) programme of Nepal were selected for the study. The study included questionnaire survey, focused group discussion, field measurement based on forest inventory protocol, checklist, observation and secondary data review. The study also compared the results of TAL targeted interventions and non-TAL interventions with pre-post data.

The various conceptual and methodological issues (approach, methods and tools) underpinning M&IA of LLC were reviewed and prioritized based on the perception, expert inputs and field data. Likewise, the study analyzed policy impacts, assessed the community based climate change adaptation and vulnerability, developed indices on biodiversity, livelihood, forest threats and disturbances reflecting the forest management scenarios using principal component analysis (PCA), multiple linear regression analysis (MLRA) and logistic regressions. The timelines for field surveys were 2008-2009 and 2012-2013.

The extent of implementation and the awareness of policies and strategies were found low as per one sample median test (2.5, 50%) at $p<0.05$. However, out of 29 impact variables, 21 variables were positively significant at $p<0.05$. The main positively performed variables in categories were in clarifying objectives, using communication channel, achieving outputs and impacts, sharing resources, changing the process, receiving funds, mainstreaming, efficiency, disseminating information and adapting policies. The five underlying dimensions of policy impacts were identified as Effectiveness, Efficiency, Additionality, Governance and Sustainability.

Community based management (CBM) had a higher alpha (α) and gamma (γ) diversity than that in state managed system (SMS). The beta (β) biodiversity estimators namely absolute beta value and Routledge beta-R Index appeared to be higher in CBM but not Mountford Index than in SMS. Between the forest management modalities, gamma (γ) diversity ranged from 70.15 to 119.6, the average basal area varied from 6.29/ha to 13.41 m^2/ha, mean species presence/ha from 13 to 32, density/ha from 2,348 to 11,788/ha and total volume from 89 m^3/ha to 150 m^3/ha. Tree species composition, however, did not differ significantly. Yet, the

forest communities differed greatly across site-or forest management modes. ANOVA showed a significant effect of forest management modalities on species richness (p=0.000) but not abundance (p=0.171), significant effect of site on abundance (p=0.000) but not on richness (p=0.236), significant effect of site based management on both richness and abundance at p=0.000 and also significant effect of CBM over SMS on richness and abundance at p=0.000. PCA and MLRA results confirmed that instead of using PCA and MLRA separately, factor score of PCA in MLRA can offer a good opportunity for developing and predicting model or equations on performance of biodiversity without multicollinearity problem. The PCA equation in CBM had R^2 = 86.5%, Adjusted R^2 = 86.4 %; and RMSE=0.433; whereas in SMS it was 88.7%, 88.5% and 0.422 respectively.

The findings under Threat Reduction Assessment (TRA) indicated that the overall current management approaches under TAL fall some short of addressing threats. Threat Reduction Index (TRI) of CBM showed significantly higher than conventional SMS (mean difference of 19.16 ± 1.238, t 224=15.74; p=0.000). One sample median test (2.5, 50%) revealed a significant difference toward positive conclusion on its simplicity to use, easy to understand, usefulness, cost effectiveness, replicability and comparatively better with p=0.000 and non-positive conclusion on its accuracy (p=0.324) and need for training (p=0.099). The study also investigated the response of forest management modalities to human disturbances to forest and biodiversity by which ten threats were identified. The pattern and trend of disturbances, which were analyzed quantitatively using a binary logistic regression model, revealed all statistically significant predictors, with Chi-square (27, n=128), 269.27, p<0.000, and distinguished between disturbances and the management modalities.

In the overall index model of livelihoods in 2009 and 2012, altogether 11 and 12 variables accounted for 31.1% and 68.5% of variations respectively. The mean annual income from farm and forests has been estimated as Nepalese Rupees (NRs) 56,288 ±1699.72 in 2009 and NRs. 115,748±2,809.01 in 2012. Similarly, with remittance it was NRs. 99,985 ± 1854.71 in 2009 and NRs. 136,460.70 ± 2,170.89 in 2012, revealed increased contribution of remittance. For non-CBM, the significant factors with p<0.05 were landlessness, forest management and access to natural resources, however, for CBM, implication of negative relationship of policies, natural shocks and human wildlife conflicts were noticed significant at <0.05.

The CBM in TAL has gained much momentum and shown several positive changes and achievements in its implementation areas. Despite the positive outcomes, however, there are scopes emerging for immediate and long-term improvements of CBM in TAL. Statistically significant perceptions on negative effects of CBM of TAL included problem of elite dominancy ($p=0.012$), increased political pressures, ($p=0.000$); and increased human wildlife conflicts ($p=0.000$). The study provided evidences that the CBM actions have the most immediate and greatest benefits for climate change adaptation, mitigation and vulnerability reduction. At community level, both observed data and local perception revealed that climate change is no longer a future phenomena but a present reality.

A total of 73 different methods and tools were categorized/subcategorized into seven groups: general, specialized technical, climate change adaptation and vulnerability assessment, livelihood improvement, biodiversity inventory/assessment, participatory biodiversity assessment and non-participatory biodiversity monitoring. Methods and tools under each category were tested and prioritized from which at least one set of methodology has been recommended for each category. The set of methodologies had four key attributes: a) access to methods and tools was not a problem but there was limited guidance available on how to select the most appropriate approaches, b) most of them were not plug-and-play, their use required training, skilful facilitations, significant data collection and resources; c) no single approach was sufficient to successfully support M&IA, and d) expert judgment was still one of the indispensable ingredients for success.

A set of process for organizing the methods and tools was presented, that demands to adapt an approach for differentiating monitoring with impact analysis, designing and implementation monitoring at central and field levels with clustering indicators in three groups. The fact that TAL indicators have limitations demands a three-levels system of IA: a) Intensive In-depth Research, b) Field Sampled Monitoring and c) System Wide Monitoring– to provide the full depth, breadth, and scope required to look at its strategy. The methodologies (methods and tools) are identified according to a) their focus; b) their approach; c) their use of indicators and whether these are community defined indicators; d) expert focused with fixed content and process and e) expert judgments. However, the methodology relies on the contention that no single aspect of impact analysis alone could produce enough information to address the objectives.

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ABBREVIATIONS

ABC	Abundance/Biomass Comparison
ACF	After Community Forests
ADB	Asian Development Bank
ANOVA	Analysis of Variance
ATBI	All Taxa Biodiversity Inventory
BCF	Before Community Forests
BIA	Biodiversity Impact Assessment
BIMS	Biodiversity Information Management System
BMP	Best Management Practice
BNP	Bardia/Banke National Park
BZ	Buffer Zone
BZC	Buffer zone Community Forests
BZUG	Buffer Zone Community Forest User Group
CARE	Cooperative for Assistance and Relief Everywhere
CBD	Convention on Biological Diversity
CBM	Community Based Forest Management
CBOs	Community Based Organization
CBS	Central Bureau of Statistics
CCBA	Climate, Community and Biodiversity Alliance
CEPF	Critical Ecosystem Partnership Fund
CFM	Community Forest Management
CFUG	Community Forest User Groups
CGIAR	Consultative Group for International Agricultural Research
CI	Conservation International
CIFOR	Centre for International Forestry Research
CITES	Convention on International Trade in Endangered Species
CMP	Conservation Measures Partnership
CNA	Conservation Needs Assessment
CNP	Chitwan National Park
DDC	District Development Committee
DFID	Department for International Development, UK
DFO	District Forest Office(r)

DFRS	Department Forest Survey and Research Centre
DNP	Dudhuwa National Park
DNPWC	Department of National Park and Wildlife Conservation
DoF	Department of Forests
DPR	Department of Plant Resources
DPSIR	Driving Forces, Pressure, State, Impact and Response
DWIDP	Department of Water Induced Disaster Prevention
E	Evaluation
EC	European Commission
EEA	European Environmental Agency
EIA	Environment Impact Assessment
EIE	Economic impact evaluation
FA	Factor Analysis
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FSM	Field Sampled Monitoring
GDP	Gross Domestic Products
GEF	Global Environmental Facility
GEM	Gender Empowerment Measure
GIS	Geographical Information Systems
GIZ	German Society for International Cooperation Ltd.
GTZ	German Technical Co-operation
GMF	Government Managed Forests
GMS	Government Managed System
GNP	Gross National Products
GoN	Government of Nepal
GPS	Global Positioning Systems
HH	Households
IA	Impact Analysis
ICDP	Integrated Conservation and Development Programme
IDRC	International Development and Research Centre
IFAD	International Fund for Agriculture Development
IIED	International Institute of Environment for Development

IIR	Intensive In-depth Research
ILO	International Labour Organization
INGO	International Non-governmental Organization
IOC	Intergovernmental Oceanographic Commission
IPCC	Inter Governmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
Km	Kilometre
Km2	Square Kilometre
KMO	Kaiser-Mayer-Olkin
KWS	Katarnia Wildlife Reserve
LA	Landscape Approach
LFA	Logical Framework Approach
LFP	Livelihood and Forestry Programme
LOAM	Landscape Outcome Assessment Methodology
LPFN	Landscapes for People, Food and Nature Initiative
LRMP	Land Resource Mapping Project
M	Monitoring
M&IA	Monitoring and Impact Analysis
MANOVA	Multivariate Analysis of Variance
MDG	Millennium Development Goal
MFSC	Ministry of Forests and Soil Conservation
MIS	Management Information System
MLRA	Multiple Linear Regression Analysis
MPFS	Master Plan for the Forestry Sector
MRV	Measurement, Reporting and Verification
MSFP	Multi-Stakeholder Forestry Programme
N	Population
n	Sample
n.d.	Not dated
N/A	Not Applicable/Available
NCVST	Nepal Climate Vulnerability Study Team
NFMA	National Forest Monitoring Approach
NGO	Non Governmental Organization

NPC	National Planning Commission
NS	Not Significant
NTFP	Non Timber Forest Products
NWFP	Non Wood Forest Products
OECD	Organisation for Economic Co-operation and Development
p	Level of Probability
PA	Protected Areas
PAS	Protected Area System
PCA	Principle Component Analysis
PCO	Programme Coordinator's Office
PRA	Participatory Rural Appraisal
RAP	Rapid Assessment Programme
RBA	Rapid Biodiversity Assessment
REA	Rapid Ecological Assessment
REDD	Reducing Emission from Deforestation and Forest Degradation
RMSE	Room mean squared error
RRA	Rapid Rural Appraisal
RRI	Rights and Resources Initiatives
RS	Remote Sensing
S	Significant
SAARF	South African Audience Research Foundation
SANRA	Sustainable Agriculture Network/Rainforest Alliance
SEA	Strategic Environment Assessment
SLF	Sustainable Livelihood Framework
SMART	Specific, Measurable, Attainable, Result Based and Timely
SMF	State Managed Forests
SMS	State Managed System
SSU	Service Support Unit
SWM	System Wide Monitoring
SWOT	Strength, Weakness, Opportunity and Threat
TAL	Terai Arc Landscape
TRA	Threat Reduction Assessment
TRI	Threat Reduction Index

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United State Agencies for International Development
VA	Vulnerability Assessment
VDC	Village Development Committee
WB	World Bank
WCS	Wildlife Conservation Society
WWAP	World Water Assessment Programme
WWF	World Wildlife Fund
WWI	World Watch Institute

CHAPTER I: INTRODUCTION

1.1 Background

Since the last decade in Nepal, the landscape-based conservation approach has been adopted as an opportunity to scale up conservation initiatives for long-term biodiversity conservation as well as to ensure sustainable development both inside and outside protected areas (World Wildlife Fund, WWF, 2004). The approach basically functions on the cooperation between people and various ecosystems connected to one another over a specified landscape. The Terai Arc Landscape (TAL) Programme based in the southern lowland of Nepal is one of the examples of such approach.

Initiated by the Nepalese Government in formulating, endorsing and implementing the TAL strategy, it was carried out in collaboration with various development partners (WWF, 2002a; WWF, 2004). WWF has supported annually average US$ 1.5 million. It has been planned to last until 2050, depending on the availability of funding. Gradual exit from sites and activities has started but the program will continue for a longer period (MSFP, 2013). Besides TAL, there are four other distinct and officially designated landscapes in Nepal namely: Chitwan Annapurna Landscape, Kailash Sacred Landscape, Kangchenjunga Landscape and Sacred Himalayan Landscape (Multi-Stakeholder Forestry Programme, MSFP, 2013).

In line with Food and Agricultural Organization, FAO (2008a) and Bodegom et al. (2009), TAL works with the philosophy of collaborative planning, implementation and monitoring for improved forests and other ecosystem-based management practices. It particularly follows a framework of effective forest based integrated conservation and development to strengthen protected areas (PAs) and forest management practices. A number of studies have reported that effective landscape approach can lead to higher level of biodiversity conservation and management, improved livelihood of local communities, sustainable forest management with increased carbon sequestration and ultimately contribute to mitigation of and adaptation to climate change (United Nations Environment Programme, UNEP, 2009; FAO, 2010; Parrotta et al., 2012).

TAL shares the roles, rights and responsibilities among diverse actors or stakeholders (Ministry of Forests and Soil Conservation, MFSC, 2006). Government, communities and other stakeholders are brought together to conserve forests and biodiversity through community based managements (TAL, 2005). Under TAL programme, community based forest management (CBM) secures the survival of forest ecosystems and enhances their environmental, socio-cultural and economic benefits (MFSC, 2013). It can both maximize the contribution of forests to society and environment and help forests and forest-dependent people adapt to new conditions caused by resource degradation and climate change. Local communities benefit directly from cash and kind supports. The increased capacity and the cooperation among the stakeholders contribute to natural resource conservation, livelihood improvement and the communities' adaption to climate change (Department for International Development, DFID, 2000; MSFP, 2013).

Drawing on the lessons in Nepal and elsewhere, TAL programme of Nepal serves as a model for how CBM could provide the foundation for linking biodiversity conservation, livelihood improvement, climate change mitigation and adaptation efforts together. It is through the insights into CBM that the multifunctional needs and challenges of landscape approach can be addressed.

1.2 Gaps

In Nepal, knowledge base on landscape level conservation (LLC) has remained fragmentary, limited and mostly undocumented. Wherever such knowledge has been synthesized, it simply presents a particular problem in developing a monitoring and impact analysis (M&IA) system. The level of study and communication among individuals and organizations has been sparse and sporadic and most of them have remained as isolated initiatives. The nature and type of information required for reflecting multi-stakeholders' interest for multiple objectives of conservation are poorly identified, studied and understood.

LLC is not a conventional development programme that implies only building physical structures, transferring technologies, or undertaking other activities with easily defined boundaries and readily measurable outcomes. It is rather an integrated approach to managing complex human-environment relationships beyond well-defined geographical boundaries. However, there is a lack of reliable information based on actual conservation conditions about the benefits and costs inherent to conservation systems.

In case of TAL, the practice of M&IA is evolving but there are problems where many questions have arisen on its overall effectiveness (MFSC, 2013). As M&IA deals with a wide range of environmental, economic, social, and cultural issues, it is becoming more inclusive with respect to the participation of interested stakeholders. However, regular M&IA is lacking due to resource, methodological and practical constraints. A proper M&IA requires time and sufficient human and financial resources, proper conduct, responses from clients, an agreed upon common methodology and willingness of clients to provide the required information. M&IA is crucial to demonstrate whether it has desired effects, served to inform strategic planning and used as an appropriate tool demonstrating positive effects to solicit external supports.

1.3 Justification

The management diversities of TAL contribute to the emergence of new national agenda to improve efficiency of the implementation and outcome of multiplicity of conservation and management demanding the need to search for common and efficient methodology or strategy for programme improvement and change assessment (Higgs, 2003; Kaimowitz & Sheil, 2007; World Water Assessment Programme, WWAP, 2012).

The formulation and implementation of the conservation strategy is a continuous process demanding to maintain a balance between the conservation, development and increased dimensions and pace of CBM (Vihemaki, 2005; Matiku et al., 2013; MSFP, 2013). The community organizations now have a greater role than ever before, calling for new and improved initiatives to meet the growing needs of society (MSFP, 2013). There can be LLC with weak measures but continued and wide spread improvement requires professional and effective interventions on assessment. It may not always be possible precisely to quantify the contribution of such interventions to the society, but there is little doubt that a well-planned and participatory approach contributes significantly in this aspect (Sayer et al., 2007). The lack of understanding and of development and dissemination of methodologies for proper understanding, planning, monitoring and impact assessment are the main obstacles to be overcome for effective conservation (Gottret & White, 2001).

Many authors argue that effectiveness of conservation depends on well-designed M&IA systems (Margoluis & Salafsky 1998a; Woodhill, 2000; Hockings, 2003; Frost et al., 2006; Stem et al., 2005). M&IA can pressurize for public and internal accountability (Hockings, 2003) and identify the conditions for successes or failures (Hatry, 1999). Moreover, it can serve as an early warning system for potential problems and remedial actions (Rigby et al., 2000; Dudley, 2008). An effective set of M&IAs, thus, contributes to improved decision making and implementation of LLC. It is particularly important when numerous efforts have been made in conservation field to develop useful and practical systems, often with mixed results (Sadler, 1996; Stem et al., 2005).

There is no generic methodology that can be universally adopted when it comes to M&IA or any other development tools. Such methodologies or tools can be tailored to specific realities and needs. The analysis requires using a mix of qualitative and quantitative tools to get a balance between analytical rigour and an understanding of impacts at different levels. Grassroot-level participatory research methods have been appreciated but not sufficient. However, a sound and participatory M&IA system is necessary to generate the information needed to inform decision makers and beneficiaries. The most important aspect of a good methodology for M&IA is that it is transparent and objective.

Though the monitoring and performance assessment could be carried out manually in spatial and temporal framework, it may take plenty of time and energy. Highly sophisticated technologies including Remote Sensing (RS) and Geographic Information System (GIS) are also to be compared based on merits and demerits. This confirms the need for the preparation of new approach introducing methodologies for practical and specific solutions, contributing to upgrading existing capacities, training of professionals and exchange of experience.

This study, therefore, represents an emerging new field of interdisciplinary inquiry concerning the future of LLC into community-based conservation that is evolving as one of the viable options of management models (Golde & Gallagher, 1999; Pennington, 2008) as it has its significance in identifying impacts and comparing and demonstrating the relevance of different approaches to M&IA. This study ultimately expects the outcome to be of a great value to make LLC programme integrated, systematic and coherent.

1.4 Objectives

The overarching objective of this study is to identify impacts and develop methodologies for M&IA of LLC. The specific objectives are to:

- identify the relevant areas of impacts of LLC interventions;
- review the current understandings, gaps, advantages and disadvantages; and analyze the relevance of prevailing methods of M&IA;

- identify the implementation impacts; and explore methods and tools to quantitatively assess them; and
- develop appropriate strategies and framework on M&IA specifically for TAL programme.

1.5. Research Questions and Hypotheses

Research questions

- How do the TAL interventions outside the protected areas contribute to achieving objectives on biodiversity conservation, livelihood improvement and climate change adaptation?
- What are the possible methods to monitor and assess the impacts?
- What are the possible strategies (including levels, methods and tools) for M&IA of LLC?

Hypotheses

The present study proceeds to examine the following hypothesis:

- There is no difference between LLC with CBM and non intervention sites on biodiversity status.
- There is no difference between LLC with CBM and non-intervention sites on livelihood status of people.
- There is no difference between LLC with CBM and non-intervention sites on performance to address climate change adaptation and vulnerability reduction.

1.6 Study Methods

This study is based on a range of literature and sources of information including participatory and expert methods and tools; literature, field level measurements, discussions and analysis. A separate section on methods is included in detail in Chapter 3.

1.7 Dissertation Structure

The dissertation is divided into six parts. It begins in Chapter 1 with introduction of LLC, objectives, hypothesis and methods of study.

Chapter 2 brings out theoretical constructs of LLC and its priority areas; presents some of the basic and crosscutting principles on M&IA of LLC and reviews literature on the methods and tools to assess livelihood improvement, biodiversity conservation and climate change.

Chapter 3 presents an overview on study sites and methods used followed by Chapter 4 which presents the result of studies.

Chapter 5 presents the analysis and discussions of the study and brings out a framework for establishing M&IA system in TAL aligning with the disciplinary principle and process of impact assessment and provides a practical and affordable approach to M&IA.

Chapter 6, the final part provides the key conclusions of the study and a supplementary discussion on the contribution of this dissertation to existing body of knowledge.

CHAPTER II: LITERATURE REVIEW

This chapter covers three aspects: reviews theoretical framework of LLC; provides a summarised overview of M&IA in conservation programme; and reviews some existing methodological framework, approaches, methods and tools.

2.1 Review of Theoretical Constructs

Landscape approach, which considers both the conservation and development (Sayer et al., 2007; 2013), has gained importance in response to increasing societal concerns on the trade-off between conservation and development. Now, the landscape concept has been central to many major national and international conservation initiatives (Sayer et al., 2013).

Following global trend, management of landscapes in Nepal started with the establishment of protected areas and strengthening of the systems through the principle of island biogeography and meta-population theory for conserving viable population of wildlife (Kingsland, 2002; Simberloff & Abele, 1982; Shaffer; 1987). The concept has now widened to embarrass the people-centred and multifunctional landscape, beyond simply protected areas and wildlife (Bennett, 1998, 2003). Since the last decade, Nepal adopted the landscape-based conservation as an opportunity to scale up both biodiversity conservation and sustainable development in the long run both inside and outside protected areas (WWF, 2004).

The term landscape, on the one hand, denotes to a physical geography or biophysical landscape that connects different parts of ecosystems. The term also signifies to a space which is lived, used and managed by people or actors. This is the part of human geography or human-environment relationship. Importantly, a landscape from conservation point of view differs from that from an engineering perspective where the former focuses on ecosystems and biodiversity as a prime concern. For example, Scherr & McNeely (2008) defines landscape as a mosaic where a cluster of local ecosystems is repeated in similar form and characterized by a particular configuration of topography, vegetation, land use, and settlement patterns.

LLC has been practiced and studied under many names, including landscape approach to biodiversity conservation (World Bank, 2014), bioregional approach (Brunckhorst, 2000a;b), ecoregional approach (Ricketts & Imhoff, 2003), transboundary landscape approach (Chettri et al., 2007), transboundary ecosystem management approach (Muhweezi et al., 2007), whole landscape management (DeFries & Rosenzweig, 2010), biological corridors (Susan, 2013), cultural landscape approach (Leader et al., 2004), forest landscape restoration (FAO, 2014), eco-agriculture (Scherr & McNeely, 2008), Satoyama landscapes (Bélair et al., 2010), living landscapes (Driver et al., 2003), landscape restoration (Karen et al., 2003) and multifunctional landscapes (Fry, 2001), to name some of them. Such approaches have recently stimulated new interests and increasingly recognized both the need and the possibility for more synergistic conservation and management landscapes ((Landscapes for People, Food and Nature Initiative, LPFN, 2012). Despite these nomenclatures, a common denominator prevails i.e. the human attachment to landscape and how the landscape as a whole is institutionally managed by the people for both ecosystems and human benefits (Taylor & Altenburg, 2006).

The LLC because of complex and many interlinked variables, posed a challenge to identify a single theoretical framework that is suitable for this study. To address the challenge, three parallel theoretical foundations in biodiversity conservation namely the theory of island biogeography and metapopulation (biophysical landscape), the human-environment theory (human geography) and political ecology (policies, institutions and contestation over the use of ecological resources) are combined.

2.1.1. Theory of Island Biogeography and Metapopulation

The theory of island biogeography holds that protected areas work metaphorically as islands whereas their surrounding landscapes resemble the water-bodies in the sea. The concept of metapopulation, on the other hand, deals with the population dynamics of species in the metaphorical islands. The component of island biogeography includes appropriate size, number, and distributions of reserves and connectivity between them (Simberloff & Abele, 1982); and the component of metapopulation concerns about maintaining viable populations (Shaffer, 1987). The former also includes the species-area relationship, island-mainland relationship, dispersal mechanisms, and species turnover. The principles of island biogeography and metapopulation contribute to a large extent to LLC in many ways (Kingsland, 2002).

Complementing the theory of island biogeography, the classical protected area conservation approach considers human dimensions as key factors responsible for damaging species and ecosystems. This approach allude to the situation where interconnected islands of protected areas support more biodiversity and ecosystems due to extended habitats for the species to move from one island to another compared to isolated islands. Nunn (1994), for example, states that human beings can cause damage to pristine island environments in four ways: overexploitation and predation, habitat loss, fragmentation and degradation and introduction of exotic species and diseases.

These theoretical foundations, however, are not free of short-comings. First, these theories basically stem from biophysical science often demeaning human or social dimensions. Human factors are considered detrimental to biodiversity. Second, a landscape is viewed as an apolitical spatial context without any institutions, which is simply hypothetical and has no meaning for management. Finally, it is not only the human factors but also various natural or biophysical factors that cause damage to species including their extinction.

Despite some of these limitations, several authors still take into account the value and contribution of the theories to modern ecology and biogeography (Yu & Lei, 2001). For this study, theory of island biogeography (MacArthur & Wilson, 1967) and metapopulation dynamics (Hanski & Gilpin, 1991) can be used to create a general framework in which the distribution of species and their trends can be studied systematically. The two theories have provided a stimulus and foundation for landscape approaches, and they have further been refined to address the priorities of local communities. The substantive innovations have been the recognition of the need to address the complex interactions between different spatial scales, and the need to embrace the full complexity of human institutions and behaviours (Sunderland et al., 2013).

2.1.2 Human-Environment Theory

The human-environment analysis lens, which refers to the study of humans and their environment together, has been deployed in the study of LLC. Unlike island biogeography theory, human-environment theory acknowledges the roles of human society not only in damaging biodiversity but also conserving them. This framework allows the human-environment interaction to be examined so that human values could be assessed alongside economic, environmental and other values.

The role of human support for conservation has been viewed as important in the context where pressure on natural resources continues to increase. Because of the fact that humans are skilled at adapting to changed conditions and are innovative for survival by playing effective roles for sustainable use of resources, they can play stimulating role for conservation (Griffin et al., 2004; Inglis, 2008). In the 1980s, the seed of contemporary environmentalism emerged to examine the Human Natural World Relationship and its role in conservation management (Mebratu, 1998). Mebratu (1998) argues that human beings have always affected the environment as they rely on the earth's resources to sustain life.

The argument that human beings play role in conservation does not speak out what role different individuals play. More recent scholars on biodiversity conservation have pointed out involvement of a diverse range of stakeholders (Figgis, 1999). Bringing insights from various disciplines such as socio-biology, behavioural ecology and evolutionary psychology (Betzig, 1997), ecological economics (Constanza, 1991), ecological psychology (Yunt, 2001) and environmental psychology (Gruenewald, 2004), researchers have demonstrated the role of multiple factors in addressing biodiversity conservation. Some relevant theories and philosophies that revolve around the Human Natural World Relationship concept are listed in chronological order in Table 2.1.

Table 2.1: Concepts and theories concerning the human-environment interaction

Human-environment theories	Relationship to nature	Environmental aspects
Tragedy of the Commons (Hardin, 1968)	Human dependency on natural resources	Recognition of human impact to develop sustainable systems
Sustainability (Strong, 1972)	Humans reliant on nature	Political leadership
Bioregionalism (Berg & Dasmann, 1977)	Recognises humans as part of nature.	Discover sense of place in nature to value resource
Natural Capitalism (Hawkins et al., 1999)	Humans reliant on nature	Develop green systems & political leadership
Theory on ICDP (WWF in 1980s)	Community centred natural resource conservation	Combines social development with conservation goals
Sustainable Livelihood Framework (DFID, 2000)	Natural capital placed under priority	Recognition and interdependence to environment

(Source: modified from Ingis, 2008; Meghi, 2014)

As visible from the Table 2.1, Human-Environment Theory is not a single theory but a set of several concepts or ideas. Yet this theory does not pay attention to human institutions and ecological distribution conflicts that affect nature conservation in many ways. Moreover, the theory like the island biogeography theory and metapopulation theory becomes apolitical and does not address the real issues about how people cooperate or confront for biodiversity conservation. It requires that the political economy of how some people gain and others lose from biodiversity conservation be studied to examine the landscape approach to conservation. This is the area of political ecology.

2.1.3 Political Ecology

Political ecology, which emerged as a perspective in 1970s, developed into a more robust field of research in 1990s. The theory emphasizes on the connections between ecology and social context by matching ecological and social sequences, contributing to the understanding of their interactions and the management of landscapes (Blaikie, 2006). The scholars on this theory have created a framework to analyse conservation in three main phases (Wilshusen et al., 2002): a) fortress conservation, b) different forms of co-management conservation and c) neoliberal conservation.

Fortress conservation

Fortress conservation is characterized by an exclusionary approach, often resulting into evictions of local people and defended the borders from outsiders (Brockington, 2002). The implementation of this model requires state bureaucratic environment (Lowe, 2006) and is dominated by experts (Saberwal et al., 2001). Several ecological distribution conflicts unfold in this approach since the local and indigenous societies dependent on the natural resources lose their access to and control over these resources. Antagonistic relationship develops between local people and the park authorities ultimately boiling down to human-nature conflicts. This model of conservation has been observed to result in extensive environmental injustices associated with the violation of traditional local rights to land and resources (Stevens, 1997). Particularly it has resulted into: a) struggles for more political and economic rights, recognition, inclusion, empowerment and participation (Escobar, 1995); b) the recognition of the role of local people in conservation (Cinner & Aswani, 2007) and c) the recognition that policies had different impacts of different intensity on different stakeholders (Bryant & Bailey, 1997). Acknowledging these shortcomings, political ecology analyses the conflicts, policies and institutions from the perspectives of who loses and wins from fortress approach to conservation.

Co-managed conservation

Co-managed conservation requires that the local communities be engaged in conservation efforts. It is a paradigm shifts from conservation-centric to people-environment centric principles. In this approach, the needs of co-managers are simultaneously met while meeting the needs of conservation; and conflicts are minimized by providing some space for the local people to be engaged in resource management. However, this approach is criticized for being overly populist at the cost of conservation. Critiques suggest that the shortcomings of co-management can be improved by making bureaucratic authorities stronger (like in fortress conservation) by providing ample space for private sector and other stakeholders to contribute to nature conservation.

Neoliberal conservation

This approach demands for deregulation of conservation, where community and private sector take on an increasingly larger role (Robertson, 2006). Scholars have viewed that the development of this approach followed general neoliberal strategies of the societies that traditionally funded conservation across the world (Reid, 2001). The roles of private sector, corporate sector, NGOs, INGOs and local communities are considered vital in this approach. The ecological distribution conflicts are managed by involving private sector and markets where the goods and services offered by ecosystems and biodiversity are valued in monetary terms.

The three different approaches discussed above have contributed to LLC. The notion of spatial contexts is borrowed from island biogeography and metapopulation theories, while their limitation on human aspects is addressed by human-environment theory. Similarly, the shortcoming of human-environment theory to address conflicts over the use of ecological resources has been addressed by political ecology. Hence, building on the merits of island biogeography and metapopulation theories and human-environment theory, LLC benefits from political ecology for managing conflicts over the use of natural resources by integrating political institutions, collective actions and markets for win-win situation of conservation and livelihoods of local communities.

2.2 M&IA in Conservation Programmes

2.2.1 Monitoring Conservation Initiatives

Monitoring is the process of observing or checking on project activities and their context, results and impact (Bhattarai & Campbell, 1985; Horton et al., 1993). Literature suggests that the goals of conservation monitoring could be: a) to ensure that inputs, work schedules, and outputs are proceeding according to the stipulated plans, b) to provide a record of input use, activities, and results; and c) to warn of deviations from prime goals and expected outcomes (Clayton, 1985; Horton et al., 1993; Stem et al., 2003; Hulme, 1997; Convention on Biological Diversity, CBD; 2006a;b)

Monitoring is one of the most important but often neglected, or least adequately carried out, aspects of the development process (Holden, 1994). In many respects, this stage can be viewed as both simple and complicated depending on the contexts. In LLC, it can be seen simple in a way that monitoring is a process whereby information is gleaned from fields and then the programmes are amended in the light of its comments (Phillips, 1983; Etington, 1984; Holden, 1994). However, it is complex in the sense that there are stakeholders with diverging views in the process (FAO, 1986; Holden, 1994). Monitoring is a separate process in a project cycle but also closely related to evaluation. Monitoring provides current information for project management and also a basis for on-going and ex-post evaluation (Cernea & Tepping, 1977).

In General, TAL monitors progress over time, both in quantity and quality, toward the delivery of outputs and outcomes, and total spending against expected expenditures both at the site and the landscape level. Each implementing unit is expected to monitor its progress and to report on a regular basis using a standard reporting template. In the TAL strategy, monitoring is facilitated by the explicit development of targets and relevant indicators. Regular monitoring has to be done for selected indicators, with at least annual review, reflection and reporting. Progress, assessed by comparison of actual achievements with intended milestones and indicators, has to be assessed along a sequenced hierarchy of outputs, outcomes and their respective milestones forming the backbone for M&IA of TAL and its components (Ashley & Hussein, 2000; Buck et al., 2006).

Monitoring reports include: a) target achieved, delayed or not achieved, b) the quality and significance of achievements, c) measures of progress on crosscutting theme d) role and engagement of partners, e) comparison of budget against actual expenditures and f) deviations from plan, new directions and revisions to the impact pathway (GTZ, 2001; Martin 2009). There are three elements that differentiate LLC monitoring from the monitoring of other development projects. First, LLC monitoring seeks to identify and document synergies as well as trade-offs between biodiversity conservation, livelihoods and climate change in such a way that the indicators elucidate more than one goal. Second, ecosystem services in LLC provide a tangible link among the goals of conservation and are considered an important focus of monitoring. Third, monitoring is carried out at a nested series of scales from individual sites and communities up to landscapes and even beyond the area.

2.2.2 Impact Analysis

IA of a project answers (Asian Development Bank, ADB, 1984): a) whether the site ecology and socio-economic conditions of the target groups have changed in significant way as a result of project activities; b) if so, in what direction (positive or negative); c) to what extent; and d) why (causal relationships). According to Gregerson et al. (1993), IA provides information that decision makers need to: a) define problems and opportunities that merit project intervention; b) formulate, appraise, and choose among alternative designs of projects; c) monitor and evaluate ongoing projects to improve project performance; and d) evaluate projects after completion to provide information to help improve the planning and implementation of future projects.

Although policy and decision makers in Governments and donor agencies recognise the need for adequate IA, the assessment is often neglected in practice, or only partially or poorly executed (Gregersen et al., 1993; Valadez & Bamberger, 1994). High proportions of assessments have tended to focus on species conservation aspects. Little attention has been devoted to broader aspects of biodiversity, social, institutional, climate change impacts and sustainability (Valadez & Bamberger, 1994). IA can be done at all stages on the project development and implementation process. Despite much existing work on various aspects of M&IA, it has been deemed necessary to develop an approach with a focus on LLC.

There is a body of rich literature (International Institute of Environment for Development, IIED, 2001) covering wide range of development projects that distinguishes impact assessment on disciplinary lines such as environmental impact assessment (EIA), social impact assessment (SIA), environmental health impact assessment (EHIA), risk assessment (RA), strategic environmental assessment (SEA) and economic impact evaluation (EIE). Strategic environmental assessment (SEA) emerged in the 1990s in response to problems observed in the project-specific EIA. Yet, another outgrowth of IA, biodiversity impact assessment (BIA), came about in the 1990s with the impetus largely coming from the 1992 Convention on Biological Diversity (CBD). BIA expands the scope of EIA to include an emphasis on avoiding or minimizing the negative effects that projects or policies may have on biodiversity (Wildlife Conservation Society, WCS and Conservation International, CI, 2004).

IA constitutes five stages: prioritization of constraints and opportunities, *ex ante* IA, on-site evaluation, conservation pathway studies and *ex post* IA. Since the different types of IA are not mutually exclusive, they are categorized mainly into three assessment types:

Ex ante IA: Methods for *ex ante* impact and priority setting are found in Douthwaite et al. (2002), Kormawa et al. (2002), Kiiza et al. (2004), Muchopa et al. (2004), Manyong et al. (2004 & 2005) and Sanusi et al. (2005).

Site level and household level IA: Examples of studies at this levels are found in Kormawa et al. (2002), Douthwaite et al. (2005), Kristjanson et al. (2005), Nkamleu & Manyong, (2005) and Tipilda et al. (2006).

Ex post IA : Examples of publications using economic techniques and approaches are found in De Groote et al. (2003), Manyong et al. (2001), Coulibaly et al. (2004), Nkamleu & Manyong (2005) and Douthwaite et al. (2005).

2.3 Crosscutting Aspects

In both types of measures discussed above – Monitoring and Impact Analysis – both effectiveness and status are necessary to assess. The effectiveness can be measured in terms of process measures, intervention measures, threat reduction measures, and outcome measures (Buck et al., 2006). The status assessment concerns on assessing the conditions or status of conservation at a particular point in time (Stem et al., 2005).

LLC operates under conditions of imperfect knowledge and uncertainties, and thus it is difficult to extrapolate from current social and ecological knowledge. Flexibility in methodological design is essential to address the challenges. Hence, lessons from integrated approaches for natural resource management need to be drawn upon. Various components in M&IA need to be analysed independently so as to acknowledge that the output or result from one component can be an important input into the other components. This requires separating individual components for further analysis. As Gregersen & Contreras (1992) have stated, separating components is important for two reasons: first, it makes the analysis process manageable; second, each component is required to demonstrate positive contribution.

The significance of stakeholders or intended beneficiaries in the M&IA process, which has been well recognized, is used as a component in this crosscutting aspect. This participatory approach can be useful in incorporating traditional and local knowledge in conservation (Berkes & Turner, 2005; Izurieta et al., 2011). The involvement of multi stakeholders is also essential to lend maximum legitimacy to monitoring and assessment results and earn credibility (UNEP; 2003; CBD, 2006a;b; Buck et al.,2006).

The issue of scale posed by M&IA can be addressed by matching the scale of project and scale of M&IA. For example, a site level project, even if quite successful, will probably have a negligible impact on landscape-scale indicators. As stated by Buck et al. (2006), these considerations suggest that measurement framework should include project-level assessment as well as landscape-scale assessments. The outcomes are affected by both site scale and landscape scale factors, reinforcing the need for a multi-scale approach (Conservation measure partnership, CMP, 2004; Buck et al., 2006).

Multiple benefits of LLC include, but are not limited to, - increased livelihood assets, biodiversity conservation, and increased resiliency to the impacts of climate change-pose challenge of addressing trade-offs between them (Adams et al., 1999). It has been argued that the interconnection of these goals is too strong for either to be attempted in isolation (Sachs et al., 2009; UNDP, 2010). Acknowledging and dealing with trade-offs is difficult but has been cited as a reason for limited success of interventions (Campbell et al., 2010).

It is also essential to link M&IA with planning conservation interventions. M&IA alone faces a recognized shortfall in funding and time allocation, skill and training of staff along with a general reluctance of conservation mangers to focus on M&IA (Bose, 2007; Kapos, et al., 2008; Bottrill et al., 2011). To address this, many frameworks already exist for integrating planning and performance assessment in the context of conservation and rural development (Buck et al., 2006; Bolwig et al., 2003; Cowles et al., 2001). These planning frameworks contribute to balancing trade-offs to meet the need of the poorest and most vulnerable.

In M&IA, baseline data, which serves as a point of comparison (Organization for Economic Co-operation and Development, OECD, 2002) should be collected at the outset of a project (IFAD, 2002). The baseline data is required to gauge progress against indicators, but is often missing or inaccessible making it difficult to gauge conservation outcomes (Pullin & Salafsky, 2010). Similarly, the data collected is often insufficient to assess if they have had any impact (Brooks et al., 2006).

Conservation intervention IA which can be defined as the difference between “with” and “without” the project is basic to TAL IA. The approach, however, is not analogues to “before” and “after” of the project. Hence, changes have to be estimated (Gittinger, 1982; Gregersen & Contreras, 1992).

Conservation can have impacts on individuals, households and communities. Given the concern that the benefits and costs associated with the conservation may not always be equitably distributed, it is particularly important to assess both costs and benefits at all possible levels (Catley et al., 2008).

2.4 Review of Existing Methodological Framework: Approaches, Methods and Tools

2.4.1 Relevant Impact Areas

LLC is a vision for effectively conserving biodiversity and ecosystem services, supporting viable livelihoods including climate change for local people and providing forestry products and services on a sustainable basis (Sayer et al., 2007; Kingsland, 2002; Simberloff & Abele, 1982; Shaffer; 1987). TAL aims to create a number of positive social, physical, environmental, and economic benefits for the communities participating in the programmes (Stevens, 1997; Machlis & Field, 2000; Bajracharya et al., 2006).

The conservation of TAL in the past relied on state managed, controlled and people exclusionary conventional approach. Under LLC, beyond the conventional paradigms, some innovative approaches such as CBM, PA management (Armitage, 2005) and the establishment of community networks have also been applied widely. These approaches emphasize on an understanding of impact on improvement of livelihoods, conservation of biodiversity and management of climate change (Scherl et al., 2004; Badola et al., 2010) which are inter-linked to address local, national and global challenges (UNEP, 2010).

2.4.2 Measurement of Livelihoods

The idea of livelihood evolved from an economic perspective to a multidisciplinary and multi-dimensional approach (Sumner, 2004). In the 1950s, quality of life was measured by a single indicator – Gross Domestic Product (GDP) per capita, perceived as an economic phenomenon. This perception was later changed to a much broader multi-dimensional concept. In the 1980s, the theories viewed a person's life in terms of functioning and capabilities (Costanza et al., 2007; Sen, 1997) and strongly influenced the Human Development Index (HDI), which was considered as one of the most widely used development indices since 1990 (UNDP, 2006). In the late 1990s, the tradition of measuring quality of life subjectively was increasingly accepted (Diener & Suh, 1997). A quite recent development in the quality of life is based on the concept of sustainability, the effort to meet the present needs without compromising for future. This concept basically draws on the Sustainable Livelihood Framework (DFID, 2000).

Livelihood is the means of gaining a living grounded on people's capabilities (Chambers & Conway, 1991; Sen, 1997), activities, assets and outputs. Sanderson (2000) described it as how people obtain assets, what they do with them, what gets in their way and who controls the resources. The sustainable rural livelihoods model developed by Carney (1998a) and used by DFID has been widely used to understand livelihoods (DFID, 2000). The model analyses the causes of vulnerability, the household assets, the livelihood strategies and the livelihood outcomes by focusing on communities at the centre (Scoones, 1998; Carney, 1998a;b; Ashley & Carney, 1999, Farrington et al., 1999). The prevailing livelihood approaches focus on what people have, not on what they are missing (Moser, 1998).

The measurement of livelihoods demands identification of suitable indicators constituting a composite index that combines various national and international indices including Human Development Index (UNDP, 1993; 2006) and Water Poverty Index (Sullivan, 2002). Attempts have been made to inculcate social indicators for complementing GDP and additional subjective measures (Moller & Schlemmer, 1989) such as satisfaction or happiness. Very recently, trends have increased to construct composite indices of quality of life at international, national, regional or community levels including either objective, subjective or both types of indicators (Cummins, 2000; Rai et al., 2008). Simultaneously, several international and cross-national indices have been developed based on time series data and spatial data.

The global indices and indicators have been used in specific spatial contexts. The measures and reports published recently include: Beyond GDP (European Commission, EC, 2007), the Happiness Index of Bhutan (The Centre for Bhutan Studies, 2008), the Canadian Wellbeing Index (Canadian Index of Well-being, 2009),Your Better Life Index (OECD, 2011), the Quality of Life Index (Moller & Schlemmer, 1989), the Everyday Quality of Life Index (Higgs, 2007), and the Living Standard Measure (South African Audience Research Foundation, SARF, 2013). The most notable and frequently used indices are: Gender Empowerment Measure (GEM) (Sharpe, 1999), Gross National Product (GNP) by the United Nations & the World Bank (World Bank, 2001), Human Development Index (HDI), the Human Poverty Index (HPI) (UNDP, 2006), the Worldwide Governance Indicators (WGI)

(Thomas, 2006) and the Doing Business (DB) Indicators (International Labour Organisation, ILO, 2007).

In conservation sector, there are a number of livelihood indices and measures of wellbeing. These include Asset Index (Filmer and Prichett, 1999), Household Livelihood Security Index (Lindenberg, 2002), Household Social Vulnerability Index (Vincent, 2004), Living Standards Index and Wealth Index (Vyas & Kumaranayake, 2006), Livelihood Vulnerability Index (Hahn et al., 2009), Livelihood Sustainability Perception Index (Adisa & Badmons, 2009), Livelihood Effect Index (Urothody & Larsen, 2010), Wealth Index or Socioeconomic Index (Gunnsteinsson et al., 2010), Livelihood Index (Rai, et al., 2008; Krishnan, 2010; Swathilekshmi, 2010), Livelihood Diversity Index (Kien, 2011), Vulnerability Index (Tesso et al., 2012), Adaptation Index (Below et al., 2012), Wealth Index (Kalinda et al., 2014) and Household Asset Index (Salia, 2014).

For the construction of composite index, there are certain steps to be followed (McGranahan et al., 1972; Sharpe & Smith, 2005). The variables need to be selected based on a theoretical framework using top-down approach (Sirgy, 2011) and/or the bottom-up approach (Dluhy & Swartz, 2006). At this stage, structured and good quality data would be essential (McGranahan et al., 1972) and select a method to treat missing data (OECD, 2008). The data can be explored using multivariate analysis techniques to identify the underlying structure and constructs followed by weighting and aggregation of the indices (McGranahan et al., 1972). The selection of the weighting method and assessment of the robustness are the main challenges in the construction of composite indices. Equal weighting is the common method to weight composite indices for simplicity (Hagerty & Land, 2007).

Multiple regression analysis is an alternative method to weight indices in which the regression coefficients are used as the weights (Cherchye et al., 2007). Principal Component Analysis (PCA) and Factor Analysis (FA) are the common multivariate statistical techniques to weight composite indices (Booysen, 2002). The factor loadings of variables on the first component of PCA or FA can be sufficiently used to represent the original variables (Ram, 1982) and if explanatory value is less than 55%, subsequent components should be included to derive the weights to preserve useful information (Aivazian, 2005). PCA is a basic method to determine the weights and select limited number of indicator variables representing the relevant dimensions. Moreover, both objectively and subjectively measured indicators can be included in the composite index (Stiglitz et al., 2009). Annex 2 summarizes approaches, strengths and weaknesses with examples of different tools and techniques prevailing in social M&IA.

2.4.3 Measurement of Biodiversity Impacts

Under LLC, the biodiversity hierarchy is composed of the genetic, species-population, community-ecosystem and landscape levels. Information of vertebrate and flowering plants are frequently used as surrogates for estimates of total biodiversity, because the inclusion of invertebrates and non-flowering plants is perceived as being too time-consuming, costly and difficult (Noss, 1991; Noss & Cooperrider, 1994). Wilson et al. (1996) identified attributes of biodiversity that can be assessed at landscape, ecosystem, species and genetic levels. It is worthwhile to assess and interpret biodiversity across all these levels of organization by using various approaches at several spatial and temporal scales (Noss, 1990; Noss & Cooperrider, 1994).

Landscape Level

Landscape diversity is the number of ecosystems, or combinations of ecosystems and types of interactions and disturbances present within a given landscape. The relevance of landscape structure to biodiversity has been established in the scientific literature (Forman & Godron, 1986) on landscape features which have effects on species composition, distribution, and viability (Noss & Harris, 1986). The monitoring focus should be on the current level of landscape diversity and comparison with historic levels, trends in habitats or populations of a particular species and trends in landscape features (McGarigal & Marks, 1993).

This level concerns to dynamic entities composed of the biological community and the abiotic environment. At this level, monitoring is important for the maintenance of ecosystem functions and integrity (Haynes et al., 1996). The monitoring focuses on the effect of management activities or natural disturbances of species diversity in a particular area. A common way of assessment is by measuring and documenting the number and relative abundance of species in a community or ecosystem, often referred to as species diversity (Hurlbert, 1971).

Diversity Indices

Various indices have been outlined to measure diversity within a biotic community

(Magurran, 1988). The various diversity measures are given below:

- Species richness indices include Simpson's Index, Margalef Index, Berger Parker Index and Rarefaction Index. Diversity Indices include Shannon Wiener Index, Brillouin Index, Log series Index, Log Normal Diversity, McIntosh's Measure of Diversity, Jackknife Index and Q Statistic.
- Species evenness indices include Hill Numbers and Caswell Neutral Model. The commonly used indices of alpha diversity are Brillouin's diversity index, Brillouin's evenness index, Brillouin's maximum diversity index, Hill's diversity index, Hill's reciprocal of C, Margalef's diversity index, Shannon index and Simpson index.

Taking into consideration the demerits of these conventional indices, new indices have been recently introduced such as Taxonomic Diversity Index, Taxonomic Distinctness Index, Phylogenetic Diversity Index and Abundance/Biomass Comparison (ABC) Plots, Dominance Plot, Geometric Class Plots and Species Area Plot (Gotelli, & Collbell, 2011; FAO, 2011).

Population-Species

The monitoring focuses on the trend in the species, population, abundance and probability of occurrence. Most monitoring of biodiversity has occurred at the population-species level, but there is no single approach without pitfalls to decide which species or population to monitor (Gaines et al., 1999). Literature shows five categories of species that may be selected for monitoring: a) ecological indicator species, b) keystones species, c) umbrella species with large area requirements, d) flagship species, and e) vulnerable species (Noss, 1990). The most reliable approach would include monitoring both habitat and population variables (Noss, 1990).

Abundance Indices

Abundance indices refer to the relative measure of the size of a population or sub-unit of the population, which are divided into direct indices and indirect indices. Direct indices are based on direct observation, either visually or through capture or harvest (Seber, 1982; Wilson et al., 1996). Indirect indices are based on indirect evidence of a presence (Seber, 1982), for example, track counts, scent station surveys, auditory indices, structure surveys, scat and other sign counts, and home range size estimates (Wilson et al, 1996). However, in case of availability of appropriate indices, there is no need to estimate an absolute density (Wilson et al., 1996).

Scale in Biodiversity Studies

Whittaker et al. (2003) argue that the scale of a study is determined by the size of its samples. The general terms, micro, meso and macro scale are used frequently in the biodiversity literature. The studies of micro-scale variation in biodiversity correspond to alpha (α) diversity; studies of macro-scale variation in biodiversity correspond to gamma (γ) diversity; and the meso-scale studies of biodiversity may correspond to either alpha (α), beta (β) or gamma (γ) diversity. An approximate guide to the scale and the diversity phenomena measurable at that scale is presented in Table 2.2.

Table 2.2: Approximate scale, sample grain and biodiversity phenomena

Scale	Approximate sample grain	Diversity phenomena measurable
Micro	< 0.01 km2 (1 ha)	Alpha (α) diversity
Meso	0.01 – 100 km^2	Alp(α), beta (α) and gamma (γ) diversity
Macro	> 100 km^2	gamma diversity

(Source: Clark, 2008)

Participatory Tools and Methods

A suitable decision to choose a particular type of method for participatory bio-diversity monitoring fully relies on attributes of biodiversity one wants to measure in particular locality (Margoluis & Salafsky, 1998a;b). Based on available literatures and applicability, the methodologies applicable for this study have been listed in Annex 3.

Non-participatory or Expert-based

The approach focuses on conventional scientific or professional methods. It has been conducted by professional scientists or ecologists applying sophisticated and complex tools and techniques (Rohr et al., 2007). There is an ample literature suggesting proper design of professional methods for monitoring biodiversity and reference materials can be found in Sutherland (1996), Elzinga et al. (2001), Hill et al. (2005), Bani et al. (2006), and Myers & Patil (2006) (Annex 4).

2.4.4 Vulnerability and Adaptation Assessment Framework

Vulnerability can be defined as the degree to which a system is susceptible to adverse effects of climate change and is commonly characterized as a function of exposure, sensitivity, and adaptive capacity (Swanson et al., 2007). The assessment selects a target group and seeks to determine the risk of specific adverse outcomes and identifies a range of factors that may reduce response capacity and adaptation to stressors (Bandyopadhyay et al., 2011). Adaptation is focused to a series of specific actions or measures that directly avoid the adverse effects of climate change.

The methodology for vulnerability assessment represents human-environment system and interactions to a wide range of interrelated issues on a) climate change impacts on livelihood b) climate change impacts on forests and ecosystem services, and c) the change of response and resilience of the system. In assessing the impacts, vulnerability and adaptation to climate change, a large array of methods and tools pertain to specific sectors, scales of analysis, and environmental and socioeconomic contexts. Various guidelines present methodological frameworks for conducting climate change vulnerability and adaptation (V&A) analyses, within which specific methods and models are described (Warrick, 2000). The basic methods and tools are included in Annex 5.

2.4.5 General Framework

The Driver-Pressure-State-Impact-Response (DPSIR) Framework

The DPSIR framework is one of the causal models, an extension of the (Pressure-State-Response) model, developed by Anthony Friend in the 1970s, and subsequently adopted by many institutions. Initiated by the Organization for Economic Co-operation and Development (OECD, 1994), the framework has been modified for use in the Millennium Ecosystem Assessment (MEA) and has also been proposed to the UN General Assembly for the global reporting and assessment of the state of the environment, including socio-economic aspects (Pierce, 1998; European Environmental Agency, EEA, 1999; UNEP, 2004; 2007; UNEP & -Intergovernmental Oceanographic Commission- The United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO), 2009). The approach is a flexible framework often used in many steps of the decision making process.

GIS and RS in M&IA

Satellite data have been used in the management of natural resources including their mapping (Baral, 2004; Ichter, 2014). RS, which is regarded as a promising data source for multi-temporal vegetation monitoring, is advantageously aligned to provide maximum benefit from resource expenditure (Australian Greenhouse Office, AGO, 2002). Satellite RS has been widely used to detect biodiversity change and update existing maps (Defourny et al., 2006). RS has been also used to gather information on biophysical i.e. vegetation cover and other terrain, and physical parameters, that could have a vital role in decision-making or livelihood options (Ichter, 2014; Mbaabu et al., 2014). However, literature review shows that there are relatively a fewer examples of remote sensing applications in social science research (Guebas, 2002; Mayer and Lopez, 2011).

Landscape Outcome Assessment Methodology (LOAM)

Working at the level of landscape meets challenges in identifying key values or functions of the landscape as a whole, as well as measuring and monitoring outcomes of conservation (Stem et al., 2005; Farina, 2006). In response to these challenges, conservation organizations have developed the Landscape Outcome Assessment Methodology (LOAM) aiming to measure, monitor and communicate the nature and extent to which a landscape is changing over time (Sayer et al., 2007; Aldrich & Sayer, 2007).

LOAM uses the capital assets mentioned in Sustainable Rural Livelihoods Framework of Carney et al. (1988a;b). This is based around five assets - natural, human, physical (or built), social, and financial (or economic). The framework identifies through a stakeholder process, a small representative set of locally appropriate indicators grouped under each of the five assets. A scoring system is then applied to measure, monitor and communicate the nature and extent to which the landscape is changing over time (Carney et al., 1998a;b).

National Forest Monitoring Assessment Approach (NFMA)

NFMA estimates the extent of forest resources through land use/land cover mapping of the field plots and through remote sensing surveys (Leppanen, 2008). Mapping of forest resources in the field plots carried out during the field inventory, on one hand, makes it possible to detect, from the ground, detailed changes in the forest characteristics and to directly relate that information to other parameters estimated on the plots (IFAD, 2009). Remote sensing, on the other hand, performs additional analysis of the data gathered in the field. Besides, the NFMA methodology captures a variety of parameters useful for assessing biodiversity, number and types of tree species, diameter at breast height (DBH) and height by species and forests (FAO, 2008b; Tomppo & Andersson, 2008; IFAD, 2009).The methodology also covers the socio-economic function of forests through a series of interviews with three major informant categories: (a) key informants, (b) focus groups or individuals, and (c) randomly selected households (Leppanen, 2008; IFAD, 2009).

Threat Reduction Assessment Approach (TRA)

The approaches to measure biodiversity outcomes are based on three categories of indicators namely habitat integrity, habitat quality and ecological processes (Olson & Dinerstein, 1997). However, challenges faced while implementing biological indicator approaches are daunting. Scientists have responded the need for practical and meaningful measures of project impact by developing the Threat Reduction Assessment (TRA), which produces TRA Index (Margoluis & Salafsky, 1998a;b). It is a measurement tool that provides useful information at an acceptable cost and complements biological indicator approaches to measuring project success. The TRA approach to measuring project success is based on three key assumptions: a) all destruction of biodiversity is human-induced, b) all threats to biodiversity at a given site can be identified; and c) changes in all threats can be measured or estimated (Margoluis & Salafsky, 1998a;b). Using a number of steps, this approach identifies threats, ranks them according to the criteria and assesses the progress in reducing them (Margoluis & Salafsky, 1999; Rome, 1999).

M&IA Approach Focused on Wildlife Management

The results of landscape and wildlife management activities are often complex to be assessed (Walters, 1986). In Annex 4, this study provides the potential methods and tools to measure performance on wildlife management in line with Greenwood (1996).

2.5 Research Gaps in the Existing Literature

There is a noticeable gap in the existing literature when quantitative and detailed analysis of impact of LLC is considered. Though there is an abundance of literature on LLC, very little is available on the impacts of LLC particularly the ones founded on empirical field-based research. Diverse approaches have been employed to determine changes related to conservation, but only a very few studies (Gregersen & Contreras, 1992; Lindenmayer, 1999) have used research results that compare changes between before and after interventions or between the areas of interventions and non-interventions.

Most of the studies conducted on impacts of LLC have based either on stakeholders' perception (Nagendra, 2002; Yadav et al., 2003; Gautam & Shivakoti, 2005; Danielsen et al., 2005; Sudha et al., 2006; Dahal & Capistrano, 2006; Tiwari & Kayenpaibam, 2006; Gautam, 2007; Ellis & Porter-Bolland, 2008; Thoms, 2008; Lund & Treue, 2008) or on small scale data collection (Conroy et al, 2002; May et al, 2004, Adisa & Badmos, 2009; Krishnan, 2010; Aryal et al., 2012; Kalinda et al, 2014; Kormawa et al, 2004; Meghi, 2014). Except in a few studies (Diener & Suh, 1997; GEF, 1998; Hockings et al, 2006; CARE, 2010; CIFOR, 2013; DeFries & Rosenzweig, 2010), a large number of other studies do not compare on the ground impacts of intervention areas to those in non intervention areas.

Different authors (Fafchamps & Gavian, 1997; Manyong et al., 2001; Shrestha et al., 2001; Selman, 2004; Kaimowitz, & Sheil, 2007) have pointed out that the surveys and desk studies are not scientifically rigorous. It has also been pointed out the field studies only looking at effects in an intervention areas fall short as well as impacts found in the field cannot certainly be attributed to the intervention alone (Bennett et al., 2002; IFAD, 2002; Bajracharya et al., 2006; Bose, 2007).

Long term environmental studies exist in a very small number because of the fact that it takes years, before the effects of interventions on species abundances and composition became apparent (Brown, 1998; Gaines et al., 1999; Buck et al., 2006; Clarke, 2008; CBD, 2011; Sayer et al., 2013). There is also lack of strong evidence on impacts of conservation on other environmental indicators such as ecosystem functions, carbon, soil and water quality or downstream effects (GEF, 1998; Smith & Scherr, 2003; UNEP, 2004; 2010).

Literature on the impacts of LLC have mostly centred on particular issues, for example, biodiversity (World Bank, 1998; Danielsen et al., 2000; Bunnell & Dunsworth, 2009), wildlife (Van Horne, 1983; Cooperrider et al., 1986; Greenwood, 1996), local communities (Boyd et al., 2005; Griffiths; 2007) and geographical areas (Higgs, 2007; Thornton et al., 2002). Typically, few specific aspects of management are assessed, for example, buffer zones (Ryan, 2008) and forest management (Dahal & Capistrano, 2006; Matiku et al., 2013). Other studies have looked at impacts on different aspects of natural resource management, for example, community forestry (Nagendra, 2002; Thoms, 2008), enterprises (UNDP, 2010), and climate change (Campbell et al., 2009; Tesso et al., 2012).

Some of the studies have pointed out complications involved in studying LLC. For instance, UNEP (2003), CMP (2004) and Buck et al. (2006) spotlighted at complexity of objectives and assessment level (individual operation vs. system-level improvements). Other studies, however, have shared positive experiences from LLC regarding literature survey of an extensive sample of case studies from various protected areas (Machlis & Field, 2000; Saberwal, 2001; Hockings et al., 2006; Stem et al., 2003; Clark et al., 2008; Coad et al., 2008;

Geldman, 2013). Yet others have shown clear correlation between LLC and positive outcomes, but they do not discuss the theory of change behind the transition (World Bank, 1994; Ashley & Hussein, 2000; Inglis, 2008; Meghi, 2014). In addition, they also do not discuss whether the improvements occurred simultaneously with LLC without confirming any attribution (correlation) or due to LLC (causality) (Karmann & Smith, 2009).

All the methods on M&IA reviewed so far are found to have focused on information needs and data collection methods rather than developing appropriate processes (Bird et al., 2005). This trend is contested (Guijt, 2009) and recommendations are forwarded for a better balance between data collection and analysis so as to identify a) lack of capacity for upward aggregation; b) dealing with intangible impacts; and c) focus on assessing benefits rather than costs. A summarized list of vast and growing literature on the subjects of M&IA ranged from small-scale projects targeting specific questions of current management to large-scale monitoring is presented in terms of strengths, weaknesses and opportunities of various approaches, methods and tools are summarized in Annex 2-5.

In the areas of biodiversity conservation, livelihood improvement and climate change management related to LLC, no integrated studies exist. In particular areas, however, there is an increased rate of publications on conservation effectiveness (Mugisha & Jacobsen, 2003; Ryan, 2008; Linder, 2012); biodiversity conservation (Pandey, 2007); livelihood improvement (WWF, 2008; Ashley & Hussein, 2000); and climate change adaptation (Warrick et al., 1996). Studies undertaken at the national level are either expert-centric focusing on wildlife (Geldmann, 2013; Meghi, 2014) or community forestry centric (Pokharel, et al, 2005) and at the global level they are mainly based on expert opinion (Buck et al., 2006; Frost et al., 2006; Sayer et al., 2013).

Many researchers and scientists (Margoulis & Salafsky, 1998a;b; Sayer et al., 2013) emphasize that M&IA of LLC can be complex since more than one type of issues may occur at any levels. This complexity makes it difficult to use the same tools, techniques and methods for addressing different types of issues. It is recognised that there is a strong need for a coordinated and complementary set of M&IA approaches. A mix of M&IA types and methods is required, depending on the goals of the M&IA (Bunnell & Dunsworth, 2009; Munks et al., 2009). Taking into consideration the purposes, strengths and limitations of the available methods, a comprehensive method that complements one another and provides different levels of qualitative and quantitative information can be developed.

CHAPTER III: MATERIALS AND METHODS

3.1 Study Sites

3.1.1 TAL Area

TAL, identified as priority landscape by the WWF Tiger Action Plan and the WWF AREAS programs, is a transboundary landscape spreading over the part of Nepal and India. Extending from the Bagmati River (Nepal) in the East to the Yamuna River (India) in the West, it is also one of the most biologically diverse habitats on the Earth with a total area of about 49,500 Km^2. There are 15 Protected Areas in the landscape, from the eastern most being Parsa Wildlife Reserve in Nepal to Rajaji National Park in India in the West catering to the need of protection of three terrestrial flagship species: Tiger, Rhino and Elephant (WWF, 2002a; WWF, 2004; MFSC, 2006).

In Nepal, it was developed jointly by MFSC and WWF Nepal as an outcomes of the learning of previous projects such as Bardia Integrated Conservation Project (BICP) and Western Terai Tiger, Rhino, Elephant Complex (WTTREC) project. Conceptualized and designed in 2000 and started implementation in 2001 though the strategy came out only in 2004, it covers a total area of 23,199 Km^2 out of which forest area covers 14000 Km^2 (WWF, 2002a; b). The TAL program encompasses six protected area systems (PAS): three National Parks (2450 $Km^{2)}$, two Wildlife Reserves (804 Km^2), one Conservation Area (16 Km^2) and four buffer zone areas (812 Km^2); and seven biological corridors and bottleneck areas (WWF, 2004).

TAL in India, on the other hand, consists of the nine PAS (four National Parks and five Wildlife Reserves) and four types of land: a) forestland owned by the Forest Department, b) state owned revenue land, c) community owned Panchayat land and d) private lands. A variety of approaches are used to minimize further habitat fragmentation and restore degraded forest areas taking into account the diverse socio-ecological situations using multi-stakeholder and multi-sectoral approach (Semwal, 2005; Meghi, 2014). Moreover, four critical sites have been identified to protect and manage the mega species along with their habitats in the landscape. Although, the National Forest Policy (1988) has provided a formal mandate to include biodiversity conservation and people's participation forest management, the policies on CBM systems in

India have not yielded significant results (Semwal, 2005).

The landscape in Nepal is located across the southern plain and Siwalik or Chure hills, bordered by Mahabharat mountain range in the North, Bagamati river in the East, Uttapardesh and Bihar state of India in the South and the Mahakali river in the West. It extends from 80° 4' 30" to 88° 10' 19" East longitudes; and from 26°21' 53" to 29° 7' 43" North latitudes. The elevation varies from 63 m to 330 m above mean sea level and is sloped gently at rates of 2-10 m per Km (Land Resource Mapping Project, LRMP, 1986).

The valleys of the landscape are made up of natural `terraces of various ages formed by the river systems. Many river streams flow into the valley from the High Himalayas, Mahabharat and Chure hills, which are of perennial, seasonal or ephemeral in character. The total annual rainfall decreases from 2,680 mm to 1,138 mm from east to west, and the mean monthly precipitation ranges from 8 mm in November to 535 mm in July. While 80% of the total rainfall occurs in the monsoon season (June-September), some rainfall also occurs during the pre-monsoon (March-May) and the post-monsoon (October-November) seasons and a few showers also occur during the winter (December-February) (LRMP, 1986; Department of Water Induced Disaster Prevention, DWIDP, 2007; Jackson 1994).

From climatic perspectives, the landscape is located in a sub-tropical zone characterized by hot and humid summers. The maximum monthly mean temperature, 35-40 °C falls in April/May and the minimum, 14-16 °C, in January (Jackson, 1994). The mean annual temperature is increasing across the Terai at the rate of 0.029^{o}C/year in the western part and 0.049^{o}C/year in middle and eastern parts of the country (LRMP, 1986; Jones et al., 2004; DWIDP, 2007).

Forest, agricultural lands, grazing lands, settlements, and waste lands are the major land-use types. The TAL area consists of forest land officially designated as different types of PAS and national forests. Rapid deforestation, land clearing for cultivation and urbanization are the major factors responsible for land-use change. Most of the areas under national forests of TAL are being handed over to communities for CBMs.

3.1.2 Study Area

This research studies corridors and bottleneck areas within TAL outside the protected areas. Corridors are crucial habitats providing connectivity among areas used by animal and plant species, whereas bottleneck areas are narrow but important forest areas between two large forest blocks which are under threats. The sites selected for this study comprised all the corridors (Mohana-Laljhadi, Basanta, Khata and Barandavar) and bottleneck areas (Mahadevpuri, Lamahi and Dovan) identified till 2009. Table 3.1 provides summarized information on total area, forest area, community forests user groups (CFUGs) and community forests (CFs) of corridors and bottleneck areas of TAL.

Table 3.1: Overall programme area, study sites, forests and CFs

Name	No. of VDCs	Total Area Km^2	Forest area Km^2	No. of CFUGs.	CF Km^2
Basanta	11	655	575	105	53.89
Khata	2	83	44	49	36.62
Mohana Laljhadhi	8	455	304	52	41.32
Barandabhar	7	104	95	15	31.84
Mahadevpuri	1	209	187	30	56.47
Lamahi	4	245	235	55	226.7
Dovan	1	80	75	35	34.13
Total	34	1830.23	1515	341	480.97

(Source: Field Survey, 2009)

The comparative time series data of study sites for 2001 and 2011 on the basis of demographic and social information is presented in Table 3.2. Figure 3.1 presents the overall location of the study sites, whereas, Figure 3.2 to 3.8 show the location and land use of each individual site.

Table 3.2: Socioeconomic trend of study area

Parameters	Years		Increased/Decreased
	2001	2011	
TAL population (million)	6.07	7.35	Increased by 1.93%/yr
Population of study area (000)	482.26	623.46	Increased by 2.59%/yr
Number of households (000)	92.53	122.48	Increased by 2.62%/yr
Family size/ hh	5.39	5.28	Decreased
Number of livestock/hh	8.1	6.9	Decreased
Landlessness (%)	10.39	12.62	Increased
Landholding ha/hh	0.56	0.47	Decreased
Fuelwood users (%)	90.54	78.41	Decreased
Average alternative energy users (%)	N/A	45.29	N/A

(Source: CBS, 2001; 2011; Field Survey, 2009-2013)

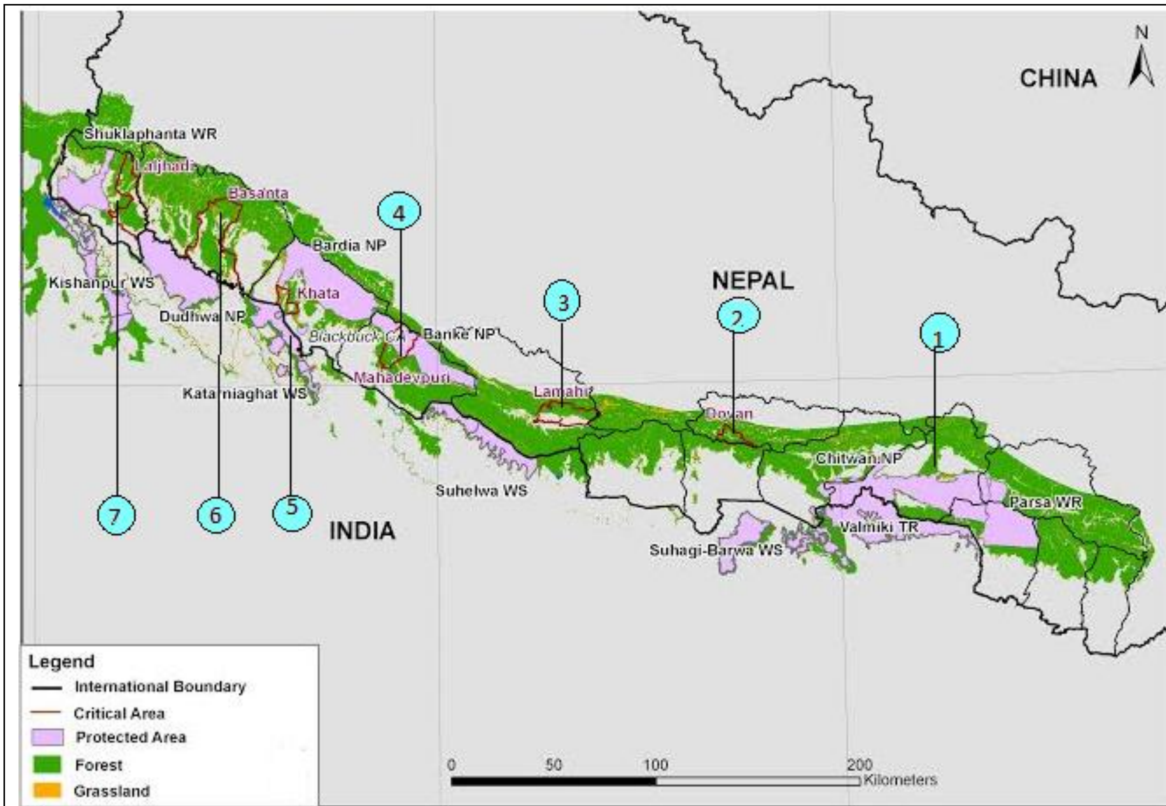


Figure 3.1: Location of TAL and study sites; 1: Barandavar; 2: Dovan; 3: Lamahi; 4: Mahadevpuri; 5: Khata; 6: Basanta; 7: Mohana-Laljhadi (Source: WWF, 2002a)

The preceding section describes the study areas based on information obtained from CBS (2011) and field surveys, 2009-2013.

Barandavar corridor

The Barandavar corridor, Sal (*Shorea robusta*) dominated deciduous forest, includes parts of Kabilas VDC, Bharatpur and Ratnanagar Municipaliies as well as the whole of Dahakhani, Jutapani, Shaktikhor, Padamapur, Bachauli, Geetanagar, Patihani and Phulbari VDCs. The corridor is the critical remaining linkage between the Chitwan National Park (CNP) in the South, Mahabharat hills in the North and the forested areas and protected areas in the Eastern and Western part of the TAL. Management and restoration of the corridor is important to maintain gene flow for mega faunal species such as one horned Rhinos and Royal Bengal Tigers. Rapid population growth and urbanization have been a serious threat to the existing forests and wildlife. The area had a human population of 111,358 living in 23,404 households, The livestock population was high with 4.9 per household. Average landholding size per household was 0.29

ha and out of total population, 5.4% were landless. Although 90.3% households used alternative energy for some of the household uses, the dependency on fuelwood was still high with 63% of households using it.

Basanta corridor

Basanta corridor connects forest ecosystems of Kailali district of Nepal with Dudhuwa National Park (DNP) of India. Eleven VDCs – Pahalwanpur, Bhajani, Ratanpur, Pawera, Hasulia, Basauti, Udasipur, Masuria, Lalbojhi, Khailad and Ramshikhar Jhala– surround this corridor. These VDCs together had 23,055 households with total population of 135,831 growing at the rate of 1.62% per year. Average livestock per household was 7.11. Each household occupied average of 0.94 ha , in which 8.6% were landless. Out of the total population, 83.6% relied on fuel-wood and 38.8% of households used alternative energy. In each of these areas, the dominant forest is pure and mixed Sal. Local people reported that they had occasionally sighted tigers in the area. The forests along the settlements were degraded and brought under restoration through community based approaches.

Khata corridor

Khata corridor connects Bardia NP of Nepal and Katarniaghat Wildlife Sanctuary (KWS) of India.. The forests along this corridor is surrounded by Karnali river in the West, Aurahi river, Suryapatuwa, and Dhodari VDC's in the East, KWS in the South and Bardia NP buffer zone in the North. Khair (*Acacia catechu*) is the main species found in the forest area with shrub plants like Banmara (*Lantana camera)* and Sindure (*Mallotus philippinensis*) species. Chittal and wild boar are commonly found, whereas tigers, elephants and rhinos are found seasonally, usually during migration time. The corridor had a human population of 20,006 distributed over 3,659 households. On the average there were 8.2 livestock per household, which were let loose during the day to graze mostly in the national forests. Although agriculture was the main occupation, 10.77% of the households were landless and average landholding was 0.33 ha per household. Out of the total households, 85.9% relied on fuelwood and 53.6% used alternative energy as supplement to fuelwood.

Laljhadi-Mohana corridor

Laljhadi-Mohana corridor, mainly Sal and Sissoo (*Dalbergia sissoo*) forest, extends from Laljhadi forest located in Kanchanpur to the Mohana river bordering between Kailali and Kanchanpur. There are four VDCs lying completely within the corridor namely Krishnapur, Baisabichuwa, Shankarpur and Raikarbichuwa whereas Dekhatbhuli lies partially inside. Northern part of the corridor adjoins Chure range while the south plains are connected with the DNP. The corridor covered a population of 101,811 spread over a total of 16,444 households. Average livestock per household was 4.3, average of landholding per household was 0.61 ha and 14.43% of the households were landless. Out of the total population, 78.8% relied on fuel-wood and 31.5% of households used alternative energy as well. Acting as a trans-boundary route for wildlife between Chure, Suklaphanta Wildlife Reserve (SWR) and India's DNP, the corridor is home to some of the rare and endangered species of wild flora and fauna.

Dovan bottleneck

The Dovan bottleneck, consisting of subtropical mixed forest, includes Butwal Municipality in Rupandehi district and Dovan VDC in Palpa district. The bottleneck links CNP in the East and the forested areas and protected areas in the Western part of the TAL. Dovan and Butwal areas had a population of 112,334 living in 31,098 households. The livestock population was high with 7.1 per household. Average landholding per household was 0.18 ha whereas 38% households were landless. Out of the total households in the bottleneck, 93% of Dovan and 4% of Butwal relied on fuelwood. High population of humans and livestock and low landholding had caused tremendous pressure on the national forests.

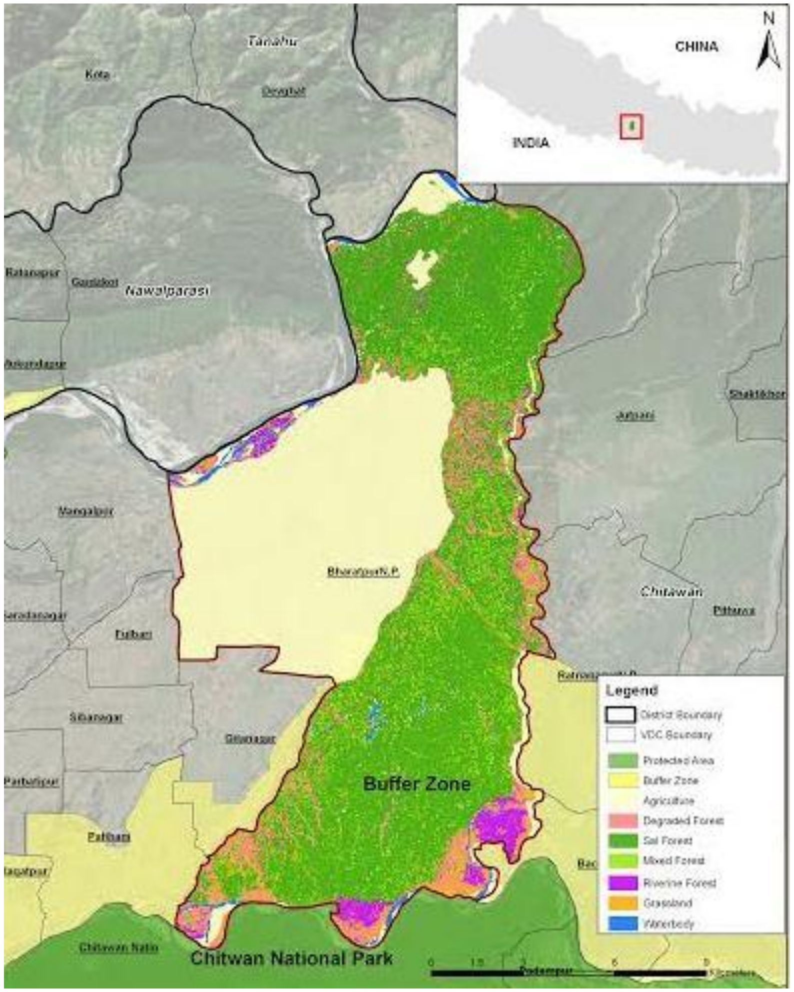
Lamahi bottleneck

Lamahi bottleneck area runs along the East-West Highway extending over five VDCs: Satbariya, Chailahi, Sishniya, Lalmatiya and Sonpur. It connects Bardia National Park (BNP) and CNP running along the Chure forests. This bottleneck, consisting of subtropical mixed degraded forest, is under heavy pressure from urban development in the Lamahi market and nearby villages.. It had 17,166 households with total population of 86,716 growing at the rate of 4.38% per year. Average livestock per household was 10.1, which was the highest among the bottleneck areas. The households hold an average of less than 0.44 ha of land, used to feed a family of 5.05 people for one whole year. Furthermore, 7.45% of the households were landless. Although 47.6 % of the total households used alternative energy for partial use, 71.5% households still used fuelwood. High human and livestock populations along with less than enough land to feed average family had made them heavily dependent on the forest. There was a strong local commitment to restore forest through community forestry. Most of the degraded areas along the northern border of settlement had been developed into community forests.

Mahadevpuri bottleneck

Mahadevpuri bottleneck area consists of Sal dominated forest under Mahadevpuri, Binauna, Phatepur, and Kanchnapur VDCs. This bottleneck had a population of 42,403 distributed over 7,649 households. It had the population growth rate of 2.76% per year. On the average there were 6.89 livestock per household, which were let loose during the day to graze mostly in the national forests. Although agriculture was the main occupation, 3.7% of the households were landless and average landholding was 0.50 ha per household. Some 28.2% households partially used the alternative energy and 81.1% of households used fuelwood. The people depended heavily on the national forests for their daily needs of fodder, fuel wood, grazing, and other forest products. Being closer to Nepalgunj, a big urban centre coupled with extreme poverty, had led to increase in illegal collection of fuel wood, timber, and wildlife poaching. Nevertheless, villagers understood the consequences of forest destruction and have come forward to establish community forests and take responsibility for managing them at the local level.

Location and Land Use Map of the Study Sites



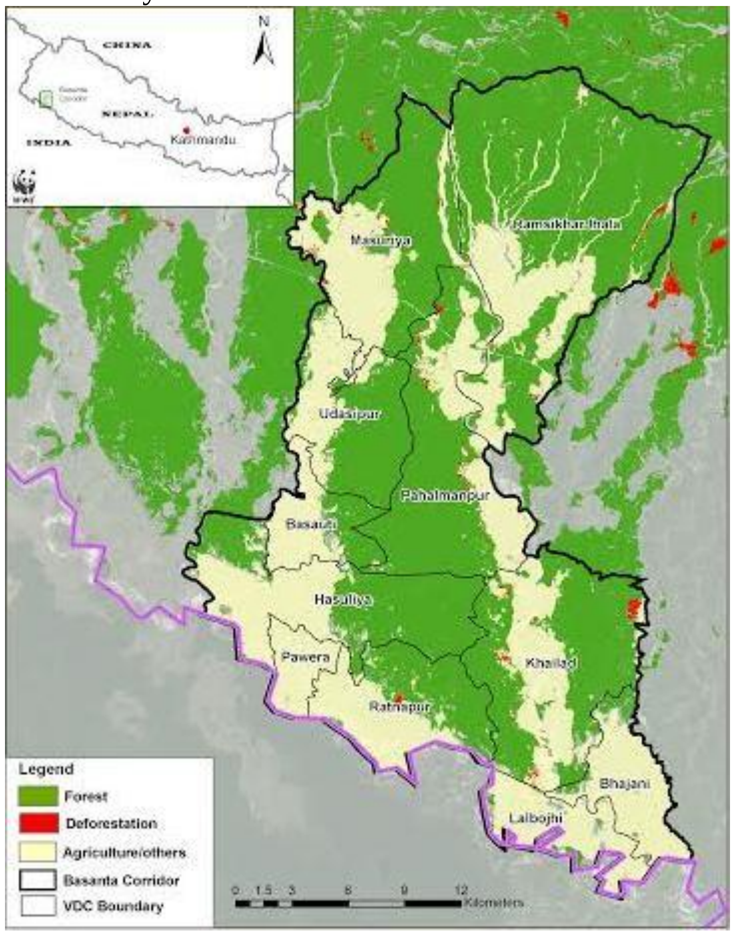


Figure 3.2: Barandavar corridor

Figure : 3.3 Basanta corridor

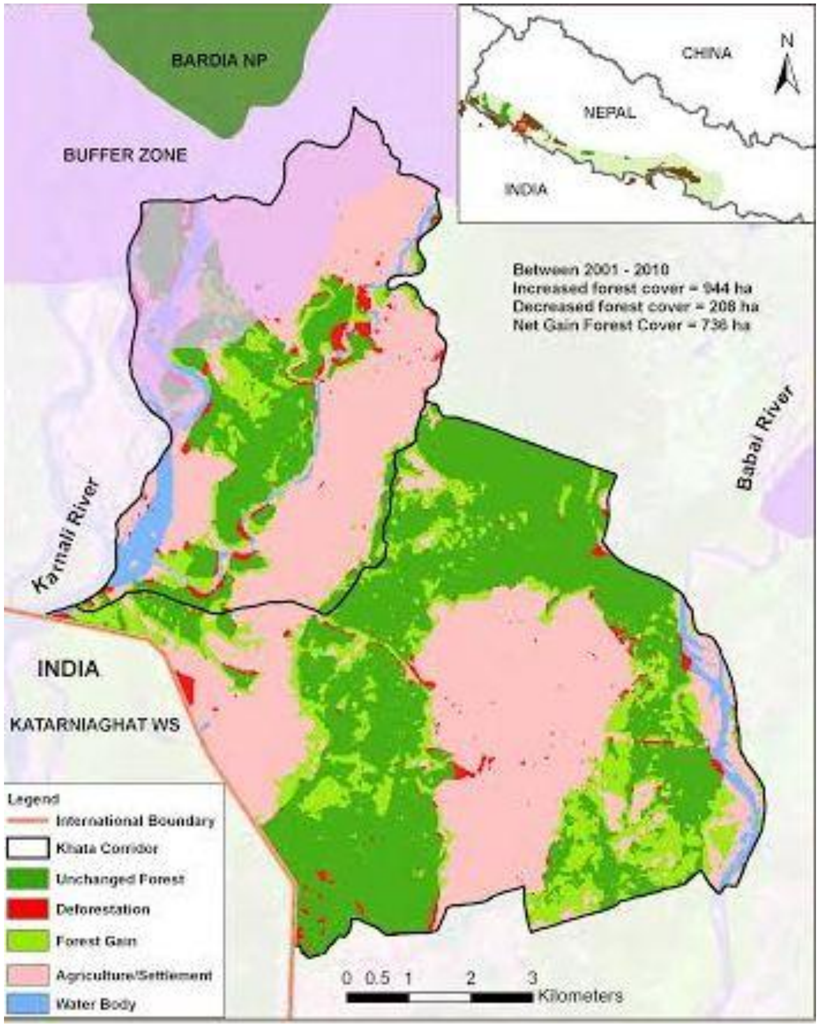


Figure 3.4 : Khata corridor

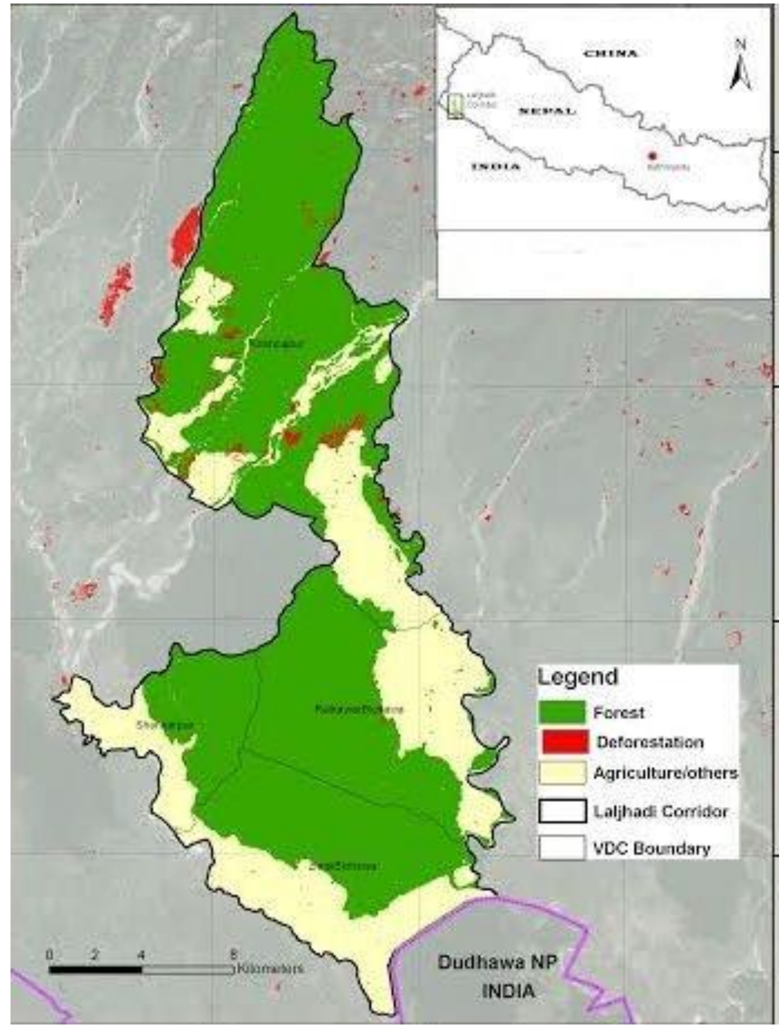


Figure : 3.5 Mohana-Laljhadi corridor

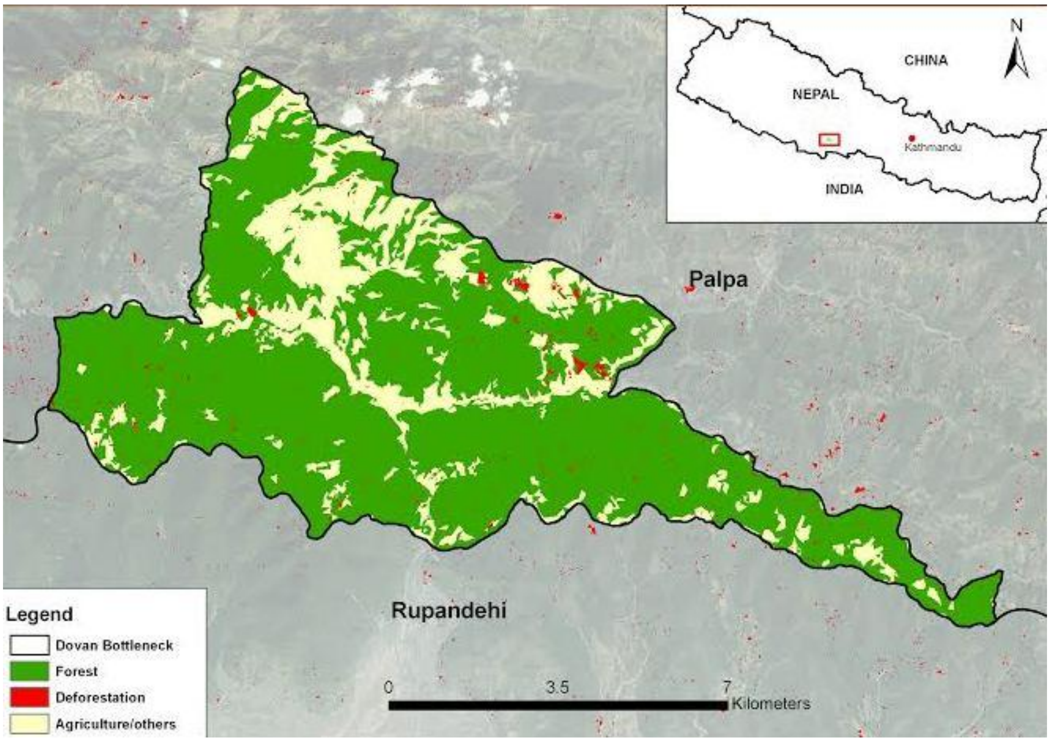


Figure 3.6 : Dovan bottleneck

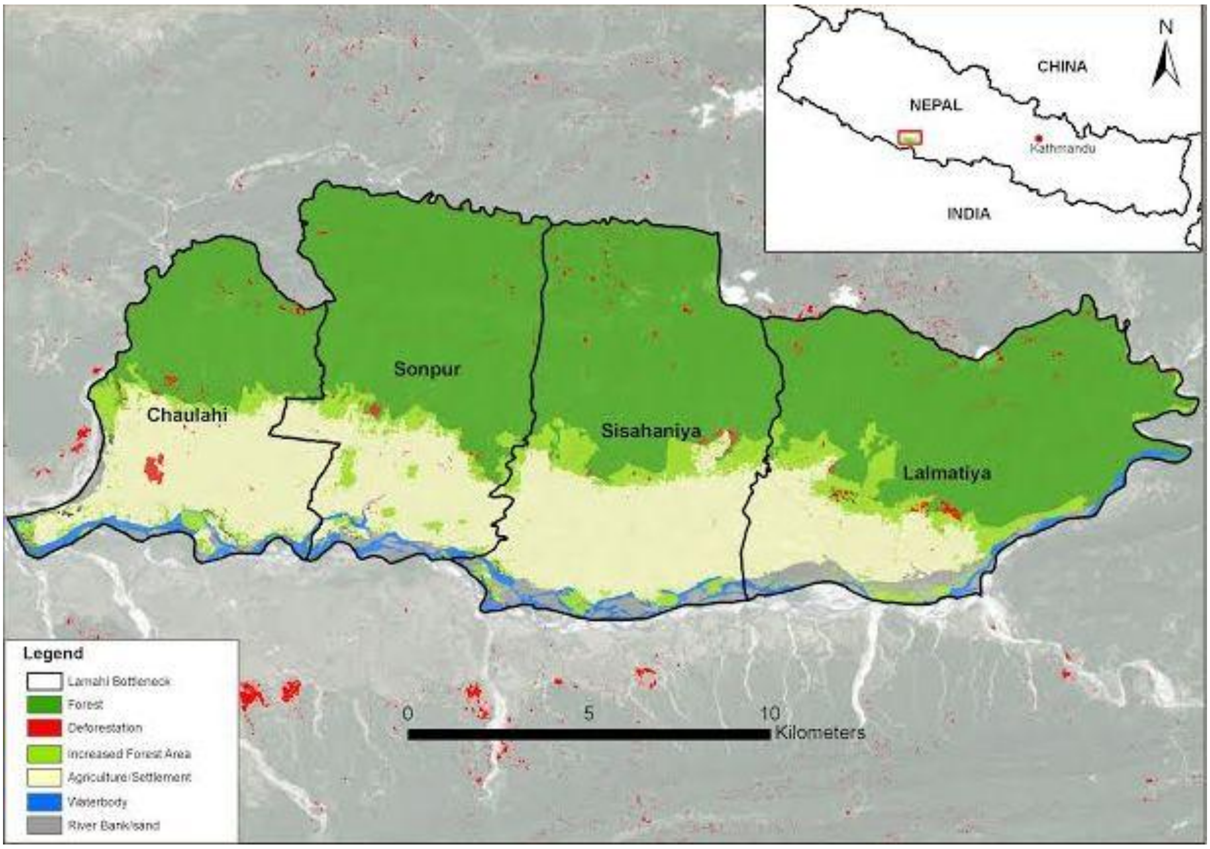


Figure 3.7: Lamahi bottleneck

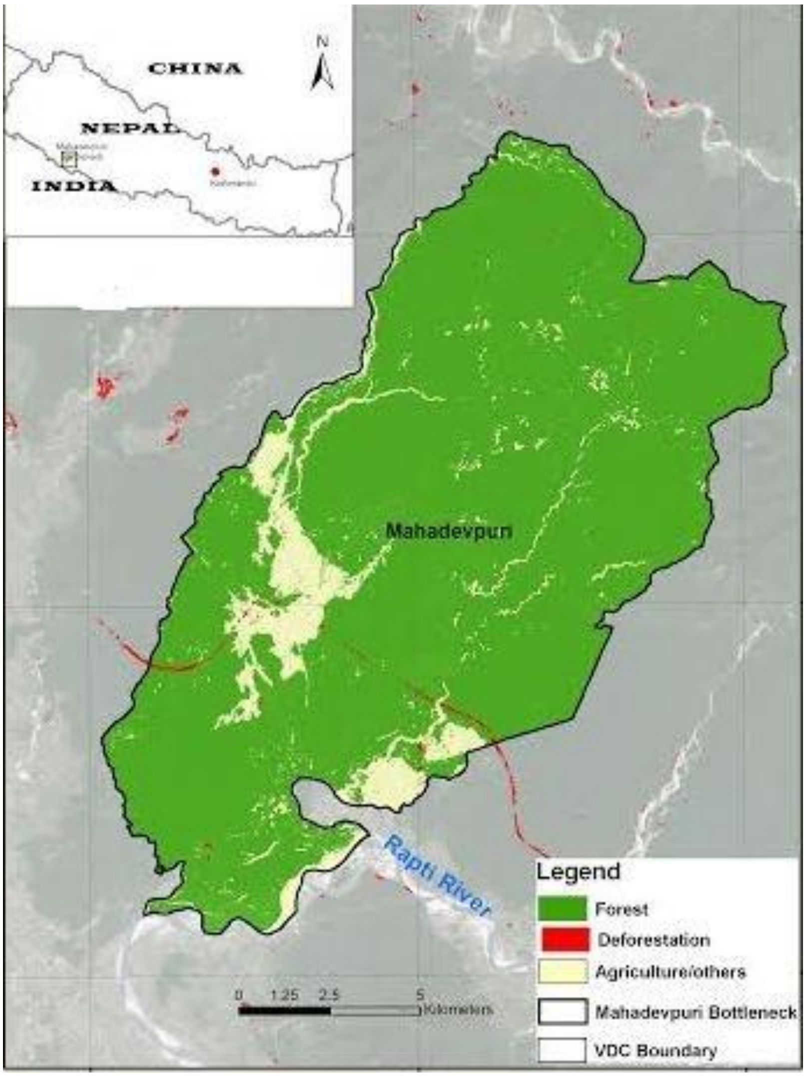


Figure 3.8: Mahadevpuri bottleneck

Changes in Demography and Socio-economy

TAL accounts for about 55.3% of 13.5 million Terai's population of Nepal. The population estimated in the 2011 Census at 7.35 million persons had more than 21% from its 2001 level of 6.07 million. Taking into account the trends over time between 2001 and 2011 as shown in Table 3.2 and Annex 6, TAL has experienced remarkable changes. Overall, the population of the intervention areas had increased from 482,261 to 623,459 with 2.59 % growth per year where as the number of households has increased from 92,534 to 122,475 with 2.62% growth per year. Lamahi had the highest growth of 4.38% per year while Khata had the lowest of 1.61% per year. Average annual growth rate for 10-year period between 2001 and 2011 was positive, but had declined over time as compared to previous 10 years. Expressed as a percentage of the population at the beginning of the period, the average population growth rate in the 2001, for example, was 3.05% per annum while it was only 1.93% per year in 2011. The land holding size had decreased from 0.56 to 0.47 per household over the ten years. The total number of livestock in TAL decreased from 8.14 to 6.93 per household. The total number of landless people rose by 2.24% in 2001 to 12.62%. in 2011. The percentage of population using fuel-wood was 90.54 in 2001, while it dropped to 78.41 % in 2011. Use of alternative energy rose by significant percentage which had also partly offset to fuel-wood use. The total number of alternative energy users in TAL was 45.29% in 2011. This was a remarkable increase as compared to that in 2001.

3.2 Study Methods

3.2.1 General Framework

A multi-method research approach was applied to address the objectives, find answer to research questions and to test hypothesis. The methodology combined quantitative and qualitative methods and tools in an integrated manner. The use of multi methods served as a crosscheck on the reliability and validity of the data and information. The study examined how the TAL has performed in achieving the change in its impact areas and analyzed whether the change in values is attributable to the TAL or has been due to contributory factors from other interventions. Finally, the Difference-in-Difference method (O'Sullivan et al., 2002) was used to compare the results of TAL targeted interventions and non-TAL interventions with pre-post data. The pre-post data was obtained through a close reading of the strategic plan (WWF, 2004; MSFP, 2013), progress reports and deliverables as identified in the Letter of Agreement between Government of Nepal (GoN) and WWF. Simultaneously, surveys were carried out to generate primary data.

A group of enumerators were recruited and then oriented on how to carry out the field survey and administer pre-test questionnaire. Pilot study was conducted before finalizing the questionnaire and inventory format. The result from pilot study was incorporated into a redesigned/adjusted questionnaire. In-depth interviews with stakeholder institutions, focus group discussions with the local communities, household surveys and field measurements were conducted in the period between 2008-2009 and 2012-2013. Data input using spreadsheets was carried out in 2013-14 and analyzed using statistical packages, SPSS 20 and online biodiversity calculator. The approach of selection of sample size was based on Cochran's sample size formula for categorical data collection. Data analysis comprised of quantitative and qualitative methods (Table 3.3).

Table 3.3: List of types of data analysis tools

Quantitative analysis	Qualitative analysis
• Descriptive statistics • Chi-square test • ANOVA and correlation analysis • Regression analysis (simple linear and multiple regressions) • T-test and Z-test • PCA and logistic regressions (binary and multinomial logistic regressions)	Summarization of categorical data on status, effectiveness, perceptions, trend/threat assessment and conduction of SWOT analysis.

3.2.2 Samples, Time Series and Study Framework

Table 3.4 provides a summarized overview of sample units, time series of data collection and total number of field samples required for testing M&IA tools and methods. Similarly, the study frameworks for policy and strategy, biodiversity conservation, livelihood improvement and CBM for climate change are presented.

Table 3.4 Sample units and time series

Study types	Sample units	Years and sample size						
		2008	2009	2010	2011	2012	2013	2014
1.Testing of tools and methods	Respondents		45					
2, Study of policies and strategies	Institutions					225		
3.Biodiversity conservation								
TRA approach to assess impact	Forest Units	225				225		
Assessment of forest biodiversity	Forest Units	147				147		
Patterns of biodiversity	Forest Units	147				147		
Assessment of human disturbances	Forest Units	128				128		
4.Livelihood improvement								
Effects of CBM on livelihoods	Respondents		400			400		
CBM on social dimensions	CFUG/Respondents		3/83				3/83	
5. Climate change related								
CBM for climate change	CFUG/Respondents		3/71				3/71	

Table 3.5 below summarizes entire framework for the assessment of LLC impacts – policies and strategies, biodiversity conservation, livelihood and social dimensions, and CBM for climate change; and identification of methods and tools –general and technical, biodiversity, livelihoods and climate change related – in terms of objective variables, measured variables and methods used.

Table 3.5: Study Framework

Major Streams	Objective variables	Measured variables	Methods used
1. Assessment of impacts			
Policies and strategies	• assessment of the familiarity and analysis of the perceived policy impacts • identification of relationship between determinants and underlying dimensions	Familiarity levels, assessment of performance variables and determinants	Questionnaire and focus group discussion (FGD)
Biodiversity conservation	• comparison of plant species diversity index, richness index and growing stock between modalities of forest management	Richness; diversity index (α, β and γ) and growing stock (density, basal area and volume)	Forest inventory protocol (number, species, DBH, height and category)
	• analysis and comparison of the structure of biodiversity indices • investigation of the relationship among biodiversity indices	,,	Desk analysis
	• identification of threats to biodiversity • development of Threat Reduction Index (TRI) between management modes • identification of suitability of TRI method.	Quantification of threats, analysis, TRI for 5 variables and perception on appropriateness of TRI.	Modification of Margoluis & Salafsky (1999); field observation, measurement; Likert scale, percent and consensus based score
	• exploration of the pattern and trend of human disturbances if that can be generalized quantitatively • identification of the performance of management modes on the disturbances	Quantification and comparison of ten disturbance variables such as logging, encroachment, fire, grazing, etc.	Modification of forest inventory protocol and included disturbance parameters, measured as percent, quantity, number, etc. in a 50 m X 10 m transect
Livelihoods and social dimensions	• assessment of the status and trend on livelihood • construction of a composite index and regression with the gross income • comparison of the components and the data set of the different sub-sets.	72 variables of livelihood framework (7 components with income)	Questionnaire survey and FGD
	• assessment of effects on social dimensions • find out on what social variables have changed over time	Perceptions and quantification of positive and negative effects and changes	Case study, questionnaire, secondary data, observation and measurements
CBM for climate change	• review of observed and perceived climate change impacts • assessment of performance of community-based mitigation and adaptation techniques • identification of issues on identification and assessment of such impacts	Perceptions on local level effects, assessment of adaptation and mitigation measures.	Case study, questionnaire/ secondary data, observation and measurement
2.Identification of methods and tools			
General & Technical Biodiversity Livelihood Climate change related	• examination, assessment and identification of appropriate tools and methods	73 methods and tools: general and technical,-17, biodiversity conservation-33, livelihood improvement-16, and climate change related-7.	Questionnaire and FGD

3.2.3 Test of Methods and Tools

Testing methods and tools for LLC M&IA was also essential for carrying out actual monitoring and impact assessment on the ground. A stocktake was carried out to identify the major discourses and trends on LLC actions and initiatives with the focus on methods and tools for M&IA referring to the various guidelines, models, toolkits and frameworks (Annex 7). The tests were carried out for a total of 73 frameworks, tools and methods. Efforts were made to develop the framework to enable simultaneous monitoring and interpretation, to help identify links between the LLC and impact areas and finally categorize tools and methods based on thematic areas.

Table 3.6: Thematic areas and categories of methods and tools

Thematic areas	Methods and tools	
	Non focused	Focused
1.Policy and strategy	1. General methods and tools	
2 Forest management 3.Biodiversity conservation	2. Specialized technical methods and tools	1. Biodiversity inventory 2. Biodiversity assessments 3. Participatory biodiversity assessment 4. Non participatory methods
4 Livelihood improvement		1. Livelihood improvements
5.Climate change management		2. Climate change management

As shown in Table 3.6, TAL has five main outcome areas: a) policy and strategy, b) Forest management, c) biodiversity conservation, d) livelihood improvement and e) climate change management. The methods and tools included non-focused and focused comprising general methods specialized technical methods, and specific methods on biodiversity, livelihood and climate change management. The analysis was also guided by a set of criteria that determined whether method and tool to LLC M&IA could be considered the most appropriate. The set of criteria included, but was not limited to, the following aspects:

- Flexibility and simplicity to use: to allow for consideration of the issue at any stage or component of the framework and to use in a simple way.
- Conceptual clarity and scope: to cover all key concepts that includes logical and plausible links in an understandable way.
- Usability: to lend itself for a practical use.
- Sustainability and cost effectiveness: whether the selected methods and tools are sustainable and cost effective over time.
- Accuracy: whether the tools and methods are reliable to generate accurate data and information.

- Skills required: whether the tools and methods require skilled human resources.
- Replicability: whether the methods and tools can be extended elsewhere.
- Baseline creation: whether the methods and tools create a benchmark for future.
- Comparatively better: while in use if the tools and methods are more preferable.
- Scales: while in use if the methods and tools cover across all scales, from the local to the national.

A one sample median test (2.5, 50%, n=45) was used to test whether a sample median differed significantly from a hypothesized value. This test was extended with a Likert scale test to include expert judgment, the value of which was added to a total score (Annex 7).

3.2.4 Performance of Policies and Strategies

This study used perception-based methods to assess the performance of policies and strategies. The method which falls under participatory stakeholder process addresses concern related to research, debate and discussion, and draws from multiple perspectives (Pahl-Wostl, 2002: Carr, 2004; Morris & Baddache, 2012; Lund, et al., 2010). A set of survey questionnaire was developed and possible institutional participants were identified through stratified random sampling. The participants were divided into three groups: community forest user groups (CFUGs), n = 90); government staff, n = 89); and civil society groups, n = 46) (Table 3.7). Civil society respondents included forestry sector stakeholders comprising federations of community based forest management groups, NGOs, INGOs, political parties, user groups of other natural resource management and development groups, private sector, professional organizations, donors and indigenous leaders. All three groups belonged to the forestry sector working with rural communities.

The sample of 225 institutions (n) out of 511 total population (N) was selected ensuring one representative per institution, by internalizing the sampling error of 5% based on Cochran's sample size formula. The sample size of each site was determined in proportion to the population size of the site. The following formula was used (Equation 1):

$$n_h = \left(\frac{Nh}{N}\right) \times n$$ (Equation 1)

Where n_h is the sample size for site h, Nh is the population size for site h, N is total population size, and n is total sample size.

Table 3.7: Population and sample of respondent institutions

Sites	CFUGs		Government staffs		Civil Society groups		Total	
	N	n	N	n	N	n	N	n
Basanta	105	30	32	28	13	9	150	67
Khata	49	15	9	8	4	4	62	27
Mahadevpuri	30	8	9	8	6	4	45	20
Lamahi*	55	13	23	16	11	12	89	41
Dovan	35	9	7	7	5	4	47	20
Mohana Laljhadhi	52	11	22	15	`8	7	82	33
Barandabhar	15	4	12	7	9	6	36	17
Total	341	90	114	89	56	46	511	225

(N=population size; n = sample size) (Source: Field Survey, 2012) (* addition from district headquarters)

The questionnaire designed to assess the conservation policy impacts comprised statements stating the degree of agreement based on literature review of conservation or other policy related studies by Varughese & Ostrom (2001), Conroy et al. (2002), Nagendra (2002), Conley & Moote (2003), Yadav et al. (2003), Ribot (2004), Husain & Bhattacharya (2004), Misra & Kant (2004), Gautam & Shivakoti (2005), Danielsen et al. (2005), Sudha et al. (2006), Dahal & Capistrano (2006), Tiwari & Kayenpaibam (2006), Balooni et al. (2007), Palmer & Engel (2007), Gautam (2007), Ellis & Porter-Bolland (2008), Thoms (2008), Lund & Treue (2008), Zulu (2008), EC (2009) and Lund et al. (2010). A five point Likert-type scale was used as the response format. The assigned values of the scale were: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree (Annex 17). The data from questionnaire survey were analyzed using one sample median test, PCA, MANOVA and ANOVA.

3.2.5 Impact on Biodiversity

Of the 341 forest management units (both community based and state managed forestry governance) inside TAL, 240 units were observed to have been used as the wildlife corridor. Considering the population (N) of 240, a sample of 147 forest units (n), Table 3.8, with sampling error of 5% was undertaken based on Cochran's sample size formula. The sample sites were divided into four groups, viz, Group 1 (ACF) – After Community Forests, (n = 43); Group 2 (BCF) – Before Community Forests, (n= 43); Group 3 (BZC) –Nearby Buffer-zone Community forests, (n=18); and Group 4 (GMF) - Nearby Government Managed Forests (GMF), (n=43).

Table 3.8: Number of forests sampled

Sites	Management types				Total
	ACF	BCF	BZC	GMF	
Barandabar	9	9	9	9	36
Basanta	10	10	0	10	30
Dovan	3	3	0	3	9
Khata	4	4	4	4	16
Laljhadhi	5	5	5	5	20
Lamahi	8	8	0	8	34
Mahadevpuri	4	4	0	4	12
Total	43	43	18	43	147

The field work was carried out in 2008-2009 and 2012-2013 following the forest inventory protocols developed by the Government of Nepal (Department of Forests, DoF, 2004; Aryal et al., 2012). Using systematic sampling method, plots comprising 10 m^2 (1.78-m radius) for herbaceous plant count were nested within the larger size circular plots of 500 m^2 (12.61-m radius). In each plot, the plants were classified based on their diameter: trees (diameter at breast height (DBH) >30 cm), pole-stage (DBH:10–29.9 cm), sapling (DBH: 4–9.9 cm), seedlings (DBH: up to 3.9 cm). Medicinal and other small plants were counted which were not included in tree categories (Annex 16).

A detail methodology for the inventory and calculation of frequency, density and volume are described in DoF (2004). Subsequently, vernacular names of the plant species were obtained from the local people and the scientific names were obtained from the government offices. The data pertaining to forest management practices, community forest operational plans, provisions of existing rules and regulations for management and utilization of forest resources as per management regimes were obtained from secondary sources. Overall, 4930 plots (Table 3.9) were sampled by using plot technique (DoF, 2004) over two different time intervals in 2008-2009 and 2012-2013.

Table 3.9: Number of plots measured

Management modes	Forest numbers	Plots
ACF (CBM)	43	1432
BZC (CBM)	18	635
BCF (SMS)	18	1419
GMF (SMS)	43	1444
Total	147	4930

(Source: Field Survey, 2008-2009 and 2012-2013)

The species richness, evenness and unified indices were calculated against each site and each management mode. Beta-Diversity (β) for each site was calculated on the basis of data from plots but the gamma (γ) diversity was calculated following the criteria developed by Schluter & Ricklefs (1993) and Lande (1996). The growing stock was estimated based on inventory protocol of DoF (2004). Both one way and two ways Analysis of Variance (ANOVA) were used to analyze the linearity of variables of biodiversity index, species evenness and forest growing stock as well as interaction among the variables.

3.2.6 Pattern of Biodiversity

To analyse and compare the structure of biodiversity and relationship among biodiversity indices with reference to management modes 24 indices that were theoretically complementary and related to number of species, evenness and diversity were analyzed. Principal component analysis (PCA) with varimax rotation and multiple regression analysis (MLRA) were carried out to investigate empirical relationships between the selected indices.

3.2.7 Threat Reduction Assessment

The set of samples used for this study was the same as in section 3.2.4, but the focus, method and time differed. Series of interviews and discussions elicited an array of perspectives and a large amount of information. Four sets of questions were given to the participants to understand threats as per their perceptions. Firstly, participants were given a list of possible risks to the forest and biodiversity and asked to respond by indicating their level of agreement or disagreement on a 5-point Likert scale starting from '1 = strongly disagree' to '5 = strongly agree'. Secondly, they answered how worrisome they estimated each threat was using the same Likert scale to their respective site based on the five principal risks. Thirdly, open questionnaire survey was supplemented for discussions during field visits; it demanded that the respondents also quantifying risks perceived by them.

The respondents were asked to consider threats to habitat integrity, quality and ecosystem functioning while natural phenomena such as earthquakes were not considered threats. Participants ranked the threats based on the relative importance and their experiences. Ranking scales of 1 (minimum) to 5 (maximum) were used throughout the exercise and all threats were ranked along one continuum. After the scoring and ranking exercise, total ranking scores were multiplied by the percentage of the threat met to get a raw score for each threat. The TRA index was computed as (equation 2):

$$TRA\,index = \frac{Sum\,of\ raw\,score}{Sum\,of\ possible\ ranking} \times 100$$

(Equation 2) (Margoluis & Salafsky, 1999)

Finally, the result obtained was presented and responses were received from field level government staff (n=45) using the standard 5-point Likert scale: Strongly Disagree = 1; Disagree = 2; Neutral = 3; Agree = 4; and Strongly Agree = 5.

Variables

The independent variables, the presumed causes, in this study were the characteristics of respondents and the types of forest management modes in relation to threat mitigation as listed in Table 3.10.

Table 3.10: Independent variables

Name	Type*	Explanation	Unit	Sources
Site name	N	Name of sites (1 to 7)	Number	Office record
Forest name	N	Name of forests	Number	Office record
Respondent groups	N	1= Community; 2= Government and 3= Civil society group	Number	Survey Design
Management modes	C	1= CBM (Community based management); 2= SMS (State managed system)	Number	Office record

The dependent variables, the presumed effect, of interest were the five priority threats which were assessed by using quantitative information as listed in Table 3.11 on both CBM and GMS.

Table 3.11: Dependent variables

Name	Variables	Type*	Unit	Sources
Different	Listing of threat variables	O	Likert scale	Survey design
CTRI	Threat reduction in CBM	C	Percent	Office records and field verification with map and questionnaire
STRI	Threat reduction in SMS	C	Percent	
CTR1	Encroachment and land use conversion in CBM	C	Percent	
CTR2	Poaching and trade in CBM	C	Percent	
CTR3	Forest fire in CBM	C	Percent	
CTR4	Commercial mining in CBM	C	Percent	
CTR5	Invasive species and grazing in CBM	C	Percent	
STR1	Encroachment and land use conversion in SMS	C	Percent	
STR2	Poaching and trade in SMS	C	Percent	
STR3	Forest fire in SMS	C	Percent	
STR4	Commercial mining in SMS	C	Percent	
STR5	Invasive species and grazing in SMS	C	Percent	

* N = Nominal; C = continuous, O= Ordinal

3.2.8 Analysis of Human Disturbances

Among 341 forest management units (both community based and state managed) established by the end of year 2012, 190 units were supported by community based anti-poaching teams. This study used the sample of 128 forest units (n) out of population (N) of 190 with 5% error based on Cochran's sample size formula. The sample sites were divided into four groups: Group 1 (G1) – community forest management (CFM) of CBM, n = 43; Group 2 (G2) – government managed forests (GMF) of SMS, n=43; and Group 3 (G3)-buffer-zone government forests (BGM) of SMS, n=21; and Group 4 (G4) –buffer-zone community forests (BCF) of CBM, n=21 (Table 3.12).

Table 3.12: Sample sites

Sites	Management types				Total
	G1: CFM/CBM	G2: GMF/SMS	G3: BGM/SMS	G4: BCF/CBM	
Barandabar	9	9	9	9	36
Basanta	10	10			20
Dovan	3	3			6
Khata	4	4	4	4	16
Laljhadhi	5	5	4	4	18
Lamahi	8	8			16
Mahadevpuri	4	4	4	4	16
Total	43	43	21	21	128

(Source: Field Survey, 2008-2009 and 2012-2013)

This study was carried out from 2009 to March, 2013 based on both literature review, open and structured interviews, discussion with local informants and field measurement (Aryal et al., 2012). The disturbance parameters were determined aligning with quantitative tools and methodology described in Community Forestry (CF) Inventory Guidelines of Government of Nepal (DoF, 2004) (Annex 16). For each forest, important disturbance factors were identified and quantified in a series of plots of 50 m long and 10 m wide along transect lines located systematically from the starting point. The starting point and direction of each transect line were recorded using GPS machine to allow transects to be relocated in the future.

Variables

The independent variables, used to determine the value of human disturbances as dependent variables, are as listed in Table 3.13.

Table 3.13: Independent variables

Name	Variables	Types*	Explanation
Site name	Name	N	Name of sites
Forest name	Name	N	Name of forests
Management types	Name	B/O	1= CFM; 2= GMF; 3= BGM; 4= BCF
Approach	Name	B/O	Community based forest management (CBM) = CFM + BCF State managed system (SMS) = GMF + BGM

(* N= Nominal; B= Binary; O= Ordinal; Unit= Number; Source: Record of District Forest Offices (DFOs))

The potential dependent variables, related to direct indicator of either forest type or forest management modes, were as shown in Table 3.14.

3.14: Dependent variables

Name	Variables	Types*	Explanation	Unit
LOG	Logging	C	Total volume removed, legally, illegally and naturally	Percent
ENC	Encroachment	C	Area encroached	Percent
GRZ	Grazing	C	Area grazed	Percent
LVD	Livestock density	D	Number per unit area	Number
INV	Invasive species	B	Presence or absence of evidence recorded as 1 or 0	Yes or No
FFR	Forest fire	C	Area under fire by proportion or events	Percent
PCH	Poaching	C	Wildlife poaching events including birds per year	Number
FWD	Firewood extraction	C	Fuel wood extraction	Metric ton
DST	Distance to settlement	C	Settlement proximity in Km	Km
NRG	No Natural regeneration	C	Area under no regeneration	Proportion in percent

(*C = continuous; B = Binary; O= Ordinal; D=Discrete; Source: Record of DFOs, field verification with map and questionnaire: 2011-2013)

Both qualitative and quantitative comparison of threats between CBM and SMS were carried out. For each of the CBM included in the study, an area conventionally managed by state (SMS) was selected for comparison based on proximity to each respective CBM. T tests, Chi-square, Principal Component Analysis, and logistic regressions were performed using SPSS 20.

3.2.9 Effects on Livelihoods

The TAL program intervention had 341 community based institutions and 66,642 households (excluded municipalities) as per data of 2012. A set of survey questions was developed and possible participants were identified with a sample strategy of 400 household respondents based on Cochran’s sample size formula with the sampling error of 5%. The survey was carried out in 2009 and 2012 to compare before and after scenario of CBM on livelihoods (Annex 15). The interview explored matters on perception, current status and changes of livelihood of communities. The interviews elicited an array of perspectives and a large amount of unstructured information. Both qualitative and quantitative data were analyzed using SPSS 20.

In the first step, seven different sub-indices with 72 variables of sustainable livelihood framework were developed. The data sets of year 2009 and 2012 were used to conduct PCA for each asset separately and aggregated for all assets. Household income was analyzed using both descriptive statistics and multiple linear regression. The data was explored using PCA to identify the underlying structure and constructs followed by weighting and aggregation of the index (McGranahan, et al., 1972). Broadly, the SL parameters were grouped into seven categories: (a) human, (b) physical, (c) financial, (d) natural, and (e) social capitals as well as (f) vulnerability context and (g) policy, intuitions and process. This clearly indicated that there was a need to develop sub-indices based on these categories and then an integrated livelihood index at landscape level. Each of the seven components had 5 to 15 subcomponents and each subcomponent had different score system containing information on the variables included in the development of different sub-indices (Table 3.15).

Table 3.15: Components and subcomponents of livelihood parameters

Components	Sub Components	Data types	Data nature	Data sources
1. Human	5	C	QN and QU	Primary
2. Physical	12	C; LS	,,	,,
3. Natural	13	C; B; LS	,,	,,
4. Financial	15	C; B; LS	,,	,,
5. Social	14	C; B; LS	,,	,,
6. Vulnerability context	8	C; LS	,,	,,
7. Policy, institutions and process	4	B; LS	QU	Secondary

Source: Survey design, 2009 and 2012; C= Continuous; LS=Likert scale and B= Binary; QU = Qualitative; QN = Quantitative

The correlation between variables and component indicated by factor loading followed by subsequent analysis was used as a basic for classifying the dominant variables in each component. If the factor loading value was more than 0.7, the attribute is thought to play dominant role in the component (Hair et. al, 2009) because it would account for more than 50% of the variance.

3.2.10 Effects on Social Dimensions

The study area was located in Kailali and Kanchanpur districts along the Mohana River. Three active and heterogeneous Community Forest User Groups (CFUGs) were selected as the study sites namely Dilasaini CFUG in Dhangadhi, Aishorya CUFG in Geta, and Jaikalika CFUG in Malakheti (Table 3.16). The study collected primary data (questionnaire partly Annex 15) and reviewed literature on community based management. Different participatory tools such as focus group discussion, key informants' survey and semi-structured questionnaire were used to generate the primary data. The sample size (n=83) was determined based on Cochran's formula using sampling error of 10%. In addition, CF inventory data were analyzed and compared between the growing stock of year 2009 and that of 2013.

Table 3.16: Sample CFUGs selected for the study on social dimensions

CFUGs	Location	Area (ha)	Households	Formation year	Nature of Forest
Dilasaini	Dhangadhi	89.0	278	2002	Plantation
Aishorya	Geta	46.5	225	2003	Plantation
Jaikalika	Malakheti	35.5	84	2005	Natural
Total		171.0	587		

(Source: Field Survey, 2009-2013)

3.2.11 Climate Change Adaptation and Vulnerability Reduction

The study was based on both primary data and literature review. Three active and ethnically heterogeneous Community Forest User Groups (CFUGs) of TAL area were selected namely Basanta CFUG in Kailali district, Khata CUFG in Bardia district, and Pragatishil CFUG in Dang district (Table 3.17). Different participatory tools such as focus group discussion, key informants' survey and semi-structured questionnaire were used to generate the primary data (Annex 18). The sample size (n=71) was determined based on Cochran's formula using sampling error of 10%. In addition, CF inventory data were analyzed and compared to the nearby government managed forests (GMF) to estimate the growing stock in relation to carbon sequestration of climate change.

Table 3.17: Sample CFUGs selected for the study on community based climate change

District	CFUG name	Handover year	Area ha	HHs
Kailali	Basanta	2010	48.46	52
Bardiya	Khata	2009	21.00	134
Dang	Pragatishil	1998	9.93	49
Total			79.39	235

(Source: Field Survey, 2009-2013)

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Testing of Methods and Tools

4.1.1 General Methods and Tools

The tests of scores were ranked on the basis of the respondents' perception (one sample median test) and expert opinion. Threat reduction assessments, disturbance analysis, abundance index and growing stock estimation were found to have the highest score; stakeholder analysis was ranked the lowest (Table 4.1.1).

Table 4.1.1: General methods and tools with score

Score range	Methods and tools	Total score
7 -12	Threat reduction assessments, disturbance analysis, abundance index and growing stock estimation	12
	Livelihood index	11
	Biodiversity index in general	11
	Alpha biodiversity	11
	Gamma biodiversity and policy analysis	10
	Beta biodiversity	9
	Stakeholder analysis	7

The findings partly corroborated the approaches and issues emphasized by Margoulis & Salafsky (1998a;b) and World Bank (1994;1996). The list of selected methods and tools developed in this study are more integrated form of M&IA tool in comparison with an isolated set of tools that have been hitherto used.

4.1.2 Specialized Technical Methods and Tools

The test result showed that the DPSIR Framework was the most preferred methods followed by M&IA approach focused on wildlife management; while other four methods and tools – landscape outcome assessment methodology, status and effectiveness measures, GIS/RS and national forest monitoring assessment – were the least preferred tools as per the total scores given by the participants (Table 4.1.2).

Table 4.1.2: Specialized technical methods and tools

Score range	Methods and tools	Total score
8 -13	DPSIR Framework	13
	M&IA approach focused on wildlife management	12
	Landscape outcome assessment methodology, status and effectiveness measures, GIS/RS and national forest monitoring assessment	8

The highest score for DPSIR Framework points to the fact that sophisticated resource-intensive systems are not feasible in TAL for monitoring biodiversity in detail. The result recommended a simple, cost-effective and field-based biodiversity monitoring system applicable even in the absence of specialist staff and resources. The finding is significant in a sense that it specified monitoring programmes to already existing forms of monitoring biodiversity conservation projects (Groombridge & Jenkins, 1996; Brown, 1998; Margoulis & Salafsky, 1999; World Bank, 1998). The program proposed by this study is likely to be optimal, or even suitable for use in LLC because of specific contexts in the studied area.

4.1.3 Climate Change Adaptation and Vulnerability Assessment

The test provided a total score ranged from 8 to 9. The most preferred options were adaptation decision matrix, adaptation policy framework, climate change impacts and adaptations and finally adaptation assessment with score 9. The second preferred options were vulnerability and adaptation assessments, vulnerability indices and multi-stakeholder processes with score 8 (Table 4.1.3).

Table 4.1.3: Methods and tools on climate change adaptation and vulnerability assessment

Score range	Methods and tools	Total score
8-9	Adaptation decision matrix; adaptation policy framework; climate change and adaptation impacts; and adaptation Assessment	9
	Vulnerability and adaptation assessments, vulnerability indices and multi-stakeholder processes	8

This test provided the specific pathways toward implementing M&IA efforts, consisting of the methods and tools out of many others that were proposed earlier (Warrick, 2000; IPCC, 2004; Bandyopadhyay et al., 2011).This recommended approach can be started immediately to frame the necessary elements of a data collection and reporting scheme which can be improved further over time.

4.1.4 Livelihood Improvement

The scores were found on a spectrum between 12 (most selected) and 8 (least selected). The results showed that community-level and household-level formal surveys were the most selected options with score 12, whereas plot and landscape field measurements of natural resources of both stocks and flows were found to be the least preferred with score 8 (Table 4.1.4). The significance of this study lies in its contribution to enhanced understanding of the relationship between LLC and livelihood outcomes. Previous studies had only assessed tools and methods (Thornton et al., 2002; OECD, 2008; Rai et al., 2008; Sharpe & Smith, 2005) without observing their relative applicability.

Table 4.1.4: Methods and tools on livelihood improvement

Score range	Methods and tools	Total score
8 -12	Community-level formal surveys and household-level formal surveys	12
	Participatory assessment, monitoring and evaluation, most significant change, livelihood assets status tracking, wellbeing monitoring, livelihood impact assessment, human perceptions of environmental change and analysis of training impact.	11
	Stakeholder consultations and key informant interviews and participatory policy impact assessment.	10
	Transect walks, aerial photography, market studies, in-depth sociological and characterization studies, financial and economic analyses.	9
	Plot and landscape field measurements of natural resources of both stock and flows.	8

4.1.5 Biodiversity Inventory/Assessment

The test showed relatively higher scores for conservation needs assessment and gap analysis with score 9 compared to the score of biodiversity information system, rapid ecological assessment, rapid biodiversity assessment, rapid assessment programme and all-taxa biodiversity inventory which was 6 (Table 4.1.5).

Table 4.1.5: Methods and tools on biodiversity inventory

Score range	Methods and tools	Total score
6-9	Conservation needs assessment and gap analysis	9
	Biodiversity information system, rapid ecological assessment, rapid biodiversity assessment, rapid Assessment programme, all-taxa biodiversity inventory	6

Assessment of biodiversity at local level showed higher score for species diversity indices, abundance indices and population estimates; whereas functional group and guild analysis were the least scored (Table 4.1.6).

Table 4.1.6: Methods and tools on biodiversity assessment

Score range	Methods and tools	Total score
6-11	Species diversity indices, abundance indices and population estimates	11
	Indices of landscape patterns and historic reference conditions, qualitative and quantitative population viability analysis	9
	Functional group and guild analysis	6

The test of 10 participatory methods and tools at micro level showed the score range of 8 to 11. The most preferred options with score 11 were species list, census, pooling local expert opinion, sampling plot while the least preferred option with score 8 was photo documentation (Table 4.1.7). Unlike previous studies which had rationalized and mandated biodiversity inventory/assessment and monitoring systems in other contexts (Gaines et al., 1999; Noss, 1999; Margoluis & Salafsky, 1998; Danielsen et al., 2000), the present study identified the methods and tools most relevant to Nepal.

Table 4.1.7: Methods and tools on participatory biodiversity assessment

Score range	Methods and tools	Total score
8-11	Species list, census, pooling local expert opinion and sampling plot	11
	Transect, key informant and semi structured interview	10
	Community group discussion and participatory mapping	9
	Photo documentation	8

4.1.6 Non-participatory biodiversity monitoring

The test of non-participatory biodiversity monitoring showed the score of 11 for total count and timed search whereas other 9 methods and tools were found to be the next options with score 10 (Table 4.1.8).

Table 4.1.8: Methods and tools on non-participatory biodiversity assessment

Score range	Methods and tools	Total score
10-11	Total count and timed searches	11
	Quadrates, distance sampling, line and strip transects, line and point intercept transects, camera trap, point count, trapping webs, removal method and mark-recapture methods	10

The findings supported the studies undertaken by Bani et al. (2006), Myers & Patil (2006), Hill et al. (2005) and Elzinga et al. (2001) in other contexts. Very specifically, it pointed out effectiveness of certain methods and tools in TAL and implied that the relevance correlates with the participation of communities and stakeholders, resources in CBM particularly outside the protected areas. The summary findings from the analysis of the existing methods and tools are: a) access, availability and selection of methods and tools depended on guidance available to the people in TAL area; b) no single approach is directly transferable from existing methods and tools to support M&IA; c) expert judgment is still one of the most important ingredients for success and cannot be replaced by any of the available methods and tools, and d) available methods and tools need adjustment and modification to fit into specific context.

4.2. Performance Assessment of Biodiversity Policies and Strategies

4.2.1 Demographic Characteristics of Respondents

The array of distribution of respondents and their characteristics are presented in Table 4.2.1. Site-wise, 67 respondents or highest in number (29.8%) were from Basanta corridor, while 20 respondents or lowest in number (8.9%) were from Dovan and Mahadevuri bottleneck area each. Ninety respondents (40%) were community representatives, 89 respondents (39.6%) were government staff and 46 respondents (20.4%) were from civil society organizations.

The age groups of the respondents were distributed in four categories---44.4% fell in the range of 31-40 years of age followed by 28% in the range of 41-50, 18.1% in the range of 20-30 and 9.3% in the range of 51-60 years. In terms of the educational qualifications of respondents; 36% had high school level education; 38.2% attained intermediate degree; 23.1% had a bachelor and master degrees; and 2.7% had higher than master degrees.

Table 4.2.1: Demographic characteristics of respondents

Variables	Frequency	Percent	Variables	Frequency	Percent
Sites			31-40	100	44.4
Basanta	67	29.8	41-50	63	28
Khata	27	12	51-60	21	9.3
Mahadevpuri	20	8.9	Total	225	100
Lamahi	41	18.2	Economic background		
Dovan	20	8.9	Lower level	54	24
Mohana-Laljhadhi	33	14.7	Medium level	127	56.4
Barandavar	17	7.6	Higher level	44	19.6
Total	225	100	Total	225	100
Stakeholder groups			Educational background		
Community representatives	90	40	High school	81	36
Governmental staff	89	39.6	Intermediate degree	86	38.2
Civil Society representatives	46	20.4	Bachelor and Master	52	23.1
Total	225	100	Higher education	6	2.7
Age group (year)			Total	225	100
22-30	41	18.1			

(Source: Field Survey, 2012)

4.2.2 Determinants of Perceived Conservation Impacts

Results from the descriptive analysis of determinants are presented in Table 4.2.2. The majority of respondents were male (60.9%) and female (39.1%). In terms of the level of job of respondents 31.6% indicated their job as belonging to the lower level; 31.1% answered for a moderate level of job, and 37.3% found to be in high level. Concerning the question about the degree of their participation in conservation, 16% of respondents indicated that their participation was low, 34.9% moderate and 59% very high or active. The way in which people were involved themselves seemed to be primarily through a mixture of professional and volunteer time. The average involvement was 11 years, with minimum 2 and maximum 27 years in conservation. From Table 4.4.2, it is clear that 50.2% of the respondents fell within the range of one to 10 years experience, while 32% were experienced 11 to 15 years and 16.8% were with 16 to 25 years in the field. However, it should be pointed out that two respondents possessed experience of more than 25 years.

As for ethnic identity, the major respondents were Brahmin and Chhetri (44%), followed by indigenous group (28.4%), Madeshi (17.8%) and Dalits (9.8%) respectively. Regarding the respondents' stake on forestry, the results revealed that 72.4% of them claimed they were involved directly whereas 27.6% responded that their involvement was indirect. Of the participants interviewed, 40.5% were found to have received some types of training and 59.6% were untrained.

Table 4.2.2: Determinants of respondents

Variables	Frequency	Percent	Variables	Frequency	Percent
Gender			16- 20	21	9.3
Male	137	60.9	21-25	17	7.5
Female	88	39.1	>25	2	0.9
Total	225	100	Total	225	100
Level of job			Ethnicity		
Lower	71	31.6	Ethnic groups	64	28.4
Medium	70	31.1	Dalits	22	9.8
High	84	37.3	Madeshi	40	17.8
Total	225	100	Brahamin and Chhetri	99	44.0
Participation			Total	225	100
Low	36	16	Types of stake		
Medium	56	24.9	Direct	163	72.4
High	133	59.1	Indirect	62	27.6
Total	225	100	Total	225	100
Experience (years)			Training attended		
<5	28	12.4	Yes	91	40.4
6- 10	85	37.8	No	134	59.6
11- 15	72	32	Total	225	100

(Source: Field Survey, 2012)

4.2.3 Analysis of Perceived Familiarity of Policy or Strategies

One sample median test (2.5, 50%) revealed significant difference on positive response to the familiarity on MPFS and TAL strategy with $p<0.5$ and other 12 policies and strategies were found significantly negative on familiarity with $p<0.05$ (Table 4.2.3). The result showed that the important stakeholders had limited understanding and awareness of various policies and strategies issued and implemented by the government for biodiversity conservation. Regarding two of the documents – MPFS and TAL strategy – however, the level of understanding was high. For the better awareness and understanding of these two documents, the respondents attributed to the peoples' routine use, relevancy and their effectiveness on the ground as well as due to the TAL programme interventions on awareness-raising, capacity-building and training to the field level stakeholders.

Table 4.2.3: One sample median tests on familiarity of policies and strategies

Policies and strategies	OP of category		+ or -
	<= 2.5	> 2.5	
Master Plan for the Forestry Sector (MPFS)*	0.33	0.67	+
Revised Forestry Sector Policy	0.85	0.15	-
National Biodiversity Strategy (NBS)	0.89	0.11	-
Domestic Elephant Management Policy	0.92	0.08	-
TAL Strategy*	0.24	0.76	+
Working Policy on Wildlife Farming, Breeding and Research	0.86	0.14	-
Herbs and Non-Timber Forest Products Development Policy	0.85	0.15	-
MFSC Human Resources Strategy	0.86	0.14	-
NBS Implementation Plan	0.86	0.14	-
National Biosafety Framework and Policy	0.99	0.14	-
Sacred Himalayan Landscape Strategy	0.86	0.14	-
Forestry Sector Gender and Social Inclusion Strategy	0.64	0.36	-
Forest Fire Management strategy	0.87	0.13	-
National Wetland Policy	0.99	0.14	-

(OP= Observed Proportion; Test Proportion=50%; p = 0.000 for all; + = positive and - = negative weight; * p value = 0.000)

4.2.4 Analysis of Perceived Conservation Policy Impacts

The potential policy impact variables identified, grouped and aggregated to the similar impact categories were put under 29 impact indicators as shown in Table 4.2.4. The data analysis did not show a clear pattern or significant differences within the category. However, the results suggested a general lack of average scores on median and modes of some of the variables and thereby indicated poor performances on planning, institutional motivations, interactions, skills and capacities, consistency in policies, participations and relevant information.

Table 4.2.4: Conservation policy impact attributes

Variables	MN	MO	RG	Variables	MN	MO	RG
Clarity on objective	3	3	3	Changed process	3	3	3
Clarity on planning	2	1	2	Continuity of infrastructure	4	4	3
Motivating institutions	2	2	2	Continuity of funding	4	3	3
Communications	3	3	4	Adoption	3	3	3
Outputs	3	3	4	Mainstreaming	3	3	3
Quality of outputs	3	3	4	Innovativeness	3	3	4
Outcomes	3	3	4	Outcome without additional budget	3	3	4
Quantitative achievements	3	3	4	Impact without additional budget	3	3	4
Impacts	3	3	4	Information dissemination	3	3	3
Sharing	3	4	4	Improved skills	2	2	3
Internal interactions	2	1	2	Consistency	2	2	3
External interactions	2	2	2	Participation	2	2	3
Flexibility	3	3	4	Information	2	2	3
Use of Inputs	3	3	4	Institutional capacity	3	3	4
				Benefit sharing	3	3	4

(Source: modification from EC 2009; MFSC; 2013; MN = Median, MO = Mode and RG = Range)

One sample median test (2.5, 50%) revealed significant in its positive impact on a total of 21 variables with p<0.05 whereas and eight variables showed negative impact with p<0.05. The main positive variables were clarifying objectives, using communication channel, achieving outputs and impacts, sharing resources, changing the process, receiving funds, mainstreaming implementation, enhancing efficiency, disseminating information and adapting policies. The variables showing weak performances of policies in descriptive analysis in Table 4.2.4 were also observed to be negatively significant in one sample median test (Annex 8).

4.2.5 Underlying Dimensions of Perceived Conservation Policy Impacts

The results of Kaiser Normalization (KMO), measure of sampling adequacy, revealed 0.857, which was sufficient for further analysis. Bartlett's Test of Sphericity revealed a significance at a level of .001 (χ^2_{171} = 2472.44). A factor analysis with a varimax rotation was performed and the factors were retained at the level of 0.60 (or higher) (Table 4.2.5). As the underlying dimensions for perceived conservation impacts, five factors emerged with eigenvalues of 1.0 or higher. These five dimensions, used in subsequent analysis, explained 85.8% of the variance in the assessment items.

Table 4.2.5: Summary results of Rotated Component Matrix

Factors	Explained variation %	Eigenvalue	Reliability coefficient
Policy effectiveness	37.86	15.981	0.77
Policy efficiency	17.42	5.02	0.86
Policy additionality	13.70	3.97	0.93
Governance	12.49	3.362	0.74
Sustainability	4.43	1.25	0.71

Note: Principle component analysis; Varimax with KMO; KMO = .857; Bartlett's Test of Sphericity: p = .001 (χ^2_{171}= 2472.44)

Policy effectiveness, which comprised 12 variables (Annex 9), concerned factors capable of producing a desired result. This factor explained 37.86% of the variance with an eigenvalue of 15.981 and a reliability coefficient of 0.77.Similarly, Policy Efficiency, which included five variables, related to performance in right orientation. This factor explained 17.42% of the variance with an eigenvalue of 5.02 and a reliability coefficient of 0.86. Likewise, Policy addtionality included five variables in relation to the extent in which a new input, action or items adds to the existing and results in a greater aggregate. This factor explained 13.70% of the variance with an eigenvalue of 3.97 and a reliability coefficient of 0.93.In the same way, the fourth factor, Policy Governance showed substantial loadings of four variables implicating to the impact of policies and strategies on participation, consistency, managerial skills and transparency in sharing information. This explained 12.49% of the variance with an eigenvalue of 3.662 and a reliability coefficient of 0.74. Finally, Policy Sustainability covered two variables reflecting the essence of sustainability. Factor five explained 4.43% of the variance with an eigenvalue of 1.25 and a reliability coefficient of 0.71

4.2.6 Determinants on Perceived Conservation Policy Impacts

Multivariate analysis of variance (MANOVA) and analysis of variance (ANOVA) were used to determine whether the TAL stakeholder perceptions about policy impacts were related to their demographic and determinant variables. The results of MANOVA revealed that the respondents' mean scores for perceived conservation impacts differed in terms of education (Wilks' Lambda, F = 15, 0.707, 4.458, p=0.000), gender (Wilks' Lambda, F = 5, 0.919, 4.458, p =0.008), ethnicity (Wilks' Lambda, F = 15, 0.818, 2.512, p =0.001) and training (Wilks' Lambda, F = 5, 0.845, 6.626, p =000) (Table 4.2.6).

Table 4.2.6: Multivariate analysis of variance with Wilks'Lambda

Source	Value	F	Hypothesis df	p
Intercept	0.916	3.322	5	0.007
Economic status	0.915	1.643	10	0.093
Education level	0.707	4.458	15	0.000
Gender	0.919	3.215	5	0.008
Level of job	0.917	1.611	10	0.102
Participation level	0.954	0.8555	10	0.576
Experience	0.487	1.175	120	0.109
Ethnicity types	0.818	2.512	15	0.001
Stake types	0.973	0.999	5	0.420
Training status	0.845	6.626	5	0.000

The results of ANOVA (Table 4.2.7) showed that the level of education (F=3, 3.582, p = 0.015) and gender (F=1, 10.066, p < 0.002) had effect in Policy Efficiency impacts; economic status (F=2, 4.302, p = 0.015), education (F=3, 15.24, p=.000), ethnicity (F = 3, 9.409, p=0.000) and training (F=1, 4.864, p=0.029) differed in Policy Additionality impacts; experience (F=24, 1.617, p = 0.029) and types of stake (F= 1,4.530, p=0.035) differed in Policy Governance; and training (F=1, 22.814, p =0.000) differed in Policy Sustainability.

Table 4.2.7: Univariate ANOVA on factor score (FS) and determinants

		Policy effectiveness		Policy efficiency		Policy additionality		Policy governance		Sustainability	
Source	df	F	p	F	p	F	p	F	p	F	p
Intercept	1	.163	.687	.225	.636	12.996	.000	2.653	.105	.582	.447
Economic status	2	.413	.662	1.443	.239	4.302	.015	.545	.581	1.162	.315
Education level	3	.322	.809	3.582	.015	15.124	.000	1.790	.151	2.539	.058
Gender	1	.657	.419	10.066	.002	.003	.957	3.084	.081	1.468	.227
Level of job	2	2.478	.087	.897	.409	2.450	.089	2.107	.125	.071	.932
Participation level	2	.353	.703	2.249	.108	.236	.790	1.020	.363	.411	.664
Experience	24	.910	.588	1.514	.067	.847	.673	1.617	.041	1.054	.401
Ethnicity types	3	.109	.955	2.285	.080	9.409	.000	.256	.857	.703	.551
Stake types	1	.042	.839	.236	.628	.188	.665	4.530	.035	.008	.931
Training status	1	1.013	.315	.036	.849	4.864	.029	1.096	.296	22.814	.000

Having observed that the identified determinants had no clearly statable relations with policy dimensions concerned with policy impact variables and the stakeholders also did not have strong familiarity with policy documents, this study concerned strategies best suitable for TAL area. Review of existing theory and practice showed evolution in the domain of policy analysis in response to changing policy thrust, methodological advancement and demand for documenting evidence of impacts (Varughese & Ostrom, 2001; Lund, et al., 2010). Yet, comprehensive quantitative studies have not been carried out regarding specific policy and strategy areas of LLC. Quite recently, there are some publications assessing CBM policy effectiveness in terms of institutions, resource conflicts, power and politics mainly using qualitative methods. This study reviewed a number of scholarly works (Nagendra, 2002; Yadav et al.,2003; Gautam & Shivakoti, 2005; Dahal & Capistrano, 2006; Thomas, 2008; Lund & Treue, 2008; and EC, 2009) and assessed the policy performance based on localized quantitative/statistical tools for extensive coverage and objectively perceivable outcomes.

4.3 Impact on Biodiversity and Growing Stock

4.3.1 The Area

The sample plots comprised forests of both CBM and SMS (BCF and GMF). The average size of forest area ranged from 140.44 ha in BZC to 597.44 ha in GMF. The average household size per forest unit was higher in GMFs (501 hhs) whereas in case of BZC it was lower (248 hhs). The distance from communities to forest area was estimated at 1.86 Km in ACF and 3.17 Km in BZC. The average areas of GMF and associated population were estimated based on portion of total block area and local communities, who used the forests illegally (Table 4.3.1). Annex 10 provides the name list of tree/timber species.

Table 4.3.1: Area, household size and distance of forests to settlements

Variables	Community based (CBM)		State managed system (SMS)	
	ACF	BZC	BCF	GMF
Area, ha	181.78	140.44	181.78	597.44
Household size, number	414	248	339	501
Distance, Km	1.86	3.17	1.86	2.47

(Data source: Field Survey, 2009-2013)

4.3.2 Tree Species Richness, Evenness and Diversity

Analysis of α biodiversity indices (Table 4.3.2) showed that the environmental conditions of ACF were the most diverse (N=11995, S=32; d= 440/ha; Dmg=2.667; Dmn=0.433), while GMF were the least diverse (N=1999; S=17; d= 272/ha; Dmg= 0.944; Dmn=0. 289). A range of diversity indices, including Reciprocal Simpson Diversity Index (1/λ), Shannon Diversity Index (H'), Dominance Index (D) Inverted Berger-Parker Dominance Index (1/d) highlighted that the ACF (1/λ=3.443; H'=3.152; D=0.629; 1/d=3.63) strongly dominated the rest of the modalities in every regards. Similar result was found in the case of BZC (1/λ = 2.793; H' = 2.845; D=0.563; 1/d=3.17). GMFs were found the least diverse (1/λ = 1.642; H' = 1.874; D=0.249; 1/d=2.320) with greater evenness (J=0.846 and E=0.632).

Table 4.3.2: Species number and alpha (α) biodiversity estimators for each management modality

Variables	Annotations	ACF	BCF	BZC	GMF
Abundance	N	11995	2168	7294	1999
Species richness	S	32	23	13	17
Density	^{0}D	440	294	551	272
Simpson Index	λ	0.362	0.691	0.479	0.750
Dominance Index	D	0.629	0.306	0.563	0.249
Reciprocal Simpson Index	1/λ	3.443	1.880	2.739	1.642
Shannon Index	H'	3.152	1.981	2.845	1.874
Menhinick Index	DMn	0.433	0.276	0.190	0.289
Buzas and Gibson's Index	E	0.456	0.586	0.522	0.632
Pielou's	J'	0.708	0.753	0.728	0.846
Simpson Index Approximation	A λ	0.181	0.344	0.227	0.375
Dominance Index Approximation	AD	0.810	0.645	0.786	0.623
Alternate Reciprocal Simpson Index	N2	6.834	3.740	5.112	3.234
Berger-Parker Dominance Index	d	0.307	0.471	0.355	0.695
Inverted Berger-Parker Dominance Index	1/d	3.630	2.588	3.170	2.320
Margalef Richness Index	DMg	2.677	0.931	1.519	0.944
Gini Coefficient	G	5.727	2.204	4.004	2.092

(Source: Field Survey, 2008-2009 and 2012-2013)

These observations could be explained according to the characteristics of forest management modalities. The CBMs recorded a greater abundance as well as variety of environmental conditions that were able to develop forest species than in other modalities of forests. That means a greater amount of forest products were available to be exploited by different local communities. The buffer-zones were observed to have transitional environments between ACF and GMFs modalities. GMF and BCF, on the other hand, represented the most extreme type of environment on poor governance and high threats limiting diversity observed in these modalities.

The absolute beta value, appeared to be the highest in ACF (22.2) and lowest in BCF (12.5). Calculating the diversity indexes online through "Biodiversity Calculator for the Simpson and Shannon Indexes", Routledge's Beta index appeared to be the greatest in ACF sites (7.73) followed by BZC sites (4.58), GMF sites (4.49) and then by BCF sites (2.5). Comparisons of Mountford's index in management modality showed the highest value to BCF (-0.6157) and lowest value to ACF (-0.1063). Community similarity in terms of common species showed the highest value of ACF (23) and lowest of BZC (12) (Table 4.3.3).

Table 4.3.3: Beta (β) biodiversity estimators for each management modality

Variables	Annotations	ACF	BCF	BZC	GMF
Absolute beta value	Abv	22.2	12.5	13.4	15.9
Routledge beta-R index	BR	7.73	2.50	4.58	2.49
Mountford index	M	-.1063	-.6157	-.2117	-.4467
Number of common species	C	23	13	12	16

Complementarity of diversity was different among forest management modalities. Low complementarity values mean high similarity values because there are a few exclusive species in each management type. All possible pairings yielded greater than 50% in complementarity. The comparison of the ACF and the GMF showed a low complementarity and a high similarity, which indicated low species turnover or few unique species for each type (CAB= 0.58, ISj = 0.73). The highest complementarity was between the ACF and BZC (CAB = 0.88), representing a high species turnover and the lowest species richness similarity value (ISj = 0.49).

Table 4.3.4: Comparison of species richness between pairs of the management modalities

Forest types	Shared species	Complementarity (CAB%)	Similarity (Jaccard index) ISj	Sorensen index (ISquant)	Whittaker index (βW)
ACF-BCF	13	0.83	0.70	0.55	0.59
ACF- GMF	6	0.58	0.73	0.51	0.44
ACF-BZC	7	0.88	0.49	0.36	0.56
BCF-GMF	6	0.78	0.73	0.35	0.58
BCF-BZC	7	0.81	0.56	0.45	0.38
GMF-BZC	6	0.87	0.51	0.33	0.51

This pattern of high complementarity was very similar between the GMF-BZC (C=0.87) and BCF-GMF (0.78) where complementarity and similarity values were similar, although the abundance of individuals in each management type was completely different. Sorensen's similarity coefficient among forest management was lowest in GMF – BZC (0.33) and was highest in ACF – BCF(0.55). The Whittaker index was the highest for ACF-BCF (0.59) and the lowest for BCF-BZC (0.38) (Table 4.3.4).

4.3.3 Integrated Landscape Biodiversity

The contribution of spatial scale and forest management type on landscape (γ) diversity of tree species was measured using the additive partitioning approach of Lande (1996) and Schluter & Ricklefs (1993) based on the values of α, β and γ. Between each of the spatial scales, the β–diversity was calculated as the difference between total species richness (γ) and mean species richness (α) within one spatial scale. The scales of management types (4), study sites (7), site-forest management combinations types (24) and approach of CBM and SMS (2) were used. Therefore, α diversity in this study consisted of species richness per forest (α1), study site (α2), forest management type (α3), and total (landscape) species richness (α4 or γ). Beta (β) diversity indicated differences of species composition between each spatial scale, and it was measured by calculating the change in species richness from forest unit to study site (β1), from study site to forest management type (β2) and from forest management type to total species richness within the study area (β3). Mathematically, species richness at a spatial scale 'n' equals α n = $\alpha_{n-1}+\beta_{n-1}$, in which the highest possible α_n equals total species richness γ.

The number of species recorded in year 2008-2009 and 2012-2013 was 23 and 32 respectively. However, species composition between the first and the second sampling period was similar. The forest communities differed greatly across site-forest management type. ANOVA statistic (Table 4.3.5) showed a significant effect of forest management typology on species richness ($p = 0.000$) but not on abundance ($p=0.171$); significant effect of site on abundance ($p=0.000$) but not on richness ($p=0.236$); significant effect of site based management on both richness and abundance at $p=0.000$ and also significant effect of CBM over GMF on richness and abundance at $p=0.000$.

Table 4.3.5: ANOVA table on species richness and abundance for each management modalities

Source	Four management types		Seven sites		24 site-management combinations		CBM and SMS	
	$F_{3,143}$	p	$F_{6,140}$	p	F23,123	p	F1,145	p
Species richness	65.3	000	1.357	0.236	10.759	0.000	145.617	0.000
Abundance (density)	1.694	0.171	0.7936	0.000	3.559	0.000	4.541	0.000

4.3.4 Contribution of α and β Diversity

Additive partitioning of the total diversity (γ diversity) into α and β diversity showed the contribution of each spatial scale on the landscape diversity. The contribution of α diversity (α1) to the total diversity was 30.43 and 28.13% in 2008-2009 and 2012-2013 respectively. The fraction of the total diversity represented by β diversity (β 1 + β 2) was about 39.13% in 2008-2009 and 37.5% in 2012-2013. Each management type (α3) supported on average 69.56% of total species richness in 2008-2009 and 65.63% in 2012-2013 of the total diversity, while variability of management type in TAL landscape (β3) contributed 30.43% to the total diversity in 2008-2009 and 34.38% in 2012-2013 (Table 4.3.6). Thus, analyzing the forest management types through the additive partitioning approach (Lande, 1996), this study observed that all forest management types contributed to the landscape level diversity. This indicated a strong effect of habitat heterogeneity caused by a variety of forest management types on landscape diversity.

Table 4.3.6: Alpha (α) and Beta (β) diversity estimation

Variables	Year 2008-2009: BCF		Year 2012-2013: ACF, GMF and BZC	
	Number	Percent	Number	Percent
Mean	23	100	32	100
$\alpha 1$	7	30.43	9	28.13
$\beta 1$	6	26.09	8	25.00
$\beta 2$	3	13.04	4	12.50
$\beta 3$	7	30.43	11	34.38

The gamma (γ) diversity measured as the cumulative number of species captured, was calculated using the following index proposed by Schluter & Ricklefs (1993):

> $\gamma = \alpha$ x isd x sd; where: α = the mean number of species per site in a landscape unit, isd= the inverse of the species dimension; that is, 1/the mean number of communities or locations occupied by a species, sd = sample dimension or total number of sites sampled.

As a result, the gamma (γ) diversity (Schluter & Ricklefs, 1993) was 70.15 for SMS and 119.6 for CBM, far more than the value of the total specific richness (S) evidenced in the study area. Within the index, the results were investigated to see if there were any apparent patterns of variation in indices between the modes. Both one-way and two-way ANOVAs were deployed to compare the different modes according to indices on biodiversity.

Table 4.3.7: One way ANOVA of biodiversity indices based on management modalities

Indices	$F_{3,143}$	p	Indices	$F_{3,143}$	p
S	65.265	0	d	5.585	0.001
^{0}D	1.694	0.171	1/d	8.943	0
λ	13.646	0	D_{Mg}	60.271	0
D	12.844	0	G	38.498	0
$1/\lambda$	22.8	0	Abv	64.933	0
H’	30.371	0	BR	61.312	0
D_{Mn}	5.945	0.001	M	6.973	0
$1/\lambda$	9.198	0	C	65.133	0
H’	0.58	0.629			

The results from the one-way ANOVA (Table 4.3.7) showed that there was a significant difference according to the management typology. It also showed a trend of difference between most of indices at p<0.05; but ^0D and H' were not significant among different modes (p=0.171 and 0.629 respectively). Looking at a potential interaction between management level and site conditions on biodiversity indices by using two ways ANOVA at p=0.05, the results were not statistically significant for all indices except in case of λ with p value 0.029 (Table 4.3.8).

Table 4.3.8: Result of two way ANOVA for the effects of management and sites on indices

Source	df	F	p	Source	df	F	p
Corrected Model	18	5.223	0	d	1	2.742	0.1
Intercept	1	0.11	0.741	1/d	1	0.186	0.667
N	1	0.001	0.981	D_{mg}	1	0.772	0.381
S	1	0	0.984	G	1	0.278	0.599
^0D	1	0.102	0.75	Abv	1	0.07	0.792
λ	1	4.883	0.029	BR	1	1.628	0.204
D	1	1.123	0.291	M	1	0.986	0.323
1/λ	1	0.299	0.585	C	1	0.003	0.955
H'	1	1.314	0.254	Error	127		
DMn	1	2.866	0.093	Total	146		
E	1	0.048	0.827	Corrected Total	145		
J'	1	0.087	0.768				

4.3.5 Growing Stock

The study of growing stock was carried out in terms of density, basal area and volume of tree species. The performance on growing stock was found higher in CBM. The average basal area varied from 6.29/ hectare (ha) in GMF to 13.41 m^2/ha in ACF; mean species presence/ha ranged from 13 in BZC to 32 in ACF; density/ha ranged from 2348 in GMF to 11788/ha in ACF and total volume ranged from 89 m3/ha in GMF to 150 m3/ha in ACF. The plant density, basal area and volume per ha were higher in CBM compared to SMS (Table 4.3.9).

Table 4.3.9: Stand structure of TAL forest based on management modalities

Variables	CBM		SMS	
	ACF	BZC	BCF	GMF
Mean basal area (m^2/ha)	13.41 (1.57)	9.54 (1.61)	8.84(1.19)	6.29 (0.75)
Mean no. of plants/ha	11788 (4188)	5777 (976)	2661 (488)	2348 (391)
Mean species (number/ha)	32 (2)	13 (1)	23 (1)	17 (1)
Mean pole volume (m^3/ha)	51 (8)	51 (7)	27 (5)	27 (4)
Mean tree volume (m^3/ha)	100 (13)	81 (14)	81 (11)	62 (9)
Mean total volume (m^3/ha)	150 (17)	132 (18)	108 (14)	89 (11)

Values in parentheses are ± S.E.

ANOVA procedure was used to examine the effect of management modalities on basal area, number of stems, number of species and volume at different sites. The test revealed that the type of management caused significant differences in all parameters except tree volume (Table 4.3.10). Between CBM and SMS, the differences were observed in density, total number of species, pole volume, total volume and basal area at $p<0.05$. While comparing the performances of four management types, similar result was found on the differences of all parameters except total volume ($p>0.05$).

Table 4.3.10: ANOVA table on growing stock based on management modalities

Source	Mean test between CBM and SMS		Mean test between four management types	
	$F_{1, 145}$	p	$F_{3,143}$	p
Density/	8.81	0.004	3.61	0.015
Species number	52.01	0	27.89	0
Pole volume	14.55	0	4.78	0.003
Tree volume	3.63	0.059	2.05	0.11
Total volume	9.05	0.003	3.49	0.018
Basal Area	12.50	0.001	6.04	0.001

Two ways ANOVA showed that there were interactions between management modalities and the sites on species, total volume and basal area at $p<0.05$; however, there were no interactions on density, pole volume and tree volume at $p>0.05$ (Table 4.3.11).

Table 4.3.11: Two way ANOVA on growing stock and management modalities

Source	df	Mean Square	F	p
Corrected Model	6	16.606	21.5	0
Intercept	1	242.347	314	0
Density/ha	1	0.064	0.08	0.774
Species number	1	15.376	19.9	0
Pole volume	1	2.866	3.71	0.056
Tree volume	1	2.907	3.77	0.054
Total volume	1	3.407	4.41	0.037
Basal area	1	36.446	47.2	0
Total	147			
Corrected Total	146			

This study allowed to compare the performance between forests under different management modes. Due to the proximity and topographical similarity within each mode, differences in biodiversity indices and forest conditions were unlikely due to environmental factors; rather the impacts of management activities had resulted in differences in parameters. Differences in management activities were due to forestry governance i.e. rules and management regimes. Under TAL, CBM in general and CFM in particular were in a significantly better condition than SMS when considering diversity indices, forest density, basal area and volume.

The present study spotlighted the importance of higher diversity and higher growing stock for CBMs. CBM had a higher alpha (α) and gamma (γ) diversity, but a lower value in certain segment of beta (β) diversity of tree species than in SMS. The finding, in contrast to the exiting literature which has spoken out the importance of CBM on density only (Acharya, 2003; Shrestha et al., 2010; Lawbuary, 1999), landed support to the conclusion that emphasized on the role of CBM in biodiversity (Pokharel et al., 2005). Hence, it is concluded that CBM is a successful regime to restore the forest coverage and improve overall forest conditions including biodiversity. This is an important finding, because most ecosystems are outside of the protected area system and hence strategies for the conservation of unprotected ecosystems must be developed. CBM, therefore, provides one possible mechanism to achieve the goal of ecosystem conservation in TAL. Although the result may not be generalized due to diverse eco-climatic zones in Nepal, the result obtained from this study gives important conclusions that the local communities' preference is higher in CBM than in SMS or GMFs.

4.4 Pattern of Biodiversity Indices

4.4.1 Use of PCA and MLRA

The measured biodiversity characteristics were assessed by using MLRA and PCA. The summary result of MLRA showed the variation of CBM, R^2=61.5%, adjusted R^2= 47.5 % and Root Mean Squared Error (RMSE) = 0.823 with the significant regressors, viz. N, 0D, H', J' and G ($p<0.05$). For SMS, R^2, adjusted R^2 and RMSE values were 56.1%, 31.4% and 0.975 respectively. $1/\lambda$, 1/d and G provided important contributions in SMS ($p<0.05$). Variance Inflation Factor (VIF) estimates (3.41 to 51.56 for CBM and 1.41 to 66.93 for SMS) displayed that there was collinearity problem in regressors (Annex 11).

4.4.2 Results of Factor Scores in MLRA

Variation of 89.7% on dimension of CBM was explained by Factors 1 to 4 with 46.3%, 30.6%, 7.2% and 5.6% respectively. The communalities varied from 0.980 to 0.699 on CBM (Annex 12). S (0.980), Abv (0.979), C (0.979) and ^{0}D (0.970) made much higher contribution to Factor 1 compared to other repressors; 1/d (0.916), $1/\lambda$ (0.853), and H (0.713) were more significant contributors on the structuring of Factor 2. Likewise, ^{0}D (0.923) and N (0.904) made greater contribution to Factor 3. Similarly, J (0.855) was the highest contributor to Factor 4. On the other hand, new uncorrelated variables provided the best results for prediction of SMS. For instance, all the Factors, 1 to 3, were responsible for total 80.47% variability with variation of 52.32%, 15.64% and 12.51% respectively. Communalities in SMS ranged between 0.967 and 0.181. S (0.967), C (0.966), Abv (0.965) and G (0.807) were of great importance in the settlement of Factor 1 ($p<0.05$). Similarly, 1/d (0.769), $1/\lambda$ (0.753), and λ (-0.748) significantly contributed to the formation of Factor 2. The structuring of Factor 3 was with contribution of N (0.906).

Results for using factor scores (FS) in MLRA are presented in Table 4.4.1 and 4.4.2. The new uncorrelated variables (FS1, FS2, FS3 and FS4) in MLRA for CBM positively influenced the these dimensions. Factor scores were significant contributors (R^2 =50.9%, adjusted R^2=49.9% and RMSE=0.35) for the CBM prediction. For SMS, the three factor scores (FS1 to FS3) containing R^2, adjusted R^2 and RMSE were 48.2%, 46.7% and 0.361 respectively. Using factor scores in MLRA exhibited a good alternative to eliminating multicollinearity problem.

Table 4.4.1: Results for multiple regression analysis for factor scores on CBM

	B	SE	Beta	t	p	Tolerance	VIF
Constant	1.302	0.039		33.675	0		
FS1	-0.247	0.026	-0.629	-9.655	0	0.867	1.153
FS2	-0.083	0.026	-0.227	-3.23	0.002	0.747	1.338
FS3	-0.074	0.042	-0.115	-1.788	0.076	0.891	1.122
FS4	-0.022	0.041	-0.036	-0.539	0.591	0.803	1.245

(R =0.714; R^2=0.509; Adjusted R^2 = 0.499; and RMSE of Estimate = 0.35)

Table 4.4.2: Results for multiple regression analysis for factor scores on SMSs

	B	SE	Beta	t	p	Tolerance	VIF
Constant	1.795	0.034		52.971	0		
FS1	-0.167	0.014	-0.758	-11.696	0	0.824	1.214
FS2	-0.074	0.026	-0.261	-2.853	0.005	0.414	2.413
FS3	-0.026	0.014	-0.161	-1.863	0.065	0.464	2.157

(R =0.694; R^2= 0.482; Adjusted R^2 = 0.467; and RMSE of Estimate = 0.361)

With PCA, after transforming original regressors into two new latent-regressors with eigenvalues of 8.332 and 5.505 and 56.9 % for variation explained for describing dimensions of CBM. PC1 and PC2 equations were:

CBM:

PC1= - 0.730 N – 0.806 ^{0}D– 0.922 λ + 939 D + 0.811 1/ λ + 0.26 H' + 0.543 DMn + 0.691 E - 0.595 G

PC2= 0. 990 S -0.574 E + 0.906 DMg + 0.694 G+ 0.989 Abv+ 0.982 BR+ 0.732 DMn + 0.989 C

For SMS, two new-latent-regressors of which eigenvalues were 9.417 and 2.814 with 47.9% variation explained; and their PCA equations were:

SMS:

PC1= PC1= 0.947 S -0.769 λ + 0.758 D + 0.838 1/ λ + 0.901 H' + 0.760 1/d + 0.915 DMg + 0.953 G +0.946 Abv + 0.956 BR + 0.944 C

PC2= PC2 = 0.689 N + 0.814 ^{0}D - 0.860 DMn + 0.506 J

Results from PCA scores in MLRA yielded worthy predictors of two PC scores for CBM (R^2=86.5 %, Adjusted R^2=86.4% and RMSE=0.433) as well as for SMS (R^2= 88.7%, adjusted R^2=88.5 % and RMSE=0.422). Using PCA scores in MLRA without multicollinearity problem, hence, was a good choice to achieve the results of importance (Table 4.4.3).

Table 4.4.3: Results of PCA Scores in MLRA

	B	SE	Beta	t	p	Tolerance	VIF	R^2	R^2adjusted	RMSE
CBM								86.5%	86.4%	0.433
(Constant)	2.151	0.104		20.669	0					
PC1	-0.384	0.075	-0.432	-5.09	0	0.812	1.232			
PC2	0.092	0.106	0.073	0.863	0.39	0.812	1.232			
SMS								88.7%	88.5%	0.422
(Constant)	3.012	0.109		27.696	0					
PC1	-0.035	0.109	-0.035	-0.32	0.75	1	1			
PC2	-0.171	0.109	-0.17	-1.566	0.04	1	1			

Lending support to wider acceptance of PCA and MLRA (Germida et al., 2006; Honnay, et al., 2009), the present study expands use of factor scores of PCA in MLRA in order to remove multicollinearity problem with very smaller RMSE and VIF. As a result, the prediction models or equations obtained by using PCA scores could be employed reliably in MLRA to remove multicollinearity problem, influence original variables and derive useful new-uncorrelated variables. However, further studies should be carried out for its validity and generazibility.

4.5 Threat Reduction Assessment

4.5.1 Threats in TAL

The threats were ranked based on values derived from Friedman test. The selection grounds on the fact that it is a measure of non-parametric alternative to the one-way ANOVA with repeated measures to test for differences between groups when the dependent variable being measured is ordinal. The test statistics was found significant with χ^2_{23}=1418.03 and p=0.000. Out of a total of 24 threats, five major threats to the biodiversity across the TAL area were identified as (a) encroachment and land use conversion, b) poaching and trade (timber, NTFP and wildlife), (c) forest fire, d) commercial mining and e) invasive species and grazing (Table 4.5.1).

Table 4.5.1: Mean rank of threats based on Friedman Test

S. N	Threats	Mean Rank	S.N	Threats	Mean Rank
1	Encroachment and land use conversion	22.57	13	Poor management	12.41
2	Poaching and trade	22.52	14	Corruption and poor governance	12.11
3	Commercial mining	18.96	15	Community rights denied	12.03
4	Invasive species and grazing	18.95	16	Unclear boundaries	11.58
5	Forest fire	18.82	17	Armed conflicts and insurgency	11.58
6	Political interference	13.38	18	Human wildlife conflicts	11.52
7	Highways and development projects	13.32	19	Bad community and staff relations	11.47
8	Fuel-wood sell	13.24	20	Lack of manpower and budget	11.34
9	Increased human population	13.16	21	Policy conflicts	11.18
10	Poor institutional capabilities	12.55	22	Charcoal burning	11.07
11	Lack of awareness	12.49	23	Land degradation and river cutting	10.78
12	Illiteracy	12.44	24	Poor law and order	10.51

Source: Field Survey, 2008-2009 and2012-2013

To test the significance of five major threats in seven studied sites, Chi-square test was carried out. Annex 13 shows the result based on proportion of respondents identifying and agreeing on existing or potential severity of threats on their locations. In general, most of the threats were found statistically significant ($p<0.05$) but not all in sites: a) all five major threats in Dovan bottleneck ($p>0.05$), b) threats of invasive species and grazing in Khata ($p=0.097$), c) poaching and trade in Mahadevpuri ($p=0.247$) and d) encroachment, and poaching and trade in Barandavar ($p= 0.056$) and ($p=0.113$) respectively. This revealed that the threats to biodiversity at a given site depended on nature and magnitude of direct and indirect threats. It means assessing how much the threat had changed at landscape level since TAL implementation also required support of experienced respondents on identification, quantification and interpretation of site level data.

4.5.2 Reduction of Major Threats

Of the threats, forest encroachment and land use conversion was found to be most significant one (Table 4.5.1). With the intervention of TAL, however, the trend has declined due to measures such as security of land tenure and access to resources for local people through CBM, strengthening protected area system and expansion of buffer zone. Also as shown in Table 4.5.3, this was the largest threats in terms of area, intensity, urgency and greatly reduced in CBM against SMS. The paired t test revealed that this threat was much lower at CBM ($\bar{x}=37.26\pm1.29$) than SMS ($\bar{x}=25.33\pm1.54$) with difference of $\bar{x}=11.92\pm1.88$ ($t224=6.324$; $p=0.000$).

The other threat, namely, poaching including its sense of including illegal logging has been reduced by CBM through the creation of local village level institutions. Through the initiative of local people, such as conducting regular patrolling against illegal activities inside forest and cooperation with the major stakeholders, the poaching activities were observed to have reduced. This reduction in CBM and SMS was found to be $\bar{x}$ =37.97 $\pm$ 1.05 and $\bar{x}$ =18.04 $\pm$ 0.68 respectively with resulting difference of $\bar{x}$ =19.92 $\pm$ 1.37 and t224=14.55; p =0.000).

Although commercial mining of boulder, stone and sand was a serious threat, it is calculated to have been reduced in CBM ($\bar{x}$ =41.05 $\pm$ 1.05) and in SMS ($\bar{x}$ =16.51 $\pm$ 0.73) (t224=17.77; p=0.000). The other threat – open grazing and invasive species – has been tackled by managing open grazing and invasive species particularly *Mikania micrantha*. This threat was found significantly lower in CBM ($\bar{x}$ =41.32 $\pm$ 1.04) compared to SMS ($\bar{x}$ =17.75 $\pm$ 0.76) (t224=17.16; p=0.000).

To manage forest fire, the involvement of local communities was crucial as traditional approach of focusing on legislation alone was not sufficient. Their involvement led to more effective fire prevention and suppression. Local ownership of forest has encouraged local participation and community based practices resulting in the reduction of damaging and unwanted forest fires Result showed that the reduction of threats on forest fire was significant in CBM ($\bar{x}$ =37.00 $\pm$ 1.04) compared to SMS ($\bar{x}$ =18.11 $\pm$ 0.68) with the difference of 18.89%; and it was statistically significant ($\bar{x}$ =18.89 $\pm$ 1.33 with t224=14.13; p= 0.000) (Table 4.5.2).

Table 4.5.2: t-test on comparing threats between CBM and SMS

Comparisons	Mean difference	SE	t value	Df	Sig (2 tailed)
Encroachment and land use conversion	11.92	1.88	6.34	224	0.000
Poaching and trade	19.92	1.37	14.55	224	0.000
Forest fire	18.89	1.34	14.14	224	0.000
Commercial mining	24.54	1.38	17.77	224	0.000
Open grazing and invasive species	23.57	1.62	17.16	224	0.000

(Source: Field Survey, 2008-2009 and 2012/2013)

4.5.3 Threat Reduction Index

Threat reduction analysis using Margoluis and Salafsky (1999) showed that at all levels of area, intensity and urgency, forest encroachment and land use conversion represented the largest threat with a total average rank value (12.55), followed by poaching of timber and wildlife (9.9), forest fire (8.44), commercial mining (7.93), and invasive species and grazing (6.18) (Table 4.5.3).

The extent of threat reduction differed between CBM and SMS. CBM illustrated reduction of threat with a range of 37.00% to 41.32%, whereas SMS showed the range between 16.51% to 25.33%. Raw factor and raw score were used to estimate TRI. The result showed that CBM with a total TRI of 38.47% with 10.31% in encroachment and land use conversion, 8.36% in poaching and trade, 6.94% in forest fire, 7.23% in commercial mining and 5.63% in invasive species and grazing. However, SMS only showed a total TRI only 19.40% with 6.95% in forest encroachment and land use conversion, 3.96% in poaching and trade, 3.36% in forest fire, 2.80% in commercial mining and 2.33% in invasive species and grazing. The TRI at CBM showed that there was significantly higher threat reduction than in SMS (mean difference of 19.16 ± 1.238, t 224=15.74; p = 0.000).

Table 4.5.3: Threat Reduction Index in CBM and SMS

Threats	Average value of threats*			RV	CBM				SMS			
	Area	Intensity	Urgency		PTR	RF	RS	TRI	PTR	RF	RS	TRI
Encroachment and land use conversion	4.35	3.99	4.21	12.55	37.26	0.37	4.64	10.31	25.33	0.25	3.13	6.95
Poaching and trade (timber. NTFP and wildlife)	3.45	3.02	3.43	9.9	37.97	0.38	3.76	8.36	18.04	0.18	1.78	3.96
Forest fire	2.9	3.07	2.47	8.44	37.00	0.37	3.12	6.94	18.11	0.18	1.51	3.36
Commercial mining	2.46	2.57	2.9	7.93	41.05	0.41	3.25	7.23	16.51	0.16	1.26	2.80
Invasive species and grazing	1.84	2.35	1.99	6.18	41.32	0.41	2.53	5.63	17.75	0.17	1.05	2.33
Total	15	15	15	45			17.31	38.47				19.40

*Measured in scale (1 to 5): Vey low, low and medium
RV = Rank value = Area + Intensity + Urgency
PTR= Percent threat reduction
RF = Raw factor = PTR/100
RS= Raw Score = RF/total rank value
TRI = Threat Reduction Index= RS/corresponding individual RV

4.5.4 PCA for Major Threats

The results of the KMO measure of sampling adequacy revealed 0.791 and Bartlett's Test of Sphericity revealed a significance at a level of 0.000 (χ^2 =2049.96, df=45). This showed the variables were related to each other for the factor analysis which was estimated with a varimax rotation and reliability test. The results are presented in Table 4.5.4 with the factor at the level of 0.50 (or higher). Two factors emerged with eigenvalues of 1.0 or higher. These two dimensions, explained 74% of the variance. The two underlying dimensions were threats on SMS and threats on CBM.

SMS threats, labelled as Factor one, explained 42.70% of the variance with an eigenvalue of 4.27 and a reliability coefficient of 0.83. CMB threats, labelled as Factor 2, explained 31.3%

of the variance with an eigenvalue of 3.13 and a reliability coefficient of 0.78. In factor matrix, STR1 to STR5 all had high positive loadings on the Factor 1 (and low loadings on Factor 2), whereas CTR1 to CTR5 all had high positive loadings on Factor 2 (and low loadings on Factor 1).

Table 4.5.4: Rotated Component Matrix on major threats

Factors	Components	
	1	2
Eigenvalue	4.27	3.14
Variance explained	42.7	31.4
STR3	0.969	
STR5	0.924	
STR2	0.910	
STR4	0.861	
STR1	0.604	
CTR2		0.880
CTR3		0.873
CTR5		0.841
CTR1		0.829
CTR4		0.778

Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; a. Rotation converged in 3 iterations.

Factor loading from SMS ranged between 0.969 and 0.604. Forest fire (0.969), invasive species and grazing (0.924), poaching and trade (0.910), commercial mining (0.861) and encroachment (0.604) were of great importance in Factor 1. Similarly, factor loading from CBM ranged between 0.880 and 0.778. Poaching and trade (0.880), forest fire (0.873), invasive species and grazing (0.841), encroachment (0.829) and commercial mining (0.778) significantly contributed to Factor 2.

4.5.5 Analysis of Other Additional Threats

The analysis of 19 other threats was compared between CBM and SMS. The specific threats identified and mitigated at different areas offered a more comprehensive understanding of conservation effectiveness. Closed questions with 3 options – “yes”, “no”, and “do not know” – were analyzed applying McNemar Chi-square test where “do not know” was taken nearer to “no” and recoded as same variable (Table 4.5.5).

Statistically significant threats with $p<0.05$ included a) armed conflicts and insurgency; b) bad community and staff relations; c) community rights restricted; d) development projects;

d) human wildlife conflicts; e) illiteracy; f) increased population; g) lack of awareness; h) land degradation and river cutting; i) policy conflicts; j) political interferences and k) unclear boundaries. Similarly, significant threats at marginal level were a) poor law and order; b) corruptions and poor governance. However, statistically insignificant threats at p>0.05 were a) lack of manpower and budget (p=0.242); b) poor management (p=0.52) and c) poor institutional capabilities (0.83).

Table 4.5.5: Comparing means of threats in SMS and CBM using McNemar test (df =1)

Additional threats	SMS		CBM		McNemar χ^2_1	p
	Yes	No	Yes	No		
Armed conflicts and insurgency	158	67	131	94	20.7	0.000
Bad community and staff relations	73	152	55	170	27.40	0.000
Charcoal burning	67	158	33	192	36	0.000
Poor law and order	128	97	130	95	4.0	0.046
Corruptions and poor governance	96	129	110	115	4.55	0.033
Fuelwood sale	137	88	101	124	11.01	0.000
Community rights restricted	74	151	96	129	25.671	0.000
Development projects	155	70	171	54	31.36	0.000
Human wildlife conflicts	159	66	161	64	37.16	0.000
Illiteracy	152	73	154	71	27.04	0.000
Increased population	145	80	122	123	8.73	0.003
Lack of awareness	144	81	126	99	9.78	0.002
Lack of manpower and budget	128	97	114	111	1.37	0.242
Land degradation and river cutting	152	73	133	92	17.47	0.000
Policy conflicts	152	73	119	106	11,02	0.001
Political interferences	159	66	134	91	23.12	0.000
Poor management	102	123	113	112	0.42	0.520
Unclear boundaries	163	62	141	84	30.74	0.000
Poor institutional capabilities	127	98	101	124	0.045	0.830

4.5.6 Assessment of TRA method

Reliability analysis was undertaken for measuring internal consistency of data among n=45 and the value of Cronbach's alpha was found to be (0.801). One sample median test (2.5, 50%) on 10 response questions of Likert scale revealed a significant difference toward positive conclusion on its simplicity to use, easy to understand, usefulness, cost effectiveness, replicability and comparatively better with p=0.000 and non-positive conclusion on its accuracy (p=0.324) and need for training (p=0.099) (Table 4.5.6).

It can be concluded that TRA acts as useful tool for monitoring and evaluation of conservation interventions, despite its limitations to directly measure threats in biodiversity conservation. Biases could occur in the process of selecting the sites and respondents.

Consequently the results might be subjective and the scores for management performance may not be directly linked to specific intervention. This study, however, highlighted that the potential for involving communities in monitoring trends in biodiversity should be integrated with biodiversity conservation.

Table 4.5.6: One sample median test on effectiveness of TRA method

	OP of category			+/ -		OP of category			+/ -
	<2.5	> 2.5	p			<2.5	> 2.5	p	
Simplicity to use	0	1	.000	+	Need for training	0.65	0.35	.099	-
Easy to understand	0	1	.000	+	Creates baseline	0.08	0. 92	.000	+
Usefulness	0	1	.000	+	Replicable	0	1	.000	+
Cost-effectiveness	0	1	.000	+	Apt for all scales	0.11	0.89	.000	+
Accuracy	0.59	0.41	.324	-	Comparatively better	0.35	0.65	.000	+

(OP= Observed Proportion; Test Proportion=50%; p = 0.000 for all; + = positive and - = negative weight)

The results provided a current snapshot of the variety and severity of threats throughout the TAL conservation system. It also found that TRA approach could be used in TAL as a tool of monitoring and assessing impact of conservation based on its scope and limitations. Compared to existing studies (Margoluis & Salafsky, 1998a;b;1999; Linder, 2012), this study added the input parameters, added quantitative dimensions, carried out parametric analysis and provided more insights.

To sum up, the study findings indicated that the existing management approaches under TAL fall short to address threats. An alternative framework derived inductively by testing of variables in the existing approaches, however, suggested that threats could be measured comprehensively and appropriately. An application of this framework showed that threats could be significantly mitigated at CBM compared to SMS, indicating the CBM as a potentially more successful approach to conservation.

4.6 Analysis of Human Disturbances

4.6.1 Comparative Analysis

Independent sample t test was carried out to compare disturbance means between: a) CFMs of CBM and GMFs of SMS; b) BCFs of CBM and BGMs of SMS and c) CBM (both CFMs and BCFs) and SMS (GMFs and BGMs). Annex 14 shows that the mean values of LOG, FFR, DIST and NR between CFM and GMF were significantly different at $p<0.000$; GRZ was significant at $p=0.023$; and ENC, LVD, PCH and FWD were not significant ($p>0.05$). Comparison of BCF with BGM showed that disturbance variables were statistically significant ($p<0.05$) except for FWD ($p=0.134$). CBM and SMS had significant different disturbance variables ($p<0.05$) except for FWD ($p=0.269$). Similarly, invasive species (such as *Michanea macrantha*, *Lantana camera and Parthenium hysterophorus)* were emerging as major disturbances. The study of INV which was based on binary variable was subjected to Chi-square test. It was found that 67 forests (52.3%) experienced as a threat whereas 61 forests (47.7%) did not, by which this difference was found to be statistically insignificant ($\chi^2_1=1.17$; $p=0.760$).

4.6.2 PCA on Disturbance Variables

PCA was used to extract factors using Varimax rotation. Prior to that, correlations were checked for multicollinearity problems. The results showed a significance level of p=0.000 under KMO test. These diagnostic procedures indicated that factor analysis was appropriate for the data (Table 4.6.1).

Table 4.6.1: KMO measure of sampling adequacy and Bartlett's test of sphericity on disturbances

Management	KMO Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
		Chi-Square	df	Sig
Both CBM and SMS	0.570	256.925	36	0.000
CBM	0.435	109.78	36	0.000
SMS	0.528	127.03	36	0.000

Table 4.6.2: Results of PCA: Varimax rotation factor matrix on disturbances

Component	Overall management				SMS				CBM			
	1	2	3	4	1	2	3	4	1	2	3	4
NRG	0.83				0.77				0.74			
ENC	0.81								0.85			
FFR	0.66				0.64				0.55			
GRZ	0.58			-0.51	0.71				0.70		0.52	
LVD		0.80				0.60		-0.55			0.85	
LOG		0.77			0.55		0.51				0.66	0.57
PCH			0.91			0.53		0.53		0.93		
DST			0.85		-0.67					0.89		
FWD				0.93		-0.57	0.76					0.87
Eigenvalue	2.93	1.567	12.31	1.081	2.554	1.658	1.252	1.064	2.943	1.593	1.230	1.032
Variance explained %	32.56	17.42	13.67	12.01	28.38	18.43	14.35	11.83	32.69	17.71	13.66	11.46
Total variance %	75.66				72.98				75.53			
Extraction Method: PCA and factor loaded above 0.5 Rotation Method: Varimax with Kaiser Normalization												

The nine variables (except INV) were included in the factor analysis and only those factors with an eigenvalue of 1.0 or more were retained. Four factors accounted for 75.66% of the total variance in overall disturbances, 75.53% of disturbances in CBM and 72.98% in SMS. The most influential variables for the first factor, labelled as "forest resource base", which explained 32.56% of the variation, with the highest loading of NRG followed GRZ, FFR and LOG; the second, "forest products" 17.42%, with the loading of ENC followed by PCH and

LOG; the third, "movements" 13.67% with the loading of DST and FWD and the fourth; "basic needs" 12.01% with the loading of LOG, INC and LVD of total variance. In SMS, the first factor explained 28.38%, the second 18.43%, the third 14.35% and the fourth 11.83 %. Together, the first four factors explained 72.98% of the variability in the disturbance variables. In CBM, the first factor accounted for 32.96%, the second 17.71%, the third factor 13.46% and the fourth factor 11.46% of total variance with the total of 75.53% of variance (Table 4.6.2).

4.6.3 Comparing Factor Structure of CBM and SMS

MANOVA was used to determine whether the disturbance variables were related to their factor score (FS) variables. It revealed the dimensions of overall disturbances differed by forest management modalities (Wilks' Lambda, F=8, 8.22, 6.44, p=0.000). The dimensions of disturbances based on individual scores differed significantly by FS1 of SMS (Wilks' Lambda, F=1, 38.54, p=0.000); FS1 (Wilks' Lambda, F=1, 33.33, p=0.000) and FS3 of CBM (Wilks' Lambda, F=1, 8.69, p < .05) (Table 4.6.3).

Table 4.6.3: Multivariate tests in CBM and SMS: between-subjects effects

Dependent Variable	SS	df	MS	F	p
SMS					
FS1	31.82	1	31.82	38.54	0.000
FS2	2.54	1	2.54	3.16	0.078
FS3	0.37	1	0.37	0.48	0.491
FS4	1.14	1	1.14	0.81	0.369
CBM					
FS1	36.30	1	36.30	33.33	0.000
FS2	0.69	1	0.69	0.96	0.330
FS3	11.80	1	11.80	8.69	0.004
FS4	4.28	1	4.28	2.89	0.091

4.6.4 Logistics Regressions

A binary logistic regression analysis was performed to assess the influence of forest management modes, CBM and SMS on conservation disturbances containing nine independent variables (Table 4.6.4). A test on the full model was statistically significant with Chi-square (27, N=128) 269.27, p<0.000 indicating that the model was able to distinguish between disturbances and management modes (Cox & Snell R^2=87.9% and Nagelkerke R^2= 94.5%). LOG had positive regression coefficient (b) of 0.451 with odds ratio (Exp b) of 0.637 which was not statistically significant (p = 0.108). This implied that increase in one unit of LOG increased the disturbance activities in the forest by a factor 0.637 and vice versa.

Table 4.6.4: Model using binary statistics on CBM and SMS

		B	S.E.	Wald	Sig.	Exp(B)
Step 1a	LOG	0.451	0.28	2.584	0.108	0.637
	ENC	0.119	0.117	1.033	0.31	0.888
	GRZ	0.116	0.097	1.424	0.233	1.123
	LVD	0.01	0.09	0.012	0.914	1.01
	FFR	-0.029	0.061	0.22	0.639	0.972
	PCH	0.977	0.635	2.368	0.124	2.655
	FWD	0	0.003	0.024	0.877	0.999
	DST	-11.431	5.272	4.702	0.03	9.21
	NRG	0.409	0.212	3.74	0.053	1.506
	Constant	-42.116	21.541	3.823	0.051	0

a. Variable(s) entered on step 1: LOG, ENC, GRZ, LVD, FFR, PCH, FWD, DST, NRG; b. df = 1, Chi-square = 160.824, d.f. =9 , p = 0.000; -2 Log likelihood = 16.622; Cox & Snell R^2 = 0.715; Nagelkerke R^2 = 0.954

ENC had a positive regression coefficient (b) of 0.119 with odds ratio (Exp b) of 0.888, with p=0.31, meaning that a unit increase in ENC activity increased the likelihood of disturbance by a factor 0.888 and vice versa. GRZ had a positive regression coefficient (b) of 0.116 with odds ratio of 1.123 which was not statistically significant (p=0.233). This meant that the chance of GRZ in TAL forests increased by a factor of 1.123 for a unit change in this variable. LVD had a positive regression coefficient (β) of 0.01 with odds ratio (Exp β) of 1.01. This indicated that disturbance in the forests increased by a factor of 1.01 for every unit change in this variable. FFR has a negative regression coefficient (β) of -0.031 with odds ratio (Exp β) of 0.972. An increase in FFR indicated that human activities in the forests had decreased by a factor of 0.72.

PCH had a positive regression coefficient (β) of 0.977 and the odds ratio (Exp β) of 2.655. This implied that an increase in PCH, which was statistically insignificant (p=0.134), indicated to increase in human disturbances by a factor of 2.655. FWD had a positive regression coefficient (b) of 0 with odds ratio of 0.999 which was statistically insignificant (p=0.887). This meant that the chance of human disturbances in the forest increased by a factor of 0.999 for a unit change in this variable. DST had a negative regression coefficient (β) of -11.431 with odds ratio (Expβ) of 9.21 with p=0.03. This implied that a unit increase in distance between the community and the forests limited the likelihood of disturbances by a factor 9.21. NRG had a positive regression coefficient (β) of 0.409 with odds ratio of 1.506 which was statistically insignificant (p=0.053). This meant that the chance of human disturbances in the forest increased by a factor of 1.506 for a unit change in this variable.

In comparison to existing studies carried out in Nepal (Aryal et al., 2012) and Latin America (Carlos & Edward, 2005; Carlos et al 2006), this study quantitatively provided detail and in-depth insights into the relationship between management modalities and forest disturbances. It is concluded that CBM remains the dominant conservation modality for prevention and mitigation of disturbances.

4.7 Effects on Livelihoods

4.7.1 Human Capital

The scores of variables were aggregated to form the human capital index. Five variables loaded highly on a single common factor for 2009 (Table 4.7.1). The most prominent factors were labour availability (0.954), human health (0.953), skilled manpower (0.941), training (0.920) and education (0.880). In 2012, however, changes were observed in the factor loadings. The receiving training (0.961) had been an important factor followed by education (0.947), labour (0.940), human health (0.921) and skills (0.839).

Table 4.7.1: Human capital factor loading and scores

Year 2009			Year 2012		
Performance indicators	Factor loading	Score	Performance indicators	Factor loading	Score
Labour availability	0.954	0.221	Training	0.961	0.226
Human health	0.953	0.220	Education	0.947	0.223
Skills	0.941	0.218	Labour	0.940	0.221
Training	0.920	0.213	Human health	0.921	0.216
Education	0.880	0.203	Skills	0.839	0.197
Variance explained (%)	86.502			85.133	

4.7.2 Physical Capital

The selection consisted of 6 variables for 2009 and 5 variables for 2012 covering the broad themes of the assessment. However, the nature of the loading of variables between 2009 and 2012 was found to be different.

Table 4.7.2: Physical capital factor loading and score

Year 2009			Year 2012		
Performance Indicators	Factor loading	Score	Performance Indicators	Factor loading	Score
Communication	0.995	0.136	House	0.942	0.201
Market access	0.995	0.136	Road	0.942	0.201
Community house	0.995	0.136	School	0.867	0.185
School	0.995	0.136	Health services	-0.852	-0.177
Road	0.995	0.136	Communication	0.852	0.177
House	0.995	0.136			
Variance explained (%)	60.727			59.446	

With factor loading of 0.995 each on communication, market access, community house, school, road and house made important contribution as regressors to the factor structure of 2009. On the other hand, house (0.942), road (0. 942), school (0.867), health services (-0.852) and communication (0.852) contributed to the factor structure in 2012 (Table 4.7.2).

4.7.3 Natural Capital

Among natural capitals, four variables were found significant with loading value >0.70 in both 2009 and 2012; however, the nature and loading differed. Fodder and fuelwood (0.968), farming system (0.948), forest management (0.948) and access to natural resources (NR) (0.824) were of great importance in the settlement of factors on non-CBM in 2009. However, access to (NR) (0.999), forest management (0.999), fuelwood (-0.999) and NTFP management (0.936) outstandingly contributed to the formation of factors on CBM in 2012 (Table 4.7.3).

Table 4.7.3: Nature capital factor loading and score

Year 2009			Year 2012		
Performance indicators	Factor loading	Score	Performance indicators	Factor loading	Score
Fodder and fuel-wood	0.968	0.345	Access to NR	0.999	0.193
Farming systems	0.948	0.236	Forest management	0.999	0.193
Forest management	0.948	0.236	Fuel-wood	-0.999	-0.193
Access to NR	0.824	0.212	NTFP management	0.936	0.153
Variance explained	50.859			56.689	

4.7.4 Social Capital

Four key variables, with loadings >0.7, were identified for the social capital index. The most important variables in 2009 were community size (0.963), landlessness (-0.963), community organization (0.926) and trust (0.926). On the other hand, the five contributing factors were trust (1.0), participation (-0.986), population (0.915), community organizations (0.915) and village size (-0.915) in 2012 (Table 4.7.4).

Table 4.7.4: Social capital factor loading and score

Year 2009			Year 2012		
Performance indicators	Factor loading	Score	Performance indicators	Factor loading	Score
Community size	0.963	0.249	Trust	1.000	0.136
Landlessness	-0.963	-0.249	Participation	-0.986	-0.128
Community organizations	0.926	0.189	Population and migration	-0.915	-0.108
Trust	0.926	0.189	Community organizations	0.915	0.108
			Village size	-0.915	-0.108
Variance explained	57.069			59.689	

4.7.5 Financial Capital

Among the financial capitals three variables with loadings >0.7 aggregated to form the financial capital index. In 2009, as shown in Table 4.7.5, the most prominent factors were entrepreneurships of households (0.855) followed by income (0.742) and employment (0.701). However, in 2012, the changes occurred; the four factors contributing were income generation (0.973), mobilization of community funds (0.970) and prospect for ecotourism (0.904).

Table 4.7.5: Financial capital factor loading and score

Year 2009			Year 2012		
Performance indicators	Factor loading	Score	Performance indicators	Factor loading	Score
Entrepreneurships	0.855	0.418	Income	0.973	0.228
Income	0.742	0.355	Mobilization of funds	0.970	0.227
Employment	0.701	0.392	Remittances	0.970	0.227
			Prospects on eco-tourism	0.904	0.236
Variance explained	53.460			59.270	

4.7.6 Vulnerability

Indicators of vulnerability which were significant with single component analysis in 2009 were natural shocks (0.857) and human health (0.823); however, in 2012 natural shock (-0.852), biodiversity threats (0.844), and human wildlife conflicts (0.766) scored higher (Table 4.7.6).

Table 4.7.6: Factor loading and score on vulnerability

Year 2009			Year 2012		
Performance indicators	Factor loading	Score	Performance indicators	Factor loading	Score
Natural shocks	0.857	0.510	Natural shocks	-0.852	-0.263
Human health	0.823	0.502	Biodiversity threats	0.844	0.291
			Human wildlife conflicts	0.766	0.243
Variance explained	39.963			40.668	

4.7.7 Policy, Institutions and Process

On policy and institutions, the significant variable was CF operational plan (0.740) in 2009; and changes occurred in 2012 with higher significance for coordination (0.962) followed by policy anomalies (0.891) in the single factor (Table 4.7.7.).

Table 4.7.7: Factor loading and score on policy, institutions and process

Year 2009			Year 2012		
Performance indicators	Factor loading	Score	Performance indicators	Factor loading	Score
Operational Plan	0.740	0.581	Coordination	0.962	0.498
			Policy anomaly	0.891	0.444
Variance explained	51.846			49.401	

4.7.8 PCA on Composite Data

While using the raw data multi-collinearity diagnostics high values of variance inflation factor (VIF>10.0) were observed. Moreover, out of 72 variables, 45 variables were excluded from multi-collinearity test considering the fact that the computed value was less than the amount specified. The VIF test only included variables used for PCA analysis through constant refinement; and the variables which did not affect the model were excluded. In the initial analysis, the first component accounted for 51.5% in 2009 and 53.1% in2012 of the variation in the original variables with loading >0.70. In the second and subsequent analysis variables of low loading were removed.

Table 4.7.8: List of the variables included in the final model

Year 2009			Year 2012		
Performance indicators	FL	Score	Performance indicators	FL	Score
Participation	0.999	-0.075	Ownership and use rights	0.954	0.078
Road	0.999	0.075	Road	0.954	0.078
House	0.999	0.075	Access to market and infrastructures	0.954	0.078
Income	0.999	0.075	Income	0.923	-0.112
Entrepreneurships	0.999	0.075	Remittances	0.923	0.112
Community organization	0.999	-0.075	Population and migration	0.823	0.028
Access and use of NR	0.999	0.075	Forest management	0.823	-0.028
Forest management plans	0.869	-0.068	Education	0.711	0.130
Labour availability	0.724	0.062	Farming system	0.711	0.130
Landlessness	0.724	0.062	Natural shocks	0.711	0.130
Natural shocks	0.710	0.077	Human wildlife conflicts	0.711	0.130
			Policy harmonization	0.711	0.130

Extraction Method: Principal Axis Factoring; Rotation Method: Varimax with Kaiser Normalization; Factor Scores Method: Regression

Finally, 11 variables for 2009 and 12 variables for 2012 were identified with the highest loadings. For 2009, the variables of factor loading of value 0.999 were participation, road, house, income entrepreneurships, community organization, and access and use of NR. Other variables were forest management plans (0.869), labour availability (0.724), proportion of land owner/landless (0.724) and natural shocks (0.710). On the other hand, for 2012, ownership and use rights (0.954), road (0.954), access to market and infrastructures (0.954), income (0.923), remittances (0.923), population and migration (0.823), forest management (0.823), education (0.711), farming system (0.711), natural shocks (0.711), human wildlife conflicts (0.711) and policy harmonization (0.711) were found major loaded variables (Table 4.7.8).

To sum up, the final selection for the model consisted of 11 variables for 2009 and 12 variables for 2012 out of original 72 variables. Calculating the index through multiplication of the coefficients and the standardised values of the respective variables, it was found that index accounted for 31.1% of the variation in the original variables used in the analysis in year 2009 and 68.5% in 2012.

4.7.9 Analysis of Household income

An analysis of household income by income group showed that the mean annual income from farm and forests was NRs 56,288 ±1699.72 in 2009 and NRs. 115,748±2809.01 in 2012. Another major source of income, remittances, when added to mean annual income the figure appeared to be significantly high with mean NRs. 99,985 ± 1854.71 in 2009 and NRs. 136460.70 ± 2170.89 in 2012 (Table 4.7.9).

Table 4.7.9: Mean incomes of households

Variables	Year	Mean (NRs)	SE of Mean (NRs)
Income from farm and forests	2012	115748.80	2809.01
	2009	56288.80	1699.72
Income with remittance	2012	136460.70	2170.89
	2009	99885.86	1854.71

(Source: Field Survey, 2009 and 2012)

The incomes, both with or without remittances were found to have increased significant between 2009 and 2012 with p =0 as revealed by independent sample t test (Table 4.7.10).

Table 4.7.10: Independent t test of income between 2009 and 2012.

Variables	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	p	t	df	p
Income without remittances	168.351	0	18.11	798	0
Income with remittances	21.649	0	12.809	798	0

CBM under TAL was found to be an important income source to the households. Because the communities had access to protect, manage and use the resources, they had increased income compared to the previous period. However, as evidenced by the correlation tests between total household income and remittance, there was no significant correlation in 2009 (p>0.05) but significant in 2012 at p=0.000 (Table 4.7.11).

Table 4.7.11: Correlation test between total income and remittances

Data types	Test types	Year 2009		Year 2012	
		Value	p	Value	p
Interval by Interval	Pearson's R	0.015	0.764	-0.371	0
Ordinal by Ordinal	Spearman Correlation	0.015	0.764	-0.374	0

Realizing the limitation of the t test and correlation test for providing only the indicative result, frequency and percentage statistics were used to calculate annual income. As shown in Table 4.7.12, the percent of income range of communities was upscaled between 2009 and 2012. There was a decline of 54.5% in number of households with low income category (<40,000) and increase of 18.2% in number of households with high income category (>160,000).

Table 4.7.12: Frequency and percentage of annual income from farm and forests

Income range (NRs)	2009		2012	
	Count	Percent	Count	Percent
<40,000	296	74.00%	78	19.50%
40,000-80,000	66	16.50%	103	25.80%
80,000-120,000	20	5.00%	73	18.20%
120,000-160,000	10	2.50%	65	16.20%
>160,000	8	2.00%	81	20.20%
Total	400	100.00%	400	100%

(Source: Field Survey, 2009 and 2012)

From 2009 to 2012, income from remittances was found to have increased sharply because active community members had migrated either to abroad or within countries for seasonal farm employment, road and building construction, rickshaw pulling and other wage labouring activities. During the period of 2009 to 2012, the proportion of remittance to total income increased from 30.5% to 44.9% (Table 4.7.13).

Table 4.7.13: Gross income of households including remittances

Income range (NRs)	Year 2009		Year 2012	
	Count	Percent	Count	Percent
<40,000	26	6.50%	3	0.80%
40,000-80,000	88	22.00%	85	21.20%
80,000-120,000	126	31.50%	140	35.00%
120,000-160,000	71	17.80%	76	19.00%
>160,000	89	22.20%	96	24.00%
Total	400	100.00%	400	100.00%
Contribution of remittances		30.5%		44.9%

(Source: Field Survey, 2009 and 2012)

It is important to note that communities also depended on farm, livestock, wage labouring, salary, collection and sale of forest products, handicrafts, skilled non-farm jobs, salaried jobs and self-employment having effects on income distribution and often subjected to debate on attributions. However, the multiple resources of CBM provided several opportunities including capital gains to the communities as an important source of income under the TAL programme TAL has encouraged local communities to participate actively in decision making on livelihood issues. There was also evidence that communities had capability to influence their access to livelihood assets.

4.7.10 Regression Analysis

The factors that contributed to household income were analyzed using a regression model consisting of variables measuring various priority assets. The dependent variable was the annual household income from different sources before CFM in 2009 (Equation 1) and after CBM in 2012 (Equation 2).

Equation 1:

$$Y=\alpha + 1\ \beta\ PAR + 2\ \beta\ ROD + 3\ \beta\ HOS + 4\ \beta\ ENT + 5\ \beta\ CMO+ \beta\ 6\ ANR + \beta\ 7\ LSS + \beta\ 8\ FMP + \beta\ 9\ LAB + \beta\ 10\ NSH + Error$$

Where; Y= household annual income (NRs), α = constant; β 1 to β 10= coefficient of variables for household assets, PAR = participation (index), ROD = road (index), HOS = house (percent), ENT = entrepreneurships (percent), CMO = community organization (Likert scale), ANR = access to NR (continuous), LSS = inverse proportion of landlessness (number), FMP = effectiveness of forest management plan (continuous), LAB= labour availability (percent), NSH= natural shock (Likert scale) and Error.

Equation 2:

$$Y=\alpha +\beta_1\ OWN + \beta_2\ ROD +\beta_3\ ACE +\beta_4\ ENT +\beta_5\ RMT + \beta_6\ POP + \beta_7\ MGT + \beta_8\ EDU + \beta_9\ FMS + \beta_{10}\ NSH + \beta_{11}\ HWC + Error, (2)$$

Where; Y = household annual income (NRs); α = constant, β1 to β11= coefficient of variables for household assets, OWN = ownership and use rights (index), ROD = road (index), ACE = access to market and infrastructure (continuous), RMT= remittances (NRs), POP= population and migration (proportion), MGT= forest management (binary), EDU= education (continuous), FMS= farming system (Likert scale), NSH= natural shocks (Likert scale) and HWC= human wildlife conflicts (percent), PHM=policy harmonization (Likert scale) and Error.

Multiple regression analysis was used to examine the link between the household income and various independent variables. Removing multicollinearity problem, the complex relationship between household income and the measured characteristics was assessed by priority variables for non-CBM in 2009 and CBM in 2012. Income was predicted by multiple linear regression method. R, R^2, adjusted R^2, and RMSE values for income prediction were estimated as 0.42, 0.18, 0.163 and 0.358 for non-CBM (Table 4.7.14); and 0.696, 0.485, 0.475 and 0.463 for CBM (Table 4.7.15). In case of non-CBM, the coefficients for the variables of three factors were significant with $p<0.05$ for landlessness, forest management and access to natural resources. However, the model eliminated ROD and CMO variables.

Table 4.7.14: Multiple linear regression on non-CBM

	B	Std. Error	Beta	t	p	Tolerance	VIF
(Constant)	1.109	0.234		4.739	0		
PAR	-0.034	0.037	-0.048	-0.934	0.351	0.94	1.063
HOS	-0.036	0.037	-0.048	-0.957	0.339	0.986	1.015
ENT	0.007	0.043	0.008	0.163	0.87	0.93	1.075
LAB	0.005	0.056	0.005	0.08	0.936	0.559	1.788
LSS	-0.141	0.116	-0.061	-1.221	0.023	0.983	1.017
FMP	-0.095	0.059	-0.081	-1.613	0.047	0.99	1.01
ANR	0.272	0.106	0.129	2.571	0.011	0.986	1.014
NSH	0.111	0.138	0.04	0.802	0.423	0.982	1.018

(Model summary=R = 0.42; R^2 = 0.18; Adjusted R^2= 0.163 and SE =0.358)

Table 4.7.15: Multiple linear regression on CBM

	B	Std. Error	Beta	t	p	Tolerance	VIF
(Constant)	2.93	0.2		14.656	0		
OWN	0.004	0.024	0.005	0.148	0.883	0.983	1.017
ACE	0.014	0.029	0.018	0.482	0.63	0.992	1.008
POP	0.034	0.048	0.026	0.706	0.48	0.956	1.047
MGT	0.012	0.022	0.02	0.526	0.599	0.95	1.052
RMT	0.874	0.368	0.643	2.376	0.018	0.018	4.67
PHM	-0.325	0.051	-0.321	-6.372	0	0.52	1.923
NSH	-0.289	0.019	-0.729	-15.369	0	0.586	1.707
HWC	-1.582	0.371	-1.158	-4.262	0	0.018	3.01

(Model summary=R = 0.69; R^2 = 0.48; Adjusted R^2= 0.475 and SE =0.463)

In CBM, the coefficient of RMT was positively linked but was moderately significant. Similarly, PHM, NSH, HWC had the negative relationship with positive significance value of p=0.000.The relationship and value of PHM implied that community rights were curtailed by the recent policies and government circulars. The variables excluded from the model were ROD, EDU and FMS.

The significance of this study lies on assessing existing scholarship and constructing an objectively weighted composite index and its application to compare livelihood variables across the diverse population of TAL. In doing so, compatibility of components to explain the most variance in the data set of the different groupings is also determined. The constructed index includes the relevant dimensions of livelihood in addition to both objective and subjective indicator variables. Importantly, quantitative analysis of income as the vital livelihood variable is carried out so as to provide disaggregated result on contributing factors where remittances are found to be confounding factor. It is shown that a single asset does not account significantly in livelihood or income in TAL area, and one particular capital cannot even encapsulate a complete description of a livelihood component- in some cases -.the nature and the number of independent asset component is found to vary slightly from one model to another.

The tools and methods of this study partially align with Ashley & Carney (1999), OECD, (2008), Rai et al. (2008) and Sharpe & Smith (2005). The particularity of this study grounds on its integration of various tools, collection of extensive, logical and evidence based data, use of valid statistical techniques, preparation of index and regression and elucidation of detail insight of livelihood impact that are not common in other studies, e.g. Nagendra (2002) and MFSC (2013). The main conclusions are: a) livelihood on the sites improved due to CBM attributable to the rights on access to resources; and b) the use of several assets prove useful to quantify livelihood is any single capital cannot confer to be superior to the others.

4.8 Effects on Social Dimensions

4.8.1 Social Organizations

The statistically significant positive perceptions with $p<0.05$ using one sample median test (2.5, 50%) were: a) empowerment of community members, b) maintenance of trust and unity, c) peaceful interaction and social control and d) interrelationship among members. However, the perceptions which were not statistically significant with $p>0.05$ were: a) commitment to collective aim and actions, b) recognition of social rules and process, c) focus on village institutions and d) adaption of consensus based approach (Table 4.8.1).

Table 4.8.1: One sample median test on variables of social organizations

Variables	Category of OP*		p
	<= 2.5	> 2.5	
Committed to collective aim and actions	0.41	0.59	0.124
Empowered the community members	0.18	0.82	0.000
Maintained trust and unity	0.14	0.86	0.000
Carried out peaceful interaction and maintained social control	0.20	0.80	0.000
Established interrelationships among members	0.18	0.82	0.000
Recognized social rules and process	0.42	0.58	0.187
Focused on village Institutions	0.48	0.52	0.826
Applied consensus based approach	0.59	0.41	0.124

(* = OP= observed proportion) (Source: Field Survey, 2009 and 2013)

4.8.2 Social Process

In 2009, statistically significant positive responses under Chi-square test at $p<0.05$ were on a) clarity on role and responsibilities, and b) managing conflicts; and negative responses at $p<0.05$ were on a) participation in decision making, b) effectiveness of decision implementation and c) transparency and democratic functioning. In 2013, statistically significant positive responses at $p<0.05$ were on a) adaption of CBM process, b) development of leadership and gender, c) clarity on role and responsibilities and d) managing conflicts. Improvements were observed in between 2009 and 2013 on increased frequency of positive responses on a) organization of meeting and attendances, b) participation in decision making process, c) effectiveness of decision implementation, d) participation of women and target groups and e) effectiveness of accountability of committees. The negative performances during this period were on a) relations between committee and members and b) satisfaction of performance of committees (Table 4.8.2).

Table 4.8.2: Comparison of responses on variables of social process

Variables	Year 2009				Year 2013			
	Y	N	$\chi2$	p	Y	N	$\chi2$	p
Adaption of process based on guidelines	38	45	0.590	0.442	51	32	4.349	0.037
Organization of regular meetings and attendance	43	40	0.108	0.742	45	38	0.590	0.442
Participation in decision making	33	50	3.482	0.062	44	39	0.301	0.583
Effectiveness of decision in implementation	27	56	10.133	0.001	33	50	3.482	0.062
Participation of women and target group	21	62	20.253	0.000	35	48	2.036	0.154
Development of the leadership and gender	46	37	0.976	0.323	52	31	5.313	0.021
Harmonization of relation between committees and members	49	34	0.271	0.100	41	42	0.012	0.913
Satisfaction of member for committee's performance	49	34	0.271	0.100	45	38	0.590	0.442
Transparency and democratic functioning	30	53	6.373	0.012	33	50	3.482	0.062
Clarity on role and responsibilities	51	32	4.349	0.037	52	31	5.313	0.021
Effectiveness of accountability of committee to users	39	44	0.301	0.583	44	39	0.301	0.583
Managing conflicts	51	32	4.349	0.037	52	31	5.313	0.021

(Responses: Y= Yes; N= No; $\chi2$ test with df=1) (Data source: Field Survey, 2009 and 2013)

4.8.3 Financial Flows and Economic Stratification

The two main sources of financial capital – available stocks and regular inflows of money (Lorenz, 1999 & DFID, 1998) –were found to be the sources of the capital in the studied area. The communities generated money from the sale of forest products, entry fees, fines, levies and grants from outside. The fund was used for community development and livelihood improvement which had its impact on employment creation and income generation (IG) package. For instance, Aishorya CFUG increased their fund nearly three folds within four year span; Dilasaini CFUG created employment for three times more members; and Jaikalika CFUG provided support to two fold members for IG (Table 4.8.3).

Table 4.8.3: Fund, employment and income generation packages

CFUGs	Fund (Rs in thousands)		Employment (number)		IG package (number)	
	2009	2013	2009	2013	2009	2013
Dilasaini	918	1,222	7	22	3	7
Aishorya	485	1,413	19	34	11	16
Jaikalika	98	236	8	17	5	11

(Source: Field Survey, 2009 and 2013)

Examining the CFUGs in terms of wellbeing rank of 2009 and 2013 revealed that the ranks improved slightly from poor to medium and medium to rich. Among most CFUGs, the change in well being rank was less than 10%; the highest change was observed in Dilasaini (8.59%) However, the shift values under Chi-square test were not statistically significant as all p values from poor to medium and medium to rich were >0.05 (Table 4.8.4).

Table 4.8.4: Economic stratification of users

CFUGs	HHs (2013)	Percent in Year 2009			Percent in Year 2013			Poor to medium		Medium to rich	
		Poor	Medium	Rich	Poor	Medium	Rich	$\chi 2_1$	p	$\chi 2_1$	p
Dilasaini	278	34.89	44.96	20.14	26.30	49.60	24.10	1.328	0.249	0.293	0.608
Aishorya	225	28.89	42.22	28.89	24.10	45.10	30.80	0.472	0.492	0.103	0.748
Jaikalika	84	60.71	22.62	16.67	55.60	26.80	17.60	0.214	0.644	0.320	0.572

(Source: Field Survey and CFUG constitution, 2009 and 2013)

4.8.4 Infrastructure Development

The fund of CFUGs was used largely (over 70% budget) on non-forestry purposes (road, schools and other infrastructure such as electricity, temple buildings and drinking water). Only a small proportion of funds was used for forestry (4% and 13% in 2009 and 2013 respectively) and for poverty reduction activities (12% and 17% in 2009 and 2013 respectively). This meant that the forestry had received minimum inputs from CFUGs, which is a non-compliance of legal provision to place at least 35% income on forest development activities, and a major concern for future sustainability (Table 4.8.5).

Table 4.8.5: Percent of budget used in local development

Activities	Percent of budget		Activities	Percent of budget	
	2009	2013		2009	2013
Forestry	4	13	Electricity	11	4
Soil erosion	5	3	Drinking water	8	9
Poverty reduction	12	17	Office building	12	2
Temple	4	6	Road	20	20
Communication	6	7	School	16	13
Health	4	6	Total	100	100

(Source: Field Survey, 2009 and 2013)

4.8.5 Capacity Building

Capacity building, which concerns skills, knowledge, capacity and human health that together enable people to convert natural capital into human-made capital (Booysen, 2002; DFID, 1998; Flora, et al., 2004) was analyzed among the CFUGs. From 2009 to 2013, in all three groups, the number of trained people increased from 85 to 177; volunteerism increased from 77 to91% in 2009 and 84 to 92% in 2013; and number of skilled manpower for jobs abroad increased from 53 to 222 (Table 4.8.6).

Table 4.8.6: Human capital on training, remittances and volunteer contributions

CFUGs	Trained people (number)		People on remittance (number))		Volunteer contribution (percent)	
	2009	2013	2009	2013	2009	2013
Dilasaini	32	63	20	79	81	84
Aishorya	44	81	27	102	77	89
Jaikalika	9	33	6	42	91	92

(Source: Field Survey, 2009 and 2013).

4.8.6 Forest Protection

The CFUGs had a strong sense of ownership over the forests. They had protected forests and operated on the basis of group constitution and forest operational plan by giving equal access as well as responsibilities to all members. The forests were restored and managed under biodiversity friendly silvicultural operations and utilized for their livelihoods pursuant to their approved operational plans.

Table 4.8.7: Record of forest offenses in the sample CFUGs

CFUGs	Year 2009	Year 2013	Percent reduction
Dilasaini	22	9	59.09
Aishorya	17	11	35.29
Jaikalika	14	8	42.86
Total	53	28	47.17

Source: Field Survey, 2009 and 2013.

The study showed that there were positive changes in forest condition and reduction in the time spent for collecting forest products. The rate of forest offences was found to have decreased by 47.17% over time (Table 4.8.7). Taking over forest by CFUGs is noted to have changed the condition of forests. Improvements were observed in terms of number or density and volume. CFUGs reported that they harvested and used a considerable amount of wood products. The survey data showed that average basal area increased from 6.11 in 2009 to 11.22 m^2/ha in 2013; mean species presence/hectare increased from 16 in 2009 to 30 in 2013; density/ha increased from 2,134 in 2009 to 11,467 in 2013; and total volume increased from

81 in 2009 to 108 m^3 per ha in 2013 (Table 4.8.8). The noted increase should not be understood as a consequence of time span only; it might have been due to other factors, namely, the management mode and site factors. The management mode covers not only the level of protection but also enrichment level of the forests; and site factors count on difference of production.

Table 4.8.8: Growing stocks in sample CBMs

Variables	Year 2009	Year 2013
Mean basal area (m^2/ha)	6.11 (0.66)	11.22 (1.44)
Mean no. of plants/ha	2,134 (334)	11,467 (4188)
Mean species (number/ha)	16 (1)	30 (2)
Mean volume (m^3/ha)	81 (6)	108 (9)

. (Source: Field Survey, 2009 and 2013) The values in parentheses are ± S.E

4.8.7 Policies and Institutions

The statistically significant positive perceptions with p=0.000 using one sample median test (2.5, 50%) were a) cohesion and network of users and b) effective implementation of forest operational plan; and negatively significant perception at p>0.05 were a) harmonization of policy implementation and b) coordination and synergy among institutions (Table 4.8.9).

Table 4.8.9: One sample median test on variables of policies and institutions

Perception Statements	Category of OP		p
	<= 2.5	> 2.5	
Harmonization of policies in implementation	0.66	0.34	0.004
Cohesion and network of user groups are	0.18	0.82	0
Forest operational plans effectively implemented	0.14	0.86	0
Co-ordination and synergy among institutions	0.64	0.36	0.015

(OP= Observed Proportions, Test proportion = 50%)

4.8.8. Negative Performances

Under Chi-square test, the statistically significant perceptions were problem of elite dominancy (p=0.012), increased political pressures, (p=0.000); increased human wildlife conflicts (p=0.000) and increased pressure on SMS (p=0.000). The non significant perceptions included loss of opportunities for forest dependent communities in recent years (p=0.113) and low level of financial inputs provided to CBM (p=0.094) (Table 4.8.10).

Table 4.8.10: Perception of local people on negative impacts of CBM

Impact statements	Y	N	DK	χ2	p
Elite dominancy	39 (46.99)	27 (32.53)	17 (20.48)	8.771	0.012
Increased political pressure	46 (55.42)	25 (30.12)	12 (14.46)	21.227	0.000
Increased human wildlife conflicts	63 (75.90)	17 (20.48)	3 (3.61)	71.229	0.000
Opportunity loss for forest dependent people	34 (40.96)	30 (36.14)	19 (22.89)	4.361	0.113
Increased pressure on SMS	41 (49.40)	33 (39.76)	9 (10.84)	20.048	0.000
Low level of financial inputs to CF	29 (34.94)	35 (42.17)	19 (22.89)	4.723	0.094

(Responses: Y= Yes; N= No and DK= Do Not Know; $\chi 2$ test with df=2. The figures in parentheses are percent)

4.8.9 Pressure on SMS

The demand and supply scenario of CUFGs were very unbalanced. The average supply of forest products in 2009 was found in a range from 16 to 62.8%, while in 2013 it was in a range from 17.94 to 64.75%. The deficit supply of timber and fuel-wood had created high pressure on the SMS (Table 4.8.11). This clearly illustrated that the communities still largely depended on the SMS to fulfil their need, which can be partly attributed to the success of CBM.

Table 4.8.11: Demand and supply of forest products

Forest products	Unit	Year 2009		Year 2013	
		Demand	Supply	Demand	Supply
Timber /hh/year	Cft	21.50	4.3 (20)	22.35	4.01 (17.94)
Fuel-wood/hh/day	Headload	0.50	0.08 (16)	0.34	0.10 (29.42)
Grass/hh/year	Headload	1	0.60 (60)	1.2	0.73 (60.83)
Fodder/hh/day	Headload	1.13	0.71 (62.8)	1.22	0.79 (64.75)

(Source: Field Survey, 2009 and 2013; One headload ≈ 30 kg; the figures in parenthesis are percent)

4.8.10 Human Wildlife Conflicts

Human-wildlife conflicts in biological corridors have become more frequent and severe over recent years. The damage of property from 2009 to 2013 was found to have increased many folds (Table 4.8.12), but cases of human life loss were not recorded. Despite endorsement of guidelines by the Government on compensation against the damage caused by wildlife on human and property, there were no effective conflict management schemes in place at the community level.

Table 4.8.12: Records of damage caused by wildlife

CFUGs	Number of incidents of damage	
	2009	2013
Dilasaini	6	44
Aishorya	12	57
Jaikalika	4	31

(Source: Field Survey, 2009 and 2013)

To sum up, CBM in TAL has provided many positive impacts despite some important emerging areas of immediate improvements. Despite some of the shortcomings, the CBM has provided local communities better option than the previous forest management strategies implemented by the government. To conserve both economic and environmental services, the devolution and right over the resources are the existing basic incentives in CBM, but additional incentives including diversification of sources of revenue from non-destructive forestry activities, are required to sustainably maintain the stability of CBM over time. However, the existing mechanisms have mostly concentrated on creating incentives for conservation rather than compensating those affected by biodiversity loss.

The future priorities require to harness the impulses by designing policies and regulations and assisting communities to implement actions that promote the sustainable management of resources, preserve biodiversity and habitat, and provide mechanisms for creating direct incentives and livelihood opportunities for local stakeholders based on local resources rather than outside sources including the government subsidies.

Methodologically, the study partially aligned with Yadav et al. (2003), DFID (2004) and MFSC (2013), but the findings of this study are statistically reliable, comparable and generate knowledge of immediate importance for policy formulation and implementation.

4.9 Climate Change Adaptation and Vulnerability Assessment

4.9.1 Observed and Perceived Impacts

The existing finding on annual temperature trend is contested as there is no clear trend with reference to increase or decrease (NCVST, 2009): McSweeney et al. (2008) showed that there is no increase in annual temperature; but, Agrawala et al. (2003) and Bhutiyani et al. (2010) reported that temperature has increased in recent years at higher altitudes. Other studies have shown that hot nights have increased by 2.5% (McSweeney et al., 2008); average temperature might rise significantly by 0.5 to 2.0 ºC by 2030 ((Nepal Climate Vulnerability Study Team, NCVST, 2009) and average air temperature has risen by 1° Celsius (Shrestha et al., 2001). At community level, it has been believed that climate change is no longer a future phenomena but a present reality.

Table 4.9.1: Chi-square test on perception of local people on climate change

Impact statement	Y	N	DK	$\chi2_2$	p
Overall awareness on climate change	11(15.49)	12 (16.90)	48(67.61)	37.55	0.000
Increased seasonal temperature	25 (35.21)	19 (26.76)	27 (38.01)	1.229	0.541
Hot winter and cold summer	35 (49.3)	15 (21.13)	21 (29.58)	8.901	0.012
Increased rainfall	44 (61.97)	12(16.90)	15 (21.13)	26.394	0.000
Delay in rainfall	34 (47.89)	14 (19.72)	23 (32.39)	8.479	0.014
Increased drought	51 (71.83)	5 (7.04)	15 (21.13)	49.465	0.000
Increased floods	45 (63.38)	7 (9.85)	19 (26.76)	31.887	0.000
Decreased water availability	51(71.83)	4 (5.84)	16 (22.54)	50.394	0.000

(Responses: Y= Yes; N= No and DK= Do Not Know; the figures in parentheses are percent)

Table 4.9.1 shows the Chi-sqaure test result on proportion of study participants responding "yes" or "no" or "do not know" to each perception statement. The statistically significant perceptions were experience of more heat in summer and cold in winter (p=0.012); increase in rainfall than before (p=0.000); delay in rainfall (p=0.014); increase in period of drought (p=0.000); increase in floods (p=0.000); and decrease in water availability (p=0.000).

4.9.2 Effects of Climate Change

Proportion of responses showing statistically significant at p<0.05 under Chi-square test were changes in the flowering and fruiting time of the forest and agricultural species (p=0.000), disappearance of some local non timber forest products (NTFP) (p=.001) and decease in production of agriculture crop (p=0.000).

Table 4.9.2: Effects of climate change

Impact statements	Y	N	DK	$\chi2_2$	p
Changes in flowering and fruiting time	50 (70.42)	9 (12.68)	12 (16.90)	44.141	0.000
Decreased availability of forest products	29 (40.85)	23 (32.39)	19 (26.76)	2.141	0.343
Decreased availability of NTFPs in forest	37 (52.11)	12 (16.90)	22 (30.99)	13.380	0.001
Decease production of agriculture crop	41 (57.75)	12 (16.90)	18 (25.35)	19.803	0.000
Extinction of plants species	20 (28.17)	6 (8.45)	45 (63.38)	32.986	0.000
Increase in forest fire	21 (29.58)	15 (21.13)	35 (49.30)	8.901	0.012
Increased invasive species	17 (23.94)	18 (25.35)	36 (50.70)	9.662	0.008
Soil moisture depletion	28 (39.44)	24 (33.80)	19 (26.76)	1.718	0.424
Wind pattern changes	29 (40.85)	19 (26.76)	23 (32.39)	2.141	0.343

(Responses: Y= Yes; N= No and DK= Do Not Know; the figures in parentheses are percent)

The proportions of respondents who said "do not know" were significantly higher on extinction of plant species (p=0.000); increase in forest fire (p=0.012) and increase in invasive species (p<0.008). The test did not show the difference to be statistically significant at 5% were decrease in availability of forest products (p=0.343); decrease in soil moisture (p=0.424) and change in wind pattern (p=0.343) (Table 4.9.2).

4.9.3 Environmental Benefits of CBM

As shown in Table 4.9.3, statistically higher percentage of respondents agreed that CBM had effects on providing cool air in summer and maintaining the atmospheric temperature (p=0.000). The higher percentage of respondents said “do not know” on role of CBM on stabilizing soil and reducing the natural hazards which was not significant (p=0.061).

Table 4.9.3: Perceived environmental impact of CBM

Impact statements	Y	N	DK	$\chi2_2$	p
Provides cool air and maintain temperature	44 (61.97)	12 (16.90)	15 (21.13)	26.394	0.000
Stabilizes soil and control natural hazards	20 (28.17)	18 (25.35)	33 (46.48)	5.606	0.061
Provides forest products and water sources	55 (77.46)	7 (9.86)	9 (12.68)	37.742	0.000
Sequesters carbon	14 (19.72)	17 (23.94)	40 (56.34)	17.099	0.000
Provides income and employment	51 (71.83)	6 (8.45)	14 (19.72)	48.704	0.000

(Responses: Y= Yes; N= No and DK= Do Not Know; the figures in parentheses are percent)

The respondents expressed that the CBM preserved the water sources and provided grass and firewood (p=0.000). The proportions of respondents who said “do not know” were significantly higher on role of CBM in sequestering carbon (p=0.000). Only 19.72% respondents perceived that CBM sequestered carbon. Higher proportion of respondents agreed that CBM provided income and employment (p=0.000).

4.9.4 Socio-Economic Characteristics and Perceptions on Impacts of Climate Change.

In Chi-square test, perceptions on the relationships between level of impacts of climate change and other variables like community composition, level of physical infrastructure, level of employment, access of market, level of education, community experience and type of farming system were not significant at $p > 0.05$. However, the response on variables such as status of forest tenure, access to finance, level of extension services, level of participation, user size and forest size were statistically significant at $p<0.05$ (Table 4.9.4). This implied that communities having these characteristics had higher resources and capacity to manage climate change.

Table 4.9.4: Chi-square result on relationship between community variables and climate change

Variables	$\chi 2_1$	p
Community composition	0.714	0.350
Level of physical infrastructure	0.525	0.551
Status of employment	0.328	0.534
Access of market	1.198	0.632
Level of education	0.298	0.733
Community experience	5.605	0.321
Type of farming system	5.920	0.245
Status of tenure	22.453	0.001
Access to finance	27.345	0.001
Level of extension services	20.205	0.001
Level of participation	19.083	0.001
User Size	97.424	0.000
Forest size	13.054	0.001

(Source: Field survey, 2009-2013)

The logistic regression results in Table 4.9.5 showed that the status of tenure had significant impacts on livestock management and soil conservation; access to finance on shade and shelter and different varieties of crops; and level of extension service on planting dates, livestock management, management of different crops and crop diversification. Similarly, the level of participation had significant influence on water conservation; user size and forest size played a positive role in water conservation; and forest size had significant role on livestock management.

Table 4.9.5 Parameter estimates of the logistic regression models of adaptation measures

Explanatory variables	Status of tenure	Access to finance	Level of extension	Level of participation	User Size	Forest size
Shade and shelter (-6.0053*)	-0.0511	0.093**	0.036	2.469	0.0350*	0.405
Different planting dates (-1.0265**)	-0.5421	1.8123	-1.1238*	0.4781	0.3451	1.7124
Livestock management (-4.4493*)	-0.0421*	1.3981	0.0523*	0.5912	1.7821	-7.371**
Soil conservation (-3.4855*)	-0.0644**	0.0020	-0.5995	0.4408	0.2178	-0.4078
Different crops (-3.826*)	-0.5671	0.9712	-2.5448*	0.0030	0.0045	0.0032
Different varieties (-1.556**)	0.0030	0.6729**	0.1346	0.0020	1.1101	0.0022
Crop diversification (-5.235)*	0.0045	1.7821	1.1367*	0.0040	1.5521	0.0021
Water conservation (-6.335)**	0.4521	0.8345	0.5124	0.5562**	0.8921**	0.0021*
N =83						

(Figures in parenthesis are intercept; * and ** Significant at 1 and 5% probability levels, respectively)

4.9.5 Community Level Adaptations

Different adaptive measures were identified based on the respondents' views on climate change management (Table 4.9.6). These included improvement of shade and shelter (14%), improved livestock management (11%), varied planting dates (10%), increased soil conservation techniques (9%), different crops (8%), use of different crop varieties (8%), diversification of crops (7%) and movement to different sites (6%). However, a less proportion of respondents (18.07%) had no adaptive measures.

Table 4.9.6: Perceived adaptations by communities (percent of respondents)

Variables	Percent	Variables	Percent
Improvement in shading and shelter	14	Increase irrigation	5
Different planting dates	10	Change use of chemicals and fertilizers	3
Adjust livestock management practices	11	Change amount of land	3
Soil conservation	9	Farming to non-farming	2
Different crops	8	Crops to livestock	2
Different varieties	8	Shorten length of growing period	2
Crop diversification	7	Use insurance	2
Increase water conservation	6	Livestock to crops	1
Move to different site	6	Non-farming to farming	1
No adaptation: 18.07%			

4.9.6 Climate Change Mitigation

The analysis of inventory data of CBM and nearby SMS showed that the state of forests in CBM improved over the year of 2009 and 2013 years (Table 4.9.7). The average basal area of CBM was 11.44 m^2/ha compared to SMS with 5.54 m^2/ha. Mean species/ha was 41 in CBM compared to 26 species in SMS. The density/ha in CBM was 13,562 plants compared to 4,578 in SMS. In CBM, the mean volume was 101 m^3/ ha and in SMS it was 71 m^3/ha. The difference showed the role of CBM as leading to a steady increase of forest carbon stocks by reducing forest disturbance and supporting mitigation measures (FAO, 2010).

Table 4.9.7: Stand structure of CBM and SMS

Variables	Average of CBM	Average of SMS
Mean basal area (m2/ha)	11.44 (1.33)	5.54 (1.01)
Mean no. of plants/ha	13,562 (6729)	4,578 (693)
Mean species (number/ha)	41 (7)	26 (5)
Mean volume (m3/ha)	101 (13)	71 (8)

The values in parentheses are ± S.E. (Source: Field Survey, 2009-2013)

The study demonstrated that adaptation can be linked to mitigation, starting from the activity level in CBM. On the mitigation side, local communities contributed significantly in storing carbon in the forests as revealed by forest inventory (Table 4.9.7) and used renewable energy. On the other hand, the same people depend on the forests and are empowered with resources in undertaking measures to help them adapt to climate change as listed in Table 4.9.6.

Despite significant interest in addressing climate related issues in LLC, this priority competes with other development priorities. Assessment of LLC outcome on climate change need to account all important impacts and interactions, including indirect and cumulative effects, in practice, which is often difficult to identify, prioritize, understand and use (Buck et al., 2006; Tillmann & Siemann, 2012). Until recently, adaptation and mitigation have often been considered separately in climate change science, policy and implementation, but this study suggests that they need to be integrated in CBM under LLC. This study presented an enhanced understanding of the relationship between elements of climate change and LLC; it is partially in consistence with the views of Climate, Community and Biodiversity Alliance, (CCBA), (2008), Campbell et al. (2009) and Cooperative for Assistance and Relief Everywhere (CARE), (2010). Unlike these previous studies, the present research is context specific to TAL and related to the assessment tool presented by McSweeney et al. (2008), NCVST (2009) and Parrotta et al. (2012).

CHAPTER V: FRAMEWORK FOR ORGANIZNING METHODS AND TOOLS

5.1 Strategic Roadmap

A synthesized M&IA framework has been proposed to ensure the integration of approaches, methods and tools, although the process and steps may vary depending on the contexts, such as locations, objectives and circumstances**.** The framework, which bases on the review of existing literature, particularly by Koohafkan and Altieri (2011), World Bank (2002), Sustainable Agriculture Network/Rainforest Alliance (SANRA) (2014) and the analysis of information generated in this research, include:

- formulation of national strategy
- identification of key features influencing outcomes
- identification of methods and best practices
- development and implementation of an action plan
- assessment of progress
- dissemination of results and
- achievement of goals

5.1.1 Formulation of National Strategy

To formulate national strategy, the first step is to develop a common understanding of the underlying factors and processes of LLC. In this step, the active participation of stakeholders is essential because an actual implementation is carried out at the local level to identify what benefits are derived from conservation and in what ways they can be assessed (UNEP, 2010).

5.1.2 Identification of Key Features Influencing Outcomes

This step identifies the drivers of positive changes in forests and communities as well as the threats and the processes underlying the functioning of TAL. This process aims to:

a) identify forces, drivers of change, trends and factors that affect the performance of TAL.
b) assess fundamental processes underlying the functioning such as policy measures, forest management, species and protected area management, climate change, and livelihood improvement.
c) determine knowledge systems, forms of social organization and networks, livelihood strategies, income generation and socio-economic factors (Smeets & Weterings, 1999; Giupponi, 2007).

While the above orientations indicate the positive changes, often the negative impacts of these forces include the drivers of deforestation, forest degradation and forest land use change (Koohafkan & Altieri, 2011).

5.1.3 Identification of Methods and Best Practices

Since LLC is multi-dimensional interacting system, it demands assembling, analyzing and synthesizing existing data on baseline and interventions (Speelman, et al., 2007; Koohafkan & Altieri, 2011) and identifying methods and best practices. This stage involves three processes: a) assessment of the pattern of interventions and outcomes, b) monitoring of changes in conservation at different scales and c) analysis and projection at the landscape level.

5.1.4 Development and Implementation of an Action Plan

TAL demands translation of general principles and natural resource management concepts into actions. This implies a clear understanding of the relationship between biodiversity, climate change and livelihood functions. Main ingredients of an action plan include a) objective setting, b) means of implementation, c) development of ownership and partnerships and d) regular implementation and follow up of M&IA actions. A number of action plans have been developed for conservation fields (FAO, 1998; Koohafkan & Altieri, 2011).

5.1.5 Assessment of Progress

This step monitors conservation activities, estimates impacts and costs, and assesses the programme direction to measure whether the objectives have been delivered or achieved. For the assessment, it is essential to a) identify a preliminary set of indicators of progress, b) select a model for identifying and using indicators to assess the changes and c) recommend for the use of indicators at multiple scales (Koohafkan & Altieri 2011). In line with prominent research undertaken by Consultative Group for International Agricultural Research, CGIAR (2003), World Bank (2002), Cooper & Murray (1992) and Koohafkan & Altieri (2011), it has been observed that LLC is directly measurable, statistically estimable and predictable by models. A pertinent issue with many indicators is that they are context-specific and may vary according to the communities or sites. In order to address the concern, qualitative indicators relevant to communities and the biophysical conditions of the area should be selected. To measure the changes and compare the results between the sites and/or along the time-line, comparable indicators are to be assessed.

5.1.6 Dissemination of Results

This process assesses and documents best practices that aim to a) disseminate positive lessons learned, b) achieve a significant increase in the knowledge and technologies and c) foster participatory research, development and networking. The adaptable methodologies should be low cost and capacity improving to innovate and develop social and technical capabilities.

5.1.7 Achievement of Goals

Achieving the goals of TAL and fulfilling the aspirations of stakeholders should be the key elements of the strategy. The ultimate goal is to support conservation and replicate sustainability across time and space based on the process and outcome criteria as shown in Table 5.1.

Table 5.1: Criteria for a successful assessment plan

Process criteria	Environmental outcome criteria	Socioeconomic outcome criteria
• Broadly shared vision • Broad alliances among the stakeholders • Open, clearly written plan with accessible and transparent process • Science based decision making • Policy and strategies in place	• Biological diversity conserved • Environmental friendly forest management practices adopted • Disturbances analyzed and threats reduced	• Livelihood improved • Vulnerability reduced and Resiliency enhanced • Increased trust and community efforts

(Source: modified from Koohafkan & Altieri, 2011; SANRA, 2014)

In summary, the strategic road map is expected to produce a dynamic plan that can be implemented, evaluated, upscaled and replicated (Koohafkan & Altieri, 2011; SANRA 2014).

5.2 Pragmatic Contextualization

5.2.1 Monitoring

Differentiating Monitoring with Impact Assessment

There is an intrinsic continuity and some necessary overlapping between monitoring and IA (Cernea & Tepping, 1977). Monitoring in TAL can be carried out at two levels- the site levels and landscape/central level. The concern at implementation levels would be largely monitoring of inputs, outputs, processes and schedules, and to some extent with ongoing evaluation of effects and impacts (Clayton, 1984). In such a tier system, it is expected that the higher levels of monitoring system would include all programmes in the lower levels (ADB, 1984).

Landscape/Central Level

Given the large variety of aspects of the LLC, a long series of indicators can be easily listed. But the ability to identify priorities and to restrict the list to a small number of key points (Cernea & Tepping, 1977) is difficult. Therefore, the aim should be to reduce information needs to the most essential and meaningful objective indicators. The selected indicators can be used not only for monitoring but also for IA (ADB, 1984). At the landscape level monitoring, it would be appropriate to select three clusters for which the indicators should account: a) the performance of stakeholders at intervention sites, b) the LLC implementation and c) the benefits.

The TAL activities are geared towards improving performance of the stakeholders at the sites. The stakeholders' work in the field provides the results expected by the TAL. Their active involvement is the final outcome of all means put in place: financial resources, training and institutional support. The performance is measurable and works as a simple proxy for the entire endeavour of TAL (Cernea & Tepping, 1977). The interventions translate into the quantity and quality of the performance which in turn offer best chance to explicitly monitor the service provided by the TAL. Therefore, the stakeholders' performance should be placed in the very centre of the monitoring effort (ILO, 1973; Cernea & Tepping, 1977; Benor & Baxter, 1984).

The benefits from LLC are the eventual consequences of the conservation effort. Under normal conditions, the TAL conservation impact should be reflected in the LLC benefits more tangibly than in other domains like the social, cultural and institutional (Cernea & Tepping, 1977; Clayton, 1985; Bhattarai & Campbell, 1985). In line with Cernea & Tepping (1977), the TAL implementations have linkages with the performances and benefits. As the contents of performance, TAL implementation works towards the benefits. The performance strives to initiate and institutionalize the LLC.

Table 5.2: Areas of M&IA at the landscape levels

<table>
<tr><td>Performance of stakeholders/sites</td><td>LLC implementation</td><td>Benefits</td></tr>
<tr><td colspan="2">Monitoring</td><td></td></tr>
<tr><td></td><td colspan="2">Impact Analysis</td></tr>
</table>

The three clusters as shown in Table 5.2 provide the entire essence of the process. =. As presented in Table 5.2, a) the performance is the main concern of monitoring; b) the benefits are the main concern of IA and c) the implementation concerns both monitoring and impact analysis. The monitoring indicators can be estimated relatively quickly and cheaply by a visual observation and survey. But, the saving of time and resources occurs at the expense of losing precision (Clayton, 1984;1985). Each indicator should be specified into a class of operationally quantifiable items at the desired level of detail. The list of indicators should be considered open. With respect to time and changes, some relevant indicators are added, while others are to be de-emphasised (Cernea & Tepping, 1977; Basu, 1988; David-Case, 1989). In addition, qualitative studies need to be undertaken on a number of topics.

The TAL is both area-based and client-oriented programme. These programmes have a series of discrete package of investments and actions which need monitoring. It is also important to carry out monitoring at the level and in the working context of the key actors and the direct beneficiaries of the site (Peterson & Horton, 1993). Therefore, monitoring need to be done at two levels: activity level and target group level. These lower levels can contribute to the higher levels of monitoring.

Site Level

At each level, the concerned stakeholders are targeted by the LLC. Previously, investment was used as prime major to achieve better capacity of the stakeholders, which however, had limitations due to nature of the groups and locations. To impact effectiveness of intervention, there is a need to examine, at every stage, what goes in interventions and in field work (McCabe, 1980). At this level of monitoring, if the intervention is satisfactory, relevant and acceptable to the stakeholders, which is to be measured by monitoring (Cernea & Tepping, 1977), positive effects on LLC implementations should be achieved, to be assessed by IA (Table 5.3).

Table 5.3: Areas of M&IA at the site level

<table>
<tr><td>Activity implementations</td><td>Site performances</td><td>LLC implementation</td></tr>
<tr><td colspan="2">Monitoring</td><td></td></tr>
<tr><td></td><td colspan="2">Impact Analysis</td></tr>
</table>

As can be noted from Table 5.3, a) the activity implementation is the main concern of monitoring, b) the LLC implementation will be the main concern of IA, and c) the performance will be the concern of both monitoring and IA. There are two major approaches in monitoring field implementation: stakeholder and activity monitoring (UNDP, 2011; James, 2001):

Stakeholders Level

LLC monitoring also requires a framework to monitor stakeholders' engagement. The framework calls for four levels of monitoring, and answers four basic questions pertaining to a) awareness and capacity, b) group dynamics, c) changes and d) results. This type of monitoring has already been in use in most of the conservation organizations in its various forms (UNDP, 2011; James, 2001).

Activity Level

The objectives based conservations derived from the concept of management by objectives are the commonest form of interventions provided by TAL through significant investment in the CBM. The objective method of interventions requires careful control in order to monitor the implementations system so as to check that the desired objectives are met (Curson, 1981). The activity standards are used to ensure that the actual process of activities is effective in terms of cost, time and employment of resources (McCabe, 1980; Curson, 1981). At this level, the activity plans and field implementations would be the main concerns of monitoring (Table 5.4).

Table 5.4: Areas of M&IA at the activity level

<table>
<tr><td>Activity Plans</td><td>Field Implementations</td><td>Performance of stakeholders</td></tr>
<tr><td colspan="2">Monitoring</td><td></td></tr>
<tr><td></td><td colspan="2">Impact Analysis</td></tr>
</table>

Focus of Monitoring in the Context of Logical Framework (LF)

The discussion on the different levels of monitoring is presented in Figure 5.1.; it illustrates how the different levels of monitoring are linked with and structured as the parts of the objective hierarchy of the LF. The figure shows that the focus of M&IA is to make the monitoring task more practical and manageable. Similarly, a nested LF for M&IA management as the part of overall TAL LF has been proposed in Annex 19.

Importantly, the LF requires information not only for monitoring but also for IA and future direction of TAL. This also includes the indicators of project inputs and activities (Annex 20). After developing indicators, the next step is to determine the data generation system along the lines of indicators retained (Cernea & Tepping, 1977). The data generation system in TAL is composed basically of two main parts: (a) internal reporting/monitoring and (b) monitoring studies. The collection, analysis and interpretation of both quantitative and qualitative information could be a participatory exercise (ADB, 1994; FAO, 1986), with both the staff members and stakeholders jointly gathering, sharing and interpreting information (David-Case, 1989; Hope & Timmel, 1994).

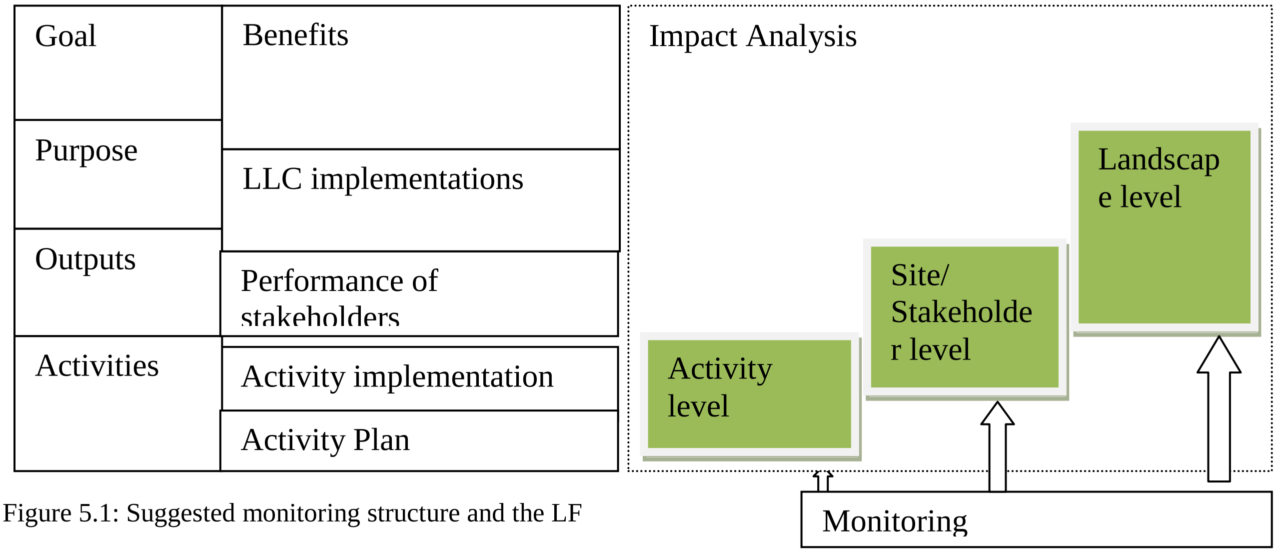


Figure 5.1: Suggested monitoring structure and the LF

5.2.2 Impact Analysis

The four elements of results sought by TAL under the intended change are (Figure 5.2): a) programme execution and delivery, b) adoption of LLC, c) social and environmental result and d) impact on biodiversity conservation, sustainable livelihood and resiliency. Since TAL is an evolving strategy, it has been developing framework to identify impact priorities and sustainability issues. TAL’s long term goals are to conserve biodiversity, address climate change and improve livelihoods in forestry landscapes (Annex 21).

The strategy developed in this study has identified five broad outcome areas within which TAL makes critical contributions. The key outcomes are: a) strengthening polices process b) improving forest management, c) enhancing biodiversity conservation, d) enhancing resiliency and e) improving livelihoods of communities. Table 5.5 presents these key outcome areas.

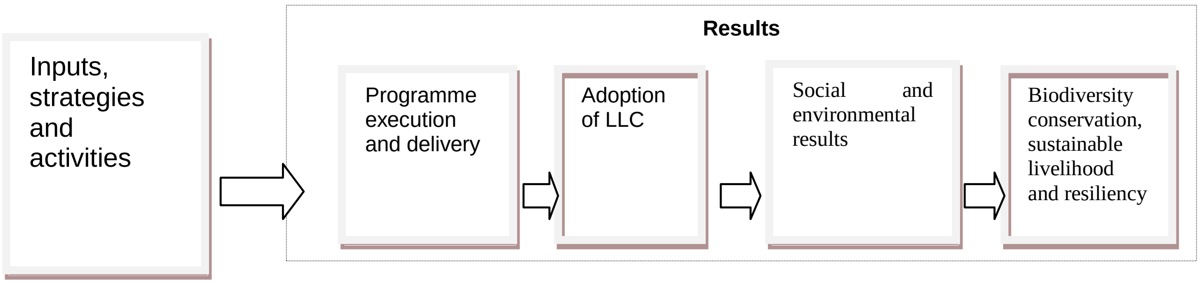


Figure 5.2: Results under intended change (Source: Modified from SANRA, 2014)

Table 5.5: Key outcome areas of TAL

Strengthen policy process	Improve forest management	Enhance biodiversity conservation	Improve livelihoods	Climate change adaptation and resiliency
Biodiversity policies and strategies formulated/revised and enforced Institutional coordinating mechanism made functional	Forests protected, restored and managed Designated areas* maintained or restored Encroachment, illegal logging, extraction, and hunting of wildlife reduced/eliminated	Human-wildlife conflicts mitigated Species and habitat conditions improved Flows of ecosystem services increased	Livelihood conditions for communities and income improved. Communities rights to sustain livelihoods established. Enabling environment on social benefits created	Awareness of the potential impacts of climate change raised. Natural and human vulnerabilities to climate change impacts assessed Policies for REDD plus formulated and executed.

(Source: modified from WWF, 2004; SANRA,2014; NPC, 2012; Koohafkan & Altieri, 2011) (* Designated areas = Protected Area System, Protected Forest and Environment Conservation Area)

5.2.3 The Levels

The overall goal of TAL IA approach is to track progress towards outputs, outcomes and impacts, and evaluate causal relationships among these levels. However, there is no single set of indicators that can test the changes across the entire area due to inherent tradeoffs among indicators, cost, scope, detail, and accuracy. For instance, outcome and impact indicators are usually too costly to apply across all implementation units, or require specialized research designs. On the other hand, indicators on programme delivery, outputs and best management practices are informative and may be feasible in all implementation units, but are not capable of attributing desired outcomes and impacts to LLC. The fact that TAL indicators have limitations demands a three-levels system of IA (Table 5.6) to provide the full depth, breadth and scope to examine TAL’s strategy and impacts partially corroborating with the views of Hulme, (1997), Koohafkan & Altieri, (2011) and SANRA (2014).

Table 5.6: Levels of IA and linkage to monitoring

Levels	Focus
Intensive in-depth research (IIR)	• Impact studies • Hypothesis testing to verify the performance or impact results
Field Sampled Monitoring (FSM)	• Assessment of livelihood, biodiversity and climate change outcomes • Stratification across the sites
System Wide monitoring (SWM)	• Programme reach • Characteristics of interventions • Changes in site performances • Changes in practices • Changes in selected outcomes

(Source: modified from SANRA, 2014)

The bottom row of the table provides system wide monitoring indicators which are utilized across all sites for high level reporting and management decision making. These indicators focus on measuring programme delivery, outputs and best management practices and can be selected based on the thematic areas of TAL LF. An outline of thematic coverage of TAL LF is shown in Annex 22. The middle level of the pyramid consists of Field Sampled Monitoring (FSM). The main purpose of this level is to provide more rigorous and detailed information on medium-term social, environmental, and economic outcomes. FSM is more relevant on a subset of forest management units that are representative of the range of sites, forest types and contexts in which TAL works. FSM is thematically comprehensive, including assessments of selected social, economic, and environmental outcomes and analyses the ways in which these outcomes relate to best management practices (BMP) over time.

The apex of the pyramid is Intensive In-depth Research (IIR) comprising individual studies, often conducted by third-party scientists. The IIR approach uses rigorous research designs to evaluate specific hypothesized pathways. Such designs are helpful for attributing observed results to specific practices or interventions. The IIR row also includes studies evaluating linkages between outcomes and impacts, that are, the long-term, large-scale, cumulative, or indirect effects. The three levels of IA complement one another to provide an overview of results that is both comprehensive and rigorous. With these relationships of levels, data on programme reach, and BMP collected for system wide monitoring can be used more credibly as proxies for outcomes or even impacts.

5.2.4 Data Collection and Analysis

Collection and recording of data depend on resource availability and field capacity, and varies according to time. Alternatively, data on forests and local forest user groups are also collected using internal monitoring tools. But, as there is no widespread data management platform to centralize and aggregate monitoring results in a consistent and systematic manner, there are key issues in data collection. For comprehensive, complete and quality data, the following measures are taken: a) revision in the format to improve internal management system, b) improvement in the type and quality of data and c) guidelines to meet stronger data requirement, reporting and documentation.

5.2.5 Period of IA

Methodologies for evaluating livelihoods, climate change and biodiversity outcomes and impacts include both quantitative and qualitative approaches (Centre for International Forestry Research, CIFOR, 2013; SANRA, 2014; Kabra, 2009; Chappell & Lavalle, 2011; Giváab & Sriskandarajaha, 2012). To test specific hypotheses related to TAL intervention to assess broader impacts, it has to be studied in targeted areas with in-depth methodologies. The approaches used for IA depend on study design and key questions. The target frequency for such studies depends on the hypothesis and the sensitivity of chosen indicators. Typically, the frequency amounts to: 1-2 years for evaluating CBM performance, 2-3 years for evaluating changes in livelihood assets, 3-5 years for evaluating changes in resiliency, and 5+ years for evaluating biodiversity changes and status of threats (Hulme, 1997; Koohafkan & Altieri, 2011; SANRA, 2014).

5.2.6 Transparency and Stakeholder Involvement

Isolated and compartmentalized working cultures are found to have resulted into lack of sharing, interaction and networking among different stakeholders. To promote greater stakeholder involvement and research activities in M&IA, the following issues are to be addressed: a) ensuring stakeholders participation in planning, goal setting, developing indicators and collecting data; b) ensuring better dissemination of the results of past and present studies to the general public, and c) producing a collective monitoring report based on commonly agreed protocols (SANRA, 2014).

VI. CONCLUSIONS AND RECOMMEDATIONS

6.1 Revisiting the Objectives

The TAL programme has gained much momentum and shown several positive changes and achievements in its implementation areas. However, there are scopes emerging for immediate and long-term improvements. This study identified impacts and developed methodologies for M&IA of LLC programme in relation to TAL. Various conceptual and methodological issues (approaches, methods and tools) which consistently underpinned M&IA of LLC were reviewed and prioritized as per relevance grounding on the stakeholders' perception, expert inputs and field data. A total of 73 different methods and tools were identified, categorized/subcategorized into seven groups, tested and recommended reflecting the thematic coverage of TAL.

The study also undertook three broad sets of activities - a) analyzed policy impacts, b) assessed the community based climate change adaptation and vulnerability and c) developed indices on biodiversity, livelihoods and threats and disturbances on forests reflecting the forest management scenarios; the study was based on various non parametric and parametric analysis mainly PCA, MLRA and logistic regressions. Finally, a set of strategies and process for organizing the methods and tools was developed.

6.2 Main Conclusions and Reflections on Research Findings

The main findings led to the following conclusions regarding methodologies of M&IA and assessment of LLC/CBM impacts:

Key conclusion 1: Based on the categories observed in the existing literature (Turall & Studd, 2009; Jones et al., 2009; Thomas & Fanshawe, 2005), and analyzing them, the following methodologies (methods and tools) have been identified for TAL M&IA according to a) their focus (community or programme performance); b) their approach (participatory, non-participatory: scientific or expert based); c) their use of indicators and whether these are community-defined indicators; d) expert focused with fixed content and process and e) expert judgments (Table 6.1).

Table 6.1: Methodological proposition in categories

Focus	Livelihood improvement	Biodiversity conservation	Climate change
Community focus, participatory and community defined indicators			
	Participatory assessment, M&E (11) and livelihood assets status tracking (11)	Transect (10) and species list (11)	Vulnerability and adaptation assessments (8)
Community focus, participatory and no indicators			
	Most significant change; Livelihood IA (11)	Participatory mapping (9) and field observation and recording (8)	Multi-stakeholder processes (8)
Community focused and non participatory			
	Household survey (12) and community level survey (12)	DPSIR framework (13)	Adaptation decision Matrix (9)
Policy intervention, community focused and participatory indicators			
	Participatory policy impact assessment (10)	Threat reduction assessments (12) and disturbance analysis (12)	Vulnerability indices (8)
Programme focus and non participatory			
	Landscape outcome assessment methodology (8)	Conservation needs assessment (11) and gap analysis (11)	Adaptation policy framework (11)
Expert focused with fixed contents and processes			
	GIS/RS (8)	Abundance index (12) and diversity indices (11)	Climate impact and adaptation assessment (9)
Expert judgments			
	Livelihood index (11)	Total counts (11), timed search (11) line and strip transects (10)	Assessing climate change impacts and adaptations (9)

(Source: modified from Turall & Studd, 2009; Jones et al., 2009 and Thomas & Fanshawe, 2005; the figure in parenthesis shows the score of test result)

The table explicates that M&IA interventions are designed and subsequently managed in the appropriate places and in the appropriate manner. Working further, these interventions are found compatible with Hulme (1997). It is concluded that the three approaches – simple, moderate and complex –are appropriate in terms of costs, timing and human resource availability and that avoids the problems (Table 6.2).

The proposed methodologies can be tested and developed with following elements of good practice:

- One size does not fit all – there is no single methodology suitable to every type of intervention---methodologies should be selected according to the particular purpose and contexts.
- For each intervention, ideally a portfolio of methods is needed to triangulate the data to provide a more complete picture and conduct analysis of changes.
- Methodologies should be adopted and used to fit in local circumstances.

Table 6.2: Possible approaches for IA in TAL

Elements	Simple approach	Moderate approach	Complex approach
Focus	Provide timely information	Proving impact and improving programmes	Proving orientation
Reliability	Moderate	Yields higher levels of reliability	High levels of reliability
Audiences	Local users, programme managers and donors	Policymakers and the senior managers	Senior policymakers and researchers
Cost	Relatively low cost	More costly than the simple approach	Costs are high, data processing and analysis take longer time
Objective	Test the impacts and contribute to programme improvement	Improve the understanding of impacts and execution	Ensure attribution of causality
Approach	Based on a small scale survey and FGD	Methodological mix and large scale survey and employs group comparisons.	Employs large scale sample survey .and employs comparison with control groups

(Source: modified from Hulme, 1997)

Key conclusion 2: The strategies of LLC as well as the outcomes of CBM initiatives vary according to their local contexts. However, successful CBM initiatives still share some replicable features including achievement of human well-being and conservation of local biodiversity.

Key conclusion 3: The forestry sector has prepared and approved a number of polices and strategies on biodiversity, whose implementation status is often questionable. Biodiversity conservation in TAL is complex and requires better understanding of interconnectedness and interactions of policy/strategy, implementation and governance processes.

Key conclusion 4: CBM had a higher alpha (α) and gamma (γ) diversity of tree species, but lower in a certain segment of beta (β) diversity than in SMS. Tree species composition was not significantly different between the management typology. In CBM, forest growing stock increased significantly with protection status where plots were associated with higher species turnover than in SMS. The study, therefore, revealed the result of practical relevance to stakeholders to change the existing policy to bring the management to a sharper focus.

Key conclusion 5: The overall management approaches under TAL fall short to address threats. The data suggested that threats were better and significantly mitigated at CBM compared to SMS, indicating the CBM as a potentially more successful approach than the traditional top-down approach to landscape conservation.

Key conclusion 6: The conclusions on livelihood study included a) livelihood has improved due to CBM attributable to the rights on access to resources, and b) the use of several assets proved useful to quantify livelihood and all the assets were found equally important for the overall livelihood improvement in a way that one cannot be highlighted at an expense of the others.

Key conclusion 7: CBM actions had the most immediate and greatest benefits in terms of strengthening people's adaptive capacity and resilience; and also increasing the mitigation contribution by increasing carbon stocks. This study brought out the need to integrate adaptation and mitigation in CF under LLC to enhance benefits to the local communities and larger society.

Key conclusion 8: The set of methodologies had four key attributes: a) access to methods and tools was not a problem but there was limited guidance available on how to select the most appropriate approaches, b) most of them were not plug-and-play, their use required training, skilful facilitations, significant data collection and resources; c) no single approach was sufficient to successfully support M&IA, and d) expert judgment was still one of the indispensable ingredients for success.

Key conclusion 9: The results demonstrated a way to achieve fusion between participatory methods and expert centric methods through training and pedagogical enrichment activities. The study found enthusiasm and strong interest within stakeholders as reflected in the level of participation and interest to use.

6.3 Contribution of the Dissertation

M&IA of any policies, programmes or projects were hitherto considered technical aspects or the part of skills that could be solved technically through training. The traditional approach to M&IA focused on universal methods and hence, was problematic. This research spelled out the fact that M&IA is a complex process and context-specific. M&IA is observed to have not only technical importance but also scholastic significance related to property rights, resource management modalities, resource distribution conflicts and political economy of projects that are imposed in natural resource management.

In regards to knowledge system, the dissertation contributes to three aspects. First, it developed new methods to undertake further critical research. Second, the research contributes to the new process of investigating M&IA. Finally, the research found that LLC draws heavily on a number of theoretical foundations including political ecology, human-environment relation and island biogeography. The novel approach developed from this study also acknowledges the need of multi-level participation of people at multiple scales of LLC, combination of different sources of information and integration of them from diverse fields. Moreover, the study is a context specific, extensive, logical, and supported by strong evidences.

The research contributes to academia as well as to the practical aspects of LLC. The specific contributions of this dissertation are:

- Provided a repository of information for further study by pulling down quantitative and qualitative data from before and after the interventions in five years periods of the selected sites.
- Developed indices on biodiversity, livelihood, forest threats and disturbances reflecting the forest management modes based on various non parametric and parametric analysis.
- Devised quantitative methods to explore different aspects and impacts of policies and strategies of biodiversity conservation under LLC in Nepal.
- Explored potential to employ a novel method drawing on PCA to develop livelihood indices applicable in later research.
- Suggested a framework for a new approach for simple and effective M&IA methodology consisting of a conceptual underpinnings and a set of procedures.
- Evaluated the performance of forest management modes and illustrated the result of immediate and long term importance to the governments and non-state stakeholders benefiting for improved efficiency in policy formulation, planning, decision-making and improved investments.

6.4 Recommendations

The study did not cover many pertinent issues because of several limitations. A number of studies can be carried out further in several thematic areas, such as: a) investigation of the status/trend of biodiversity, livelihood and climate change adaptation periodically, b) identification of possible ways of improving the science based performance and assessment of LLC; c) identification of relationship between selected indices of biodiversity, livelihood and resiliency; and d) comparative contributions of horizontal and vertical linkages in self-inspired and externally-driven CBM in TAL.

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ANNEX 1: List of papers and events

1.1 List of peer reviewed journal papers

Lamsal, R.P. & Khanal, S.N. (2014). Assessment of Human Disturbances in the Wildlife Corridor Forests of Terai Arc Landscape, Nepal. *Indian Journal of Applied Research*. Volume: 4, Issue: 11, November 2014; ISSN- 2249-555X

Lamsal, R.P. & Khanal, S.N. (2014). Community Based Forest Management for Climate Change Adaptation and Mitigation Under Terai Arc Landscape Program in Nepal. *Indian Journal of Applied Research.* Volume, 4, Issue 11, November 2014, ISSN - 2249-555X.

Lamsal, R.P. & Khanal, S.N. & Adhikari, B. (2014). Performance of Community Forestry on Social Organization and Livelihoods under Terai Arc Landscape Program, Nepal. *International Journal of Innovative Research in Science, Engineering and Technology,* Vol. 3, Issue 11, November 2014, ISSN: 2319-8753.

Lamsal, R.P. & Khanal, S.N. & Adhikari, B. (2014). Performance of Community Based Forest Management on Reducing Threats Under Terai Arc Landscape Program, Nepal. *International Journal of Engineering Science and Innovative Technology (IJESIT),* Vol. 3, Issue 11, November 2014, ISSN: 2319-8753.

Lamsal, R.P., Adhikari,B., Khanal, S.N. & Kanel, K.R. (2015). Effects of Community Based Forest Management on Livelihoods under Terai Arc Landscape Program, Nepal. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS),* Volume 8, Issue 1, Ver. I (Jan. 2015), PP 00-00.

Lamsal, R.P., Khanal, S.N. & Kanel, K.R (2014). Patterns of Biodiversity in State Managed and Community Based Forest Management Categories of Terai Arc Landscape, Nepal. *International Journal of Engineering Science and Innovative Technology (IJESIT),* Vol. 3, Issue 12, December 2014, ISSN: 2319-8753.

Lamsal, R.P., Adhikari,B., Khanal, S.N. & Dahal, K.R (2015). Threat Reduction Assessment approach to assess impact of landscape level conservation in Nepal. *Journal of Ecology and the Natural Environment (JENE),* Vol 7(2), pp. 29-37, February, 2015.

Lamsal, R.P., Khanal, S.N. & Kanel, K.R (2014). Assessment of forest biodiversity across varying management categories in Terai Arc Landscape, Nepal. *Physiological Ecology and Environmental Science,* Volume 5, Number 1&2; 2014; ISSN 2311 – 1569.

Lamsal, R.P., Khanal, S.N. & Kanel, K.R. (approved). Reviewing biodiversity related policies and strategies and assessing the performances in Terai Arc Landscape, Nepal. *Kathmandu University Journal of Science, Engineering and Technology (KUSET).*

1.2 List of paper under process

Lamsal, R.P. & Khanal, S.N, Gauchan, D. & Aryal, A. Integrating ethnobotanical criteria and parameters into the inventory of community-based forest management.

Lamsal, R.P., Khanal, S.N., & Kanel, K.R. Bridging the widening Gap between Conservation Biology and Practice in Nepal.

1.3 Paper presented and attended international events

Lamsal, R.P. (2010). Integration and institutionalization of community-based forest fire management in community forests of the Terai region of Nepal. *International Forestry Review*, Vol. 12 (5), 2010. IUFRO World Congress, Seoul, Republic of Korea, 23-28 August 2010.

Lamsal, R.P. (2010). Participatory mountain forestry development in Nepal. *International Forestry Review* Vol. 12 (5), 2010. IUFRO World Congress, Seoul, Republic of Korea, 23-28 August 2010.

Lamsal, R.P. (2010). Impacts of community forestry on conservation and livelihoods in the biological corridor of Nepal. *International Forestry Review*, Vol. 12 (5), 2010, IUFRO World Congress, Seoul, Republic of Korea, 23-28 August 2010.

Lamsal, R.P. & Khanal, S.N. (2014). Changing Scope Of Community-Based Forestry: Analysis Of 30 Years Of Community Forestry Impacts In Nepal. *International Forestry Review*, Vol. 16 (5), 2014, IUFRO World Congress, Salt Lake City, United States, 5-11 October, 2014.

Lamsal, R.P. & Khanal, S.N. (2014). Performance and potential of landscape level biodiversity conservation for climate change adaptation and mitigation in Nepal. *International Forestry Review*, Vol. 16 (5), 2014, IUFRO World Congress, Salt Lake City, United States, 5-11 October, 2014.

Lamsal, R.P. & Kanel, K.R. (2104). Multistakeholder Approach For The Development Of New National Forestry Sector Strategy In Nepal. *International Forestry Review*, Vol. 16 (5), 2014, IUFRO World Congress, Salt Lake City, United States, 5-11 October, 2014.

Lamsal, R.P. & Kanel, K.R. (2104). Addressing climate change adaptation and mitigation through community-based forest management in Nepal. *International Forestry Review*, Vol. 16 (5), 2014, IUFRO World Congress, Salt Lake City, United States, 5-11 October, 2014.

Ghimire, M. & Lamsal, R. (2014). Conservation of wildlife outside protected areas in community forests. *International Forestry Review*, Vol. 16 (5), 2014, IUFRO World Congress, Salt Lake City, United States, 5-11 October, 2014.

Lamsal, R.P., Khanal, S.N., Joshi, G.R., Kanel, K.R, & Paudel, K.C. (2015). Analysis of Community Forestry Impacts on Livelihoods and Food Security in Nepal. *World Forestry Congress Publication*, World Forestry Congress, 7-11 September 2015, Durban, South Africa

Lamsal, R.P., Khanal, S.N., Joshi, G.R., Kanel,K.R. & Paudel, K.C. (2015). Managing forestry conflicts through multi-stakeholder approach in Nepal. *World Forestry Congress Publication*, World Forestry Congress, 7-11 September 2015, Durban, South Africa.

Lamsal,R.P., Khanal, S.N., Kanel,K.R., Paudel, K.C. & Ghimire M. (2015). Performance of forestry sector policies and strategies and coordination among the sectors in Nepal. *World Forestry Congress Publication*, World Forestry Congress, 7-11 September 2015, Durban, South Africa.

Nepal, S.N., Kandel, Y.P, Manandhar, U. & Lamsal, R.P. (2015). Transformational Change in forestry governance structure an approach to address drivers of deforestation and forest degradation case study from TAL, Nepal. *World Forestry Congress Publication*, World Forestry Congress, 7-11 September 2015, Durban, South Africa.

Lamsal, R.P. (2012). Community-based climate resilient forests: Pathways to green economy, improved ecosystem and poverty reduction, Side event, *Rio+20 UN Conference on Sustainable Development 2012).* Rio, Brazil.

ANNEX 2: Summary of social M&IA approaches, strengths and weaknesses

Types			Approaches	Uses and Strengths	Weaknesses
P3	Q1	SE	Stakeholder consultations and key informant interviews (Kristjanson et al., 2002)	Good for identifying key impacts, indicators and key factors	Elite dominancy
P2	Q2	SE	Community-level formal surveys (Pender & Scherr, 1999)	Useful for gaining an understanding of the characteristics of communities and diffusion of new interventions	Quality of information dependent on few individuals
P2	Q2	SE	Household-level formal surveys (Baidu-Forson, 1999)	Possibilities for studying household-level adoption and impact.	Time consuming and relatively expensive
P2	Q3	E	Financial and economic analyses of new technologies (Place et al., 2002)	Monitoring of resource requirements for a particular integrated system.	Some benefits and/or costs that are not captured in the marketplace
P1	Q2	T	Transect walks, aerial photography (Reid et al., 1997)	Estimating the numbers and locations of adopters of interventions	Limited area coverage and getting cheaper but still can be quite costly
P1	Q3	T	Spatial analysis, GIS & satellite imagery (Staal et al., 2002)	Allows forward-looking approach to understanding systems and impacts of change.	Dependent on good spatial datasets
P2	Q3	ST	Plot and landscape field measurements of natural resources of both stock and flows	Allows accurate measurement of impacts of policy and management interventions	Often are avoided because of cost
P3	Q1	ST	Human perceptions of environmental change (household/community surveys)	To estimate environmental change over time	Restricted by human abilities to sense environmental change
P2	Q2	ET	Market studies (Fafchamps & Gavian, 1997)	For analysis of differences in market conditions, demand studies and determinants of prices	Requires A regular market visits over a long period
P1	Q3	ET	Economic surplus methods (Alston et al., 1995)	For investigating the effects of interventions that have measurable impact on the production	Non-marketed benefits and hidden costs difficult to incorporate
P3	Q1	S	In-depth sociological and characterization studies (Ashby, 1990)	Good for characterizing major household types; identification of important livelihood strategies	Time consuming and relatively expensive
P3	Q1	ST	Participatory nutrient flow diagrams (De Haan, 2001)	Good for capturing indigenous knowledge	Cover a small number of households/area
P3	Q1	SET	Participatory technology development (Douthwaite et al., 2002)	Useful for gaining knowledge as to complex experimentation, learning and adoption processes	Time consuming and relatively expensive
P1	Q3	T	Hard biophysical simulation models (MacRobert & Savage, 1998)	To assess productivity and environmental impacts at different levels	Data intensive and time consuming
P2	Q2	T	Softer biophysical models of component processes and interactions (Walsh et al., 1998)	To assess productivity impacts at farm level; simple to use, can identify broad changes	May not have the sensitivity required
P1	Q3	ET	Multiple objective mathematical programming models of the household (Herrero et al., 1999)	To assess changes in resource use and trade-offs in objectives at the household level	Data intensive and time consuming
P2	Q2	SET	Rule-based models of the house-hold (Thornton et al., 2002)	To assess changes in household well-being	May not have the required sensitivity
P2	Q2	ST	Analysis of training impacts (Van Aaken & Watts, 2001)	To assess the impacts of training programmes often not simple	Can be time consuming and costly
P1-3	Q2	SET	Program Logic Models (Wong-Reiger & David, 1995)	To predict and set the framework for planning and relationship among project activities, outcomes, intermediate results and ultimate impacts	Subject to errors in logical linkage development
P1-3	Q2	ST	Organizational assessment (Bennett-Lartey et al., 2002)	To assess the multiple dimensions associated with organizational success and failure	Assumes that organizational development contributes to higher level impacts

Source: Adapted and modified from Thornton et al., 2002; Participatory nature: P1, little or none. P2, somewhat, P3, very; Quantitative nature: Q1, mostly qualitative; Q2, somewhat; Q3, highly; Expertise required: S, social science, E, economics and T, technical.

ANNEX 3: Common participatory biodiversity monitoring methods

Methods	Strength	Weakness	Opportunity	Reference
Field observation and recording	•Simple to use, easy to integrate with daily activity and record and information useful for long term comparison of change	•Labour extensive and requires experiences; and data may be biased and inconsistent	•Can be improved with assistance of expert	Danielsen et al., 2000; Poulsen & Luanglath, 2005.
Photo documentation	•Useful for collecting data on permanent plots/sample units and showing visual change	•Lack of good camera operation skill and interpretations and difficult to generate consensus on large scale	•Train on camera use and interpretations	Danielsen et al., 2000; Poulsen & Luanglath, 2005.
Transect	•Easy for apply and local people are willing to conduct •Easy on data on trend, absence/presence of plant and animal species, resource use and track change.	•Biased data can occur due to different collectors •Seasonal variation limiting access	•Proper planning of transect and selection of transect area	Danielsen et al., 2000; Gaidet-Drapier et al., 2006
Community group discussion	•Collection of overall data related people's perception during short period of time. •Good to fit at large scale trend analysis •Can be carried out in all season	•Villagers may feel reluctant to provide information •Data is more subjective and qualitative	•Should select key informants •Enabling environments to build trust	Danielsen et al., 2000; Steinmetz et al., 2006.
Participatory mapping	•Spatial data of biodiversity on relatively large area.	•Qualitative data, and sometimes area and positional inaccuracy	•Use in combination with published map	Steinmetz et al., 2006.
Species list	•Quick capture of data on absence/presence of species and villagers and any others can easily fill in species	•Bias can occur towards rare species	•Constraint can be reduced	Roberts et al., 2005; Hockley et al., 2005.
Key informant and semi structured interview	•Quick data collection on general issues for planning an sensitive data can be gathered	•Take more time to conduct •Data may not be represented of general important issues.	•Increase more samples for interview •Building good relationship with villagers	Danielsen et al., 2000; Green et al., 2005; Townsend et al., 2005.
Census	•Use in combination with transects method. •Collect data on species composition, abundance, presence/absence of animal and plants and resource use	•Difficult for hiding or stochastic animals and others cannot be seen by naked eye	•Training may provide appropriate skills in detecting and identifying species	Townsend et al., 2005; Gaidet-Drapier et al., 2006; Gaidet et al., 2005.
Pooling local expert opinion	•Rapid capture of data on animal abundance, density, use and threat	•Data may not so accurate because it largely depends on memory	•Should select several experts	van der Hoeven et al., 2004.
Sampling plot	•Assess status and trend of biodiversity, especially plants in restored ecosystems by employing count method in the chosen plots	•Limitation to conduction of sampling by villagers as this deals with statistical techniques	•Improved capacity trained by experts	Soontornwong et al., 2005.

ANNEX 4: Common non-participatory biodiversity monitoring methods

Tool and technique	Analysis	References
Total count	Regression and Time series	Greenwood (1996)
Timed searches	T-test, ANOVA, regression and nonparametric test	Hill et al. (2005)
Quadrates	Chi square; T-test; ANOVA, regression and non-parametric	Greenwood (1996)
Distance sampling	Both parametric and non parametric analysis	Elzinga et al. (2001)
Line and strip transects	Interpret indices of abundance and compare population trend by using t-test, ANOVA, or nonparametric like Mann-Whitney or Kruskal-Waillis tests	Elzinga et al. (2001)
Line and point intercept transects	Find out change in cover-abundance of species by using descriptive statistic and come up with presence-absence by using chi-square test on data from point intercept.	Elzinga et al. (2001); Greenwood (1996)
Camera trap	Conclude absence/presence of animal including abundance	Silver et al. (2004)
Point count	Statistical analysis is identical as line transect of infinite width or strip transect	Hill et al. (2005)
Trapping webs	Compare presence-absence and analysis of change in frequency over time by using Chi-square	Greenwood (1996)
Removal method	Examine population size plotting against cumulative catches and uses non/parametric statistic tests depending on data by year	Greenwood (1996)
Mark-recapture methods	Determine population size and infer about movement pattern, survival rate, trend and underlying causes	Greenwood (1996)

ANNEX 5: IPCC technical methods and tools on climate change adaptation and vulnerability assessment

Name	Descriptions	Use	Key tools	Applications	Cost	References
Guidelines for Assessing Climate Change Impacts and Adaptations (CCIA)	Technical guidelines, a seven step process, starting from defining problem to evaluating strategies	To estimate impacts and adaptations in different sectors or regions.	Models scenarios (http://unfccc.int/national_reports/nonannex...items/2709.php)	Used by UNEP and UNFCCC	Up to USD 100,000	Benioff et al., 1996
UNDP Adaptation Policy Framework (APF)	A flexible approach following a five steps process	Integrate adaptation measures into broader sectoral specific policies,	Vulnerability mapping, dynamic simulation of sustainable livelihoods, decision trees, etc.	In least developed countries	Depends on specific application.	Burton et al., 2004
Scenario Data for Climate Impact and Adaptation Assessment (CIAA)	To establish for baseline and scenario information on climatic, environmental, and socioeconomic conditions.	Part of the greater methodological framework for climate change vulnerability and adaptation assessment	GCMs, weather generators, statistical downscaling, high resolution GCM experiments, sensitivity analysis, among others.	Not available	Guidelines and data free of charge.	Carter et al., 1999
Developing Socioeconomic Scenarios: For Use in Vulnerability and Adaptation Assessments (VAA)	developing scenarios of the future, both without climate change and with climate change and adaptation.	can be used in analyses of vulnerability and adaptation to climate change at local, sectoral, regional, and national scales.	Several qualitative and quantitative tools	UNDP support countries	No direct cost.	http://www.undp.org./cc/cop9.htm
Adaptation Decision Matrix (ADM)	Multicriteria assessment techniques to evaluate the relative effectiveness and costs of adaptation options.	Useful when many important benefits cannot be easily monetized. For all locations; all sectors; national or site-specific.	Several qualitative and quantitative tools	U.S. Country Studies and UNEP assistance programs	No direct cost	Mizina et al., 1999
Vulnerability Indices (VI)	To identify the combination of sensitivity to climatic variations, the probability of adverse climate change, and adaptive capacity	Can help identify and target vulnerability at all levels , raise awareness, and be part of a monitoring strategy	Both participatory and scientific tools	Bangladesh and LDCs	No cost	Downing et al., 2001
Multistakeholder Processes (MP)	promote better decision making by receiving the views of the main actors concerned	There is no one set approach.	There is no one set approach.	Adaptation policy framework	Depends on the scale of the process.	http://www.earthscan.co.uk/.

(Source: Intergovernmental Panel on Climate Change, Task Group on Scenarios for Climate Impact Assessment IPCC-TGCIA, 1999; IPCC, 2004)

ANNEX 6: Time series data between 2001 and 2011 on demographic and social information of the study sites

Sites	Year	Population	Households (hh)	Family size	Livestock/hh	Landholding ha/hh	Landlessness (%)	Fuel-wood use (%)	Alternate energy use (%)	Population growth %
Dovan	2001	101,768	21,764	4.68	8.05	0.23	32	93		
	2011	125,334	31,098	4.03	7.1	0.18	38	85[1]	77	2.15
Barandavar	2001	80,845	19,584	4.13	5.4	0.41	4.2	68		
	2011	111,358	23,404	4.76	4.9	0.29	5.4	63	40.3	3.32
Lamahi	2001	56,550	8,950	6.32	12.15	0.55	6	87.8		
	2011	86,716	17,166	5.05	10.01	0.44	7.45	71.5	47.6	4.38
Mahadevpuri	2001	34,232	5,881	5.82	8.09	0.61	2.4	96.3		
	2011	42,403	7,649	5.54	6.89	0.5	3.7	81.1	28.2	2.13
Khata	2001	18,300	3,453	5.30	9.3	0.37	9.2	97.1		
	2011	20,006	3,659	5.47	8.2	0.33	10.77	85.9	53.6	1.14
Basanta	2001	115,177	19,197	6.00	7.6	1.06	7.1	93.4		
	2011	135,831	23,055	5.89	7.11	0.94	8.6	83.6	38.8	1.61
Mohana-Laljhadi	2001	75,389	13,705	5.50	6.4	0.72	11.8	98.2		
	2011	101,811	16,444	6.19	4.3	0.61	14.43	78.8	31.5	3.02
TAL	2001	482,261	92,534	5.39	8.14	0.56	10.39	90.54		
	2011	623,459	122,475	5.28	6.93	0.47	12.62	78.41	45.29	
Growth %	2001-11	2.59	2.62							

(Source: CBS, 2001; 2011; WWF, 2002; field survey, 2012) ([1]data excludes Butwal municipality due to outlier figure; alternate energy includes improved cooking stoves, biogas, LPG and electricity)

ANNEX 7: Assessment of methods and tools

The methods and tools were subjected to the perception survey and analyzed quantitatively using one sample median test to the 10 response variables and crosschecked with the scientific reliability. The test with reference to value 2.5 and 50 percent cut point revealed the score on significant (S) and not significant (NS) differences toward positive conclusion on each methods and tools as shown in the table below:

Methods and tools	Simple to use	Easy to understand	Useful	Cost-effective	Accurate	No training required	Creates baseline	Apt for all scales	Comparatively better	Replicable	Score out of 10	Expert judgment
General methods and tools (11)												
Threat reduction assessments	S	S	S	S	NS	NS	S	S	S	S	8	4
Disturbance analysis	S	S	S	S	NS	NS	S	S	S	S	8	4
Abundance index	S	NS	S	S	NS	S	S	S	S	S	8	4
Growing stock estimation	S	S	S	S	NS	NS	S	S	S	S	8	4
Livelihood index	S	NS	S	S	NS	NS	S	S	S	S	7	4
Biodiversity index in general	S	NS	S	S	NS	NS	S	S	S	S	7	4
Policy analysis	S	S	S	S	NS	S	NS	S	NS	S	7	3
Alpha biodiversity	S	NS	S	S	NS	NS	S	S	S	S	7	4
Stakeholder analysis	S	S	S	NS	NS	S	NS	S	NS	S	6	1
Gamma biodiversity	NS	NS	S	S	NS	NS	S	S	S	S	6	4
Beta biodiversity	NS	NS	S	S	NS	NS	S	S	NS	S	5	4
Specialized technical methods and tools (6)												
DPSIR Framework	S	S	S	S	S	NS	S	S	S	S	9	4
M&IA approach focused on wildlife management	S	S	S	S	NS	NS	S	S	S	S	8	4
Landscape Outcome Assessment Methodology	S	S	S	S	NS	S	S	NS	S	NS	7	1
Status and effectiveness measures	S	S	S	S	NS	S	S	NS	NS	NS	6	2
GIS/RS	S	NS	S	NS	NS	NS	S	NS	S	NS	4	4
National Forest Monitoring Assessment	S	NS	S	NS	NS	NS	S	NS	S	NS	4	4
Climate change adaptation and vulnerability assessment (7)												
Adaptation Decision Matrix	S	S	S	S	NS	S	S	S	S	NS	8	1
Vulnerability and Adaptation Assessments	S	S	S	S	NS	S	S	NS	S	NS	7	1
Vulnerability Indices	S	S	S	S	NS	S	S	NS	S	NS	7	1
Multistakeholder Processes	S	S	S	S	NS	S	S	NS	S	NS	7	1
Adaptation Policy Framework	S	S	S	S	NS	S	S	NS	NS	NS	6	3
Climate Change Impacts and Adaptations	NS	NS	S	NS	S	NS	S	S	S	NS	5	4
Climate Impact and Adaptation Assessment	NS	NS	S	NS	S	NS	S	S	S	NS	5	4

Methods and tools	Simple to use	Easy to understand	Useful	Cost-effective	Accurate	No training required	Creates baseline	Apt for all scales	Comparatively better	Replicable	Score out of 10	Expert judgment
Livelihood improvement (16)												
Community-level formal surveys	S	S	S	S	S	S	S	NS	S	S	9	3
Household-level formal surveys	S	S	S	S	S	S	S	NS	S	S	9	3
Stakeholder consultations and key informant interviews	S	S	S	S	NS	S	S	NS	S	S	8	2
Participatory assessment, monitoring and evaluation	S	S	S	S	NS	S	S	NS	S	S	8	3
Most significant change	S	S	S	S	NS	S	S	NS	S	S	8	3
Livelihood assets status tracking	S	S	S	S	NS	S	S	NS	NS	S	7	4
Wellbeing monitoring	S	S	S	S	NS	S	S	NS	NS	S	7	4
Livelihood impact assessment	S	S	S	S	NS	S	S	NS	NS	S	7	4
Participatory policy impact assessment	S	S	S	S	NS	S	S	NS	NS	S	7	4
Human perceptions of environmental change (household/community surveys)	S	S	S	S	NS	S	S	NS	NS	S	7	4
Analysis of training impacts	S	S	S	S	NS	NS	S	NS	S	S	7	4
Transect walks, aerial photography	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Market studies	S	S	S	NS	S	NS	S	NS	S	NS	6	3
In-depth sociological and characterization studies	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Financial and economic analyses	NS	S	S	NS	S	NS	S	NS	S	NS	5	4
Plot and landscape field measurements of natural resources of both stock and flows	NS	S	S	NS	S	NS	S	NS	S	NS	5	3
Biodiversity inventory (7)												
Conservation Needs Assessment	S	S	S	S	NS	S	S	NS	NS	S	7	4
Gap Analysis	S	S	S	S	NS	S	S	NS	NS	S	7	4
Biodiversity Information System	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Rapid Ecological Assessment	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Rapid Biodiversity Assessment	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Rapid Assessment Programme	S	S	S	NS	S	NS	S	NS	S	NS	6	3
All-taxa Biodiversity Inventory	NS	S	S	NS	S	NS	S	NS	S	NS	5	4

Methods and tools	Simple to use	Easy to understand	Useful	Cost-effective	Accurate	No training required	Creates baseline	Apt for all scales	Comparatively better	Replicable	Score out of 10	Expert judgment
Biodiversity assessments (5)												
Species diversity indices	S	S	S	S	NS	S	S	NS	NS	S	7	4
Abundance indices and population estimates	S	S	S	S	NS	S	S	NS	NS	S	7	4
Indices of landscape patterns and historic reference conditions	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Qualitative and quantitative population viability analysis	S	S	S	NS	S	NS	S	NS	S	NS	6	3
Functional group and guild analysis	NS	S	S	NS	S	NS	S	NS	S	NS	5	1
Participatory biodiversity assessments (10)												
Species list	S	S	S	S	NS	NS	S	S	S	S	8	3
Field observation and recording	S	S	S	S	NS	NS	S	NS	S	S	7	1
Photo documentation	S	S	S	S	NS	NS	S	NS	S	S	7	1
Transect	S	S	S	S	NS	NS	S	NS	S	S	7	3
Community group discussion	S	S	S	S	NS	NS	S	NS	S	S	7	2
Participatory mapping	S	S	S	S	NS	NS	S	NS	S	S	7	2
Key informant and semi structured interview	S	S	S	S	NS	NS	S	NS	S	S	7	3
Census	S	S	S	S	NS	NS	S	NS	S	S	7	4
Pooling local expert opinion	S	S	S	S	NS	NS	S	S	S	S	7	4
Sampling plot	S	S	S	S	NS	NS	S	NS	S	S	7	4
Non participatory methods (11)												
Total count	S	S	S	S	NS	NS	S	NS	S	S	7	4
Timed searches	S	S	S	S	NS	NS	S	NS	S	S	7	4
Quadrats	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Distance sampling	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Line and strip transects	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Line and point intercept transects	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Camera trap	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Point count	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Trapping webs	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Removal method	S	S	S	S	NS	NS	S	NS	NS	S	6	4
Mark-recapture methods	S	S	S	S	NS	NS	S	NS	NS	S	6	4

(Perception based acceptance from one sample median test, 2.5, 50%, n=45; S = significant; NS = not significant; p = 0.05; * level of appropriateness; 1 –in question 1; 2 – slightly inappropriate; 3– slightly appropriate; 4– appropriate and 5– strongly appropriate).

ANNEX 8: One sample median test on policy responses

Variables	OP of category			+/ -	Variables	OP of category			+/ -
	<2.5	> 2.5	p			<2.5	> 2.5	p	
Clarity on objective	0.41	0.59	.001	+	Changed process	0.18	0.82	.000	+
Clarity on planning	0.88	0.12	.000	-	Continuity of infrastructure	0.06	0.94	.000	+
Motivating institutions	0.76	0.24	000	-	Continuity of funding	0.1	0.9	.000	+
Communications	0.35	0.65	.000	+	Adoption	0.06	0.94	.000	+
Outputs	0.36	0.64	.000	+	Mainstreaming	0.08	0.92	.000	+
Quality of outputs	0.37	0.63	.000	+	Innovativeness	0.35	0.65	.000	+
Outcomes	0.36	0.64	.000	+	Outcome without additional budget	0.38	0.62	.000	+
Quantitative achievements	0.38	0.62	.000	+	Impact without additional budget	0.37	0.63	.000	+
Impacts	0.41	0.59	.001	+	Information dissemination	0.06	0.94	.000	+
Sharing	0.36	0.64	.000	+	Improved skills	0.72	0.28	.000	-
Internal interactions	0.88	0.12	.000	-	Consistency	0.75	0.25	.000	-
External interactions	0.76	0.24	.000	-	Participation	0.78	0.22	.000	-
Flexibility	0.35	0.65	.000	+	Information	0.79	0.21	.000	-
Use of Inputs	0.36	0.64	.000	+	Institutional capacity	0.35	0.65	.000	+
					Benefit sharing	0.06	0.94	.000	+

Source: modification from European Commission (2009); OP= Observed Proportion; Test Proportion = 50%; p = significance value; + = positive proportion; - = negative proportion

ANNEX 9: Rotated component matrix

	Components				
	1	2	3	4	5
Eigen value	10.981	5.050	3.974	3.622	1.257
Percent of variance	37.865	17.415	13.702	12.490	4.334
Effectiveness					
Achieved outputs	.986				
Communications	.984				
Flexibility/adaptability	.983				
Innovative	.983				
Input management	.979				
Achieved outcome	.979				
Institutional capacity	.976				
Quality output	.950				
Policy achievements	.930				
Outcomes without additional budget	.929				
Impacts without budget	.913				
Policy impacts	.855				
Efficiency					
Benefit sharing		.958			
Information dissemination		.956			
Adoption		.956			
Mainstreaming		.797			
Implementation infrastructure		.788			
Additionality					
Clarity in planning			.938		
Internal interaction			.936		
External interaction			.930		
Institutional motivation			.929		
Clarity in objectives			.690		
Governance					
Participation				.970	
Consistency				.967	
Improving skills				.947	
Information				.925	
Sustainability					
Continuity of funding					.800
Changed the work processes					.759
Sharing in policy process					

Note: Principle component analysis; Varimax with KMO; KMO = .857; Bartlett's Test of Sphericity: p = .001 (χ^2_{171}= 2472.44)

ANNEX 10: List of tree/timber species

S.N.	Botanical name	Local name
1	*Acacia catechu*	Khayar
2	*Adina cordifolia*	Karma
3	*Albizia lebbeck*	Siris
4	*Anthocephalus chinensis*	Kadam
5	*Bombax ceiba*	Simal
6	*Buchanania latifolia*	Piyar
7	*Cassia fistula*	Rajbrikchha
8	*Cleistocalyx operculatus*	Kyamino
9	*Dalbergia latifolia**	Satisal
10	*Dalbergia sissoo*	Sissoo
11	*Diospyros malabarica*	Khalluk
12	*Diploknema butyracea*	Chiuri
13	*Engelhardia spicata**	Mahuwa
14	*Eucalyptus camaldulensis**	Masala
15	*Ficus racemosa*	Gular
16	*Hymenodictyon exelsum*	Bhurkut
17	*Mallotus philippensis*	Sindure
18	*Melia azedarach**	Bakaino
19	*Michelia champaca**	Champ
20	*Ougeinia oogensis**	Sadan
21	*Pinus roxburghii**	Salla
22	*Pterocarpus marsupium**	Viyaya Sal
23	*Rhus wallichii*	Bhalayo
24	*Schima wallichii*	Chilaune
25	*Schleichera oleosa*	Kusum
26	*Shorea robusta*	Sal
27	*Syzygium cumini*	Jamun
28	*Tectona grandis**	Teak
29	*Terminalia chebula*	Barro
30	*Terminalia chebula*	Harro
31	*Terminalia tomentosa*	Asna
32	*Trewia nudiflora*	Bhelor

(* = species only found in CBM)

ANNEX 11: Multiple linear regression analysis (MLRA)

Variables	CBM: ACF and BZC							SMS: BCF and GMF						
	B	SE	Beta	t	p	Tol*	VIF	B	SE	Beta	t	p	Tol*	VIF
(Constant)	-1.83	3.47		-0.53	0.60			2.72	3.04		0.90	0.37		
N	0.00	0.00	-2.29	-3.27	0.00	0.02	5.80	0.00	0.00	0.29	0.68	0.50	0.06	6.01
S								-0.49	2.22	-1.91	-0.22	0.83	0.00	66.93
0D	0.00	0.00	1.90	3.00	0.00	0.02	15.78	0.00	0.00	-0.28	-0.69	0.49	0.07	4.80
λ	1.80	2.54	0.48	0.71	0.48	0.02	13.47	0.58	2.17	0.19	0.27	0.79	0.02	7.51
D	-2.60	4.39	-0.68	-0.59	0.56	0.01	51.56	-0.40	2.24	-0.14	-0.18	0.86	0.02	13.40
1/λ	0.61	0.42	0.91	1.46	0.15	0.02	24.91	-2.29	0.88	-2.10	-2.60	0.01	0.02	18.31
H’	2.12	0.87	1.61	2.43	0.02	0.02	19.71	0.59	0.79	0.42	0.74	0.46	0.04	18.15
DMn	0.51	1.16	0.17	0.44	0.66	0.06	17.36	-0.93	1.24	-0.17	-0.75	0.46	0.22	4.53
E	1.30	1.79	0.24	0.73	0.47	0.08	11.91	-0.16	1.37	-0.03	-0.12	0.91	0.23	4.44
J'	-0.75	0.35	-0.60	-2.17	0.04	0.11	8.81	0.07	0.71	0.01	0.09	0.93	0.48	2.10
d	-3.10	3.17	-0.51	-0.98	0.33	0.03	10.84	0.30	0.27	0.18	1.10	0.28	0.42	2.36
1/d	-0.29	0.20	-0.42	-1.47	0.15	0.11	9.46	0.83	0.42	1.00	1.97	0.05	0.04	13.18
DMg	-0.86	0.83	-0.97	-1.04	0.31	0.01	10.65	0.51	0.81	0.25	0.63	0.53	0.07	14.26
G	-0.72	0.30	-1.88	-2.39	0.02	0.01	30.65	0.91	0.49	1.22	1.86	0.07	0.03	18.28
Abv								-0.02	1.74	-0.06	-0.01	0.99	0.00	40.40
BR	-0.27	0.45	-0.90	-0.60	0.55	0.00	25.37	0.50	0.41	0.69	1.22	0.23	0.04	18.65
M	-1.69	1.26	-0.23	-1.34	0.19	0.29	3.41	0.13	0.18	0.10	0.75	0.45	0.71	1.41
C	0.24	0.17	2.35	1.38	0.18	0.00	33.92	0.14	1.36	0.54	0.10	0.92	0.00	24.67
R^2: 61.5% R^2 adjusted: 47.5% RMSE: 0.823								R^2: 56.1% R^2 adjusted: 31.4% RMSE: 0.975						

(*Tol = Tolerance)

ANNEX 12: Rotated factor loadings and communalities

Variables	CBM					SMS			
	Factor 1	Factor 2	Factor 3	Factor 4	Comm	Factor 1	Factor 2	Factor 3	Comm
N	0.277	-0.231	0.904	-0.08	0.954	0.284	-0.015	0.906	0.902
S	0.98	0.104	0.089	-0.017	0.98	0.966	0.153	0.104	0.967
0D	0.089	-0.305	0.923	-0.133	0.97	-0.06	0.018	0.95	0.906
λ	-0.189	-0.73	0.586	-0.081	0.918	-0.518	-0.748	-0.271	0.901
D	0.178	0.734	-0.613	0.075	0.952	0.516	0.727	0.273	0.869
1/λ	0.332	0.853	-0.161	0.259	0.931	0.588	0.753	0.023	0.914
H’	0.467	0.713	-0.436	0.123	0.932	0.703	0.649	0.135	0.934
DMn	0.275	0.273	-0.293	0.68	0.699	0.079	-0.256	-0.855	0.802
E	-0.631	0.645	-0.214	0.206	0.902	-0.51	0.713	-0.165	0.795
J'	-0.133	0.174	-0.011	0.855	0.779	0.011	0.681	0.194	0.501
d	-0.107	-0.837	0.417	-0.107	0.897	-0.204	-0.235	-0.29	0.181
1/d	0.013	0.916	0.008	0.217	0.885	0.497	0.769	-0.006	0.838
DMg	0.906	0.23	-0.106	0.259	0.951	0.93	0.149	-0.214	0.932
G	0.665	0.599	-0.296	-0.103	0.899	0.807	0.538	0.07	0.945
Abv	0.98	0.103	0.09	-0.021	0.979	0.965	0.152	0.108	0.966
BR	0.972	0.099	0.098	-0.018	0.964	0.95	0.212	0.078	0.954
M	0.74	0.094	-0.079	0.049	0.564	0.402	0.1	0.192	0.209
C	0.98	0.103	0.09	-0.021	0.979	0.966	0.145	0.108	0.966
Eigen	8.332	5.505	1.2099	1.001		9.417	2.814	2.252	
% Var	46.3	30.6	7.2	5.6		52.32	15.64	12.51	

ANNEX 13: χ^2 test result on site specific risk of primary threats

Sites	Threats														
	Encroachment and land conversion			Poaching and trade			Forest fire			Commercial mining			Invasive species and grazing		
	χ^2	n	p	χ^2	n	p	χ^2	n	p	χ^2	n	p	χ^2	n	p
Basanta	31.55	44	0.000	22.06	40	0.000	17.58	38	0.000	15.25	37	0.000	21.16	40	0.000
Khata	9.56	16	0.008	16.22	18	0.000	6.89	14	0.000	6.89	14	0.032	4.667	14	0.097
Mahadevpuri	12.40	14	0.02	2.80	10	0.247	6.70	12	0.035	9.80	15	0.007	16.30	15	0.000
Lamahi	25.95	29	0.000	15.42	25	0.000	34.39	31	0.000	15.42	25	0.000	22.88	28	0.000
Dovan	1.60	8	0.45	5.20	10	0.074	4.90	9	0.086	0.10	7	0.951	0.10	7	0.951
Laljhadi	35.09	27	0.000	21.27	23	0.000	27.46	25	0.000	12.18	18	0.002	24.18	24	0.000
Barandavar	5.765	10	0.056	4.353	9	0.113	1.53	8	0.000	7.882	11	0.019	18.47	14	0.000

ANNEX 14: Analysis of human disturbances: Independent sample t test

Disturbance variables	Types	Between CFM (1) and GMF (2)				Type	Between BGM (3) and BZC (4)				Types	Between CBM (CFM and BZC), 0, and SMS (GMF and BGM), 1			
		n = 43 each, df=84					n = 21 each, df =40					n = 64 each, df =126			
		Mean	SE	t	p		Mean	SE	t	p		Mean	SE	t	p
LOG	1	3.63	0.34	-5.08	0	3	14.57	1.72	2.523	0.016	0	5.328	0.616	-3.466	0.001
	2	5.95	0.30			4	8.81	1.50			1	8.778	0.782		
ENC	1	15.12	2.22	-1.958	0.054	3	25.05	2.68	4.541	0	0	13.078	1.703	-3.962	0
	2	20.81	1.89			4	8.91	2.33			1	22.203	1.551		
GRZ	1	30.42	3.04	-2.321	0.023	3	58.81	4.85	3.179	0.003	0	32.420	2.633	-3.643	0
	2	41.00	3.40			4	36.52	5.06			1	46.840	2.956		
LVD	1	21.02	1.92	-1.763	0.082	3	32.29	3.32	2.679	0.011	0	21.078	1.515	-3.006	0.003
	2	25.70	1.83			4	21.19	2.48			1	27.859	1.672		
FFR	1	27.95	2.99	-4.1	0	3	57.52	5.19	4.686	0	0	28.470	2.217	-5.955	0
	2	44.81	2.83			4	29.52	2.96			1	48.980	2.637		
PCH	1	9.00	1.06	-1.608	0.112	3	13.81	0.92	3.473	0.001	0	9.300	0.741	-2.752	0.007
	2	11.23	0.90			4	9.90	0.65			1	12.080	0.687		
FWD	1	386.70	49.91	-0.284	0.777	3	479.38	99.21	1.53	0.134	0	363.500	35.987	-1.11	0.269
	2	408.05	56.08			4	316.00	39.42			1	431.450	49.513		
DST	1	0.81	0.08	-6.024	0	3	2.36	0.14	7.989	0	0	0.838	0.066	-6.988	0
	2	4.11	0.54			4	0.91	0.11			1	3.531	0.380		
NRG	1	28.05	2.43	-5.803	0	3	61.43	3.91	5.834	0	0	29.270	1.950	-7.851	0
	2	47.72	2.36			4	31.76	3.25			1	52.220	2.179		

ANNEX 15: Questionnaire for household survey

1. Basic information Date:

1. 1 General Information

1.1.1 Code: 1.1.2 UG name: 1.1.3 District
1.1.4 VDC/Municipality 1.1.5 Village/tole:
1.1.6 Name of the respondent:
1.1.7 Sex:
1.1.8 Age:
1.1.9 Religion:
1.1.0 Ethnicity:
1.1.10 Occupation:
1.1.11 Well-being ranking of HH: ❑ Extreme poor ❑ Poor ❑ Middle class❑ High class
1.1.12 Religion: ❑ Hindu ❑ Buddhist ❑ Muslim ❑ Christian ❑ Others (specify)
1.1.13 How long have you been involved in forest protection and conservation?
1.1.14 UG membership date:
1.1.15 Walking distance from HH to nearest roadhead (two-way):
❑ Less than two hours ❑ More than two hours
❑ Less than half day ❑ More than half day

1.2 Details of respondents and family members

1.2.1 Is this your ancestral home or have you migrated? ❑ Yes, it is ❑ Migrated
1.2.2 If migrated, why did you leave your earlier place?
❑ Natural disaster ❑ Poverty ❑ Easier livelihood ❑ Economic progress
❑ Employment ❑ Education ❑ Health ❑ Others (specify)
1.2.3 Give the details of member who has migrated from the list provided above, if any:
12.4 If it is internal, specify district of migration and VDC:
1.2.5 Educational status: ❑ Illiterate ❑ Literate

2. Access to assets and services

2.1 Income generating activities

2.1.1 Are you involved in any income generating activities other than your main occupation mentioned above
❑ Yes ❑ No

If yes, give the following details which are directly related with you

S. No.	Activities	Priority (Rank 1, 2. 3. etc)

2.2 Physical status of HHs

2.2.1 What is your housing condition? ❑ Building ❑ Semi Buidling ❑ Tin Shed❑ Sun grass/bamboo ❑ Mud
2.2.2 Do you have a shed for livestock farming?❑ Yes ❑ No
2.2.4 Is there a toilet in your house?❑ Yes ❑ No
2.25 What is the source of light in your house? ❑ Diyalo ❑ Keresone ❑ Biogas ❑ Electrification ❑ Solar energy
2.2.5 Do you have telephone access? ❑ Yes ❑ No
2.2.6 What is the provision of drinking water?
2.2.7 How do you manage solid waste?
2.2.8 Which kind of fuel do you use for cooking? (Tick any three major sources)
❑ Firewood ❑ Biogas ❑ LP gas ❑ Gobar Gas/Guitha ❑ Jhijha/karchi ❑ Coal ❑ Bricket ❑ Kerosene ❑ Other (specify)
2.2.9 Do you use improved stove? ❑ Yes ❑ No
2.2.10 What are the major changes in you HH status in last five years?
❑ Significant change ❑ Improved ❑ No change ❑ Worse than before ❑ Has really worsened
2.2.11 What is the role of CF in abovesaid change?
❑ Significant ❑ Little bit ❑ Nothing

2.3 Fixed and movable HH assets

2.3.1 HH assets

S. N.	1.Description	2. Number (quantity)	3.Changes in last five years (1: increased, 2: decreased, 3: no change)	4. Reason
1				
2				
3				
4				

2.3.2 What is the role of CF in the abovesaid change? ❑ Significant ❑ Little bit ❑ Nothing

2.4 Land ownership

2.4.1 Do you have own land in your family? ❑ Yes ❑ No

2.4.2 If you have land in your family, how much land have you used for farming?

If you have farming land, give the following details:

Type of land	1.Own land, own use		2.Rented in		3.Rented out		4.Others		Change since last five years (1: increased, 2: decreased, 3: no change)
	Unit	Area	Unit	Area	Unit	Area	Unit	Area	
Khet									
Bari									
Karesa-baari									
Private forest									
Khar-bari									
Others, specify									

2.4.3 Is there any change in status of land due to the increased income from CF/F activities? ❑ Yes ❑ No

2.4.4 Irrigation status

Description	Unit	Area
1. Land with irrigation facility throughout the year		
2. Land without irrigation facility		

2.5 Ownership of tress

2.5.1 Do you have trees in your own land? ❑ Yes ❑ No

2.5.2 What are the changes in the status of tress s in your land since last ten years?

❑ Decreased ❑ Increased ❑ No change

2.5.3 What are the reasons for abovesaid changes?

2.6 Food security

2.6.1 Is your own production sufficient for food throught the year?

2.6.2 If no, specify number of food sufficiency months?

2.6.3 Has there been any change in food sufficiency months in last five years?

❑ Increased ❑ Decreased ❑ No change

2.6.4 How CF/F has contributed in bringing the changes in food security status?

S.N.	Type of foods recently received from CF/F	Contribution of such foods in food security
1		
2		
3		

2.7 Livestock farming

2.7.1 Are you involved in livestock farming?

If yes, give the following details:

Livestock	Increment in number		3. No. of livestock sales in last 12 months	4.Changes in last five years (1: increased, 2: decreased, 3: no change)	5.Reasons	6. Contribution of CF in bringing changes (increased/ decreased)
	1.Local	2.Hybrid				

2.7.2 What are the changes in livestock (self or rented) in your house since last ten years?

❑ Decreased ❑ Increased ❑ No change

2.7.3 What are the reasons for abovesaid changes?

2.7.4 Is there any changes in your pattern of livestock farming since last ten years?❑ Yes❑ No

2.7.5 If yes, what are the changes?

2.7.6 What are the reasons for abovesaid changes?
2.7.7 How do you manage domestic animals (goat/ship, cow/buffalo)?
❑ Open grazing land ❑ Stall feeding ❑ Both
❑ Shed management ❑ Other (specify)
2.7.8 If you use grazing land, where is it?
❑ Community forest ❑ Other forest ❑ Self grazing land/
❑ Common grazing land in village ❑ Open ❑ Other (specify)

3. Forest Users Group and Forest

3.1 Did you participate in any forest management activities last year? ❑ Yes ❑ No
3.2 If yes, how many days (last year)? ❑ <5 days ❑ 6-10 days ❑ 10 days+
3.3 If not, was there any provision of penalty? ❑ Yes ❑ No
3.4 If yes, how much did you pay and how many times? .... times and NRs. ....
3.5 Why did you pay penalty ? What are the reasons? ❑

Distribution of forest resources

3.6 Have you received paid employment in forest? ❑ Yes ❑ No
3.7 If yes, how many days (last year)? .... days
3.8 If not, why didn't you get?
3.9 Do you think, forest resources are distributed as per social needs? ❑ Yes ❑ No
3.10 If yes, what are the provisions? and for whom? Give details. ❑

Demand and supply of forest products

3.11 What kind of forest products do you need? How much? and how did you get that?

S. N.	Forest resources	Unit	1. Need	2. Received from CF	3. Able to fulfill the needs from CF since last five years (1: increased, 2: decreased, 3: no change)
1	Firewood	Bhari			
		K.G.			
2	Timber/wood?	cft			
3	Poles	Pieces			
4	Bhui Ghass	Bhari			
5	Fodder	Bhari			
6	Straw	Bhari			
7	Herbs	K.G.			

3.12 How do you fulfill the unmet requirements?

3.13 What is the status of supply of forest resources?

S. N.	Forest resources	1 Availability (before ten years)				2 Availability (currently)			
		Sufficient	Moderate	Relatively less	Less	Sufficient	Moderate	Relatively less	Less
1									
2									

CF land allocated for poor

3.14 Have your UG allocated CF land for poors? ❑ Yes ❑ No
3.15 Have you received land from any CF? ❑ Yes ❑ No
3.15 If yes, how much area of land? ....
3.17 If you have received land, do you need to pay in return? ❑ Yes ❑ No
3.18 If you need to pay, how much? NRs. ....
3.19 What kind of benefits have you received? ❑ Firewood ❑ Straw ❑ Non-timber products ❑ Grass ❑ Others (specify)
3.20 Do you need to pay money to use CF and land? ❑ Yes ❑ No
3.21 If yes, what percentages? ....
3.22 Do you need to share the benefit (for example, forest products) for using CF land? ❑ Yes ❑ No

3.23 Use of saved time

S.N.	1.Where have you used the saved time?	2. Male's time	3. Female's time
1	Agriculture		
2	Enterprise/IG activities		
3	Labour		
4	Health		
5	Education		
6	Sanitation		
7	Meeting		
8	Others, specify		

3.24 Additional burden created by UG activities

S. N.	1 Burden areas	Average burden saved per day (in hour)	
		2. Male's time	3.Female's time
1	Firewood collection		
2	Grass/straw collection		
3	Water collection		
4	Carrying crops from Khet		
5	Flour mill		
6	School		
7	Service centre		
8	Others, specify		

3.25 Income and expenditure

Annual expenditure of HH last year

S. N.	1. Description	2. Annual expenses	3. Changes in last five years (1: increased, 2: decreased, 3: no change)	4. If possible, specify reasons
1				
2				

3.26 What are the changes in your HH income (except agriculture/livestock) since last ten years?

❑ Increased ❑ Same ❑ Decreased

3.27 What about the income sources? ❑ Increased ❑ Same ❑ Decreased

3.28 What are the contributions of CF in HH income?

S. N.	1. CF contributions	2. Contribution in income	3. Reduction in income
Direct			
1	Employment		
2	Sales of forest products		
3	Service (Training, eco-tourism etc.)		
Indirect			
1	Saving/credit		
2	Improvement in land fertility		
3	Improved livestock farming		
4	Enhancement in water resources		
5	Reduction in soil-erosion and floods		
6	Increment in tourism		
7	Improvement in management		
8	Others (specify)		

3.29 What type of employment is created for you from CF?

❑ Forest watcher ………….. day/per year
❑ Daily wages ………….. day/per year
❑ Office assistant ………….. day/per year
❑ Messenger ………….. day/per year
❑ Facilitator ………….. day/per year
❑ Teachers ………….. day/per year
❑ Others (specify) ………….. day/per year

3.30 Loan
3.30.1 Have you received loan since last five years? ❑ Yes ❑ No
3.30.2 If yes, give reasons:

S. N.	1. Activities	2. Year	3. Time period (in months)	4. Amount (NRs.)	5. Annual interest rate	6. Source of loan (1: money-lender, 2: NGO, 3: friends, 4. bank, 5. cooperatives, 6. dhukuti, 7. UG fund, 8. saving/credit group, 9. others)	7. Due loan except interest
1							
2							
3	Others (specify)						

3.31 Health and sanitation
3.31.1 What are the changes in your health and sanitation status since last five years? ❑ Improved ❑ Same ❑ Worst
3.31.2 Do you have kitchen with improved cooking stove? ❑ Yes ❑ No
3.31.3 Do you have toilet? ❑ Yes ❑ No
3.31.4 Have you used alternate energy sources? ❑ Yes ❑ No
3.31.4 If yes, what is it? ❑ Biogas ❑ Solar energy ❑ Others (specify)
3.31.5 Have you received cash support from UG for treatment? ❑ Yes ❑ No
3.31.6 Have you received commodity support (stretcher, midwife, herbs) from UG? ❑ Yes ❑ No
3.32 Education
3.32.1 Have you received the following support? ❑ Scholarship ❑ Dress ❑ Books ❑ Communication ❑ Internet ❑ School construction ❑ None of above ❑ Others (specify)
3.32.2 If support is received, what is the impact? ❑ Good ❑ Bad
3.32.3 What are the reasons of such effect (good/bad)? ❑
3.33 Agricultural tools
3.33.1 Have you received improved tools from UG? ❑ Yes ❑ No
3.33.2 If yes, what kind of tools have you received? ❑
3.34 Contribution of users in CF
3.34.1 What kind of contribution you need to provide in CF? ❑ Forest watcher ❑ Forest management Meeting/general assembly ❑ All ❑ Others (specify)
3.34.2 How much abaitanik labour/fee does your family need to contribute/pay in CF management related tasks?

S. N.	Description	Unit	Quantity	Female	Male	Fees
1	Meeting	Day				
2	Forest protection	Day				
3	Forest management	Day				
4	Others (specify)	Day				

4. Capacity building and empowerment

4.1 Participation in decision making regarding CF
4.1.1 Are you or your family member in UG executive committee? ❑ Yes ❑ No
4.1.2 If yes, give the following details: ❑ Designation: ❑ Nominated date: ❑ Tenure (years):
4.1.3 How you of your family member selected in executive committees?
❑ Nominated ❑ Consensus from all ❑ Elected
4.1.4 Do you attend meeting regularly?
❑ Generally present ❑ Occasionally present ❑ Generally absence
4.1.5 If you do not attend, what are the reasons?
❑
4.1.6 If you attend, how you perform?
❑ Generally active ❑ Occasionally active ❑ Keep quiet
4.1.7 If you keep quiet, why? ❑
4.1.8 If you are active, what are the issues you raise? ❑
4.1.9 How others respond your issues?
❑ Nobody listens❑ Listens but does not affect the decisions
❑ Listens and also affects the decision
4.1.10 Are you a member in any other UG? ❑ Yes ❑ No
4.1.11 If yes, are you in executive committee too? ❑ Yes ❑ No

4.1.12 If you are in executive committees, mention the designation:
4.1.13 Why did you become member in other UG too?
❑ Nearby home ❑ Higher access in productions
❑ Need of forest products ❑ Low resource in main committee
❑ Party politics ❑ Due to the request
❑ Others (specify)
4.1.14 Is there any - under UG? ❑ Yes ❑ No
4.1.15 Are you member of any sub-committee under UG? ❑ Yes ❑ No
4.1.16 If yes, give the following details:
❑ Name of sub-committee:
❑ Designation:
4.1.17 After enactment of CF, what have you felt regarding the availability of essential forest products?

Forest products	Availability (Tick any one)					
	Expansion of forest area, easier	Same	Reduced more	No meaning, only useful for elites	Poor(s) have been affected by rules	Others (specify)
Wood/ Timber						
Firewood						
Grass						
Straw						

4.1.18 Have poors/targeted groups been identified after well-being ranking? ❑ Yes ❑ No
4.1.19 If yes, what kind of facility do the poor/targeted groups receive?
❑ Loan ❑ Forest products without cost ❑ Free membership
❑ Forest products in discounted price ❑ Others (specify)
4.1.20 After the enactment of CF, what kind of benefits (cash and commodity) you received? Predict one year info.

Cash		Commodity	
Description	amount?	Description	amount/quantity
Employment/job (person)		Wood/timber (c.f.)	
Daily wages (day)		Firewood (bhari)	
Allowance (NRs.)		Grass (bhari)	
Others (specify)		Others (specify)	

4.1.21 Where the UG funds have been used?
❑ School ❑ Road ❑ Water and sanitation ❑ Electricity
❑ Health ❑ Soil conservation ❑ Poverty reduction ❑ Communication
❑ Office building ❑ Temple ❑ Other (specify)
4.1.22 Where does the higher investment go?
4.1.23 What are the benefits to you or your family from abovesaid investments? ❑
4.1.24 In your view, who gets maximum benefits from such investments?
❑ Equal for all ❑ Dalit ❑ Women
❑ Elites (with higher financial status) ❑ Poor ❑ Contractors ❑ Others (specify)
4.1.25 Can you borrow loan from UG fund? ❑ Yes ❑ No
4.1.26 If yes, which source of loan is easier for you?
❑ UG fund ❑ Relatives/neighbours
❑ Bank or cooperatives ❑ Money lenders
❑ Saving groups ❑ Others (specify)
4.1.27 Why do you find above-said alternate easier? ❑

Training

4.1.28 Have you received any training from UG? ❑ Yes ❑ No
4.1.29 Give the following detail if you have received any training.

Training	Times	Duration (days)	Training provided by	Participation status		Use of training	Effect	
				Full/partial	Reason		Positive	Negative
Forest management								
Skill development								
Institutional development								
Empowerment								
Others (specify)								

4.1.30 Have you received any other training, if so give the following details: ❑ Training topic: ❑ Provided by:
4.1.31 Have your other family members received training? ❑ Yes ❑ No
4.1.32 Briefly present traditional use of forest resources. ❑
4.1.33 What are the changes in traditional (??) use of forest products since last five years?

5. Social Inclusion

5.1.1 Does UG operational plan focus on the following:
Requirements of poor: ❑ Yes ❑ No ❑ Don't know
Requirements of women: ❑ Yes ❑ No ❑ Don't know
Requirements of socially excluded groups including Dalit, Janajanti
❑ Yes ❑ No ❑ Don't know
5.1.2 Are you satisfied with current UG mechanism of benefit sharing?
❑ Highly satisfied ❑ Satisfied
❑ Not any effect ❑ Not satisfied
❑ Highly dissatisfied
5.1.3 What are the reasons for being satisfied/dissatisfied as you mentioned above?
5.1.4 Are you satisfied with current UG distribution system regarding timber and firewood?
❑ Highly satisfied ❑ Satisfied ❑ Not any effect ❑ Not satisfied ❑ Highly dissatisfied
5.1.5 What are the reasons for being satisfied/dissatisfied as you mentioned above?
5.1.6 Have you participated in the UG assembly? ❑ Yes ❑ No
5.1.14 Do you know about UG policy, regulations, and guidelines? ❑ Yes ❑ No
5.1.15 Do you know about UG handover? ❑ Yes ❑ No
5.1.16 Do you know about UG executive committee? ❑ Yes ❑ No
5.1.17 Do you know about master plan? ❑ Yes ❑ No
5.1.18 Do you know about forest acts and regulations? ❑ Yes ❑ No
5.1.19 What other things do you know about forest related policies?

5.2 Participation in in-house decision making

5.2.1 Give the following information on decision process:

S. N.	1. Type of decisions	2. Decision-making process (1: decided by male, 2: decided by women, 3: decided by both)	3. Changes in role of women since last five years (1: increased, 2: decreased, 3: no change, 4. not applicable)	4. Role of youth, if any
1	Travel			
2	Treatment			
3	Transaction			
4	Education			
5	Financial matters			
6	Community Work			

5.2.2 What are the contributions of CF in brining abovesaid changes? ❑ Highly contributed ❑ Moderate contribution ❑ No contribution
5.2.3 Do any women in the family own asset legally? ❑ Yes ❑ No
5.2.4 What are the contributions of CF in bringing abovesaid changes? ❑ Highly contributed ❑ Moderate contribution ❑ No contribution
5.2.5 Disaster management – what is the relationship of this question to the CF impacts?
5.2.6 Do you remember any of the following disaster events since last ten years?
❑ Losing family members ❑ Natural calamities (flood, soil erosion, khaderi)
❑ Not being able to pay loan ❑ Affected by conflict

❑ Anikal ❑ Not getting medical treatment
❑ Social disorders ❑ Firing ❑ Others (specify)
5.2.7 How was the abovesaid disaster was resolved?

6. Negative Impacts

Although conservation activities generated considerable environmental improvements, they caused direct negative impacts on the peripheral communities.
6.1 Has quantity and frequency of forest products harvested has declined due to limited access to the forest, causing income losses and affecting food security?
❑ Yes ❑ No
6.2 Is the dependency on non timber forest products (NTFPs) as a source of income much low?
❑ Yes ❑ No
6.3 Is the annual income loss due to banning of shifting cultivation and reduced harvesting is much low?
❑ Yes ❑ No
6.4 Financial supports or technical assistance available in the locality to support livelihood (micro credit, NGOs support etc) and agreements

Types of support	Provider	Agreement	Remarks

6.5 Is human wild life conflict increased? ❑ Yes ❑ No

S. N.	Conflicts	Rank
1	Wildlife poaching	
2	Retaliatory killing	
3	Human live loss	
4	Human injury	
5	Loss of domesticated animals	
6	Loss of crop	
7	House damage	

6.6 Is conservation threats increased? ❑ Yes ❑ No
6.7 Extinct / disappeared biodiversity (flora and fauna) from the forest in the recent past

Items	Species	Cause
Flora		
Fauna		
Others		

6.8 Threatened plants and animals in the forest and the major threats behind it

Species	Threats	Cause

6.9 Major threats to the forest/biodiversity according to the local peoples

S. N.	Threats	Rank
1	Encroachment	
2	Illegal logging	
4	Forest fire	
5	Wildlife poaching	
6	Grazing	
7	Mining, gravel, sand etc	
8	Others	

7. Variables used for PCA

1.Human assets (Continuous scale)

- Status of human health; Status of education; Total employments ; Labor availability; and Presence of skilled manpower

3. Physical assets (Continuous scale and Likert scale ranged between 5 to 1)

- Drinking water; Community House; Schools; Health services; Road; House; Irrigation facilities; Access to markets and other infrastructures; Transport; Energy; Information source and Material possession

4. Natural assets (Continuous, binary and Likert scale as 5: effectively managed and 1: completely unmanaged)

- Forest and wildlife management; Grazing land and forage management; NTFP management; Pesticide use and impact; Water availability; Availability of fodder and fuel wood; Access to and use of natural resources; Land management; Soil management; Livestock composition; Crops; Farming system; and Cropping System

4. Social assets (Continuous, binary and in Likert scale as 5: effectively managed and 1: completely unmanaged)

- Population increase including migration; Family planning; Village size; Percentage of landowners/landless; Community organizations; Ownership and use rights; Rights to indigenous people; Indigenous knowledge and skills ; Community development; Research and education; Religious and cultural significance; Resources for future generations; and Participation

5. Financial Assets (Continuous, binary and Likert scale)

- Level of income; Amount of annual saving/Amount of credit reduction ; Remittances ; Household expenses; Insurance scheme used; Entrepreneurships; Changes in main income sources, emergence of new income-generating activities; Marketing of different foodstuffs, access to markets, prices of foodstuffs and good; Opportunities for employment; Forest products (timber and non-timber); Prospects for eco-tourism; Cost reduction scheme; Collection and mobilization of community funds; Contribution to national revenues; Contribution to earn foreign currency; and Support in poverty reduction

6. Vulnerability (Continuous and Likert scale (5 = effectively managed to 1= completely unmanaged)

- Human wildlife conflicts; Social inclusion; Biodiversity threat reduction; Human health (epidemics, hunger periods, etc.); Natural shocks (Erosion of fertile land, landslides and floods droughts, floods, etc.); Livestock disease and crop failures; Economic shocks (sudden variations in prices, unemployment periods, etc.); and Conflicts (between landowners and landless, between forest authorities and users and others)

7. Policy institutions and process (Binary and in Likert scale (5 = Effectively managed to 1= Completely unmanaged)

- Policy harmonization; Cohesion and network of user groups; Implementation of Forest management plans; and Co-ordination and synergies among institutions

ANNEX 16a: Data collection form (sample plot method)

(A) Basic Information on the Plot		
Name of CFUG:	Block no.	Plot number:
Condition of the forest:	Name of block:	Date of forest inventory:
Forest types:	Area of block:	Name of collector:

Description of the plot:			
Slope:	Aspect:	Soil erosion:	Other:

(**B) Data collection form for trees, poles, regenerations and other forest products**

(1) Data Collection Form (regeneration, poles and trees)

Regeneration						**Poles (diameter 10-29.9 cm) (Plot size 100m^2)**					**Trees (diameter greater than 30 cm) (Plot size 100-500m^2)**				
Seedlings Plot size 10 m^2 Diameter <4 cm Height >30 cm			**Saplings Plot Size 25 m^2 (Diameter 4-9.9 cm)**												
S. no.	Species	No.	Species	No.	Age	Species	Diameter (cm)	Unit (m)	Quality	Age	Species	Diameter (cm)	Unit (m)	Quality	Age

(2) other NTFPs and their estimation (Plot size 100 m^2)

S.no.	**NTFPs**	**Unit**	**Clear felling**	**Sustainable harvest**	**Rotation age**	**Remarks**
1	Fuelwood (only from regeneration)	Bundle				
2	Fodder	Bundle				
3	Leaf litter	Bundle				
4	Bamboo	Number				
5	Other					

(3) Other Important information from biodiversity point of view

1	==

ANNEX 16b: Data collection form (relascope method)

Name of community forest:

Forest types: Relascope factor (b):

Name of data collector:

Date:

Forest block or sub-block	Relascope point number	Tree species	Number of trees inside relascope (a)	Basal area (m^2) (a) x (b)	Mean height of trees (m)	Slope (percentage)
(a)	1					
	2					
	3					
	4					
	5					
	6					
	7					
(b)	1					
	2					
	3					
	4					
	5					
	6					
	7					

ANNEX 16c: NTFP and plants/trees recording form

Name of community forest: Forest block no:

Forest types: Relascope point no:

Name of data collector: Date:

Measurements of fodder and other NTFPs should be done in 100 m^2 plot (estimate asking users)

S. No.	Species	Regeneration no. < 4cm diameter (10 sq. metre)	No. of saplings Diameter in cm (25 m^2)		No. of Pole (100 m^2)		No. of Trees (100-500 m^2)	
			4-6.9 (13-21)	7-9.9 (22-31)	10-19.9 (32-62)	20-29.9 (63-94)	> 30cm (> 94)	3 Ds
1	Tree							
2								
3								
4								
5								
1	Shrub							
2								
3								
4								
5								
1	Climber							
2								
3								
4								
5								
1	Herbs							
2								
3								
4								
5								

Note:

- 3D means dead, diseased and dying, trees (also includes trees lying on the ground)
- The four types of regeneration are trees, shrubs, climber sand herbs. Calculate separately.
- The figures in parenthesis are the girth of the trees in cm

ANNEX 17: Summarized form of questionnaire on performance assessment of biodiversity related policies and strategies in TAL

Section 1: Demographic characteristics of respondents

The following section is on your demographic and background information in relation to this study. Your information is only be used for this study and kept confidential.

Question	Answer	Code
Name		
District		
Site		
Institution		
Name of forest		
Type of forest ownership		
Age		
Economic background		
Educational Background		
Gender		
Level of job		
Level of participation		
Job experience (yr.)		
Ethnicity		
Types of stake		
Training attended		

Section 2: Familiarity on the policies and strategies

The following question is related to the statements of your response on familiarity to the following policies and strategies to be measured on the scale from 1 to 5. Please read each item carefully the select the appropriate number that indicates how much you are familiar or not with the statement with the scales:1 – not at all familiar (NF); 2 – Less familiar (LM); 3 – Somewhat familiar (SF); 4 – Moderately familiar (MF); and 5 – Extremely familiar (EF).

Policies and strategies	1-NF	2-LF	3-SF	4-MF	5-EF
Master Plan for the Forestry Sector (MPFS)					
Revised forestry sector policy					
National Biodiversity Strategy (NBS)					
Domestic Elephant Management Policy					
Terai Arc Landscape (TAL) Strategic Plan					
Working Policy on Wildlife Farming, Breeding and Research					
Herbs and Non-Timber Forest Products Development Policy					
MFSC Human Resources Strategy					
NBS Implementation Plan					
National Biosafety framework and Policy					
Sacred Himalayan Landscape Strategic Plan					
Forestry sector Gender and Social Inclusion (GESI) strategy					
Forest fire management strategy					
National Wetland Policy					

Section3: Possible impacts of policies and strategies

The following questions are related to the statements of conservation policy impacts to be measured on the scale from 1 to 5. Please read each item carefully the select the appropriate number that indicates how much you agree or disagree with the statement using the scales: 1 = strongly disagree (SD); 2= disagree (D); 3= moderate (M); 4= agree (A) and 5= strongly agree (SA**)**

S.N.	**Statement**	SD	D	M	A	SA
1	Specification of policy objectives and target is clear					
2	There is clarity in the planning and input required					
3	Policy is effective in motivating relevant organizations					
4	Policy is effective in communication mechanisms.					
5	Policies has achieved output					
6	Quality of the policy output is assured.					
7	Policies have achieved a specific outcome					
8	Policy has achievements in numbers					
9	Policy has long lasting impacts					
10	Implementation lessons are shared in policy process.					
11	Policy interacts with other policy initiatives and integrated.					
12	Policy interacts with the other sectors in implementation					
13	The policy is flexible/adaptive enough to feedback/monitoring results.					
14	Inputs are being managed in relation to outputs					
15	Policy initiative changed the work processes of the beneficiaries					
16	Implementation infrastructure set up by policy continues					
17	There is continuity in size of funding					
18	There is adoption of the policy methodology					
19	There is capacity to internalize and mainstream within policy and institutional process					
20	Policy is innovative compared to preceding policies.					
21	Outcomes have occurred at the same level without additional funding					
22	Impacts have occurred at the same level without additional funding					
23	Information generation and dissemination have occurred					
24	Policy meets the objective of improving managerial understanding and skills					
25	Policies are consistent and do not contradict					
26	There is high level of participation					
27	Local communities have information on policies?					
28	Institutions have capacity to implement the policies					
29	There is benefit sharing of conservation benefits					

(Source: modified from European Commission, EC, 2009)

ANNEX 18: Climate change adaptation and vulnerability assessment

18.1 Checklist for data collection

18.1.1Checklist for secondary information

Use a folder in desktop related to climate change information

- Global
- National
- Local

Checklist for FGD

- Name of the group members
- Major resources in the study area
- Pattern of management
- Changes in practices
- Main dependencies on resources
- Major threats t sources
- Major climatic hazards of the area
- Trend analysis of major climatic hazards
- Major impacts of climate change in the study area
- Major adaptation strategies adopted by the people

18.1.2 Checklist for questionnaire

A. Respondents

- Social well being (rich, medium, poor)
- Major occupation
- Major income source
- Education
- Farming land availability and livestock keeping
- Household size
- Daily activities related to water

B. Climate change

- Climate change awareness
- Temperature: increased, decreased, constant
- Precipitation: increased, decreased, constant
- Rainfall pattern: predictable, unpredictable, constant
- Drought: increasing, decreasing, constant
- Disaster: increasing, decreasing, constant
- Climatic shocks /extreme event in the past
- Impact of climate change
- Dependency on resources

C. Climate vulnerability

- Trend
- Resource availability: increasing, decreasing (sufficiency/deficiency)
- Resource demand and scarcity
- Driving forces leading to scarcity
- Households impact due to scarcity
- Climate related hazard
- Time consumed in resource collection (trend)
- Responsibility for resource collection (male/ female)
- Level of vulnerability(high , medium, low-man, women, children/rich , medium, poor)

D. Adaptation/coping strategy

- Resource saving strategy at households level

- Resource protection activities
- Farming activities
- Housing and infrastructure
- Modification of agronomic practices and in the choice of crop varieties that tolerate the water resource vulnerability
- Possible adaptation measure to cope the resource vulnerability

Others: photo clips, personal experiences/story

18.2 Questionnaire for household survey

18.2.1 Socio-economic status

A. General information

1. Respondent No ……………………. Date:
2. Respondent information
3. Name of the respondent:

Gender a) Male b) Female

4. Age: Caste/ethnicity…………………………………….
5. Name of VDC/ ward …………… District…………..
6. Total family size…………… Male …………… Female…………
7. Wealth class ranking a) Rich………… b) Medium ……… c) Poor……………….
8. House type a) thatch ……..b) mud ……… c) RCC…………
9. Educational status of the family members a) Illiterate ….….... b) Literate………..c) above SLC ……d) higher education…………..

B. Land tenure and land holding size:

What are types and area of land that your family holds?

C. Food production

Type	Cultivated area	Production last year	Production before 5 years	Trend (Increased, constant, decreased)

D. Food sufficiency and income

1. How many months in a year does your production of crops feed your family?

A) Less than 3………….. B) 3-6 months ……. C) 6-9 months …D) 9-11 months …E) Whole year…

2. What is the source of your family incomes?

Source of income	Percent

3. How do you utilize the cash income?

E. Livestock rearing

1. How many of the following livestock do you have and hoe you are managing them?

Type	Owned	Half share	Stall feed	Grazing

17.2.2 Vulnerability of forest dependent people livelihoods

1. What plant and wildlife are found in your nearby CF? a) Plant b) wildlife
2. Do you collect any product from forest? a) Yes b) No
3. What product do you use to collect from the forest?
4. For what purposes do you collect these products? a. Subsistence b. commercial

If use for commercial purpose, how much % income is related to total income?

5. What other activities do you conduct in forest for your livelihoods?

a) Livestock grazing b) tourism based income c) other
6. Are there any plant/product do you use for the cultural or religious and other traditional purpose?
a) Yes b) No if yes what plant do you use? ....
7. Could you say please how much time do you use to invest for the collection of a unit quantity of product?
8. Any plant or wildlife disappears from your forest in the past years, which are linked to your livelihood?
a) Yes b) No
If yes what is the cause of disappearance?
9. Do you have any water source in the forest area? Yes No
If yes do you feel the changes in number, types and quantity of water resources? Since 30 years. If change what may be the cause of the change?
10. Have they affected for livestock and your daily life?
11. Do you have experience of suffering from the natural disaster or climate change effects?

Climate related events	Experience of suffering		Loss of property (land/ livestock agriculture /human beings/bridge)
	Yes	No	
Long drought			
High intensity of rainfall			
Landslide/Erosion			
High temperature			
Forest fire			
Floods			
Strong storm			

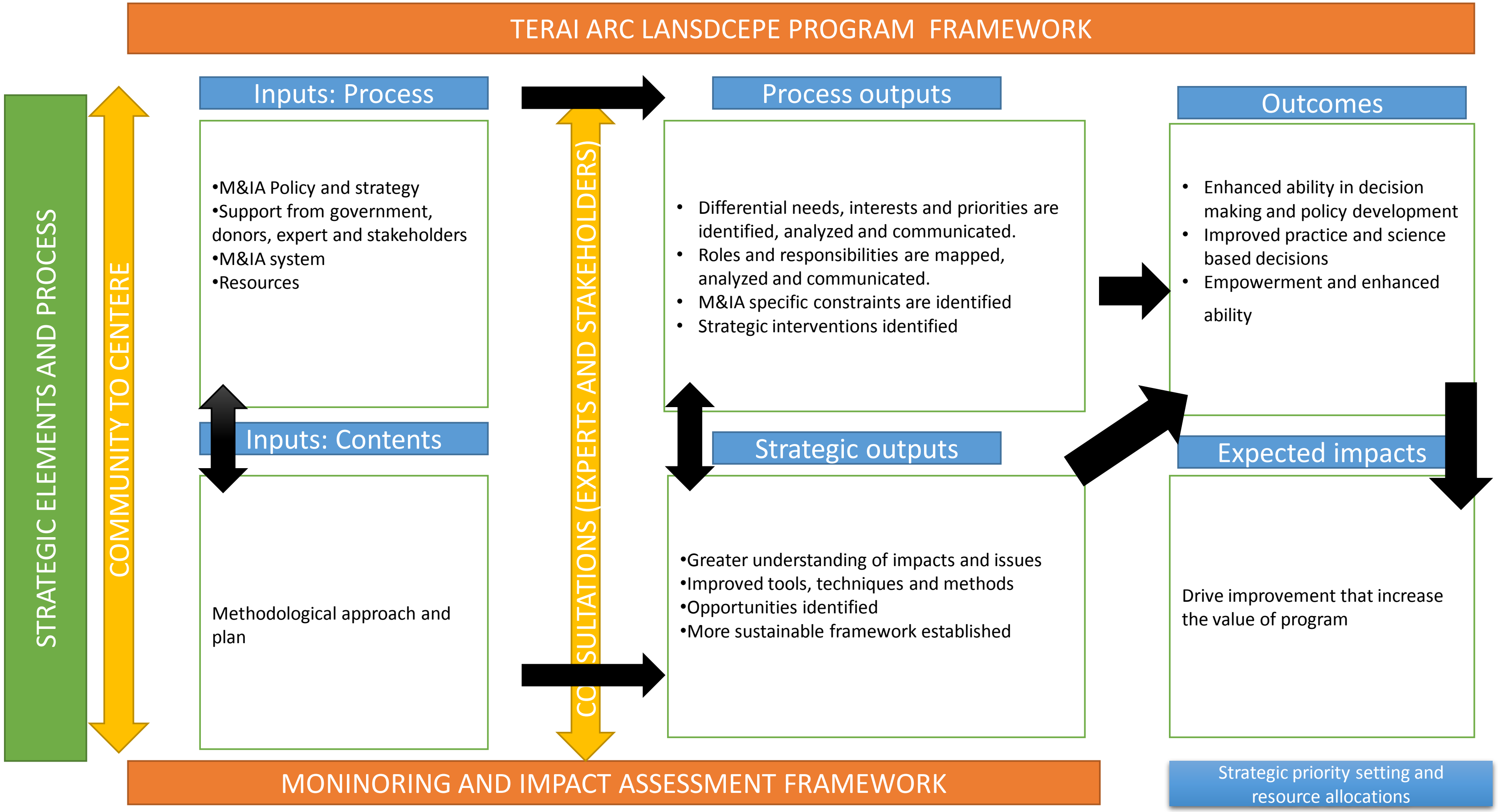
12. What are the natural hazards or climate change effects different now than they were 15 years ago?
13. What are the effects on your livelihoods? Since 15 years.
14. Are you able to cope these hazards?
15. Are you a member of any institution? Yes No
If yes what are the local and district national level institution?
16. Have you got any support from these institutions to reduce the impact of climate change/ natural disaster effects?
17. Are there safe places used to protect from hazards (to store food, shelter for livestock)?

18.2.3 Adoptive strategies adapted against the adverse impact of climate change
1. Are you carrying out the adaptation activities to fulfil the subsistence and commercial needs of forest products? Yes or No.
If yes, what adaptation strategies are currently used to deal with hazards identified? Are they working?

Climate hazards	Adaptation Strategies
Change in temperature	
Change in rainfall	
Landslide	
Flood	
Fodder deficient	
Livestock problems	
Water shortage	

2. Has CFUGs provided the land for IGAs? Yes ………… No………………..
3. What are the existing information systems in the village?
4. Are all these existing adaptation practices are sufficient for reducing the climate change effects?
a) Yes b) No
5. What should be done for minimizing climate change effects?

ANNEX 19: M&IA management framework



ANNEX 20: Monitoring indicators and means of verifications

List of performance monitoring indicators

Relevant indicators	Sources of information
Improved quality and approaches in biodiversity conservation (CBM, PAS and protected forests)	Report and observation
Positive attitude of stakeholders and adoption of TAL program	Field survey/follow-up
Increased conservation knowledge, participation of communities and stakeholders	Record and field survey
Increased outputs on species, diversity, livelihood and climate change adaptation	Field survey/follow-up
Increased practice on conservation based use	Field survey/follow-up and office record
Increased institutional capacities	Office record and Management information system
Increased use of adaptive management and research	Office record
Increased concern and implementation on climate change adaptation practice.	Staff record
Degree to what extent the BMPs are adopted?	Field survey/follow-up
Increased quality of conservation plan and resources to implement	Field survey/follow-up

(Source: modified from Stem et al., 2003; CBD, 2006 and UNEP, 2010)

List of LLC implementation indicators

Relevant indicators	Sources of information
Increase in actively managed CB management and area under effective conservation	Progress report
Maintain populations of species	Monitoring survey/follow-up
Populations are not vulnerable to extinction	Monitoring survey/follow-up
Maintained species richness and diversity	Monitoring survey/follow-up
Maintained landscape patterns	Survey/Inventory
Maintained resource availability	Reports of UGs and field staff
Improved livelihood of communities	Office record
Strengthened Local management institutions	Users report
Increased participation by local people in governance	Users report
Increased understating on climate change issues	Field study
Improved community forest based adaptation	Field study
Decreased forestry threats	Survey and field study

(Source: modified from Thomas & Sqaud, 2004; CBD, 2006a and UNEP, 2010)

List of activity monitoring indicators

Indicators	Information sources
Number of: activity delivered or people benefitted	Reporting
Quality of activities	Monitoring sample survey and observation before and after
Implementation of work plan	Report of implementation agencies
Usefulness of the conservation activities	Interview of stakeholders Feedback by implementing agencies
Degree of stakeholders' participation	Reporting and feedback.
Degree of fulfilment of objectives	Questionnaires to stakeholders
Degree to what extent the process and contents are followed?	Activity observation

(Source: modified from Horton et al., 1993; CBD, 2006a; UNEP, 2010; WWF International, 2007; Sayer et al., 2007; Hockings et al., 2006).

Levels of stakeholder monitoring

Levels	Questions
Awareness & capacity	Do the stakeholders have awareness about TAL? Do they have capacity?
Group dynamics	What is the process of performance on coordination and decision making?
Changes	Do the stakeholders change their behaviour for community based conservation?
Results	Does the change in behaviour positively affect the conservation?

Methods: a) stakeholders observer- continuous or intermittent b) questionnaire at different stages of the implementation c) testing of stakeholders before, during and after; d) interviews; e) projects and role plays; and e) records of stakeholders progress/development through the implementation (Rae, 1986; GEF, 1998; Critical Ecosystem Partnership Fund, CEPF, 2006).

Activity monitoring

- Relevant indicators: the improved quality and approaches used
- Activity proposals are supposed to include: a) the goal; b) the target group; c) the content; d) the method; e) organization of all activities; f) and the required resources (Elington, 1984; CEFP, 2006).

ANNEX 21: Impact level interventions of TAL

1.Biodiversity conservation
Conservation of species and ecosystem
• Conserve rare or threatened and native species including species in decline, migratory species, and narrowly distributed species • Desire impacts from ecosystem services by establishing linkage among conservation, livelihoods, and resiliency against climate change • Prioritize maximizing the contribution of TAL supported interventions to landscape, ecosystem, and species conservation over the achievement of maximum species richness or abundance.
Sustainable forest management
• Maintain or restore the natural composition of ecosystems • Maintain or restore the natural structure (e.g., vegetation structure, landscape connectivity, waterway connectivity) of ecosystems • Maintain, restore, or enhance the ecological function of natural, semi-natural, and managed lands • Manage community based forest management and reduce and mitigate key threats to ecosystems.
2.Sustainable Livelihoods
• Maintain or enhance livelihood assets and capabilities over time; and • Maintain the long-term productivity of the natural resource base.
3.Climate changes
• Build the capacities for reducing emissions from deforestation and forest degradation (REDD+) readiness. • Increase the ability of target human and ecological communities to adapt to the adverse impacts of climate change

(Source: modified from WWF, 2004; SANRA; 2014; NPC, 2012)

Annex 22: Broad outline of TAL LF with indicators and means of verification

Goal: Conserved biodiversity, improved livelihoods and increased resiliency of poor and disadvantaged people to maintain integrity and multifunctionality of the landscape.

Outcomes	Targets	Indicators	Means of Verifications	
			Macro level	Micro level
Policy and governance				
Improved policies and strategies on LLC	Package 1 (5 sectors)	Formulation, approval and enforcement	Stakeholder analysis, MP, progress report, policy announcement	Policy impact analysis
Improved governance and established multi-stakeholder mechanism	14 districts and centre	Establish coordinating bodies and make functional	National Progress report	Key interview survey, office records and LLC progress report
Sustainable forest management				
Increased the area of managed forests	100,000 ha	Restoration, protection and effective management	GIS/RS, vegetation mapping, NFMA and national level assessment	Field survey, key interview survey, TRA, Disturbance analysis, LOAM, sample hh survey, observation, field records, biodiversity indices, forest inventory, participatory biodiversity inventory and assessments
Increased the area under protection and restoration	450,000 ha			
Reduced the deforestation rate in corridors and bottlenecks	50 percent			
Species and ecosystem conservation				
Conserved species and genetic resources under PA arrangement including protected forests	7 protected areas plus 4 protected forests	Effective conservation	,,	,,
Double the population of mega-fauna	200% by 2022	Improvement in habitat and increase in species population	Census	Wild life focused and non participatory methods
Livelihood improvement				
Improved livelihood of poor and disadvantaged groups	66,642 hhs	Support to livelihood.	Livelihood index aligned with the Human Development index	Livelihood index, and methods and tool on participatory livelihood assessments
Increased social and economic benefits from conservation based household income	From 3% to 6%	Improved forest based income	National level impact study	,,
Climate change adaptation and mitigations				
Increased net carbon storage (REDD+ pilot)	1site	Increased carbon in forests	GIS/RS, Forest Resource Assessment	Forest inventory and MRV
Reduced the climate vulnerability and increased resiliency	66,642 hhs.	Effective adaptation and resiliency	See Table 4.1.3	See Table 6.1

(* MRV = Measurement, reporting and verification) (Source: modification from WWF, 2004; literature review, 2009 to 2013)

ANNEX 23: Activity photos


Team building and orientation for field study

Afforestation, Deuki CF, Lamahi, <2008

Deuki CF, Lamahi, 2013


Forest conservation, Khata, in 2008 and 2013

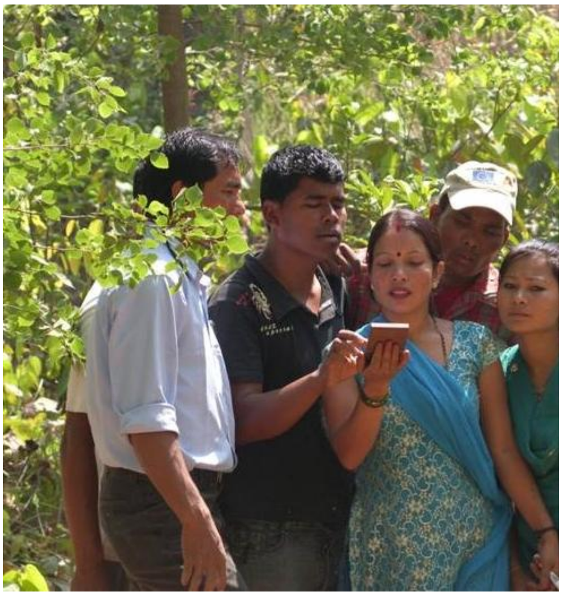
Waterhole restoration in Khata, in 2008 and 2013

Water conservation, Ghondaghondi Lake complex, in 2008 and 2013

Observation of CF area in Basanta

Forest inventory process



Recording during forest inventory

Measuring during forest inventory
(

Forest based enterprise, Bel juice, Khata

Alternate crop (Chamomile) for livelihood and adaptation,

Micro-hydro in Dovan

Fishing based livelihood of indigenous community


Watch tower for wildlife control


Pond: Water management for adaptation


Extension, Bardia


Training, Bardia


Date collection/FGD, Kailali


Group discussion, Kailali