Forest Habitat Restoration in Lowland Nepal

Tiger as the Restoration Success Indicator Species

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By

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Declaration

I hereby declare that the work presented in this dissertation is my own, where it is indebted to the work of others, acknowledgement has duly been made. The material contained in the dissertation has not been previously submitted for a degree at Dortmund University of Technology or any other university.

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Date, Ramji Bogati

Abstract

The forest ecosystems in Nepal is degraded and habitat is fragmented due to anthropogenic (e.g. logging, grazing) and natural disturbances (i.e. climate change, invasive species). In addition, conflicts in natural resource use and between wild animals and human are still prevalent in local communities that depend on forest resources. These environmental and social variables force some species to the verge of extinction. Nevertheless, no research has been conducted from an interdisciplinary perspective. The integration of social science, ecological restoration and biological conservation has not been made and the complex nexus between them has not been explored in the lowlands of Nepal. Therefore, the present research responds to this gap and investigates the question 'what is the process of forest management planning and restoration practices, and its implication for indicator species conservation?' The research has used qualitative and quantitative methods to cover both social and ecological elements. Data was collected using various tools such as interviews, observations, surveys and ancillary sources and the findings have been triangulated for corroboration.

Interviews with forest users (n = 84) and Forest User Group Committee members (n = 20) were conducted to understand the attitudes and perceptions toward ecological restoration and wildlife. It was evident that the attitude of respondents was positive toward forest restoration in the studied buffer villages (i.e. Ranjha and Balapur). Nevertheless, some respondents had negative perception towards wildlife due to property loss and livestock depredation from wild animals, lack of awareness, and the occupation of ranching. A participatory planning approach has been practiced in plan formulation (operational and annual working plans of forest management) and restoration practices, such as thinning, controlled grazing, plantation, etc. have been introduced which have positively contributed in the conservation of wildlife species. However, severe anthropogenic disturbances such as felling/ chopping, poaching, and livestock grazing, as well as low prey species abundance (2.91 prey pellet/100 m^2) have imposed seasonal dispersal, reduced mobility, and have created a critical situation for tigers in Banke National Park. Additionally, climate change, human and livestock mobility inside the park, encroachment and road traffic are major impediments in restoration. Integration of restoration ecology and sustainability science is vital for people's participation in planning, attitudinal change towards ecological restoration, forest habitat quality management, and indicator species (e.g. tiger) conservation in the potential habitat of the Terai landscape.

Key words: attitude, conservation planning; ecosystem disturbances; active restoration; tiger conservation

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Abbreviations and Acronyms

AAA	Akademisches Auslandsamt
ANOVA	Analysis of Variances
ANSAB	Asia Network for Sustainable Agriculture and Bioresources
ADB	Asian Development Bank
BACI	Before-After Control Impact
BFUG/C	Buffer Forest User Group/ Committee
BZMC/R	Buffer Zone Management Committee/ Regulation
BNP	Bardia National Park
BaNP	Banke National Park
BPP	Biodiversity Profile Project
CAMC	Conservation Area Management Committee
CBD	Convention on Biological Diversity
CBS	Central Bureau of Statistics
CFCC	Community Forest Coordination Committee
CFUG/C	Community Forest User Group/ Committee
c.f./ qtd.	Cited from (confer)/ quoted
CITES	Convention on International Trade of Endangered Species of Wild Fauna and Flora
CMRN	Country Monitoring Report on Nepal
DAAD	Deutscher Akademischer Austausch Dienst
DBH	Diameter at Breast Height
DDC/VDC	District Development Committee/ Village Development Committee
DFID	Department for International Development
DFO	District Forest Office
D/NPWC	Department of/ National Parks and Wildlife Conservation
EADANL	Environmental Assessment Division Argonne National Laboratory
EC/EU	European Commission/ European Union
FAO	Food and Agriculture Organization
FRA	Forest Resources Assessment
FECOFUN	Federation of Community Forestry Users Nepal
Ha	Hectare
HMGN/GoN	His Majesty's Government of Nepal, hereafter Government of Nepal
GPS/GIS	Global Positioning System/ Geographic Information System

GTI	Global Tiger Initiative
ICIMOD	International Centre for Integrated Mountain Development
I/NGO	International/ Non-Governmental Organization
IUCN	International Union for Conservation of Nature
IVI/FQI	Important Value Index / Forest Quality Index
LSGC	Local Self-Governance Act
MEA	Millennium Ecosystem Assessment
MFSC	Ministry of Forests and Soil Conservation
MoPE/MoE	Ministry of Population and Environment/ Ministry of Environment
NBH	National Biology Handbook
NPC	National Planning Commission
NTNC	National Trust for Nature Conservation
NTFPs	Non-Timber Forest Products
PPT/RH	Precipitation/ Relative Humidity
RRA	Rapid Rural Appraisal
SER/I	Society of Ecological Restoration/International
SNV	Netherlands Development Organization
SPSS	Statistical Package for the Social Sciences
TAL	Terai Arc Landscape
TCU	Tiger Conservation Unit
Tmax/Tmin	Temperature Maximum/ Temperature Minimum
TU	Technische Universität
UNDP	United Nations Development Program
UNEPWCMC	United Nations Environment Program: World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WDPA	World Database on Protected Areas
WTLCP	Western Terai Landscape Complex Project
WWF	World Wide Fund for Nature

Glossary

Adaptability The ability of people to adjust in a new socio-ecological system which manages resilience through collective action (Walker et al. 2004).

ANOVA A statistical analysis technique to estimate the probability of distribution, explanatory power of one or more independent variable(s) on a dependent variable.

Attitude The state of judgment on a situation, event or any entity.

Buffer zone An area of different forests (e.g. community, religious, private) including human settlements within the periphery of protected areas.

Chi-square Non-parametric test that is used to measure statistical significance for a contingency table.

Coding A value or symbol to use statistical calculation or categorization.

Community forest A national forest handed over to community users group for its development, conservation and utilization for collective interest (HMGN 1995).

Conservation area An area to be managed according to an integrated plan for the conservation of natural environment and balanced utilization of natural resources (DNWC Act 1973).

Cross-sectional study A study conducted on a single subject or issue in the form of various variables (e.g. social: age, sex, education, occupation, ecological: flora, fauna).

Forest habitat Uncultivated land area, with at least 10 percent tree coverage, and the existence of trees higher than 5 meters that provides shelter for wild animals.

Forest user Individual having membership to the Forest User Group; has the right to utilize forest resources and are the direct beneficiaries of community development activities.

Gothala A person who watches livestock during grazing.

Goths A temporary shelter for human and livestock inside or outside forests.

Hypothesis An informed speculation to test the possible relationship between two or more variables (Bryman 2008).

Halo effect Personal biasness on work, value or priority given to a known person or relative.

Jhadi saphahi Cutting off unwanted parts or removing invasive species entirely.

Machan A watchtower from which one can observe wildlife mobility.

National or government managed forest All forest areas, excluding private forests, within the boundary of Nepal, either marked or unmarked as the forest boundary, including wasted or uncultivated land or unregistered land surrounded by forest or situated near the adjoining forest as well as paths, ponds, lakes, rivers or streams and riverine land within the forest (HMGN 1993).

National park An area set aside for the conservation, management and utilization of flora, fauna and scenery along with the natural environment (DNWC Act 1973).

Perception The process of accomplishing and understanding any components or situation by interpreting the sensory information.

Psychology Study of mind and behavior. For the purpose of this research, it is the link between biological and social sciences that establishes attitude and perception of people to any entity.

SPSS A computer based program for statistical analysis.

Standardized questionnaires The wording, order of the questions and the way of questioning are fixed and used similarly in different areas.

Terai Plain area (<500 m altitude) that lies in the southern part of Nepal.

Tole A small group of households that make a community.

Users committee in protected areas The Warden, in co-ordination with local authorities, may form a users committee for the management of fallen trees, dry wood, firewood and grass in a national park, reserve, conservation area or buffer zone (DNWC Act 1973).

Variable An attribute that is used in research for logical evaluation.

Warden Officer of protected areas, who is responsible for managing and protecting forest and wildlife.

Wildlife reserve An area set aside for the conservation and management of wildlife resources and their habitats (DNWC Act 1973).

Chapter I

Introduction

1.1 Problems in Restoration and Tiger Conservation

Habitat is a frequently used term in conservation and restoration literature. Nevertheless, in practice habitat restoration has become a more challenging task for restorationists and conservation practitioners in human-dominated landscape. On the one hand, people's high dependency on forest resources for commercial and socio-cultural purposes is disturbing ecological sustainability (Aronson et al. 1993a), while on the other hand, natural disturbance such as climate change is affecting species (Harris et al. 2006, Brown 2008). The excessive use of natural resources to fulfill agricultural and industrial demands has degraded and modified ecosystems since the 1950s (MEA 2005), particularly in developing countries as encroachment (e.g. deforestation) for agricultural land and new settlements has accelerated the forest conversion (FRA 2001). The remnant forested areas have been isolated due to severe destruction, deforestation, mining, fuel and energy extraction and large scale industrial work (Miller 1999). As a result, the forested landscapes are fragmented, habitats are degraded and faunal and floral species are reduced (Wu 2008). Hence, anthropogenic disturbances (e.g. over use of resources, illegal activities, forest fire, over grazing, pollution) and natural disturbances (e.g. flash flood, climate change, invasion species) are the major impediments for restoration (Hobbs and Huenneke 1992). Moreover, the rate of anthropogenic disturbance is higher outside the protected areas than inside and in isolated patches (Gove et al. 2005). This calls for ecological networks focusing on restoration and conservation beyond the protected areas (Bennett and Mulongoy 2006).

Conservation of wildlife has become complicated. The tiger (*Panthera tigris*, Linnaeus 1758) has been particularly isolated in and around the protected areas and its number has dramatically reduced worldwide (Damania et al. 2008). Compared to the previous century, approximately four percent of the tiger population and seven percent of their original habitat remains in a few protected areas and adjoining forests of thirteen tiger range countries[1] (Dinerstein et al. 2006). Habitat encroachment and loss, retaliatory killing (Dinerstein et al. 2006, Damania et al. 2008),

1 Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal,

declining availability of prey species (Ramakrishnan et al. 1999) and poaching (Shepherd and Nijman 2008) are the major causes of decline of tiger populations. For instance, a few sub-species of tiger that are found only in some protected areas and their prey species are depleting drastically in Asian regions (Sunquist and Sunquist 2002). All existing tiger habitats are of poor quality for breeding (Smith et al. 1998). Isolated protected areas are not able to support an increased tiger population if the boundaries are not extended beyond the reserves (Wikramanayake et al. 2011).

In Nepal, tiger habitat widely extended from the foothills of the mountains to the lowlands during the 1930s (Smythies 1942). When malaria was eradicated in the 1960s, the forested land of the Terai (lowland) region was highly degraded and encroached for cultivation and settlement (Gurung 1983). As a result, tiger habitat is presently limited to only some protected lowland areas (i.e. Chitwan, Bardia and Banke National Parks, Parsa and Suklaphanta Wildlife Reserves) (DNPWC/MFSC/GoN 2007, DNPWC 2010). These existing protected areas have degraded ecosystems and very limited ecological connectivity (WWF 2001). Such areas will affect the persistence of endangered wildlife species and interrupt ecological integrity (Miller 1999). The impact of forest restoration on wild cat conservation and the state of people's participation is also limited. Human-tiger conflicts (Gurung 2008), unemployed and illiterate people, and conflict in resource use are the major social issues in restoration and conservation (WWF 2008). Therefore, landscape level restoration and conservation was considered essential for establishing networks of protected areas to ensure the long term survival of endangered species (e.g. tiger) (HMGN/MFSC 2004, Sanderson et al. 2006). This led to the introduction of the Terai Arc Landscape program in 2001. Hence, an analytical research on attitude and perception of people toward forest habitat restoration and wild cats, human intervention in restoration, and its impact on tiger conservation are essential in such a landscape.

1.2 Research Rationale

The off-reserve forest is important for the long-term survival of endangered species and the sustainability of protected areas (Primack 2008). It also provides ecological goods and services to the community although people do not know about its ecological value (Arcese and Sinclair 1997). As a result, several problems arise at the community level including human-wildlife conflict and social disputes (White et al. 2005) and conflicts in natural resource use (Sanginga et al. 2007) which might lead to negative attitudes amongst the communitty. Additionally, the

unwise use of natural resources, and introduction of invasive species accelerates the degradation of habitat beyond the protected areas in Nepal (WWF 2001). In particular, in the context of Nepal, the southern part of the lowland that lies in and around the protected areas provides homes for different ethnic races and thus varied norms and values, social structures, knowledge and understanding about their life and nature (WWF 2008). Most of these communities have a low educational background and inadequate access to basic facilities. They are economically deprived and are disadvantaged, while elite and bureaucratic classes control forest resources (Timsina 2010). Participation of these disadvantaged groups in forest habitat restoration with emphasis on wild cat conservation is definitely not an easy task, especially when their basic needs are not fulfilled. Hence, it is essential to protect forest habitat outside the protected areas by means of attitudinal change in ethnic communities.

Sustainable conservation is less likley without integrating biodiversity conservation and economic development (BDP 2001). It is necessary to incorporate the principles of ecology in national policy and planning, strategies for sustainable development and biodiversity strategies to maintain the functions of ecosystems and promote sustainable use of natural resources (Bennett and Mulongoy 2006). In Nepal, forest resources management and development have been integrated in conservation since 1990s. In particular, the Forestry Sector Master Plan (1989), Forest Act (1993) and the Forest Rules (1995), Buffer Zone Management Regulation (1996), Terai Arc Landscape (TAL) Strategic Plan (2004-2014), and action plans for some wildlife species (e.g. tiger, rhinoceros, snow leopard, elephant) have been formed and implemented.. These policies have emphasized the components of landscape conservation with special emphasis on forest restoration and management, biodiversity conservation and local livelihood upliftment (HMGN/MFSC 2004). Recently, the Government of Nepal has proposed a strategy to increase the tiger population from 121 to at least 250 adults by 2022 and to maintain, restore and conserve at least 6,500 km^2 outside protected areas as high quality tiger habitat (DNPWC 2010). Out of twenty-three ecosystems described by Dobremez (1970) in the lowlands (Terai and foothills), fifteen are included in the current protected areas, whereas the remaining ecosystems and biological resources are located in off-reserve areas, which are under great pressure from exploitation and encroachment (c.f. HMGN/MFSC 2002). Hence, species conservation outside the protected areas is still a great challenge (Bogati and Basnet 2001).

During the first decade of the 21^{st} century, big wild cats particularly tigers have become a flagship species, as is reflected in the recently promoted ‘Global Tiger Initiative (GTI)’

program by the World Bank Groups and the Smithsonian Institution in thirteen tiger range countries. The tiger is listed as an endangered species under the International Union for Conservation of Nature's (IUCN) 2000 Red list of threatened species and in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (WWF 2002a). It is considered as the indicator of a healthy forest ecosystem. Therefore, 'tiger conservation units' have been established to conserve biodiversity under the umbrella of conservation (Sanderson et al. 2006). Tiger habitat restoration does not only contribute to the protection of its population, it also assists in conserving other important species and sustains ecological integrity (Damania et al. 2008). Restoration should emphasize to provide habitat for such target species, where there are few studies in restoration (Hobbs and Norton 1996).

Ecological research, mainly terrestrial ecosystem management and wildlife conservation, has been emphasized since the 1970s and was further emphasized in landscape level conservation since the 1990s. Most of the researchers (e.g. McDougal 1977, Tamang 1982, Smith 1984) have focused on the ecology of wild cats and few researchers (e.g. Shrestha 2004) have focused on prey species, fundamental to initiate restoration, as well as conservation. Few studies (e.g. Smith et al. 1998, Wikramanayake et al. 2004) have explored the relationship between species and habitat. Similarly, other researchers (e.g. Jnawali 1995, Zhou et al. 2008) have carried out research in the field of restoration ecology but very little research (e.g. Gurung 2008) has been conducted by integrating ecological and sociological aspects in different regions. Additionally, no research has been conducted from the interdisciplinary perspective, which integrates social science, ecological restoration and biological conservation. Furthermore, no research has been conducted to explore the relationship between these disciplines in Nepal.

In today's context conservation managers should have the knowledge and skills of both social and natural sciences, unlike in the past when biologists, foresters or administers were the dominant professionals in this field (Ishwaran 1991). Without integrating these sociological and ecological disciplines, restoration of the ecological component is almost implausible (Choi et al. 2008). Integrative perspective and approach is crucial in natural resources conservation (Wu 2008).

Restoration of forest habitat, ideally, will not only benefit conservation of wildlife, rather it will have a multiplier effect in the socio-economical development of a human dominated landscape in total. Thus, reasearch into the role of the integrative perspective and approach

mentioned above is particularly relevant in the Nepal context as the country struggles with conservation, despite a forty year history in this field. Hence, I undertook this research on **'Forest Habitat Restoration in Lowland Nepal: Tiger as the Restoration Success Indicator Species'.**

As there is a high potentiality in landscape level wildlife conservation in various geographical regions of Nepal, this study will have wider application and impact. Most importantly, it is a key component and requirement with regards to spatial planning in a recently federalized country like Nepal where sustainable development, appropriate land use, environmental issues, etc. have not been fully realized. I hope this research will play a vital role in influencing further policies and plans in the conservation sector. Furthermore, the findings of this research can be widely replicated in other parts of the world (having similar settings) by planners, sociologists, conservationists, ecologists and restoration practitioners.

1.3 Objectives and Hypotheses

The overall objective of the research was to analyze social and ecological data, and evaluate restoration practices, which will contribute to the better management of forest resources, restoration of terrestrial ecosystems, and conservation of biodiversity in a landscape. The specific objectives were to:

- understand the status of attitude and perception of people toward forest restoration and wildlife;
- assess the community level planning process for forest management and address restoration and conservation issues;
- interpret the practices of forest habitat restoration and wildlife conservation, and
- appraise the implication of forest restoration for big wild cat conservation and tigers as the restoration success indicator species.

Hypotheses

The Terai Arc Landscape program, since 2011, has been implemented to conserve and rehabilitate forest, protect biodiversity and integrate a social-ecological system through people's participation and institutionalization. The peoples' participation is crucial to maintain the quality of habitat, which is fundamental to target species conservation. In this regard, I believe that 'there is a simultaneous positive change in the attitude of people toward forest

restoration and wildlife, and habitat restoration and tiger conservation have been enhanced in the Terai landscape'. I also concur with the Field of Dreams Hypothesis "if you build it, they will come" Palmer et al. (1997:295) in habitat restoration. In order to examine the main proposition, the following specific hypotheses were developed:

- Human disturbances on national forest/ national park have been reduced after the community forest restoration.
- There is a significant relationship between the quality of forest habitat and the abundance of tiger prey species in and around the restored forest patches.
- The optimistic hypothesis 'undisturbed, bigger and connected habitat is the best for sustainable tiger conservation' shows dispersal behavior of tiger. Thus, it is taken as restoration success indicator in and around the protected areas.

1.4 Scope and Limitations

The broad scope of theoretical aspects of restoration ecology is practiced through ecological restoration. In this regard, the present research has focused on a biological conservation (species conservation) oriented approach rather than scientific ecological restoration (i.e. functional or structural attributes of an ecosystem). The research on the ecosystem attributes in the restored habitat has focused on the composition of ecosystem i.e. the presence of indicator species and the relative abundance of prey species and resilience i.e. recovery from anthropogenic disturbances. The research has been triangulated through different methodologies such as inquiry, data sources and analysis in the context of human intervention, and participation in forest habitat restoration, and its impact on indicator species conservation.

People's attitude and perceptions, human intervention in restoration, and the planning process and practices for conservation were studied in general as the social aspect. A rapid assessment survey on flora and fauna status in restored forest habitat was used for the ecological aspects. The research has focused on the implementation of participatory forest restoration on tiger conservation in the buffer zone of eastern Bardia and the southern part of Banke National Park and has used a quasi-experimental research design. In order to be more focused, attain the desired results and given the time and logistic constraints, only the aforesaid contents are included in the research. The study area was limited to the mid-western Terai complex, mainly the Mahadevpuri bottleneck of Banke National Park (part of Terai Arc Landscape), due to budget and time constraints.

1.5 Organization of Dissertation

The dissertation paper is divided into eight chapters. **The first chapter** presents the problems of restoration and conservation, research rationale, objectives, scope and limitation and structure of dissertation. Based on a desk study, the knowledge of the field study is explained and enhanced. It is a general and brief but enlightened part of the dissertation.

The second chapter deals with the terms, definitions and concepts of natural and social sciences, important theories and research results in restoration ecology. At the beginning, the terminology of different ecological and sociological fields are summarized and defined. Following this, appropriate concepts and theories are mentioned and the practices of restoration ecology are explained. In particularly restoration design, participatory planning and practices, conservation approaches, monitoring and evaluation focusing on indicator/ criteria of restoration success, indicator species and forest management, wildlife conservation and restoration in Nepal are discussed. Finally, a conceptual framework has been illustrated and presented with an explanation and research questions.

The third chapter deals with the research process, data collection, data interpretation and analysis technique. It explains the detailed research inception, gaps, design, approach, tools selection, data collection tools, and data interpretation techniques. It is a common part of methods and analysis of different chapters.

The fourth chapter presents the changes of attitude and perception of community people after the restoration practices in the study area. It explains the respondents, motivation toward forest habitat restoration, wildlife disturbances, and the attitude of community people toward restoration and wildlife, and the impact on sustainability of resources.

The fifth chapter deals with the process of forest management plans, participation of forest users in decision making for planning and integration of restoration activities, and wildlife conservation in the plan.

The sixth chapter acknowledges the involvement of people in restoration. It provides the information based on the field survey and explains the practices of restoration activities. It

highlights the barriers for restoration and wildlife conservation in and around the protected areas.

The seventh chapter deals with the evaluation of forest restoration and its impact on wildlife and habitats. It provides techniques to find the indicator of habitat restoration success and the tiger as the indicator species for successful restoration. It also deals with the implication of forest habitat restoration for sustainable tiger conservation in the context of the Terai landscape of Nepal.

A general discussion on triangulation, conclusions, conceptual and pragmatic implications, recommendations and annotation of some ingredients for new concepts are highlighted in the **eighth chapter**. This chapter deals with the general discussion on methodology and triangulation of findings. It provides conclusions and summarises the study. Furthermore, it deals with the implication of each chapter, and provides recommendations to policy makers/ planners, practitioners and researchers for the improvement of forest restoration and wildlife conservation. Finally, it fortifies the use of an integrated approach to restoration ecology and sustainability sciences for forest restoration and wildlife conservation at landscape level.

Chapter II

State of Art

2.1 Ecological Restoration: Integration of Social and Natural Sciences

Ecological restoration is a practical science in which people can be involved in restoration endeavors. Turner (2005:165) states that the science of restoration "helps to improve restoration by bringing clarity in the form of order, understanding and descriptions of uncertainty". Similarly, Adams and Hutton (2007:148) discuss the social and natural sciences, describing how "social science integrates politics centrally within its analysis of conservation, while natural science typically places it outside, as the constraint on practical action". The social and natural sciences are viewed as complementary subjects in restoration and conservation. Scientific activities are indispensable in restoration due to the need to integrate economically, socially and politically acceptable goals (Choi et al. 2008). In a larger landscape, scientists and other different professionals are involved, their ideas are acknowledged, and applied as a participatory way for habitat restoration (Turner 2005). Furthermore, restoration can be achieved through scientific, technical and social knowledge from integrative practices (Higgs 2005). Hence, restoration is a holistic scientific process of both social and natural sciences in which environmentally oriented scientists, other professionals and practitioners work in as interdisciplinary manner (Naveh 2005).

2.1.1 Ecological Terms and Definitions

The term 'ecology' is derived from the Greek word. The 'oikos' means 'habitation' or home and 'logos' means 'discourse or study'. The combination of this result ecology is "a study of the habitation of organisms" or study of the balance of natural home. It was first described by Ernst Haeckel, a German Zoologist, in 1866. He coined the world 'oekologie' for "the relation of the environment, particularly its friendly or hostile relations to those animals or plants with which it comes in contact" (qtd. in Kendeigh 1974:2). Ecology has been defined by various researchers in diverse ways. For instance, Handler (1970:431) defines that "ecology is that branch of biology that deals with mutual relations between plant and animal organisms and their environment". Likewise, Odum (1971:3) defines ecology as "the study of the relation of organisms or groups of organisms to their environment, or the science of the interrelations

between living organisms and their environment". Similarly, Kendeigh (1974:2) identifies that "ecology is a study of animals and plants in their relation to each other and to their environment". In the same way, Krebs (1985:4) mentions that "ecology is the scientific study of interactions that determines the distribution and abundance of organisms".

The term 'landscape ecology' was first coined by the German biogeographer, Carl Troll integrating ecological and geographic discipline (Troll 1939, c.f. Wu 2007). Troll (1971) defines it as "the study of the main complex causal relationships between the life communities and their environment which are expressed regionally in a definite distribution pattern (landscape mosaic, landscape pattern)" (qtd. in Wu 2007:1433). Likewise, Forman and Godron (1986:11) define landscape as the "heterogeneous land area composed of a cluster of interaction that is repeated in similar form throughout". They state that landscape ecology "studies both the principles concerning structure, function and change, and their application, that is, the use of these principles in the formulation and solving of problems". Furthermore, Turner (1989:172) states that landscape ecology deals with "broad spatial scales and ecological effects of the spatial patterning of ecosystems", particularly "it consists of development and dynamics of spatial heterogeneity, interactions and exchanges across heterogeneous landscapes and the influences of spatial heterogeneity on biotic and abiotic processes".

The term 'restoration ecology' was first defined by John Aber and William Jordan in the late 1980s (Jordan et al. 1987). The term 'restoration ecology' and 'ecological restoration' are used interchangeably and are made complex in developing the ontogeny of terminology by ecologists (Hobbs and Norton 1996). In this regard, Higgs (2005:159) clarifies the meaning of these two terms and explains that "restoration ecology is the suite of scientific practices that constitute an emergent sub discipline of ecology and comprises the typical of a contemporary natural science: hypotheses, conjectures, testing, experiments, field observations, publications and debate whereas ecological restoration is the ensemble of practices that constitute the entire field of restoration, including restoration ecology as well as the participating human and natural sciences, politics, techniques, economic factors and cultural dimensions". The definition of restoration has advanced many times. A more developed definition is given by the Society for Ecological Restoration International Science and Policy Working Group in 1994 (Jackson et al. 1995). It states that "ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER and Policy Working Group 2004:3).

The term ‘conservation biology’ was used at the end of 1970s. After this, attempts were made to fill the gap between ecology and conservation practice in “all mission or crisis-oriented disciplines” (Soule 1985:727). Conservation biologists use “all applicable methods to maintain the integrity of natural ecosystems and stem the loss of biodiversity” (Hedrick et al. 1996:1313). In this regard, G.T. Miller states that “the conservation uses scientific data and concepts to find practical ways to protect critical ecosystems and biodiversity-rich areas and prevent the premature extinctions of species” (Miller 1999:437). It focuses more on “zoological, descriptive/theoretical, population, community and genetic studies” (Young 2000). The conservation ecology mainly focuses on ecosystem conservation (Mackey et al. 1998).

The term ‘habitat’ was used in the 1970s as “a place of an organism, where it lives, or the place where one would go to find it” (Odum 1971:234). Morrison et al. (1991:106) defines wildlife habitat as “an area with the complex association of interrelated factors used by an individual (and collectively, the population) and composed of all factors (temperature, precipitation, presence or absence of predators and competitors) that supply the life requisites (e.g. food, water) and control of animal”. Hall et al. (1997) evaluated the term ‘habitat’ in the literature of the 1990s. They define that “habitat is the resources and conditions present in an area that provides occupancy including survival and reproduction by a given organism” (Hall et al. 1997:175). Habitat is applied in various forms such as habitat selection, preference, availability and quality (Krausman 1999). ‘Habitat quality’ is defined as “the ability of the environment to provide conditions appropriate for individual and population persistence” (Hall et al. 1997:178) and serve as a main goal of forest restoration.

The ecological term has been acknowledged since the 1860s and has continued to advance into ‘landscape ecology’ since the 1930s, ‘conservation biology’ since the 1970s, then ‘restoration ecology’ since the 1980s and the latest form as ‘habitat restoration’ since the 1990s. Hence, I use the term ‘forest habitat’ as the uncultivated area having more than 10 percent trees that provide, a resting place during wild animal mobility, a hunting place for predators, a foraging area for herbivores, or suitable place for colonization for wildlife species. The term ‘restoration’ is used as the recovery of degraded forest habitat and ecosystem through human interventions by controlling and or mitigating any disturbances and accelerating the re-vegetation processes.

2.1.2 Sociological Terms and Definitions

Social science has a long history: the philosophical thoughts of Saint Simon and Auguste Comte were the pioneers in developing modern sociology (Barnes 1948:81). The term 'sociologism' is used by synthesizing 'positivistic methodology' and postulated the concept of methodology, social facts, division of labor, suicide, knowledge, religion, etc. postulated by Emile Durkheim, which are the foundation of sociology (Benoit-Smullyan 1948). The term 'social capital' was coined by Ferdinand Tönnies (1887), shaped by Jane Jacobs (1961) and defined by Pierre Bourdieu (1986). Its theory was conceptualized by James Coleman (1988) and made public by Robert Putnam (2000) (c.f. Pretty 2003:9). Bourdieu (1986:248) defines social capital as "the aggregate of the actual or potential resources which are linked to the possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition or, in other words, to membership in a group" (c.f. Dick 2008:88). It forms from formal and informal relationships of people, their networks and cultural activities (Dick 2008). It contributes to biodiversity conservation and protected area management (Pretty and Smith 2004) and to the resolution of conflicts in the use of natural resources (Sanginga et al. 2007).

The term 'institutionalization' is defined as "the process whereby social practices become sufficiently regular and continuous to be described as the institutions', that is social practices that are regularly and continuously repeated, are sanctioned and maintained by social norms, and have a major significance in the social structure" (Abercrombie et al. 1988:124, qtd. in Levy 1996:1). Similarly, the term 'participation' means "a partaking in the enterprise of others", and community participation means "a partaking of sub-communities in the enterprise of the larger moral community whose premises are shared" (Friedmann et al. 1973:6). The World Bank (1994) defines participation "as a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them". Hence, social norms and values, people and their groups, establishment of community based institutions and their networks, and involvement of local people as individuals or groups greatly contribute to forest restoration and conservation of natural resources and wildlife.

2.1.3 Concepts and Theories

Various ecological concepts and theories have been postulated, and practiced for the conservation of natural resources. The theory of ecology is based on seven fundamental principles. They are "the heterogeneous distribution of organisms, interactions of organisms, contingency, environmental heterogeneity, finite and heterogeneous resources, the mortality of organisms and the evolutionary cause of ecological properties" (Scheiner and Willig 2007). However, the concept of wildlife management was introduced by Aldo Leopold from the 'game management' concept in the 1930s (Ripple and Beschta 2005). Miller (1998:690) states that "wildlife management entails manipulating wildlife populations (especially game species) and their habitats for their welfare and for human benefit including preserving endangered and threatened wild species and enforcing wildlife laws". In the 1940s, the concept of 'ecological integrity' was postulated as preserving 'the integrity, stability and beauty of the biotic community' (Leopold 1949.

After three decades, in the 1980s, the concept of 'ecological integrity' was advanced by Karr and Dudley. They define it as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley 1981:56, c.f. De Leo and Levin 1997). However, in late the 1960s, Odum (1971:252) presented 24 ecosystem characteristics of natural change 'succession'. In the same decade, MacArthur and Wilson (1967) proposed a 'species equilibrium model or island biogeography theory'. These authors explain the rate of immigration and rate of extinction of species on islands (c.f. Miller 1999). Levins (1969) advances a theory 'metapopulation' which is based on the classic model of colonization and extinction in an infinite number of equally connected habitat patches. Metapopulation is defined as "a population of populations which go extinct locally and recolonize" (Levins 1969, c.f. Wu 2008:208).

Various international conferences (e.g. UNESCO's Biosphere Conference in 1968, Stockholm Conference in 1972) in the late 1960s and early 1970s emphasized environmental conservation and socio-economic development in which the Man and Biosphere Program was initiated to bring together natural and social sciences concepts in 1971 (Ishwaran 1991, Adams and Hutton 2007). Thereafter, many socio-ecological theories and concepts have been developed and practiced in natural resources conservation. For instance, the concept of resilience is used in socio-ecological systems (Holling and Gunderson 2002). At present, different integrative

perspectives and interdisciplinary approaches have developed and have been applied in biological conservation (Wu 2008).

The concept on ecological restoration entails an interdisciplinary approach (Higgs 2005). Nevertheless, it was initiated from the understanding of restoration as the 'acid test' of ecological theory in which ideas and understanding are tested whether the restored ecosystem has restarted its function or not (Bradshaw 1987). Yet, it can be done by integrating ecology, technology, socio-economy, cultural understanding and strengthening of partnerships. Particularly in developing countries, this includes changes of social and cultural forms (Koehler 2005). In this regard, ecological theory has been developed including 'conceptual restoration model that includes ecological succession and disturbance, community assembly rules, trophic interactions, population dynamics, species ecology and soil ecology' (Burke and Mitchell 2007).

Few researchers (e.g. Hansson and Angelstam 1991) have studied communities, as well as single species concepts, which are affected by the 'combination of succession and climax biotopes'. Aronson et al. (1993a) explains the ecological restoration, rehabilitation and reallocation as ecosystem functions and structure. In the same way, Palmer et al. (1997) addresses the role of community ecological theory which contributes toward the development of restoration ecology and research. They mention that the goal of restoration is to re-establish a functional group or assemblage of species, and to understand the relationship between physical habitat structure and restoration ecology.

Among the different theories and concepts, some of sociological and ecological theories and concepts are briefly explained below.

Positivism

The 'positivist theory' was postulated by Auguste Comte to explain social control (sovereignty) and social reconstruction (Barnes 1948:97). However, the term 'positivism' was coined by Saint-Simon in the development of social science or 'social physics' (Benoit-Smullyan 1948:499). The positive implies "the given i.e. what is observable, actual, real-with and undertone of what is useful" (Olsen 2008:37). This has been prominently used in the theory of historical development, evolution, etc. in which positivists have transferred findings within biology to other areas of knowledge, mostly linked with religion. However, some

scientists (e.g. Max Plank, Einstein) have denied the religious positivism. Max Plank says that "the most important features of all scientific research is a demand for a constant world picture independent of all evolutions in time and among human beings" (qtd. in Olsen 2008:61). Scientists believe their scientific findings are the facts, not human observations and religious thoughts. Positivists use observation, analysis and categorization and coined the term 'Dynamism' in 20th century. After that 'legal positivism' was postulated by H. L. A. Hart. According to him "in every community where law exists, there exists a standard that determines which of the community's norms are legal ones" (Coleman 1982:139).

Positivism is either negative or positive where 'natural law theory' is hard to follow because of its connection between 'law and morality' (Coleman 1982), but it is believed that the law and morality are to be separate from each other (D'Amato 1985). Likewise, Postema (1987) postulated a 'participant theory' in which "participants are to describe or justify their own behavior" (qtd. in Holton 1998:599). Holton postulated the moral attitude positivism and gave reasons behind for this attitude as follows"(i) whether the officials have a normative reason to enforce and obey the law, (ii) whether they believe they have a normative reason to enforce and obey the law, and (iii) whether they have a motivating reason, that is, one that will actually move them to act, to enforce and obey the law" (Holton 1998:621). According to scholars a person develops attitude for a particular entity. Olsen (2008:40) defines attitude as "the reminiscent of that modern ideological criticism, which endeavors to analyze the attitude to life formulated in literary works and to relate them to the surrounding society". Furthermore, attitude is defined as "dispositions to evaluate given entities with some degree of favor or disfavor" (Eagly and Chaiken 1993, qtd. in White et al. 2005:26). Hence, the theory of 'positivism' is the foundation of attitude.

Constructivism

The term 'constructivism' was developed by Socrates who contributed in establishing its foundation (Hagege et al. 2007). The way of thinking is "a reconstruction of the concept of knowledge" (von Glasersfeld 1985, qtd. in von Glasersfeld 1990). The knowledge is formed from a construction process (Hagege et al. 2007). According to Piagent's coherent theory "knowledge is not passively received either through the senses or by way of communication, and it is actively built up by the cognizing subject, the function of cognition is adaptive, in the biological sense of the term, tending toward fit or viability, cognition serves the subject's organization of the experimental world, not the discovery of an object ontological reality", but

it cannot be practical in reality (von Glasersfeld 1990). According to Olsen "perception starts from objects, it is not in the first place an activity of the human brain, a statement that would seem to need some kind of further explanation" (Olsen 2008:71). Hence, perception is constructed from the way of thinking that starts from an entity.

Disturbance and Resilience

Disturbance is commonly used term in ecological science. Pickett and White (1985) define disturbance as "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (Hobbs and Huenneke 1992:325). It is taken as the altering factor of ecological structure and functions of community. It occurs from natural factors or human inducement. Most of these disturbing agents have a negative impact on ecosystems, some of which (e.g. fire suppression) will, however, increase the density and composition of vegetation (Rogers 1996).

Based on the disturbances, Holling (1973) has postulated a 'resilience' theory in the ecological system. Walker et al. (2004) define resilience as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks". Similarly, Pimm (1984:322) defines resilience as **"**the rate of variables return toward their equilibrium following a perturbation in an unstable system". Moreover, ecological resilience is defined "as the capacity of an ecosystem to resist disturbance and still maintain a specified state" (Brand 2009:606). To explain it, Holling and Gunderson (2002) postulated an adaptive cycle, where release, reorganization, exploitation and conservation are the elements of a cycle in the ecological system. More recently, resilience has been used in various subjects such as ecology, development, social science, etc.

Sustainability Science: Integrative Perspective and Approaches

The concept of 'sustainability' was published in a book 'Sylvicultura Economica' by Hannß Carl von Carlowitz in 1713, which is the pioneer work in forest management (Grober 1999). Thereafter, various concepts and theories have been developed in conservation. Analyzing different theories (i.e. balance of nature, island biogeography, single large or several small reserves, minimum viable population, metapopulation) in this context, Wu (2008:209) acknowledges the use of these theories and concepts for conserving biodiversity. He also scrutinizes their inadequacy to cover various arrays of complex patterns and processes. Further,

he reviews ‘integrative perspectives of landscape ecology and sustainability science’ by emphasizing landscape level ecological concepts, and principle of biodiversity conservation planning and sustainability. In this regard, the National Research Council (1999) has developed the concept of ‘transition to sustainability’ in which it highlighted the ‘navigation’ for adaptive and intelligent adjustments in social learning process. It further highlighted the concept of ‘journey’ for better understanding of social and environmental changes, improved tools and understanding future threats and opportunities to meet the goals (i.e. fulfill the needs of future generations, sustain life support systems and reduce hunger and poverty). Sustainability science has a ‘problem-driven agenda’, and emphasizes the ‘dynamic interactions between nature and society’ (Clark and Dickson 2003). It is an interdisciplinary array of social and natural sciences in progress; however, scientific basis is needed for sustainable development rather than generally used sustainability science (Walker et al. 2004).

In social and natural sciences, various theories have been developed. Social science has focused on people, social norms and values which are philosophically sound but practically complex. The pure ecological science emphasizes the conservation need of environment, flora and fauna. It further emphasizes that this is crucial but convincing people to practice strict conservation is difficult. Restoration ecology says that the need for restoration is not the matter of an individual subject, concept or theory, but rather a matter of people who are indispensable in active restoration and should benefit the preservation of ecological conservation. Hence, I have concurred the concept of integrative approach and perspective (Wu 2008) and have also adopted the idea of resilience from disturbances (Holling 1973) for restoration in the socio-ecological system.

2. 2 Restoration and Conservation Approaches

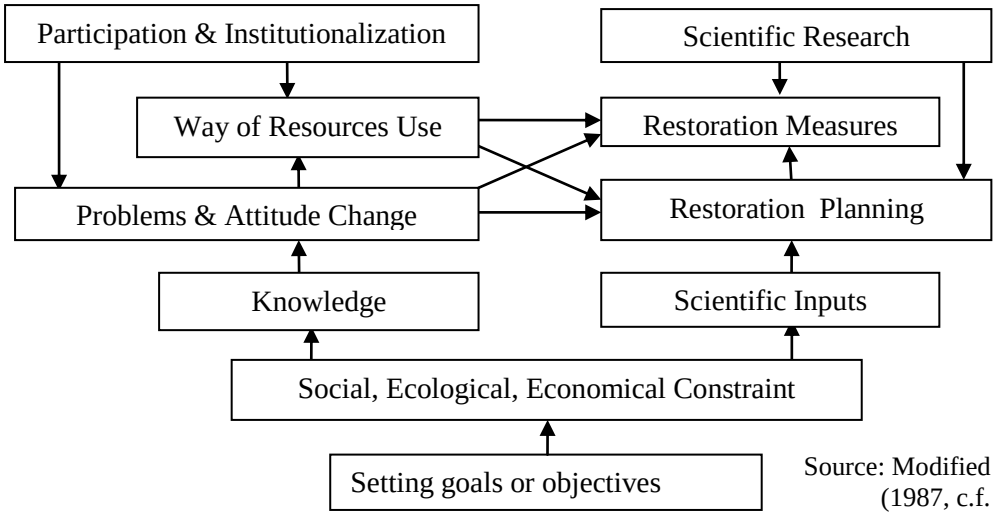
Restoration is practiced by recovering the function and structure of ecosystem or through a conservation approach. Habitat restoration is taken as a biological conservation-oriented management technique. It contributes in recovering wildlife species and providing suitable in-situ living conditions. Restoration activities are carried out to enhance ecological values in productive landscapes where it will also consider conservation purposes (Hobbs and Norton 1996). Forest and grassland habitat restoration will be a key component for wildlife conservation in terrestrial landscape. For such type of conservation WWF, IUCN, and other conservation and development groups developed the ‘forest landscape restoration’ concept in

2000, which is comprised of "a planned process that aims to regain ecological integrity and enhance human wellbeing in deforested or degraded landscapes" (Dudley and Aldrich 2007:3). It also provides refuge habitat on the migratory routes for wildlife (Koehler 2005). Restoration is essential in the degraded and fragmented areas, which will be a possible connectivity or 'stepping stones' in forested areas for wildlife movement (Lamb and Gilmour 2003).

Human intervention is crucial for controlling the habitat fragmentation. Fragmentation restricts breeding populations and causes barriers to disperse and colonize new areas (Miller 1999). To minimize fragmentation, passive and active restoration can be practiced. Forest habitat can be restored through passive restoration (e.g. controlling destructive logging, road building, livestock grazing, mining, off-road vehicle use, alteration of fire regimes) and active restoration (e.g. planting, prescribe burning, road obliteration, invasive species control, fuel treatment) (Dellasala et al. 2003). The protected area restoration is a good initiative for understanding the spatial population dynamics of keystone or indicator species (Hansson and Angelstam 1991), but these areas will not sustain conservation. Conservation beyond the protected area with active restoration is needed; however, active manipulation of wildlife species is costly and needs more effort (Scott et al. 2001).

Ecologists or restorationists have developed different schemes for practicing restoration. Vollenweider (1987) has developed a scheme of strategies for lake management (Gulati 1989). According to him, it is necessary to define the 'object of/ for restoration'. Based on his scheme, a strategic plan for terrestrial ecosystem can be designed as illustrated in figure 1.2. It depicts that the selection of restoration goals and activities will depend on social (e.g. acceptable for its value, norms, understanding), ecological (e.g. possible from climate, land topography, biotic community) and economical (e.g. efficient for cost and benefits) constraints (Miller and Hobbs 2007) in which knowledge is on one side and scientific technology (Higgs 2005) is on the other. Participation and institutionalization determine the nature of forest resources use, knowledge contributes in problem identification and attitudinal change, analysis of the problems whereas facts from the scientific research and the availability of scientific technology determine the restoration planning. Finally, based on goals or objective of forest restoration, restoration measures can be identified and applied in practice.

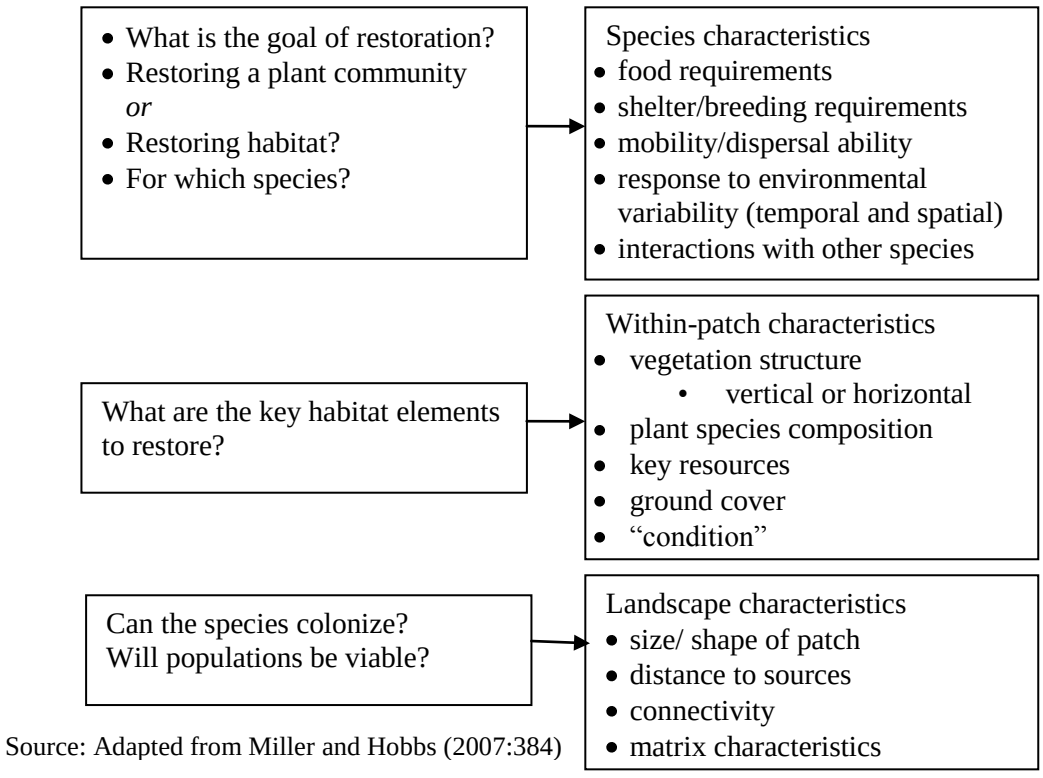
Figure 1.2 Strategic principles of terrestrial habitat restoration



Source: Modified based on Vollenweider (1987, c.f. Gulati 1989:83)

The selection of restoration goal is a complex process that results from ecological, socio-economical, ethical and philosophical aspects (Hobbs 2007). In this context, Ehrenfeld (2000) reviews the relative merits and pitfalls associated with specifying restoration goals based on species, ecosystem functions and ecosystem services. He views goal setting to be highly complex and diverse, therefore flexibility should be maintained in goal setting and necessary guidelines should be developed. Furthermore, Miller and Hobbs (2007) describe a general process of defining habitat restoration goals to target species and the key set of elements which need to be taken at the formulation of habitat restoration projects (figure 2.2).

Figure 2.2 Key considerations while setting goals for habitat restoration projects

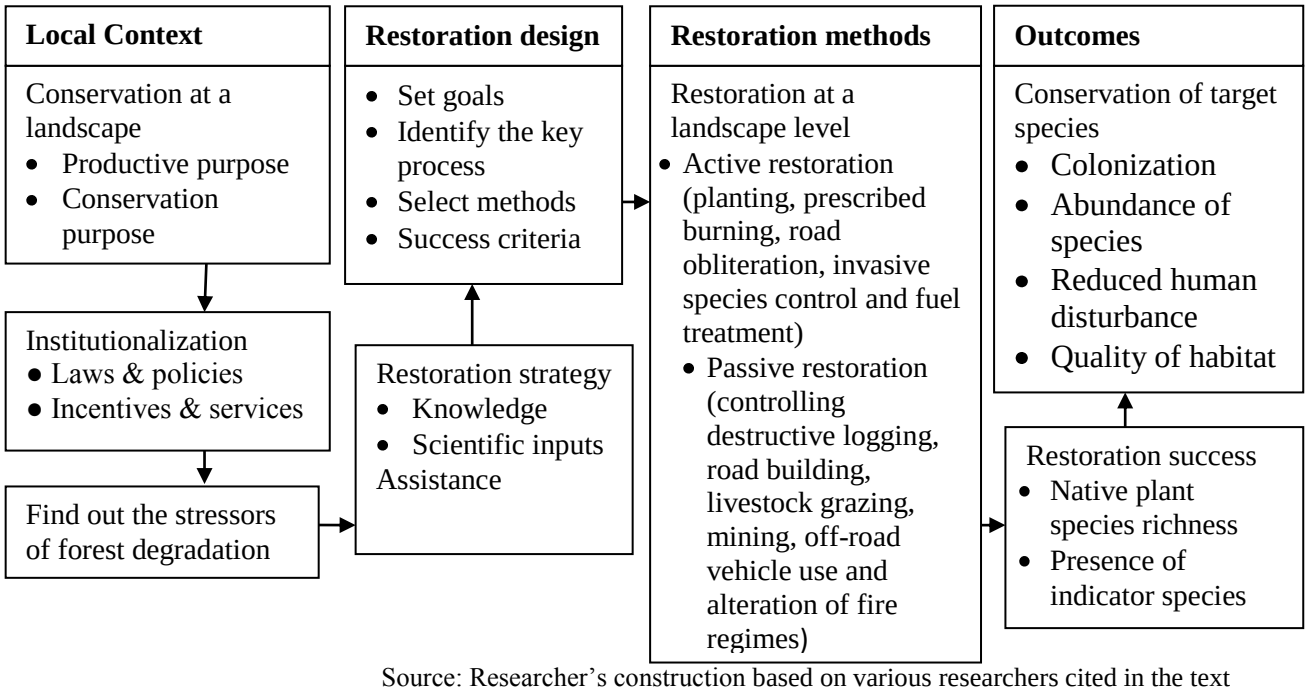


Source: Adapted from Miller and Hobbs (2007:384)

These elements are set by including important major aspects in restoring the habitat at landscape level. The success of restoration depends upon setting the goals, however, restoration of the natural system in the original state would be an unachievable goal in some cases (Hobbs and Norton 1996).

Similarly, Hobbs and Norton (1996) identify some key principles, processes, criteria of success and methodologies with clear explanation that guides the formulation of a conceptual framework for restoration ecology. They emphasize the participation of people in restoration, integration of productive and conservation values, and land use planning and management at landscape level. Based on this guideline, I intend to develop a conceptual framework for the conservation of indicator species at landscape level (figure 3.2). In the landscape, restoration can be done for production and conservation values through community people's participation. The institutionalization of community people will sustain restoration programs. For this, problems can be identified and restoration plans can be developed by integrating the conservation strategy. Based on the objective, one can select methods and implement in habitat restoration, which will support to target species conservation, providing good shelter, food and better environment for recolonization that might be the indicator of restoration success.

Figure 3.2 Concept of restoration for target species conservation at landscape



Source: Researcher's construction based on various researchers cited in the text

Researchers have explained ecological restoration as a scientific discipline in various ways. For instance, Michener (1997) describes research design and analytical options by assessing

their uses in restoration ecology. He explains that the scientific research and analysis of ecological patterns and process becomes incomplete only through 'experiments', it needs a broad mix up of appropriate research approaches (e.g. long-term and large-scale comparative studies, modeling, and experiments) and various analytical tools (e.g. observational, spatial, and temporal statistics). Likewise, Scott et al. (2001) discuss how to maximize the potential for colonization of restoration sites at landscape level, and the contribution of each restoration project to regional, management area, ecosystem or target species goals, which are the areas for strategic planning in passive wildlife restoration. Similarly, Harris et al. (2006) explains the impact and implications of global climate change in ecological restoration. According to them, the changes in weather patterns, increases in mean temperature, changes in patterns of precipitation, increasing incidences of extreme climate events and increasing sea levels are the major impacts of climate change. Sarr and Puettmann (2008) discuss the conceptual basis development for sustainable forestry. They explain the triad model, i.e. social, economical and ecological systems, to tackle the goals of sustainability and their roles for forest management, restoration, and designing ecosystems in forest landscapes.

Conservation Approaches

Restoration of degraded ecosystems for functional and conservation purposes is vital in conservation science, in which the conservation of nature and natural resources has a long history. However, the practice of forest and wildlife resources conservation began in 1870s, when the first national park (Yellow Stone National Park, USA) was established in 1872 (Mackey et al. 1998). In 1879, the Royal National Park was established south of Sydney, Australia, which is the second national park in the world. Ecosystem-based conservation was realized after the 1930s, when Aldo Leopold postulated the relationship among carnivores, ungulates and vegetation (Ripple and Beschta 2005). Thereafter, natural resources were managed under preservation, 'wilderness' or conservation i.e. protection with proper use (Miller 1998). Currently, debates on the approach to natural resources protection exist whether to emphasize a single species or multiple species or ecosystem-based conservation (Wassenaar and Ferreira 2002).

Protected areas have been established to conserve nature and natural resources. Over 120,000 protected areas have been recorded in the World Database on Protected Areas (WDPA), with nationally designed protected areas covering 11.3 percent of the terrestrial and marine areas of national territories (UNEP-WCMC 2008). Until 1978, IUCN used ten categories for protected

areas (IUCN 1994). After the 1990s, six categories of areas were put into use to manage biodiversity in protected areas according to worldwide importance and objectives (scientific research; wilderness; preservation of species and genetic diversity; maintenance of environment services; protection of natural species and cultural features; tourism and recreation; education; sustainable use of resources from natural ecosystem, and maintenance of cultural and traditional attributes) (IUCN 1994, table 1.2). Most of these protected areas are conserved under the conventional approach while some are conserved through the participatory approach.

Table 1.2 IUCN management categories of protected areas

Category	**Title**	**Protected areas managed mainly for:**
Ia	Strict Nature Reserve	Science
Ib	Wilderness Area	Wilderness protection
II	National Park	Ecosystem protection and recreation
III	Natural Monument	Conservation of specific natural features
IV	Habitat/ Species Management Area	Conservation through management intervention
V	Protected Landscape/ Seascape	Landscape/ seascape conservation and recreation
VI	Managed Resource Protected Area	Sustainable use of natural ecosystems

Source: IUCN (1994)

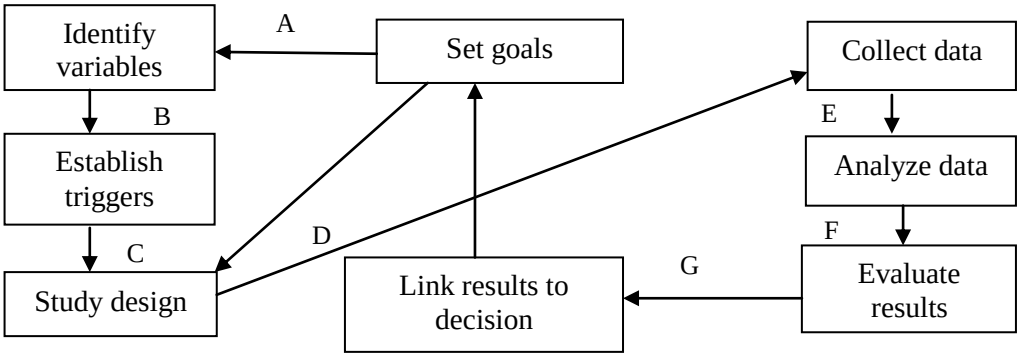
2.3 Restoration Planning and Monitoring and Conservation Strategy

Traditional ecological knowledge (Huntington 2000) and wilderness protection have a relationship in restoration and protection (Watson et al. 2003). Knowledge and skills have been established from the ecological and social disciplines (Sarr and Puettmann 2008); they have been utilized knowingly or unknowingly in making plans since ancient time. Since the 1980s, the conventional top-down planning approach has shifted toward a bottom-up or democratic and participatory approach (Amler et al. 1999). The latter approach through the utilization of local knowledge is an excellent method for developing forested corridors (Chettri et al. 2007). Such management plans contribute to reduce habitat loss and fragmentation, and recover and conserve endangered species (Huxel and Hastings 1999). However, most of the ecological plans are prepared by a person who has an academic background in ecology or has experience on ecological research, and thus, such planning is a top-down process of planning (Fazey and McQuie 2005).

Restoration monitoring is a complicated process which should cover different ecological attributes. Block et al. (2001) have created a conceptual framework for monitoring the

restoration success on wildlife. They advocate an assemblage of umbrella species for monitoring because of its representativeness, and the array of spatial and functional attributes. They have proposed the following seven steps. They are (1) setting monitoring goals, (2) identifying the resource(s) monitoring, (3) establishing a threshold or trigger point, (4) developing a sampling design, (5) collecting data, (6) analyzing the data, and (7) evaluating the results (figure 4.2). The process of monitoring has focused on the effectiveness of a program to meet the target of wildlife restoration.

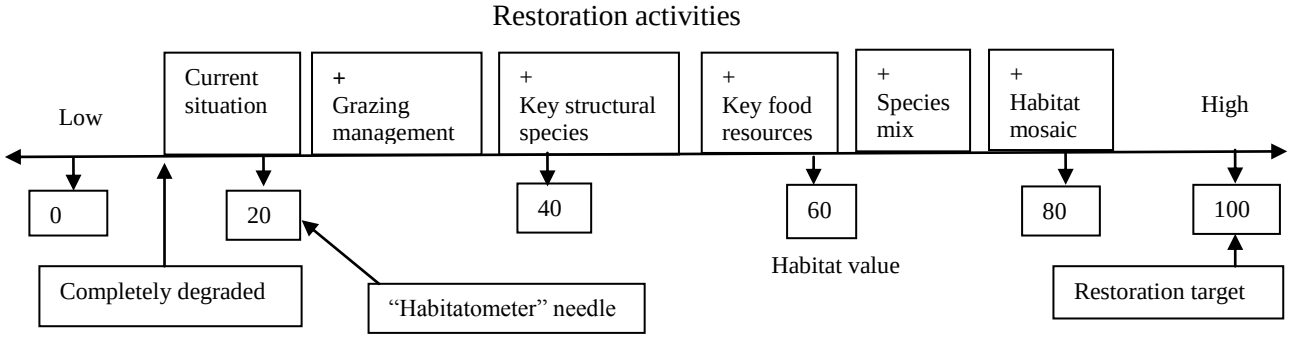
Figure 4.2 Flow diagram of steps involved in monitoring of restoration. Letters A through F signify feedback points when monitoring methods and results are evaluated



Source: Adapted from Block et al. (2001:295)

Habitat restoration monitoring has mainly focused on effectiveness, fulfilling the regulatory requirements, and guiding restoration for enhancing the target of its success (EADANL 2004). Monitoring of a certain key species (e.g. salamander) having indicating features of biodiversity, and ecosystem integrity plays a significant role (Welsh and Droege 2001). In this regard, Aronson et al. (1993a) have developed the 'vital ecosystem attributes' as the indicator of ecosystem structure and ecosystem function. These types of vital attributes are evaluated in rehabilitation, restoration, reallocation and sustainable land management by differentiating very good, good, non-degraded, degraded and badly degraded states of different lands (Aronson et al. 1993b). Likewise, Miller and Hobbs (2007) have formulated a scheme for the process of habitat restoration and prioritized the activities that indicate the status from the degraded state of relatively low habitat quality toward the target of improved conditions, in which each management activity (e.g. grazing, structure of species, food resources, species mix and habitat features) has a given value (figure 5.2). Monitoring these management activities will define habitat quality.

Figure 5.2 Habitat restoration entails assessing the current status and moving the 'habitatometer' needle progressively toward higher habitat quality



Source: Adapted from Miller and Hobbs (2007:388)

Brewer and Menzel (2009) have proposed a method to evaluate habitat restoration using habitat data matrix and species number without comparing references information. They have used vegetation community in the habitats of conservation concern and disturbed habitats to produce indicator scores. Similarly, Gibbs et al. (2008) have evaluated the role of endangered species i.e. giant tortoises (*Geochelone nigra hoodensis*) and arboreal cactus (*Opuntia megasperma var. magaesperma*) reintroduction efforts which can play in the larger context of ecosystem restoration. Likewise, van Aarde et al. (1996) have used species richness to evaluate large ecosystem restoration.

During conservation planning, ecological integrity and species conservation can be focused. In this regard, Miller (1999:437) has considered the importance of human activities in conservation and developed four principles in conservation biology. These are (i) preserve biodiversity and ecological integrity (ii) control premature extinction of populations and species by disrupting evolutionary processes and critical ecological processes, (iii) preserve habitats, niches and ecological interactions, and iv) formulation of goals and strategies based on a deeper understanding of the ecological properties and processes of the system. Furthermore, it integrates the 'coarse-filter' strategy which focuses on the ecosystems and climate, 'meso-filter' (Hunter 2005) bridge between coarse and fine filter and the 'fine-filter' strategy which is focused on species spatial distribution patterns in the broad strategies for multispecies conservation planning (Noon et al. 2008). Hence, conservation strategy can be focused on species or groups of species, habitat and ecosystems, and mitigation of human interferences to continue the existence of all creatures and formulate conservation planning from various scales i.e. small/ regional to large scale considering all ecological components.

2.4 Participatory Restoration and Conservation

In general, people only get involved in conservation and restoration once they understand the value of ecological services. Conducting restoration activities by involving people is considered to be a participatory restoration. The restoration done by Civilian Conservation Corps workers by replanting tall prairie grass on a piece of farmland in the edge of Madison, USA with the direction of Aldo Leopold in 1935 (Jordan et al. 1987) was a pioneering participatory approach to ecological restoration. Nevertheless, indigenous people have been practicing resources management and restoration for hundreds of years (Anderson 2005). In the landscape context, human well-being is considered and the needs of local people and their involvement in land-use management are recognized (Maginnis and Jackson 2005). Participation of local people and social capital is vital for biological conservation (Pretty and Smith 2004). The participatory approach is the democratic way of decision-making that maintains relationships between various actors, which helps to institutionalize the local government (Rauch et al. 2001). Participatory restoration 'focal practice' is excellent to achieve wilderness preservation (Higgs 2003). Nevertheless, people's participation in some restoration endeavors can alter the wilderness of an ecosystem (Throop and Purdom 2006).

Participatory restoration contributes to progressive outcomes in restored patches (Hobbs and Norton 1996). Forman and Godron (1986:83) define a "patch as a nonlinear surface area differing in appearance from its surroundings". According to them, it is different in size, shape, type, heterogeneity and boundary characteristics. In these forest patches, introduction of exotic plant and animal species (HMGN/MFSC 2002) and human interference will fragment the landscape and disturb the patches. In such cases, motivated people can play a vital role in reforesting degraded patches and controlling disturbance (Forman and Godron 1986). The ecological system has the capacity to be resilient from slow paced disturbances, therefore, exploitation by human being should not be higher than the recovery rate of the patches (Cairns 2005).

Participatory restoration is essential in highly degraded or disturbed areas. It is important to transform the social mechanisms for adaptive co-management which focuses on social and ecological systems at landscape level (Olsson et al. 2004). This approach has become popular in the conservation and development field when 'the centralized management and community-based approaches' do not meet the needs and interest of diverse groups (Mburu 2003). At the international level, Natura 2000 is the most popular participatory and interactive policy-making

legal framework in the field of nature conservation in the European Union. Natura 2000 includes both the Habitats Directive and Birds Directive, however conflicts may arise with local actors during implementation (Keulartz 2009).

Decentralization helps local decision-making in resource conservation, this also contributes in establishing social networks and institutionalization (Agrawal and Gupta 2005). However, for the successful conservation, management and restoration of forests, critical social elements including good governance, local level cooperation and collaboration, social capital, etc. are essential (Dudley and Aldrich 2007.

2.5 Indicators/Criteria of Restoration Success and Indicator Species

An indicator can show the overall progress of projects/ programs or environmental state. It can be interpreted as a particular variable, which provides information for the purpose of decision-making of such activities at a certain level. Hellawell (1986:45) defines indicators "as a bio-sensor of the environmental contamination for that pollutant or stressor". McGeoch (1998) divides it into three 'bioindicators' such as environmental indicators, ecological indicators and biodiversity indicators. Here biodiversity indicators are defined as the "group of taxa (e.g. genus, tribe, family or order, or a selected group of species from a range of higher taxa), or functional group, the diversity which reflects some measure of the diversity (e.g. character richness, species richness, level of endemism) of other higher taxa in a habitat or set of habitats". Similarly, an ecological indicator is defined as "a characteristic taxon or assemblage that is sensitive to identify an environmental stress factor, that demonstrates the effect of these stress factors on biota, and whose response is representative of the response of at least a subset of other taxa present in the habitat" (McGeoch 1998:184, qtd. in Martino et al. 2005:4). Similarly, an environmental indicator is defined as the "physical, chemical, biological or socio-economical measures that best represents the key elements of a complex ecosystem or environmental issues" (Saunders et al. 1998:5).

Ecological indicators are used for the purpose of measuring environmental conditions, changes in these conditions and causative agents of the problems (Cairns et al. 1993, c.f. Dale and Polasky 2007:288) and methodology (e.g. chemical, biological, physical) and resources application (e.g. fresh water, forest) (Jackson et al. 2000). The indicators are also needed to capture key attributes of ecological systems of interest (Dale et al. 2008). Based on the

indicators, success or failure of restorations is determined and new goals are developed to start new activities or continue the previous activities. Nevertheless, the integrated restoration goals i.e. to improve biodiversity and ecological productivity and to enhance human livelihoods and empower local people, determine the success of management which depends an all of these elements (SER and IUCN 2004).

The Society of Ecological Restoration International (SER and Policy Working Group 2004:3) has produced a primer that provides a list of nine ecosystem attributes as a guideline for measuring restoration success. Based on this, the restored ecosystem should have nine attributes. They are as follows (i) contains an assemblage of the species and community structure in comparison to the reference sites, (ii) consists of indigenous species, (iii) all functional groups necessary for development or stability, (iv) capable of sustaining reproducing population in a physical environment, (v) absence of dysfunction, and normal functioning of ecological development, (vi) suitable to integrate into a landscape, (vii) eliminated or reduced potential threats to health, (viii) resilient to the normal stress and maintain integrity, and (ix) self sustainability and potential to persistence. In this regard, Ruiz-Jaen and Aide (2005a) reviewed published articles to determine how restoration success has been evaluated in restoration projects. They found that no study has measured all these SER primer attributes, but most studies have included at least one measure in each of the three general categories of the ecosystem attribute such as diversity, vegetation structure and ecological processes.

Ewel (1987) has listed five criteria (i.e. sustainability, invisibility, productivity, nutrient retention and biotic interaction) for judging ecosystem restoration and reconstruction success. Similarly, Dale and Beyeler (2001:6) have suggested ecological indicators (table 2.2) and criteria that should:

- be easily measurable;
- be sensitive to stresses on the system, and respond to stress in a predictable manner;
- be anticipatory, predict changes that can be averted by management actions, and
- be integrative, have a known response to disturbances, anthropogenic stresses, and changes over time, and have low variability in response.

Table 2.2 Indicators for ecological integrity

Hierarchy	**Processes**	**Suggested indicators**
Organism	Environmental toxicity, mutagenesis	Physical deformation, lesions, parasite load
Species	Range expansion or contraction, extinction	Range size number of populations
Population	Abundance fluctuation, colonization or extinction	Age or size structure, dispersal behavior
Ecosystem	Competitive exclusion predation or parasitism, energy flow	Species richness, species evenness, number of trophic levels
Landscape	Disturbance, succession	Fragmentation, spatial distribution of communities, persistence of habitats

Source: Both indicators and criteria are adapted from Dale and Beyeler (2001:4 & 6)

Flora or fauna species can be considered as the indicator of restoration success. Success depends on the type of species and their habitats. For example, the tiger needs large home range and undisturbed habitat (Miller 1999). Sometimes it is also difficult to choose appropriate keystone species due to its unclear and nonspecific definition, but complex interactions among species helps to apply in environmental policy and management (Mills et al. 1993). The response of an indicator or guild species is used for indicating ecological management but a multi-species approach is suitable in the broad spatial perspective (Thompson et al. 2000). Smith et al. (2001) have developed the following four criteria for selecting restoration sites for tiger conservation in Nepal.

- Outside the sphere of influence of Bardia and Chitwan NP, where previous community forestry projects have been successful.
- An area where forest edge is becoming increasingly degraded.
- The area having tigers and low but recoverable population of prey.
- A degraded forest minimum of 150 square kilometer (sq km) and an edge where community forestry can be developed by local people to meet their daily resource needs.

Furthermore, Sanderson et al. (2006:88) define "success" for tiger conservation and state that "success is a known and secured breeding population of tigers in areas large enough for a substantiative population". They have proposed the criteria for different classes. For instance, the criteria such as the tiger having a breeding population, sufficient prey species, sufficient habitat area (enough for 100+ tigers), and sustainable conservation measures is a Class-I Tiger Conservation Landscape. Hence, forest habitat quality, abundance of prey species, tiger population and minimize edge effect with extended habitat can be the indicators of forest habitat restoration success and be considered for tiger as an indicator species.

Indicator Species

An indicator species can play a key role in restoration and conservation. Indicator species indicate a particular suite of environmental conditions mainly structure, function and composition (Dale and Beyeler 2001). They have categorized a focal species into indicator, keystone, umbrella, link, ecological engineers and special interest species. Miller et al. (1999) have categorized a target species into four options such as keystone, umbrella, flagship and indicator species. Similarly, Caro and O'Doherty (1999) have categorized species into three options such as indicator species (health indicator, population indicator and biodiversity indicator), umbrella species and flagship species (see definition, table 3.2). Indicator species are used to measure the anthropogenic disturbances (Caro and O'Doherty 1999), umbrella species are used to determine the size of habitat for species (Simberloff 1998) and flagship species are used to attract public attention (Western 1987). Species are used as the 'goals (target species) or as the tools (indicator species)' (Maes 2004). Nevertheless, monitoring and managing all flagship, umbrella and indicator species is problematic and difficult, therefore, it is better to manage ecosystem and species that have the feature of unit or single species i.e. 'keystone species' (Simberloff 1998), which was first defined by Paine (1969).

Table 3.2 Definition of some type of species

Species	Definition	Reference
Indicator	An organism whose characteristics (e.g. presence or absence, population density, dispersion, reproductive success) are used as an index of attributes too difficult, inconvenient, or expensive to measure for other species or environmental conditions of interest.	Landres et al. (1988:317)
Flagship	Popular, charismatic species that serve as a symbol and rallying point for major conservation initiatives.	Noss (1991: 361)
Keystone	As one whose impact on its community or ecosystem is large, and disproportionately large relative to its abundance.	Power et al. (1996:609)
Umbrella	A species with such demanding habitat requirements and large area requirements that saving it will automatically save many other species.	Simberloff (1998:249)
Focal	A species that has enough foundation of information to indicate long term trends and responses to change.	Dale & Beyeler (2001:8)

Source: Researcher's compilation

Among the various species, indicator species can be used as the target to protect, manage or restore habitats. The selection of an indicator species is controversial but researchers have developed certain criteria such as sensitive, widespread, occurrence, measurable, etc. for selection that is potential in conservation (Hutcheson et al. 1999). In this context, Salwasser et al. (1982) have proposed a guideline for selecting indicator species which include "rare and endangered, great consumptive or noncomsumptive value, closely associated with specific

habitat conditions, and whose habitats and populations could be monitored to index those of species with similar ecological requirements" (Block et al. 1987:265). Similarly Spellerberg (1991) has used criteria for the selection of indicator species such as sentinels (provide early-warning of pollutants), detectors (measurable response to change), exploiters (indicate disturbance), accumulators (accumulate pollutants) and bioassay organisms (detect pollutant toxicity) (Chambers 2008). In this regard, Lindenmayer et al. (2000:943) have characterized the indicator species into seven types. According to them, an indicator species indicates:

- Key roles for the presence or absence of a set of other species;
- Condition of an ecosystem or changes in the abundance of species;
- Anthropogenic effects such as air or water pollution;
- Biomass or number of individuals in an area;
- Environmental conditions such as certain soil or rock types (Klinka et al. 1989);
- Initial stressors of environmental changes such as global warming (Parsons 1991), and
- Management of disturbance regime or effectiveness of mitigating measures for disturbance effects (Milliedge et al. 1991).

Conservation biologists use surrogate species for understanding and solving the problems of conservation (Caro and O'Doherty 1999). For instance, carnivores (e.g. brown bear, wolf, eurasian lynx) can be used as a flagship, indicator and umbrella species because of their importance for sustainability of ecosystems (Ucarli 2011). In some areas, conserving these carnivores can mean "conflict-full flagships, leaky umbrella and insensitive indicators and their keystone role is uncertain" (Linnell et al. 2000:862). Hence, it is essential to inform local people about their important role in ecosystems to resolve human-carnivore conflicts and to conduct detailed research on the keystone roles of carnivores in the ecosystems.

2.6 Forest Planning, Management and Wildlife Conservation in Nepal

2.6.1 Forest Planning

Before the 1950s, no forest plans were formulated and only a few landlords owned and managed the main forest areas, and in an ad hoc manner (Gautam et al. 2004). In 1956, the first systematic plan was developed in Nepal (MFSC 2009) followed by the development of the periodic plans that emphasized forestry sector conservation and socio-economic development (table 4.2). Later, the National Conservation Strategy (1988), Nepal Environmental Policy and Action Plan (1993), Agriculture Perspective Plan (1995), Nepal Biodiversity Strategy (2002), Terai Arc Landscape Strategy (2004-2014), etc. were developed and implemented, focusing on forestry sectors, restoration and conservation.

Table 4.2 Periodic plan and their emphasis in the forest sector

S.N.	Plan Year	Focus
1	1956-61	Infrastructure development and revenue generation
2	1963-65	Forest conservation through large-scale afforestation
3	1965-70	Emphasis of forestry sector on resettlement in Terai forest areas, survey of forest and land to access natural resources for planning
4	1970-75	Delineation of major agricultural areas, reclamation of land for agriculture, increase in revenue from forestry and surveys for soil and land use
5	1975-80	Forest to the economic, social and industrial development, concept of ecological balance and economic development
	1976- National Forestry Plan	• recognition of people's participation in forest management • concept of village Panchayat forests
6	1980-85	People's participation, 'conservation' in the implementation of development programs, launching of community forestry development projects
7	1985-90	Integrated approach to forest through developmental and environmental considerations. Fulfillment of the daily needs, participation in afforestation and protection of these afforested areas on a large scale
	1989- Forestry Master Plan	• incorporation of the concept of Community Forest User Group • priority given to community forestry
8	1992-97	Formulation of acts and rules, public participation in private forestry, initiation to handover national forest to the community forestry
9	1997-02	Poverty alleviation by providing economic opportunities for poor people and encouraging their participation in development activities
10	2002-07	Forest resources in reducing poverty through forest development activities, agro-forestry, income generation, conserve and manage forests, soil, watershed and biodiversity
11	2008-10 (3 yrs Interim Plan)	Role of forestry sector in poverty reduction, legal and institutional reform

Source: MFSC (2009)

2.6.1.1 Planning Process in the Forestry Sector

Forestry planning and policy is oriented toward participating local people, generating means of livelihood and ultimately alleviating poverty through institutionalization (Ojha et al. 2009, NPC 2007). After the development of the Forest Master Plan (1989), and formulation of the Forest Act (1993) and the Forest Regulation (1995), local institutions i.e. District Forest Offices, have the power to make plans and govern community forest and government managed forest at district level. Nevertheless, the planning process of forest is ad hoc or has traditional bureaucratic control and lacks interaction during decision making at local level (McDougall et al. 2007).

Community level

i. **Forest User Group (FUG)**: The buffer/ forest user groups prepare operational plan with the assistance of the Range Post, which they present in the FUG assembly. The assembly of users has the right to determine rules and take every decision related to forest management including forest restoration, conservation, harvesting and sharing benefits (Acharya 2002). After the approval from the assembly, they forward the plan to the concerned Sector/ Ilaka Range post (figure 6.2). The Buffer Zone Management Committee and Community Forest Coordination Committee support in making plans through the hiring of resource persons.

   The local government unit (Village Development Committee - VDC) also collects information on the development needs from each ward representative for conserving government managed forests. However, it is still not clear whether the forestry laws or Local Self Governance Act (1999) can be activated for managing forests at the local level (Jamarkattel et al. 2009).

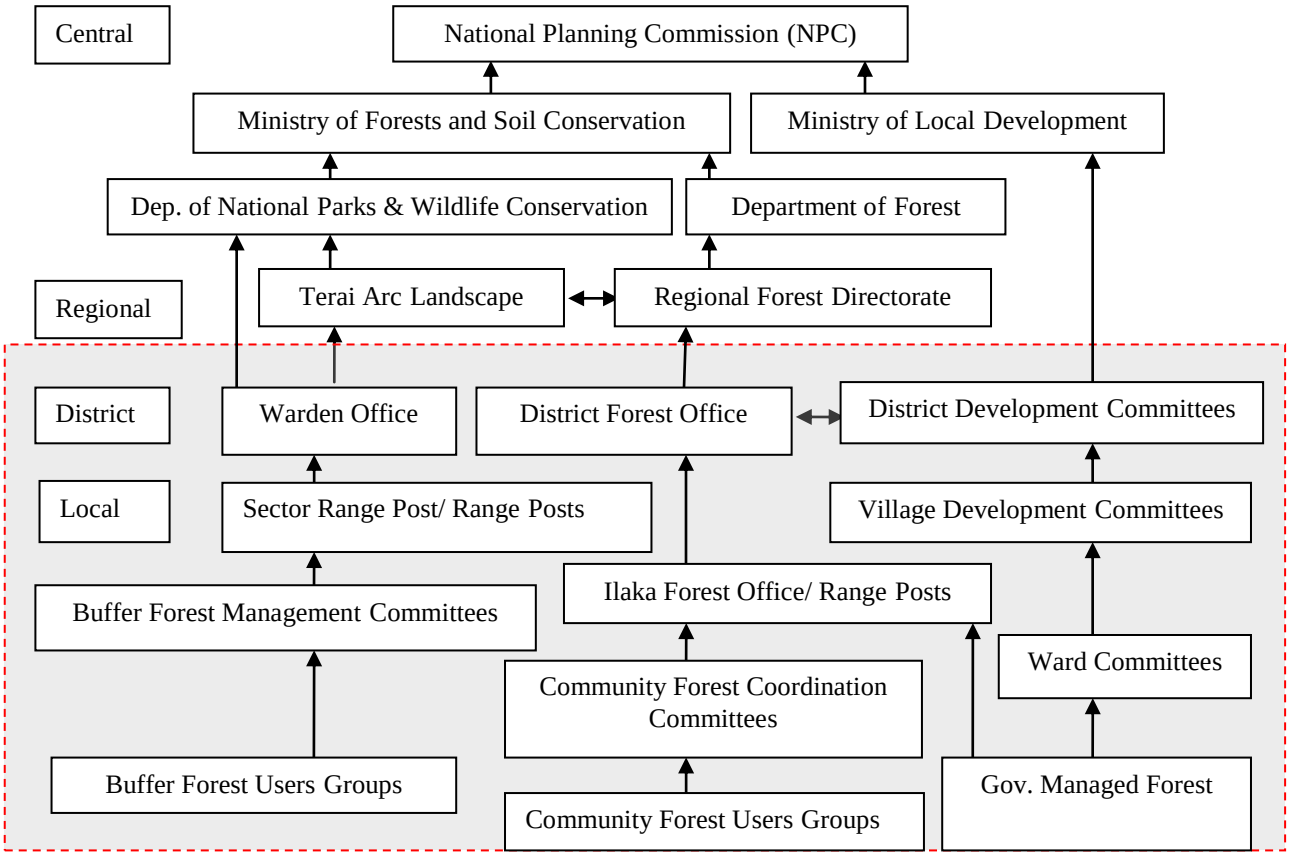
ii. **Sector/ Ilaka Range Post**: The Range Post provides technical support during forest surveys, conducts training and holds meetings with Forest User Groups (per. com., Forest Officer, Obhari). Each Range Post prepares and submits an annual program to the user groups' network meeting. At the same level, the VDC prepares an annual program and discusses it with ward representatives based on the district budget ceiling and approveal by the Village Development Council.

Warden/ District Level: The approved program from the general assembly and the Range Post is submitted to the Warden Office by the Buffer Community Forest User Committee (BCFUC) and District Forest Office by Community Forest User Committee (CFUC). District programs are guided by the Ministry of Forests and Soil Conservation (MFSC), which is also provided with the norms and guidelines by the National Planning Commission (NPC). The Warden Office and DFO coordinate with the District Planning Committee to eliminate duplication of the programs with VDC programs. After the tie up of the programs, within the budget ceiling, the District Planning Committee submits annual programs to the District Development Council (per. com. Planning Officer, Ministry of Local Development). The district level annual program is prepared by incorporating each program of all institutions (e.g. Warden Office, DFO, VDCs and other sectoral offices) at the district. Once the buffer/ community forest committee submits an application for registration or renewal, the Warden Office or DFO takes the decision.

Regional Level: There are five regional directorate offices of forest, the Terai Arc Landscape and Western Terai Landscape Complex Project are working in collaboration with the respective regional offices. The district forest annual programs, and the budget prepared and approved by the District Development Council are presented at the regional planning workshop (Kafle 2008). The regional offices are responsible to coordinate planning and monitoring programs and also conduct in-service refresher training for the lower-level technicians through seminars and workshops (Gautam et al. 2004). However, DDCs have a direct link with the Ministry of Local Development while the Warden Offices are connected with the Department of National Parks and Wildlife Conservation (DNPWC).

Central Level: The annual programs are forwarded to the respective department (Warden Office to DNPWC; DFO to Department of Forest) and then sent to the Ministry of Forests and Soil Conservation. The National Planning Commission is the apex body of planning in Nepal (NPC 2007). After receiving programs from the Ministry of Forests and Soil Conservation, NPC discusses with the Ministry of Finance regarding the availability of budget, and the evaluation report of the previous year. After evaluating the progress of programs, the budget and programs are finalized and printed in the Red Book. This is then sent back to the districts from the respective departments (Kafle 2008).

Figure 6.2 Forest planning process in Nepal

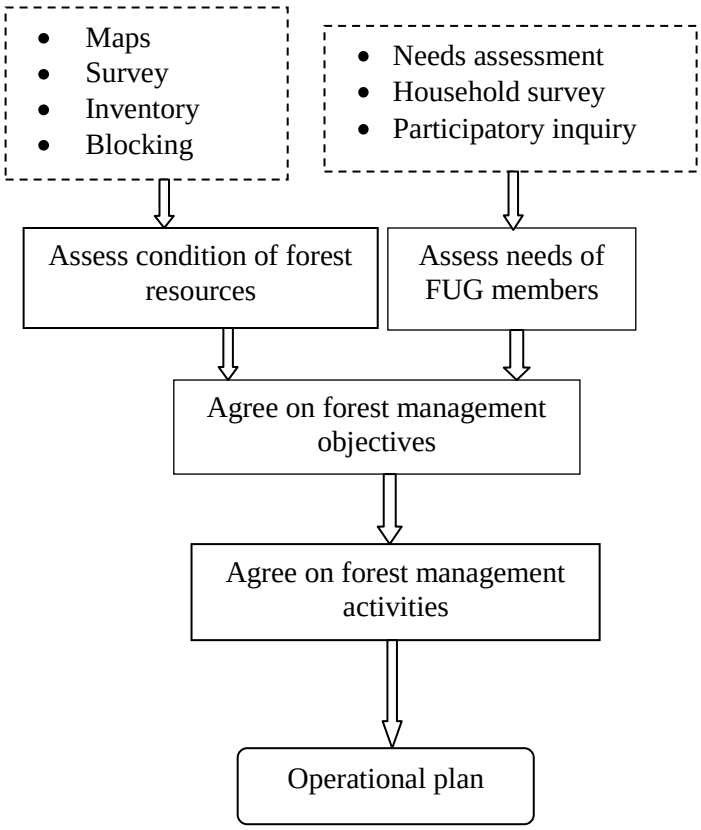


Source: Researcher's construction based on literatures

2.6.1.2 Forest Operational and Annual Management Plan

The Forest Act (1993) is the milestone for community forest which has provided the gateway to handover forest for fulfilling the local forest needs. In regulation (Forest Regulation 1995), local people establish a Community Forest Users Group (CFUG) and it prepares an Operational Plan for forest management, with technical assistance from the forest officials and non-governmental organizations (NGOs) (Acharya 2002). The five years Operational Forest Management Plan (OFMP) should be prepared and registered in the District Forest Office in the case of community forests, while the buffer community forest should be registered at the office of protected areas. At the beginning, NGOs workers or forest staffs provide orientations. Based on this and also on the government guideline, the local people start preparing plans (HMGN 1995). Regarding this, Branney et al. (2001) have constructed a framework (figure 7.2) that includes social and ecological surveys, selection of objectives, decision making by local people and development of a plan.

Figure 7.2 Process of developing operational management plan



Source: Adapted from Branney et al. (2001:5)

The guideline (HMGN 1995) also mentions the contents of the plans which are as follows:-

- Details of forest name, boundaries, areas, condition, forest type;
- Map;
- Block division with details of each block;
- Objectives of forest management;
- Methods of forest protection;
- Forest development activities;
- Nursery, plantation and income generating programs;
- NTFP development activities;
- Provisions for using income from sale of products;
- Penalties, and
- Provisions for wildlife protection.

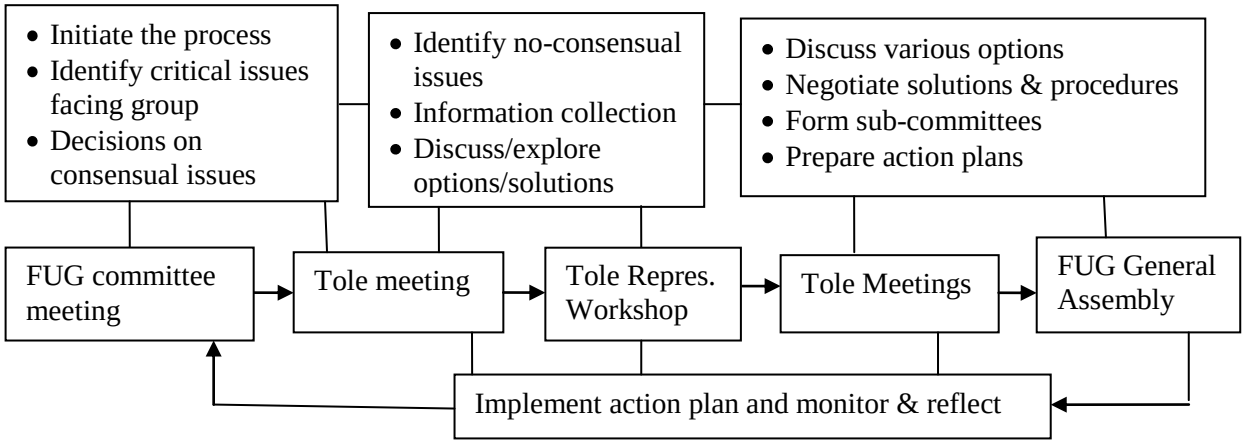
Likewise, the buffer zone management regulation (HMGN 1996) provides the guideline, based on which the BCFUG should prepare a plan including the following contents:-

- Name of the concerned users' committee;
- Boundaries of the units of the concerned users' committee;
- Management methods to be adopted for the conservation of forests, wildlife and environment;
- Method of forest resources collection**;**
- Grazing place and method in forest area;

- Plant thinning, pruning, cleaning and other methods of forest silviculture,;
- Method of reforestation and forest reform;
- Method of distribution, management and sale of forest resources,;
- Method and policy to be adopted for land management, and
- Other necessary matters

Based on the operational plan, the FUG Committee prepares management plans using the aforementioned guideline and interest of community people. Malla et al. (2002) have developed the process of forest management planning and monitoring based on their field work (figure 8.2). They have proposed five steps to identify problems and issues of forest management, plan preparation and monitoring its implication at the community level (Malla et al. 2002).

Figure 8.2 A generic process of forest management planning and monitoring systems with forest users



Source: Adapted from Malla et al. (2002:64)

Hence, there are common processes of local people participation in the Community Forest Users Groups. This include 'a wide array of institutional mechanisms such as *Tole* (hamlet) based decision making, elected executive committees, annual assembly and formulation of forest management plans' for forest management and conservation (Ojha et al. 2009).

2.6.2 Forest Management

The sustainability of forest resources is a prominent issue due to huge anthropogenic pressure over it (GoN/MFSC 2009). In this regard, different strategies and approaches have been practiced to conserve forest in Nepal. Until the 1950s, the forest areas were used by Rana families during their autocratic regime. At the same time, the timbers from forests were sold to India for the construction of railway sleepers during the 1920s (Joshi 1993, c.f. Gautam et al.

2004). At the end of 1950s, forests were managed by the central bureaucratic system while after the 1970s, local people were involved. The participatory approach was practiced at the end of 1980s for management (Gautam et al. 2004). This shows three major shifts in the forestry sector: privatization, centralization or nationalization, and decentralization (Hobley 1996). Among them, centralization and decentralization approaches will be explained in the document.

2.6.2.1 Centralized Approach

Forest resources were managed by the central bureaucratic system for two decades after the 1950s. In this regard, the first Forest Act (1957) was formulated and all of the forest areas were nationalized (MFSC 2009). The Forest Act (1961) categorized forest areas and empowers forest officials. Although the Forest Act (1967) provided judicial power to forest officials, forest degradation has continued. The centralization of forest led to rapid degradation of forests due to weak state ownership and the breakdown of indigenous management systems (Sowers et al. 1994). At the same time, malaria was eradicated from the Terai, encouraging people to migrate from hills and mountains and clearing forests for agricultural land (Gurung 1983). The government emphasized 'plantation and protection' of foresst during the early 1970s (table 5.2). This approach was not successful since it undermined the role of local people's participation and their daily livelihood needs (Adhikari 2009). After heavy encroachment, the government realized the need to involve local people in forest management. Therefore, the National Forest Plan (1976) was formulated to include the participation of local people and the Panchayat Forest Rules (1978) were imposed to consider or recognize the rights of people over forests.

Table 5.2 Forestry act and policy in Nepal

Year	Policy/Legislation	Effect
1957	Private Forest Nationalization Act	• Indiscriminate cutting of forests • Conversion of private forest into farm land in Terai plains
1961	Forest Act	• Forest categorization • Empowerment of forestry officials
1967	Forest Protection Act (special Management Act)	• Judicial power to forestry officials, • Reinforcement of law enforcement power
1971	Forest products sales and Distribution Rules	• Simplification of the mechanism to forest product sale
1973	National Parks and Wildlife Conservation Act	• Categorization of Protected Areas • Management of protected areas
1974	National Parks and Wildlife Conservation Regulations	• Provision of Hunting Licenses • Management of Protected Areas

1977	Amendment in Forest Act 1961	• Provision of 'Panchayat Forest' and 'Panchayat Protected Forest'
1978	Panchayat Forest and Panchayat Protected Forest Regulation	• Handing over of National Forest to village Panchayat • Formal recognition of rights of local people for forest management
1982	Decentralization Act	• Authority to District and Village Panchayat • Promotion of user's committee concept
1984	Private Forestry Rules	• Promotion of Private Forest
1987	Revision of PF and PPF Rules 1978	• Earning from 'Panchayat Forest' and PPF channeling back to the concerned Panchayats
1993	Forest Act	• Reduction of the extent of quasi-juridicial authority of forestry officials • Empowerment of FUG for forest management • People-based management
1995	Forest Regulation	• Legalization of the process of Community Forestry • Outlining the process of Community forestry • Change on the role of Forestry staff's from custodial to facilitation
1999	Revision of Forest Act, 1993	• Development of the control mechanism for violation of Operational Plan by FUGC member • Provision for spending the FUG fund in various developmental activities
2000	1. Revision of CF Directives, 1994 2. Revision of MPFS, 1988	• Provision for compulsory inclusion of growing stock of CF and annual allowable cut in Operational Plan • Collaborative management of national forests on the basis of landscape planning approach
2002	Revised Forest Policy	• Management of degraded and open forest areas in the Terai and Inner-Terai regions
2002	Leasehold Forestry Policy	• Provision of basis for the handing over of national forests to the private sector in the form of leasehold forests
2004	Herbs and NTFP Development Policy	• Provisions for conservation, management and utilization of NTFPs

Source: MFSC (2009)

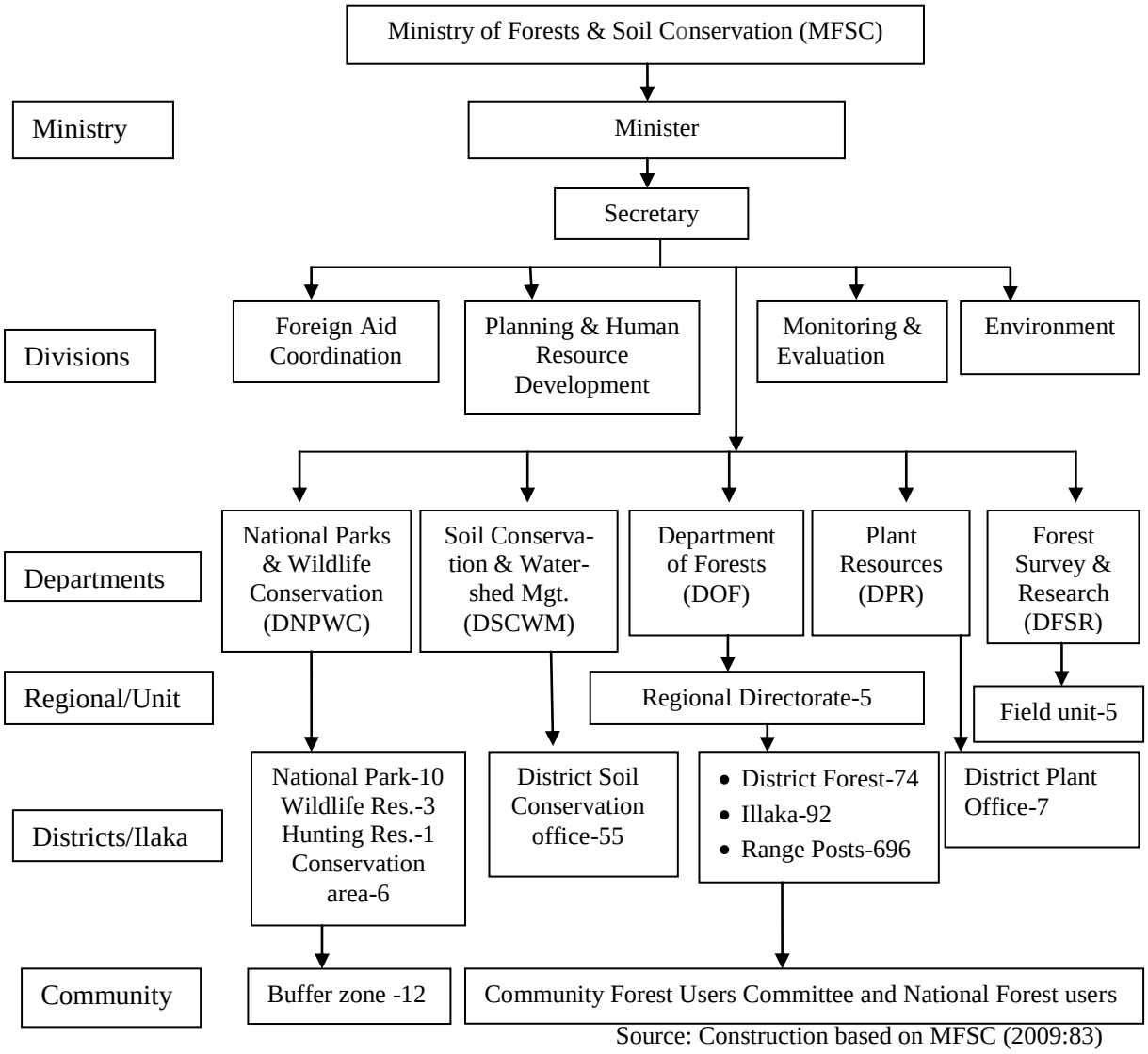
2.6.2.2 Decentralized Approach

The Decentralization Act was enacted in 1982 and empowered the district and village Panchayats and the political bodies at the local level (Sowers et al. 1994). This emphasized the participatory and integrated planning process, mobilization of local resources and strengthening of local institutions (Pokharel et al. 2007). Similarly, District Forest Offices (DFOs) were formed in 74 districts of Nepal to work under the direct supervision of the Ministry of Forests and Soil Conservation (figure 9.2). The Department of National Parks and Wildlife Conservation are responsible for managing the protected areas and buffer zones whereas other forest lands and its inhabited wildlife are under the responsibility of the Department of Forest, both of which are under the control of Ministry of Forests and Soil Conservation.

Actual participatory forestry management has been in practice since the 1990s in Nepal. To institutionalize people's participation, the concept of Forest Users Groups was initiated through the Forestry Sector Master Plan (1989). The Forest Act (1993) and the Forest Rules (1995) made provisions to hand over national forests to Community Forestry User Groups (CFUGs). The forest laws, too, made provisions to define government-managed forests (national forest), leasehold forests, private forests, religious forests, community forests, and buffer zones. Until May 2010, there were 14,572 CFUGs of 1672,007 households managing 1243,897 ha forests; 4,918 leaseholds groups of 43,762 households managing 26,900.38 ha leasehold forest; 21 religious groups covering 574.49 ha of religious forest, and 2,458 private forest registered as covering 2360 ha (Gautam 2010).

Likewise, collaborative forestry programs are running in eight Terai districts, where 136,463 households with a population of 1370,690 are managing 17,997 ha forest and pilot projects in Bara, Parsa and Rautahat Districts were launched (DoF 2010, c.f. Gautam 2010). Additionally, 12 buffer zones, 206 users committees, and 4,093 users groups (DNPWC 2010) have been established around the protected areas, where 116,754 households are managing 560,267 ha of forests (GoN/DNPWC 2011). Management of forest resources by the users groups includes plantation in the degraded forest, control of forest fires, control of illicit tree felling, controlled grazing, etc. However, the management of community forest has a top-down approach (Jamarkattel et al. 2009) and the forest handing over process is still passive in the Terai region (Bampton et al. 2007).

Figure 9.2 Organizational Structure of the Ministry of Forests and Soil Conservation



Source: Construction based on MFSC (2009:83)

2.6.3 Wildlife Conservation

Since the early 1970s, wildlife conservation and management has been initiated in Nepal. However, hunting of certain animals such as rhino, tiger and elephant was restricted even in the 1840s during the Autocratic Rana Regime (HMGN/MFSC 2002, DNPWC 2009). After the formulation of the first Wildlife Conservation Act (1957), the concept of wildlife conservation was initiated, which was followed by the National Park and Wildlife Conservation Act (1973) (HMGN 1973). The conventional way of conservation commenced after the protected areas were established, these areas were however, isolated and fragmented by agricultural land and settlements. To involve local people in conservation, the community forest concept was incepted during the 1980s, whereas buffer zone management began in the mid 1990s (HMGN 1996). Similarly, large scale (i.e. regional and landscape level) conservation was initiated to

conserve wildlife species beyond reserves in 2001. Including parts of Nepal, India, Bhutan and Myanmar, nineteen different ecoregions and seventeen conservation landscapes in the Eastern Himalaya Ecoregion Complex have been identified. Among them, the Terai Arc Landscape is a prominent area based on ecological integrity and biodiversity conservation of particularly mega species such as tigers, rhinos, elephants, etc. (WWF 2006).

2.6.3.1 Conventional Approach

After the formulation of the Wildlife Conservation Act (1957), Mahendra Mriga Kunj was declared in 1959 and a rhino sanctuary was established in 1963 in Chitwan (DNPWC 2009), but it was used as a hunting area by the royal family. After the formulation of the National Parks and Wildlife Conservation (NPWC) Act 1973 (HMGN 1973), this sanctuary was converted into the first national park of Nepal. During the 1970s and 1980s, most of the protected areas were established and managed by the government. The Nepalese Army (NA) was deployed in order to ensure strict law enforcement, and prevent deforestation and poaching of endangered species such as tiger and rhino. Furthermore, the NPWC Act (1973) was amended many times (in 1974, 1982, 1989 and 1993) to manage protected areas, conserve wildlife, and develop, promote and manage these areas thereby integrating the local livelihood (Bajracharya et al. 2007). At present, there are twenty protected areas and 12 buffer zones covering 34,185.62 km^2 (i.e. 23.23 percent) of the total land surface of Nepal (DNPWC 2010). Among them, ten national parks are under the IUCN Category II, three wildlife reserves are under Category IV and six conservation area,s with one hunting reserve, are under Category VI in Nepal (table 6.2).

Table 6.2 Protected areas and buffer zones in Nepal

S.N.	Description	IUCN category	Area (sq. km)	Year Declared	Conservation focus
1	Chitwan NP	II	932	1973	Rhinoceros, elephant, tiger, bison
1.1	Buffer Zone	-	750	1996	
2	Bardia NP	II	968	1976/88	Rhinoceros, elephant, tiger, etc.
2.1	Buffer Zone	-	508	1997/010	
3	Rara NP	II	106	1976	Musk deer, red panda, and high alt. lake
3.1	Buffer Zone	-	198	2006	
4	Langtang NP	II	1710	1976	Musk deer and red panda
4.1	Buffer Zone	-	420	1997/98	
5	Sagarmatha NP	II	1148	1976	Musk deer, red panda, snow leopard
5.1	Buffer Zone	-	275	2002	
6	Khaptad NP	II	225	1984	Wild goat, blue sheep and spiritual site

6.1	Buffer Zone	-	216	2006	
7	Shey Phoksundo NP	II	3555	1984	Wild goat, blue sheep, musk deer, lake
7.1	Buffer Zone	-	1349	1999	
8	Makalu Barun NP	II	1500	1991	High altitude endangered plants
8.1	Buffer Zone	-	830	1998	
9	Shivpuri NP	II	144	2002	Conservation of capital city
10	Banke NP	II	550	2010	Tiger and its prey
10.1	Buffer Zone	-	343	2010	
11	Koshi Tappu WR	IV	175	1976	Wild buffalo and migratory birds
11.1	Buffer Zone	-	173	2004	
12	Suklaphanta WR	IV	305	1976	Swamp deer, rhinoceros, tiger
12.1	Buffer Zone	-	243	2004	
13	Parsa WR	IV	499	1984	Tiger, deer, antelopes, bison
14	Buffer Zone	-	298	2004	
15	Dhorpatan HR	VI	1325	1987	Blue sheep
16	Annapurna CA	VI	7629	1985	Endemic plants and animals
17	Kanchenjunga CA	VI	2035	1997	Endemic plants and animals
17	Manaslu CA	VI	1663	1998	Endemic plants and animals
18.1	Blackbuck CA	VI	15.95	2009	Blackbuck
19	Gaurishankar CA	VI	2179	2010	Cultural and natural heritage
20	Api-Nampa CA	VI	1903	2010	Musk deer and other species

Source: WWF (2006), MFSC (2006), DNPWC (2010), (Note: NP-National Park, WR-Wildlife Reserve, CA-Conservation Area)

In order to overcome the existing conservation challenges and comply with international rules and regulations, the Government of Nepal has signed more than two dozen of international convention and treaties. Among them, the United Nations Convention on Biological Diversity (CBD) (1992), Convention on Wetlands of International Importance (Ramsar Convention 1971), World Heritage Convention (1972), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) (1975), UN Framework Convention on Climate Change (1997) and UN Convention to Combat Desertification (1994) are the most relevant ones (GoN/MoEST 2008).

2.6.3.2 Participatory Approach

Local people were restricted from carrying out their traditional practices and customary rights after the establishment of protected areas in Nepal (WWF 2006). In some other countries, many communities have been displaced, and their practices have been restricted. After the establishment of parks, their livelihoods have been interrupted. These issues are hard to manage mainly because of weak governance (Coad et al. 2008, Schmidt-Kallert 2009). In Nepal, indigenous people (for instance Tharu) have claimed their rights for resources management. At the same time, some people are involved in poaching and hunting even after the strict protection endeavors from the Nepalese Armed Forces. In order to solve these

problems and control illegal activities, the Government of Nepal has initiated a community-based conservation (CBC) approach for managing forest resources and wildlife conservation since 1980s.

The Annapurna Conservation Area (est. 1985) was the first protected area, and is protected and managed by a Non-Governmental Organization through active local participation (Bajracharya et al. 2007). At present, Makalu Barun National Park, six conservation areas and all of the buffer zones are being managed by the local community with the assistance of the government and NGOs (table 6.2). Buffer zones are being expanded for biodiversity conservation thereby reducing pressure on national parks and wildlife reserves, and bringing local people into the mainstream of conservation through their livelihood enhancement and community development (Heinen and Mehta 2000). However, the protected areas are still under pressure from encroachment, grazing and excessive collection of Non-Timber Forest Products (NTFPs) as well as the natural disturbances (e.g. invasive species) (WWF 2006).

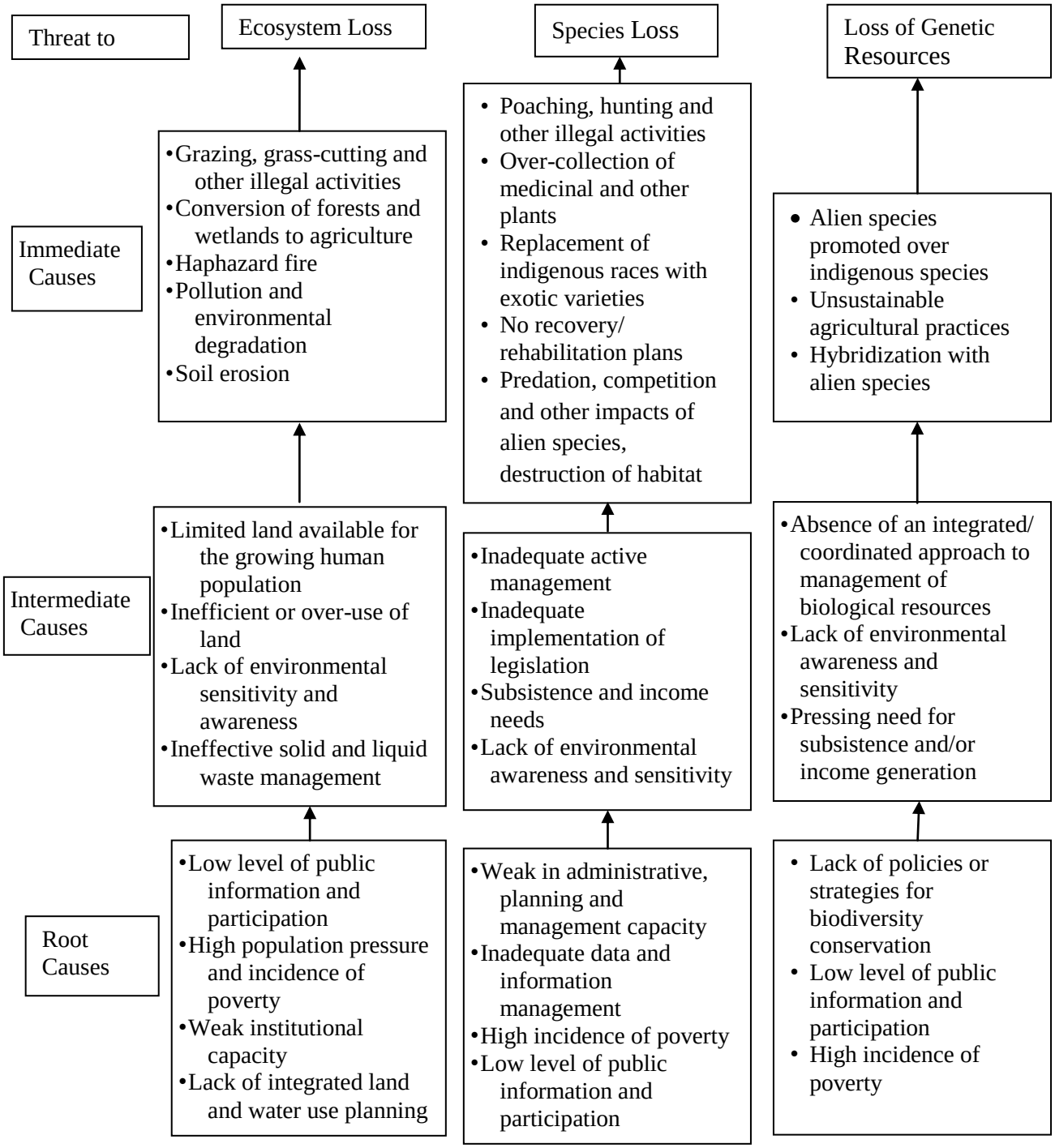
2.6.4 Restoration Practices

2.6.4.1 Major Issues in Restoration and Conservation

Restoration of degraded forest areas has become complicated as it is influenced by multiple factors such as political instability, social and economical issues, climate change, etc. in Nepal. Human encroachment has continued in forested land, and some areas have been affected by the introduction of exotic species (HMGN/MFSC 2002, GoN/MFSC 2009). In general, native species are declining, however, the number of some plant and animal species have increased in numbers after the introduction of exotic species. For instance, between 1971 and 1975, three fish species i.e. *Salmo guirdneri, S. trutta* and *Oncorhychus rhodurus* were introduced from India, England and Japan (Shrestha 1994, c.f. HMGN/MFSC 2002), and new fruit species (e.g. strawberries and grapes) were introduced in the last three decades. But there are over a hundred exotic plant species (e.g. *Eupatorium adenophorum, Lantana camara, Mikania micrantha, Bidens pilosa, Amaranthus viridis, A. spinosus, Cassia tora, C. sophera*) which became weeds in Nepal. Some plant species (e.g. *Eucalyptus, Pinus, Populus)* used for restoration in degraded land have affected the composition of Nepal's biodiversity (HMGN/MFSC 2002). In this regard, the Nepal Biodiversity Strategy (2002) has identified causes of threats to ecosystems,

species and genetic resources in Nepal (figure 10.2). These causes (i.e. root, intermediate and immediate) are embedded as the barriers of restoration and conservation.

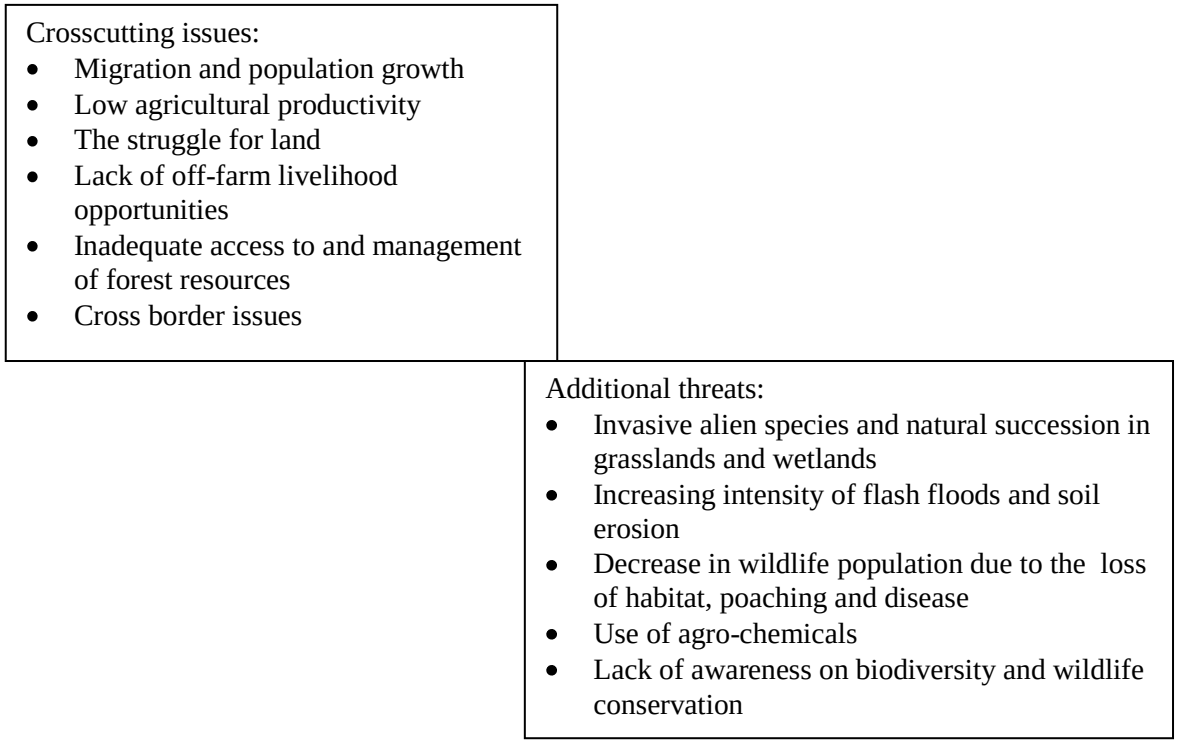
Figure 10.2 Root causes of the threats to ecosystem, species and genetic resources loss



Source: HMGN/MFSC (2002:82, 83, 84)

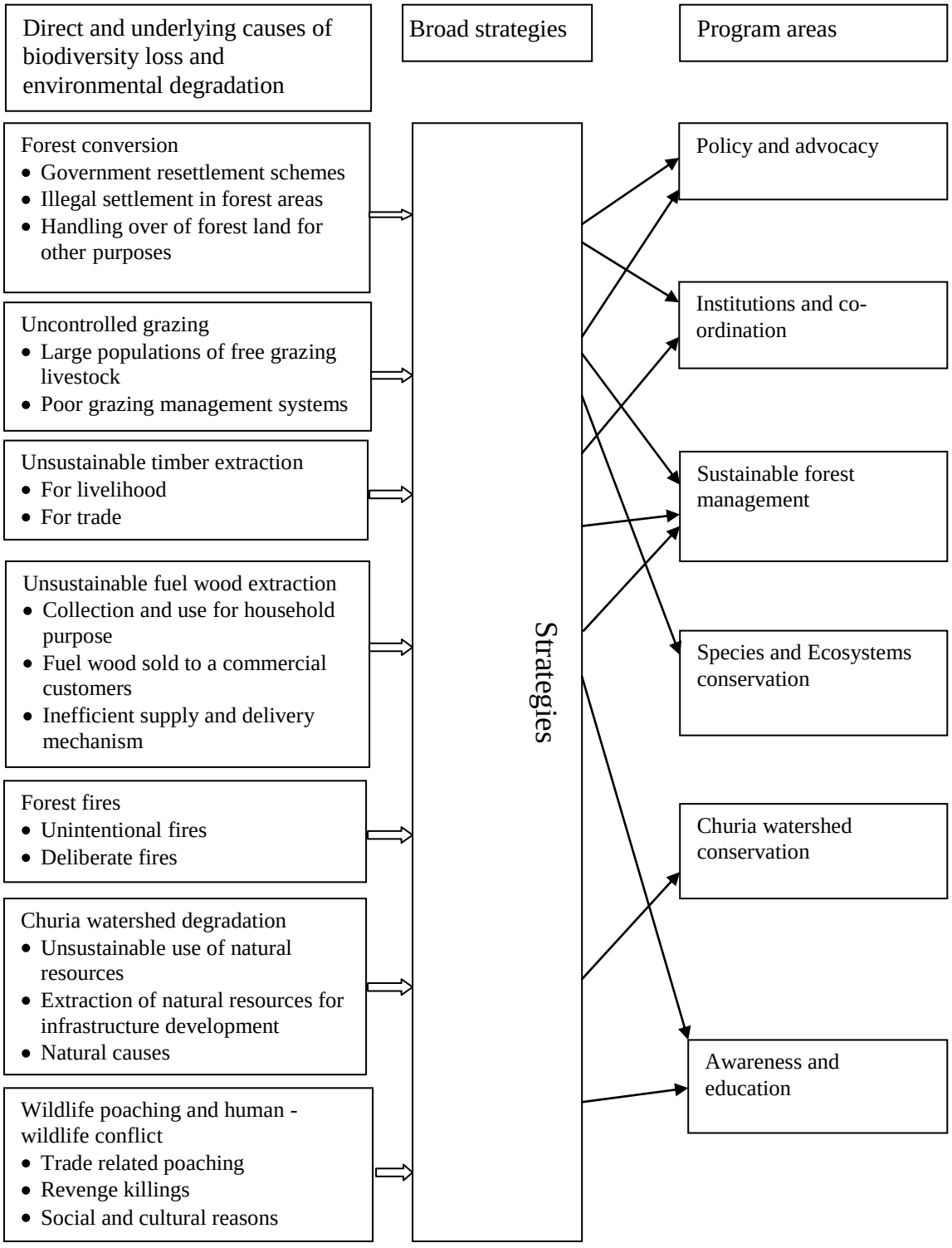
Similarly, the TAL Strategic Plan (2004-2014) has analyzed the threats, i.e. biological analysis and Root Causes Analysis (RCA), of causal factors for leading biodiversity loss and environmental degradation in the Terai Region. The Terai Arc Landscape (TAL) program was launched in this region in 2001. During the implementation of the first phase of the program, the livelihood upliftment, forest and wild animal conservation were implemented. Based on the evaluations of the implemented project, a new ten years TAL strategic plan has been developed for conserving biodiversity (HMGN/MFSC 2004). It has identified seven direct causes such as forest conversion, uncontrolled grazing, unsustainable timber harvesting, unsustainable fuel wood extraction, forest fires, churia watershed degradation, and wildlife poaching and human-wildlife conflict, and additional threats (figure 11.2 and 12.2). To solve these issues, it has developed six programs involving many actors which are implemented in the landscape.

Figure 11.2 Issues and threats in Terai landscape



Source: HMGN/MFSC (2004)

Figure 12.2 Root causes and identification programs by TAL strategic plan



Source: Adapted from HMGN/MFSC (2004:23)

2.6.4.2 Land Use and Forest Cover Changes

About 97 percent of the total area of Nepal is covered by land. The mountain region covers over one third of the total area, whereas, only two percent of the land in this region is suitable for cultivation. Likewise, in the hill region, about one-tenth of the land is considered suitable for cultivation while the Terai region is fertile and productive land. In the Terai region, about 23 percent of the total area supports nearly half of the total population of the country through agriculture. The land use data shows that the land area includes 2.96 million ha of cultivated agricultural land, 0.98 million ha of non-cultivated agricultural land, 5.8 million ha of forests (including shrubs), 1.7 million ha of pasture land and 3.1 million ha of other categories of land uses (table 7.2) (MoPE 2004).

Table 7.2 Land use pattern in Nepal

Land Use Type	**Area (000 ha)**	**Percent**
Cultivated land	2,969	**20.2**
Non-cultivated land	987	6.7
Forests	4,269	29.0
Shrub land/degraded forests	1,559	10.6
Grassland	1,757	12.0
Others	3,167	21.5
Total	**14,718**	**100.0**

Source: MoPE (2004)

In the Terai region (20 districts), a total of 17,395 ha of forest outside protected areas was converted to other land uses during 1990-2000, while only 8,344 ha was reforested. Among these districts, the annual forest change in Bardia (-0.51%), Banke (-0.20%), and Bardia National Park is decreasing, while it is, comparatively, increasing in Dang (0.16%) (table 8.2 & 9.2) (DoF 2005).

Table 8.2 Forest areas (2000/01) in Bardia, Banke & Dang excluding protected areas

	Forest cover (area in ha)			**Cover (%)**		
District	**Forest**	**Degraded forest**	**Total**	**Forest**	**Degraded forest**	**Total**
Bardia	25996	7723	33719	2.3	0.7	2.9
Banke	108900	1920	110820	9.5	0.2	9.6
Dang	181533	12729	194262	15.8	1.1	16.9

Table 9.2 Forest areas changes (2000/01) in three districts with park

District/Park	**Forest cover 1990 (area in ha)**	**Forest cover 2000/01 (area in ha)**	**Change in forest cover (area in ha)**	**Annual rate of change (%) within 10 years**
Bardia	35491	33719	-1772	-0.51
Banke	113074	110820	-2254	-0.20
Dang	191200	194262	3062	0.16
Bardia NP	78637	77437	-1200	-0.15

Source: DoF (2005)

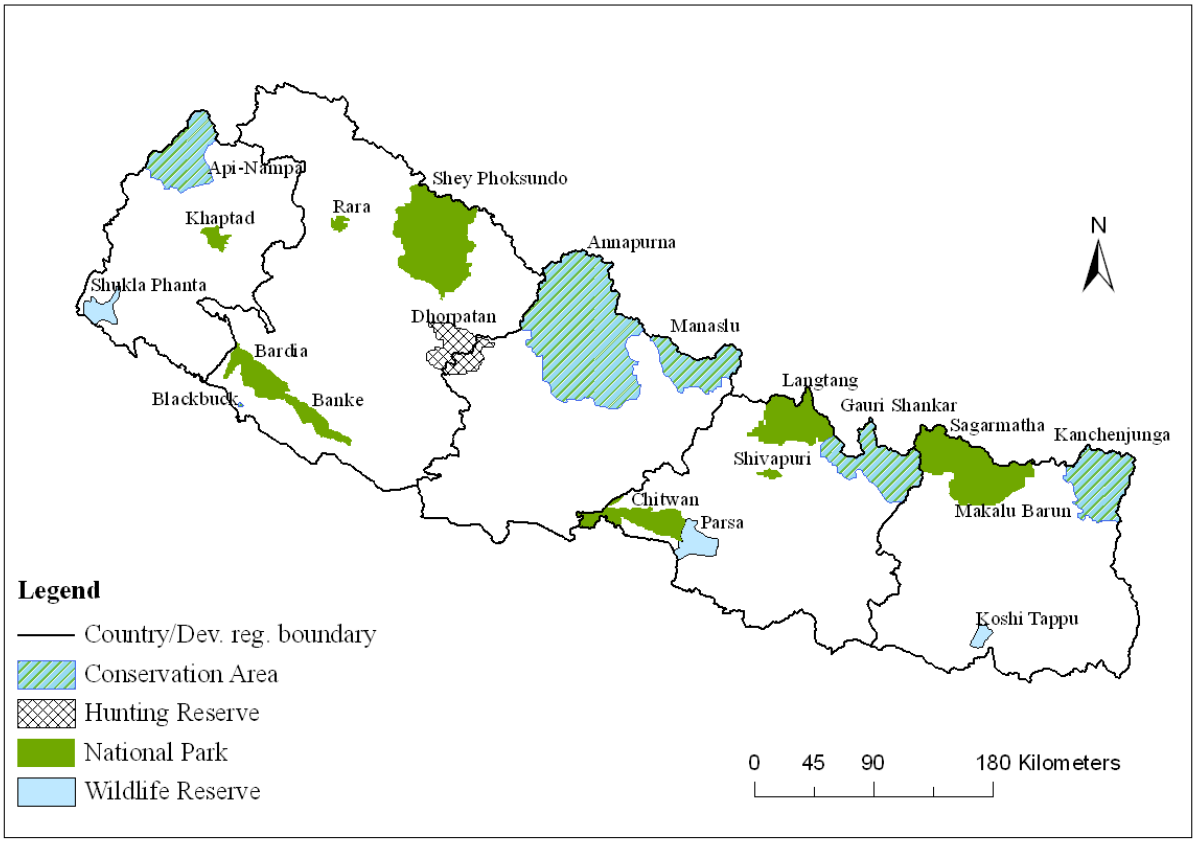
2.6.4.3 Restoration in the Field

To address the issues of conservation and restoration of forest, different measures have been adopted since 1950s in Nepal. Passive restoration (establishment of protected areas) and active restoration (plantation, thinning/ pruning, controlled grazing/ logging, etc.) are in place. Aronson et al. (1993a) have used the terminology restoration, rehabilitation (to repair damaged ecosystem functions) and reallocation (to describe new state of ecosystem structure and functioning). Similarly, Brown and Lugo (1994) have used restoration along with two other terminologies: reclamation (highly degraded lands returned to productivity through restoring some functions) and rehabilitation for sustainable tropical forest development. Likewise, Atkinson (1994) used rehabilitation, revegetation, recovery, enhancement and ecological engineering (establish new combinations of plants and animals, native and exotic, as biotic communities for conservation purpose) in restorative action. In Nepal, restoration actions can be explained in terms of passive restoration, revegetation, rehabilitation and translocation.

Passive Restoration

To conserve rare and endangered species of flora and fauna and unique environment, protected areas have been established since 1973. There are twenty protected areas including national parks, wildlife reserves and conservation areas in Nepal (table 6.2, figure 13.2). Target species such as tiger, snow leopard, rhino, elephant, etc. are being conserved by maintaining and protecting prime habitat within the protected areas and intact forest under the Ministry of Forests and Soil Conservation (DNPWC/MFSC/GoN 2007). These protected areas are reducing habitat degradation, controlling anthropogenic disturbances and restoring the target or umbrella species for ensuring long-term survival. Hence, protections of these areas act as passive restoration to revitalize degraded forest ecosystem and increase wildlife species.

Figure 13.2 Protected areas of Nepal



Source: Digitized based on DNPWC (2010)

Revegetation

Restoration of private grassland and forested areas might have been practiced from the primeval period. People have been uprooting and burning unwanted plants and planting new valuable seedlings. In Nepal, formal restoration program at community level was initiated in 1978. The first project of this kind was launched in the mid hills by the Australian International Development Assistance Bureau and the Government of Nepal. This bilateral project, "the Nepal-Australia Community Forestry" was initiated in two districts, namely, Sindhupalchok and Kavrepalanchok. Within the period of 17 years, (from 1978 to 1995), a total of 18,000 ha of new community plantation, mainly *Pinus species* on grasslands, degraded shrub land and abandoned agricultural land, was established (Evans 2001).

Forest restoration was accelerated after the formulation of the Forest Act (1993), which emphasized people's participation and handed over the national forests to the community. After the community forestry program, the rate of deforestation was controlled, green areas have expanded, degraded land has been rehabilitated and biodiversity has been restored,

making it a successful program in Nepal (Gautam et al. 2004). The number of people's participation in forest restoration is rapidly increasing, which not only increases socio-economic benefit, but also contributes to the management and conservation of the forest. Various restoration techniques such as prohibiting wild animal hunting, controlling forest fire, restricting grazing and forest encroachment, and plantation and silviculture practices (cleaning, weeding, singling, thinning, selective felling, etc.) are the major activities practiced in the community forests (Acharya 2003). Most of the degraded community forests have improved, although they are using limited technical silvicultural activities (Yadav et al. 2003). Restoration and active community forest management is essential for long term conservation where there is under-utilization of forest and protection oriented management (Yadav et al. 2009).

Rehabilitation

The buffer zones support in conserving core habitats of protected areas. A total of twelve Buffer Zone Management Committees/ Conservation Area Management Committees have been formed for community based conservation and management of target species including wild cats around the protected areas of Nepal (DNPWC 2010). Buffer zone community forests have contributed in rehabilitating the core habitat (protected areas) as well providing refuge habitat in the buffer forest for wildlife (DoF 2005). Despite this, nominal active restorations (e.g. grassland management, invasive species control) have been practiced to rehabilitate habitat inside the protected areas.

Translocation of Species

Some species (rhino, black buck, gharial, etc.) are translocated to other habitats in the protected areas. Among the target species in the Terai landscape, rhinos were found only in Chitwan National Park, prior to its translocation to Bardia National Park (BNP) and Suklaphanta Wildlife Reserve (SWR). A total of 87 rhinos were translocated from Chitwan National Park (CNP) to Bardia National Park (BNP) and Sukla Phanta Wildlife Reserve between 1986 and 2003 (DNPWC 2009). Among them, four were translocated to SWR in 2001 to establish viable rhino populations in other protected areas (GoN/MFSC 2006). After the translocation and rehabilitation of the species, the population of some species like the black buck in Khairapur (near BNP), rhinos in BNP and SWR, and gharials in rivers inside CNP and BNP, have increased (HMGN/MFSC 2002, DNPWC 2010). Unlike this, the translocation program of five

blackbucks in 1980 and twenty five in 1992 to Bagaura Phanta inside Bardia NP was a failure, due to the introduction of blackbuck to a completely new habitat (Upreti 1994). A tiger translocated from CNP to Lamidamar, BNP in 2011 was also unsuccessful in the long run due to limited community support and poor management from the government side.

Some Restoration Achievements in the Terai Landscape

Different national and community based organizations are involved together with the Nepal Government in forest conservation and management. The National Trust for Nature Conservation (NTNC) (formerly King Mahendra Trust for Nature Conservation-KMTNC)/ Nepal Conservation Research and Training Center is one example of an organization that has supported community forest programs in the buffer zone of Chitwan National Park since 1989. KMTNC (2001) mentions that over 4,000 ha of degraded forest areas have been restored and developed into community forest, which is the potential habitat for endangered species such as tiger and rhinoceros. NTNC has launched programs such as the restoration of community forest, wildlife monitoring, GIS map analysis, ecotourism along with awareness activities for habitat restoration.

Likewise, various international conservation organizations (e.g. DFID, IUCN, ICIMOD, SNV, UNDP, WWF) have been working in the field of restoration. For example, WWF Nepal has been involved in Terai region restoration since late the 1990s. As mentioned in a report of WWF (2002a), during the first year, the Community Forest Users Groups (CFUGs) planted 38,933 seedlings (161.5 ha of enrichment plantation) in the degraded community forest land along the corridors and bottlenecks. Similarly, a total of 30.22 km of trenches and 28.79 km (including 5.4 km in Lamahi) of barbed wire fencing was also constructed, 30 percent of the cost was borne by the Terai Arc Landscape (TAL) program. Similarly, the District Forest Office - Banke carried out regeneration on 50 ha of degraded land in Dhakeri at Mahadevpuri through barbed wire fencing. There were 25 CFUGs in Lamahi, and 13 Buffer Zone Users Committees and four CFUGs Coordination Committees formed. Similarly, degraded patches in various community forests have been restored and 17.864 km of trenches have been constructed in 14 CFUGs areas in TAL. In order to prevent fire induced forest damage, a four kilometer long fire line was constructed in four community forests under the Dovan Community Forest Coordination Committee (CFCC). More than 160,000 non-timber forest products (NTFPs), fodder and tree species seedlings were produced in different CFCCs and District Forest Office (DFO) nurseries. In this regard, the mid-term evaluation report of Lamsal

et al. (2010) mentions that about 1051,635 seedlings of multipurpose use (trees, fodders and NTFPs) was planted in 1,156.39 ha land; 1,762.5 ha encroached forest was restored and 370 ha grassland was managed in the TAL program area between 2006 and 2010. Another mid-term evaluation of the Western Terai Landscape Complex Project (WTLCP) reports plantation in 157 ha land, bio-fencing in 90.4 km, and maintenance of 100 ha of grasslands and 31 wetland sites (Acharya et al. 2010).

Besides the community forestry and buffer zones, the TAL program has been supporting habitat restoration interventions inside protected areas. Both financial and technical support are provided to clear the unwanted bushes, burn grasses and uproot the unpalatable trees. As mentioned in a report from WWF (2002a), approximately 50 ha of grassland in Lamkauli (BNP) have been managed especially to rehabilitate the blue bull population. In addition, 100 ha of grassland in a Chepang area (BNP) has been managed by uprooting invasive species such as simal *(Bombax ceiba)* and unwanted grasses. Further, in Suklaphata Wildlife Reserve (SWR), 100 ha of grassland have been managed for restoring the swamp deer population and a few waterholes were constructed in Bardia National Park (BNP) and SWR. This shows active forest restoration endeavors practiced for wildlife conservation in and around the protected areas.

2.7 Conceptual Framework

A conceptual framework is developed for directing the research process. It explains, either "graphically or in narrative form, the main things constructs the key factors or variables, and the presumed relationships among them", which can be "rudimentary or elaborative, theory driven or commonsensical, descriptive or causal" (Miles and Huberman 1994:18). I have prepared a rudimentary type of framework which visualizes the process of restoration particularly participatory restoration and evaluation (figure 14.2). Evaluation research can concentrate on 'process or on the outcomes or both the process of the program and its outcomes for the recipients' (Weiss 1998:5). Hence, I have used both process and outcome of restoration in which each step has variables that are needed to be considered in restoration. Nevertheless, the main focus is on the restoration outcomes. The outcomes of the restoration show the indicator of success which can be determined on the basis of the objectives or goals.

Influencing Elements: Besides climate change and natural calamities (flood, landslide, fire, draught, etc.), forest restoration has been influenced by the governmental and international/

national non-governmental institutions. Restoration can be conventional or participatory, establishment of protected areas that are governed under the strict rule of protection is considered as the conventional approach whereas active involvement in decision making, use and conservation of resources, is participatory. Most of the protected areas have been established on the basis of scientific research and the decision of central government in the recent decade. However, long-term conservation is not possible without taking into account the local people. It is their right to manage, conserve and properly use resources and fulfill their daily forest needs. Availability of the means of livelihood, social norms and values, use and importance of resources, and political situation and regulations affect decision making. Hence, ecological, socio-cultural practices, economic and political, social capital are the different influencing factors that determine the participation in restoration endeavors.

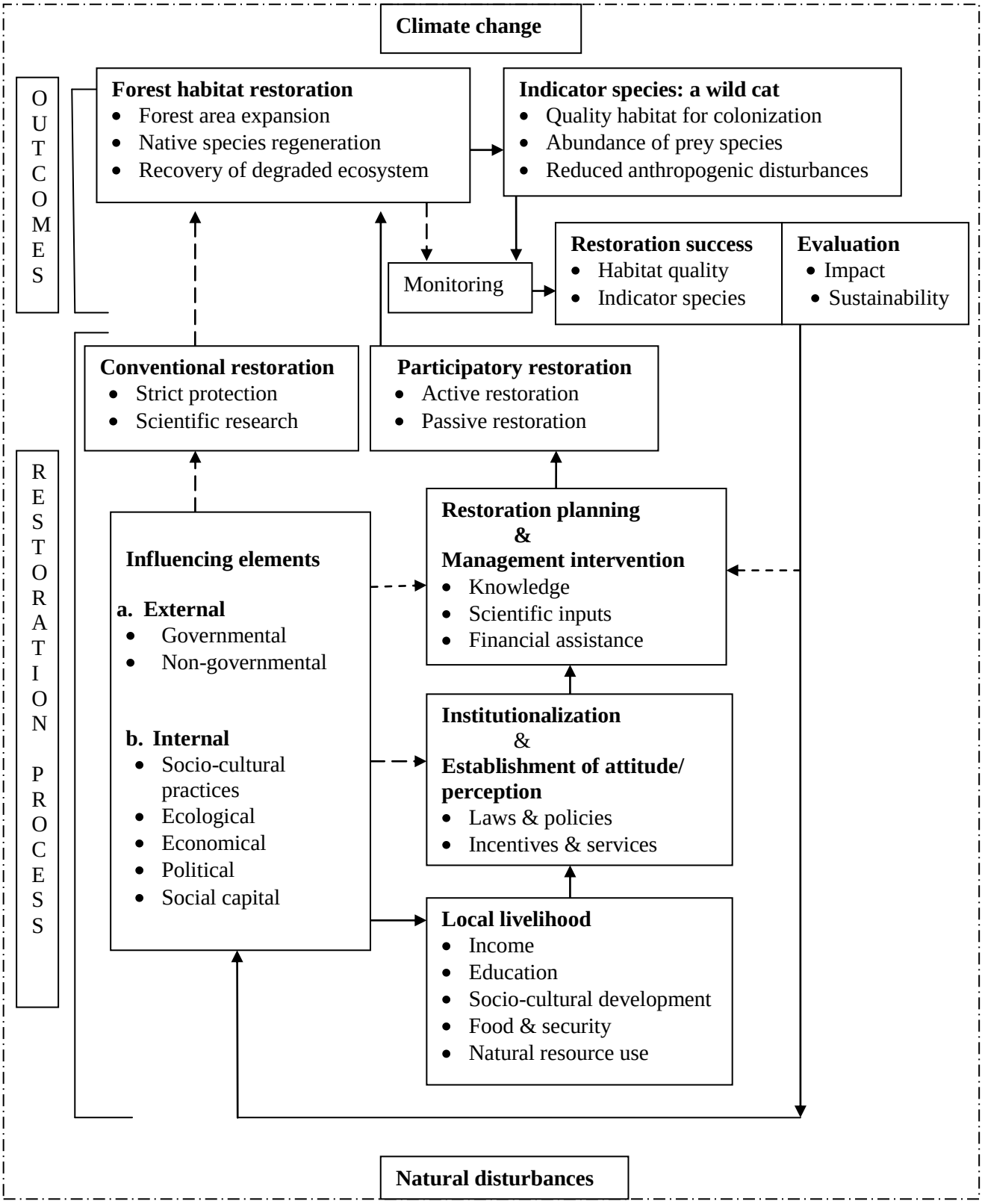
Local Livelihood and Institutionalization: In most of the developing countries, means of livelihood hinders the conservation of wildlife and its habitat restoration. People depend on ecological goods and services for their livelihoods. If we want to conserve these ecological goods and services, they demand certain incentives or inducement for participation. In some parts of the world, active and educated people use more resources and pro-poor people demand immediate benefit from any conservation programs. Hence, it is difficult to motivate people to participate in such type of programs. For the sustainability and good governance of resources use, all people should participate and establish institutions and network among them. These institutions should provide equal opportunity to all and run by the norms of institutions. If the government formulates the right rules and regulations and community people find the means of livelihoods and are assured to use resources, then their attitude is positively changed toward restoration and wildlife. The attitude and perception of people should be changed so that they can easily accept the project and have a feeling of ownership.

Restoration Design and Conservation Issues: After the formation of groups, they have to find the problems and stressors of forest degradation, which is essential in restoration planning. Success of restoration will depend on the goals and process of the project. It needs good ideas, scientific as well as technical inputs, and financial resources. Based on the constraints of these elements, an integrated plan of restoration will be developed. The plan should have clear objectives or goals, implementation strategies, easily measurable criteria of success and practical monitoring methods.

Restoration Implementation: Restoration can be done either through direct human interventions or through the establishment of protected areas. However, local participation and effort is essential to extend forest land outside the protected areas, recover the degraded ecosystem and reduce anthropogenic disturbances. At the time of participatory approach to restoration, the study will consider active restoration (e.g. planting, prescribed burning, road obliteration, invasive species control and fuel treatment) and passive restoration (e.g. stopping destructive logging, road building, livestock grazing, mining, off-road vehicle use and alteration of fire regimes).

Output/ Outcomes: Indicators of success of habitat restoration denote the reverse of degraded ecosystem, expanded forest area or native species richness and reappearance or growth of endangered species of wildlife. Naturalness in forest habitat, native plant species richness and presence of indicator species are the key elements of habitat quality, whereas colonization of indicator species, abundance of prey species and disturbances reduction, and supportive and minimum required habitat quality are the key elements of indicator species conservation. To update the condition of these components, monitoring of indicator species (e.g. tiger) and evaluation of the effectiveness of restoration particularly impact and sustainability of forest habitat are considered for the purpose of this research. If it is realized that the goal of restoration has not been made, replanning should be done through the involvement of the local management committee or central governmental institution or non-governmental organizations. Hence, the present research will examine the functioning of these steps and evaluate the impact of restoration on indicator species conservation.

Figure 14.2 Conceptual framework



Legend: ⟶ direct/strong connection, and - - - → weak connection
Source: Researcher's construction

2.8 Research Questions

Based on the conceptual framework, I developed research questions. The main research question was ‘what is the process of forest management plans, restoration practice, and its implication for wildlife, particularly indicator species conservation at the landscape level?’ In order to answer the main research question, the following specific and sub-questions were formed:-

1. What is the extant attitude /perception of people toward forest restoration and wildlife?
    a. How are people motivated to restore forest?
    b. Do they tolerate the disturbances of wild animal?
2. What is the process of forest management planning at community level?
    a. How do the forest users take part in the decision making process on forest management plans, thereby addressing restoration?
    b. How do they incorporate conservation issues in forest management plans?
3. What are the main human interventions on forest restoration and wildlife conservation, and hindering factors for it?
    a. What are the efforts/ activities that have been practiced for restoration and wildlife conservation?
    b. What are the constraints hindering restoration and wildlife conservation?
4. Can active forest restoration contribute to conserve a wild cat (tiger) and its habitat?
    a. Does active restoration contribute to the persistence of tiger in and around the protected area?
    b. Does forest quality play significant role to conserve tiger prey species?
5. Have tigers occupied the restored space after enhancing forest habitat restoration?
    a. Does it recolonize or live permanently in and around the restored habitat?
    b. How could the forest restoration and tiger conservation strategy be more appropriate?
6. How can people, forest and wildlife be integrated in the restoration?
    a. How could restoration and conservation be more sustainable?

Chapter III

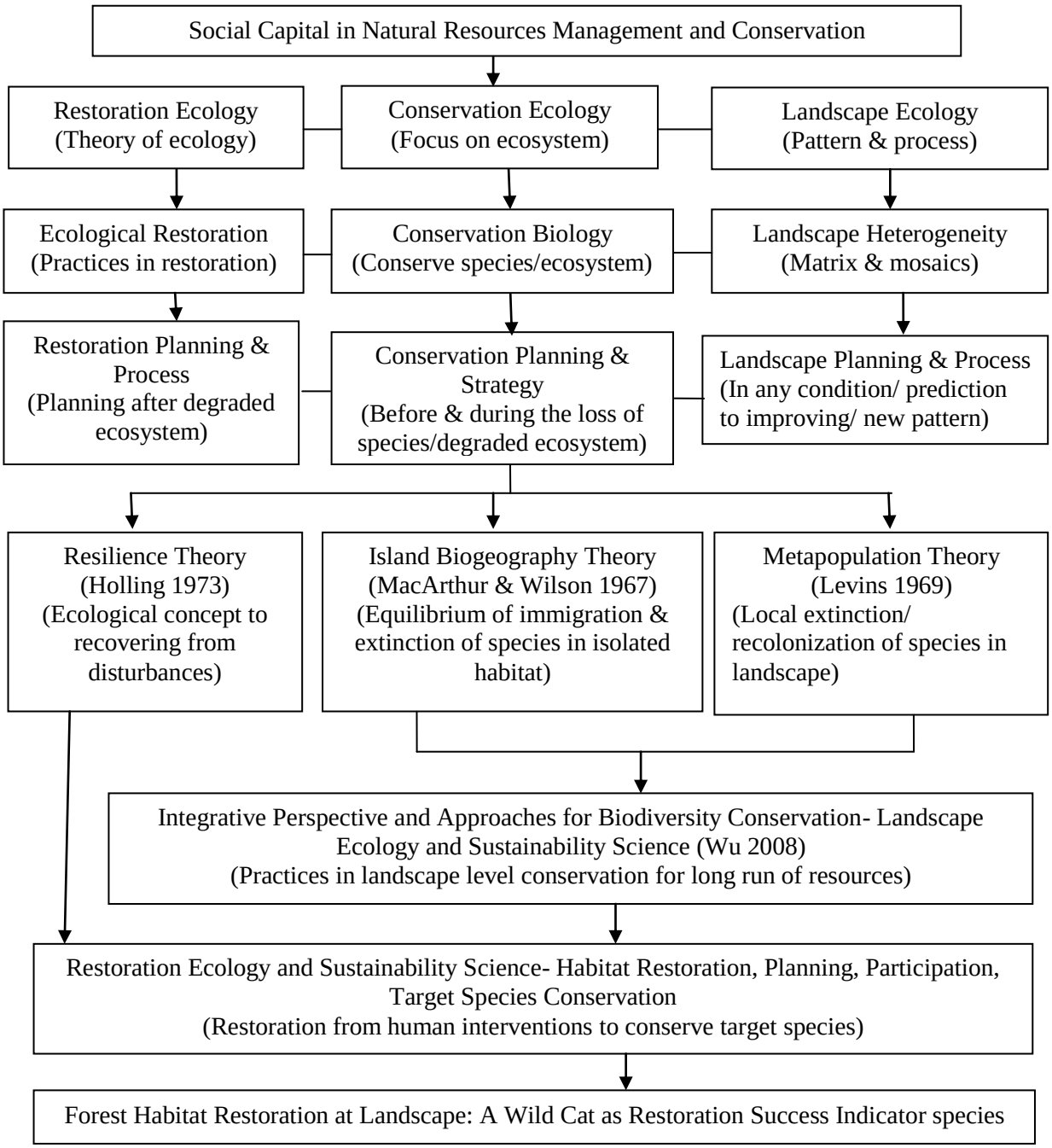
Methodology

3.1 Research Inception

In the beginning, the research started from two areas i.e. natural resources management and conservation and social capital (figure 15.3). Having understood the theories, planning and practices of restoration, conservation and landscape ecology, complications in completing the study in these areas within a period of three years was realized. In terms of consulting the literatures in the areas of my interest, Wu (2008), a well known theorist of ecological science, I have been convinced with his integrative perspective and approaches on the 'landscape ecology and sustainability science'. I have also consulted other theories, generating different ideas. Therefore, being influenced by this concept and partly from others concept, I developed a concept on restoration ecology and sustainability science in restoration and wildlife conservation for the purpose of this research. In this context, I have picked up four terms i.e. habitat restoration, planning, participation, and target species conservation, these were the unit area of initial indefinite subjects.

Finally, I tried to link this PhD research with the research of my previous Masters Degree, which was conducted on tiger ecology in Bardia National Park-extension Area (currently Banke National Park) in 1999/ 2000. Finally, I gave the present shape to my research with regard to its research working title and focus area after six months of secondary data research.

Figure 15.3 Steps of research inception



Source: Researcher's construction

3.2 Research Process

Research Gap Detection

Sufficient desk study was conducted to design the research proposal. In the beginning, I studied basic definitions and concepts of ecology and sociology, followed by the landscape ecology, restoration ecology, conservation biology and participatory restoration. After receiving the general idea of ecology, conservation and social science, I considered the contemporary research articles related to these subjects published in the scientific journals mainly in *Biological Conservation, Conservation Biology, Restoration Ecology, Landscape Ecology and Ecology & Society.* Such articles were at first separated into the theoretical and empirical category, and then classified under the specific topics such as habitat restoration, conservation approaches, participation in restoration, planning and practices, monitoring, methods, indicator species, restoration success, wild cat conservation, etc. Most of the conservation related articles were published since late 1960s, restoration ecology since early 1990s and habitat restoration since late 1990s. After analyzing the arguments and problems presented in these articles and relevant reports published in Nepal, I realized that very few researches have been conducted with regard to participatory habitat restoration with their focus on indicator species. In fact, I did not find any research conducted on tiger as an indicator species in Nepal, which is a significant research gap.

Research Procedure and Conceptual Framework Configuration

I have developed objectives, propositions and a sketch of the research procedure, which has been termed the methodology. Bailey (1982:32) defines methodology as "a research process which includes the assumptions and values that serve as a rationale for research and the standards or criteria the researcher uses for interpreting and reaching conclusions". This research has been designed to integrate different concepts, methods and sources of data available in the social and natural sciences and triangulated at the end. Triangulation is that aspect of the research which is performed by combining multiple methods and tools such as observations, interviews and surveys and findings (Silverman 1993, Denzin 2010).

Following this, a research guideline was designed that included the influencing factors, establishment of attitude and perception, planning, implementation, and variables associated

with the forest and wildlife restoration, then the conceptual framework was shaped (figure 14.2). A wild cat was taken as the conservation target species and tiger is considered as an indicator species in restoration. On the basis of objectives and conceptual framework, the main and the specific research questions have been formulated.

Research Approach Identification

While shaping the conceptual framework, I reviewed the literature to select the research approach. Research can be done through the empirical method where data will be obtained from observations or experimental research where data will be obtained from experimenting different dependent and independent variables (Simon 1969). The experiments are designed based on the 'cause and effect' and observations are designed for measuring patterns (Manly 1992). Experimental research emphasizes on the objectivity and generalizability of the conclusions (Stecher and Davis 1987). Experiments are categorized as true (controlled) experiments or quasi-experiments (Eberhardt and Thomas 1991, Epstein and Tripodi 1977). The true experiment contains attributes of random treatments and controls in the experimental units (Eberhardt and Thomas 1991). Nevertheless, a true traditional experiment approach is hardly applicable due to natural and man made circumstances (Michener 1997). Hence, the quasi-experiment is an alternative experiment approach, even if it does not meet the criteria of true experiment (Adelman 1991, Glass 1997).

Quasi-experiment and its Application in Research

In 1960s, the term 'quasi-experiment' (Campbell and Stanley 1966) was introduced referring to the "studies that were not true experiments, although they had important features in common with experiments" (Ellis 1994:241). Bailey (1982:242) states that "the quasi-experimental research does not have full control over all the sources of variation, and lack one or more of these factors". Ellis (1994:242) divides quasi-experiments into three main categories: (i) retrospective/ ex post facto designs (i.e. research after fact) (ii) prospective designs, (i.e. independent variable are measured) and (iii) time series designs (i.e. the value of dependent variables and its responses to changes of independent variables over time are measured). Similarly, Campbell and Stanley (1966) defined different types of quasi-experiment. Among them are time series designs, and multiple time series designs that use control groups and non-equivalent control group designs as the major types (Adelman 1991:296). There is a relationship between "quasi-experiment and case study, where case study is designed for one

group post-test only, time series is designed for one group pretest-post-test, and non-equivalent control groups are designed for only post-test with non-equivalent control group" (Adelman 1991). Yin (1994:13) defines case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident, and where multiple sources of evidence are used".

In this context, the quasi-experimental designs particularly 'interrupted time-series design' are used in evaluation research (Epstein and Tripodi 1977). Rossi and Freeman (1982:20) define evaluation research as "the systematic application of social research procedures in assessing the conceptualization and design, implementation, and utility of social intervention programs". It has relationship between cause and effect, however, there are third 'variables' which influence it (Glass 1997). For example, the teacher's salary and pupil's achievement maintenance have mutual relationship, but it will be influenced by a third variable i.e. family wealth. In the interrupted time-series design, research is conducted before and after intervention with certain time intervals. It will compare experimental groups with other groups or same experimental groups before and after interventions which will determine the effectiveness or effect of interventions (Weiss 1998).

The social experimental evaluation research was started in the 1970s. The independent variables and dependent variables are used for describing the quasi-experiments (Weiss 1998). In this regard, quasi-experimental design was used by Kapoor (1991) in India. His study was conducted six years after the disaster in Bhopal, (accident in India 1984) and investigated the evidence of increased risk of miscarriage among women who were in the affected area at the time of the Methyl Isocyanate release (Kapoor 1991, c.f. Ellis 1994). Another research was conducted by Smith (1985) in Australia, which was a group matching project to evaluate the effectiveness of an Alcoholics Anonymous (AA) program for women. The study compares the treatment outcome for 43 participants with 35 similarly diagnosed Australian women where these two groups of women were not significantly different on the basis of a place of birth, years of residency in Australia, age of first intoxication and age of first seeking treatment (c.f. Ellis 1994:243). Similarly, Reiser and Simmons (2005) applied a quasi-experiment to measure the effectiveness of ecolabel promotion by changed tourists' behavior in New Zealand. They surveyed the attitude of tourists after promoting the touristic information materials (e.g. brochures) by observing flow of tourists in the cities and interviews, and analyzed through

triangulation. In natural science, researchers used experiments or quasi-experimental designs for monitoring restoration with regard to wildlife (Block et al. 2001).

After gaining basic knowledge on the quasi-experimental design, I took one community forest, a newly restored site in the Mahadevpuri bottleneck and a buffer forest in Bardia National Park as a reference site After the TAL program, forest habitat restoration interventions were undertaken that contributed in maintaining forest quality, increasing tiger prey species and ultimately increasing the mobility of tiger. If such casual relationship is not found, a third variable i.e. disturbance, can be considered influential in tiger dispersal. In the same area, I performed research (e.g. Bogati and Basnet 2001, Bogati 2012) before the TAL project, and other studies (e.g. Basnet et al. 1998, Gurung 2002) have also been conducted. This available information was compared with the present data of tiger after the habitat restoration in and around the Banke National Park. Hence, 'quasi-experiment' is the appropriate approach for the present research.

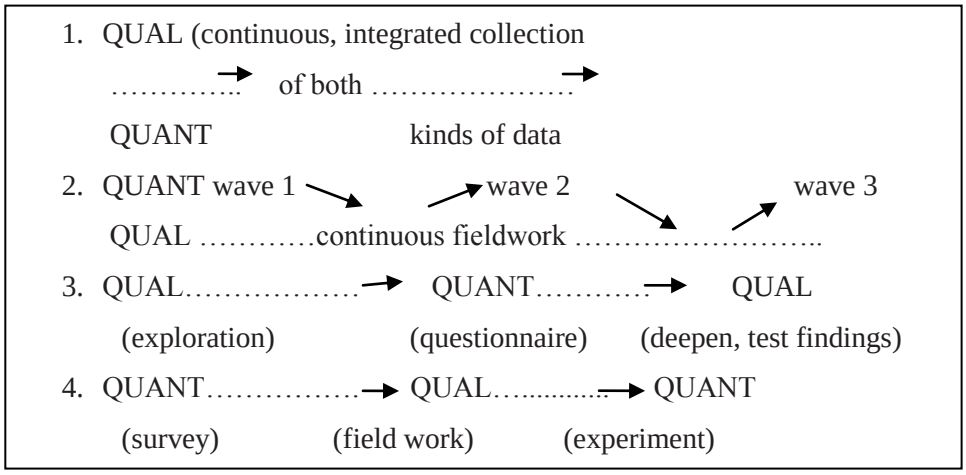
Research Method Selection

Both qualitative and quantitative methods were designed to include both the social and natural sciences. It is suitable to use both methods in the case where the cross-cutting of social and natural arrays and diverse research questions require to be addressed. However, the selection of qualitative and quantitative research is complex and controversial for judgment (Rossman and Wilson 1985) where researchers have pointed out that both methods have merits and demerits (Bryman 2008, Borrego et al. 2009). Many researchers have agreed (e.g. Rossman and Wilson 1985, Creswell and Plano Clark 2007, Creswell 2009) that both the qualitative and quantitative methods are suitable in modern research and have given the term 'mixed method research'. Johnson and Onwuegbuzie (2004:17), defined as "mixed research method is the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or languages into a single study". Likewise Creswell and Plano Clark (2007:5) define that "mixed research method is the research design with philosophical assumption as well as the methods of inquiry. As a methodology, it involves philosophical assumptions that guides collection and analysis of data and mixture of qualitative and quantitative approaches in many phases of the research. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approaches"

(c.f. Creswell 2011:271). Greene et al. (1989) divide five justifications such as triangulation, complementarity, development, initiation and expansion for combining both methods (Bryman 2006:105). Rossman and Wilson (1985) advocate the reasons (i.e. to enable corroboration via. triangulation analysis, to elaborate analysis, to initiate richer and insightful analysis) behind the selection of both methods.

Research methods can prioritize either/ both qualitative or quantitative approach, or sequence and both of these methods become the complimentary aspect (Morgan 1998). For instance, Miles and Huberman (1994) proposed four designs to link both data. In their idea, Design 1 is fieldwork with continuous integrated process, Design 2 is a multiwave survey with parallel process, and Designs 3 and 4 are alternative kinds of data collection processes (figure 16.3).

Figure 16.3 Designs linking qualitative and quantitative data



Source: Adapted from Miles and Huberman (1994: 41)

Mixed research method has been used in various fields, for instance, in pragmatic research (Morgan 1998, Giddings 2006), technical science (e.g. engineering) for descriptive and analytical research (Borrego et al. 2009) and educational research for using multiple approaches of data collection and analysis (Migiro and Magangi 2011). It has also been used in qualitative and quantitative evaluation research in an integrative way (Dennis et al. 1994). Weiss (1998:82) characterizes quantitative evaluation as the method of "collecting data that can be transformed into numerical form, so that analysis can be largely statistical, and reports are based on a larger part on the size of effects and significance of the statistical relationships, and qualitative evaluation tends to use unstructured interviewing and observational techniques, so that the analysis and reporting take the shape of narrative".

Based on Miles and Huberman (1994) design of linking, both kinds of methods have been selected for the purpose of this research, interviews, observations and survey methods have, therefore, been used. Ancillary data such as population, basic socio-economic components, GIS and climatic information have been collected from secondary sources. The data before and after the restoration have been compared, which can be termed as evaluation research. The 'mixed research method' has been selected to evaluate the impact of forest restoration on tiger conservation and to triangulate different data sources and findings at the end.

Research Tools Selection

After the proposal was prepared, it was presented in the informal and formal PhD colloquiums of the university, based on which the objectives, hypothesis and research questions were revised. The data collection methods and tools, both from the social and natural sciences have been utilized to answer the research questions. The validity and reliability of the methods and tools in this context is quite complicated. For this reason, I consulted some books and research reports (e.g. Bailey 1982, Ellis 1994, De Leeuw et al. 2008, WWF 2008) from social science, and scientific research (e.g. Dinerstein 1979/1980, Basnet et al. 1998, Smith et al. 1998, Sapkota et al. 2009, Tripathi and Singh 2009, etc.) from natural science as special references. Based on these references and the criteria developed (e.g. based on ecological, social, methodological), I selected the data collection tools. Furthermore, to make the research process understandable and precise, the research tools were selected based on specific research questions (table 10.3).

Table 10.3 Selection of tools based on specific research questions

Specific research questions	Tools to be used in data collection	Information required
How are people motivated to restore forest?	Household interview, questionnaire survey	Attitude of people
Do they tolerate the disturbances of wild animal?	Household interview	Knowledge on wild animal hazards and responses of people
How do forest users take part in the decision making process on forest management plan, thereby addressing restoration?	Questionnaire survey, household interview, observation	Acknowledge the participation and role of community people in decision making process
How do they incorporate the conservation issues in forest management plan?	Questionnaire survey, key informant interview	The elements of restoration in plan
What are the efforts/activities that have been practiced for the restoration and conservation?	Key informant interview, questionnaire survey, observations	Acquisition of local actor's involvement in restoration, activities for the restoration and conservation
What are the constraints that hinder restoration and wildlife conservation?	Questionnaire survey, secondary data	Elicit the impediment for restoration and conservation

Does active restoration contribute to persist tiger in and around the protected area?	Observation, document review, survey	Forest habitat quality, prey species, disturbances
Does forest quality play a significant role to conserve tiger prey species?	Observation, survey	The presence of prey species, forest quality
Does it recolonize or live permanently in and around the restored habitat?	Sign survey, field observation	The occupancy of habitat, presence/absence of tiger
How could the forest restoration and tiger conservation strategy be more appropriate?	Key informant interview, questionnaire survey, document review	Strategies for better management, restoration of forest & tiger conservation
How could restoration and conservation be more sustainable?	Interviews, observation, document review	Develop a new concept

Source: Researcher's construction

Research Tool Construction

Based on the research questions, I prepared the interview guide and questionnaires for Community Forest User Group Committees, household survey, and drivers and road side dwellers. I have used the terms, definitions and questionnaire guideline construction referring to Bailey (1982:111) where he mentions that interview questions should be developed that are relevant to the objectives, data-collection tools and respondents. According to him "a survey consists of asking questions to a representative cross-section of the population at a single point in time, and the person to whom the questions are asked, are called the survey respondent" (Bailey 1982:110). Hence, I prepared questions relevant to the objectives, research questions and interviewees. After consulting the supervisors and receiving comments from the colleagues during colloquium, I finalized the questionnaires, interview guides and the sample forms (annexes i-v). Similarly, the prepared questions were tested during the preliminary field visit (i.e. during rapid rural appraisal) in September 2010 and finalized for interviews.

Validity

The validity of each measuring method and tool is an insightful but also a contentious part of the research. According to Bryman (2008:32), validity is "concerned with the integrity of the conclusions that are generated from a piece of research". It is concerned with whether the applied instrument is actually measuring the concept and the concept is being measured accurately. Weiss (1998:144) explains the way of assessing the validity from criterion, construct and content, where the correlations between the variables and particular measure show validity. Positive significant correlation shows valid measurement and negative suggest that the measure is not valid. I have used the measuring instruments and tools that researchers (citation) have already used.

Reliability

Reliability is an important aspect of the research. The measurement should be performed by a process of consistency in each step of research (Goodwin and Goodwin 1984). Bailey (1982:73) defines reliability as "a measure where the measurement does not change when the concept being measured remains constant in value". It is the instrument of "test-retest procedures and by internal consistency checks" (Weiss 1998:146). Hence, for the reliability of data, the same key informants as used in the past research and the same test items were used, further, I conducted interviews and observations myself.

Data Collection

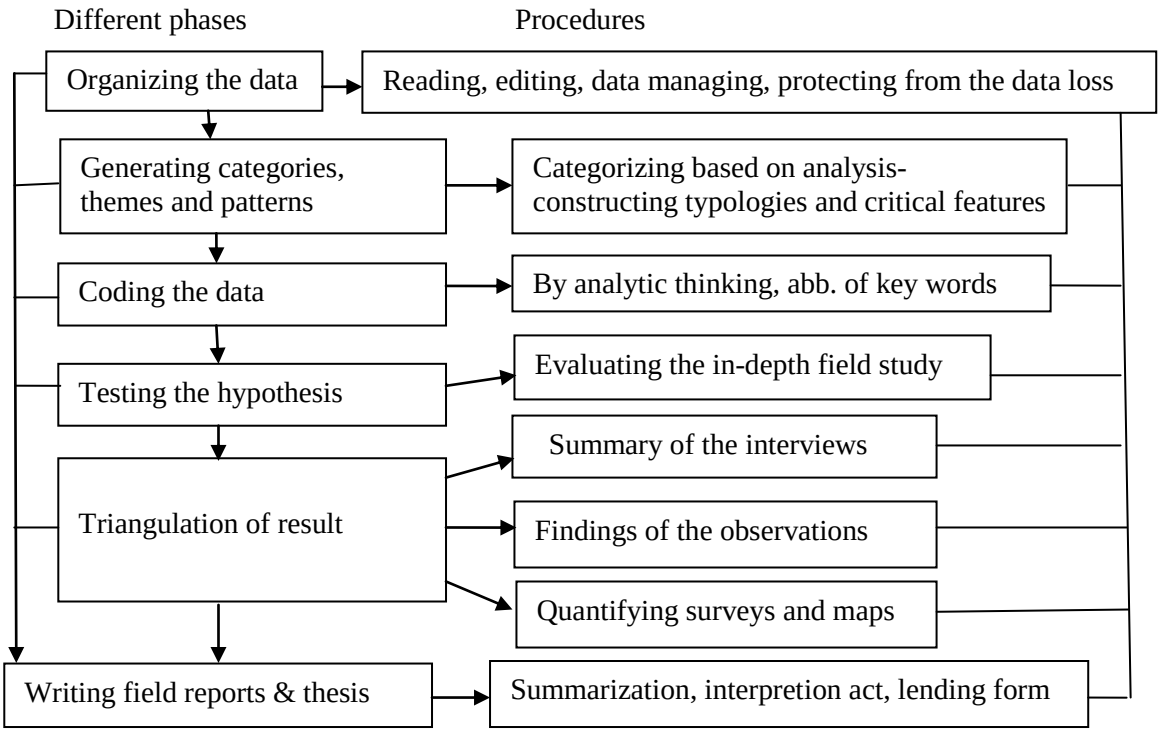
I conducted field work between September 2010 and January 2011, because of the suitability of the time and easiness to monitor the sign of wildlife. During the first month, I tested the rapid rural appraisal (RRA), key informant interview and questionnaire. Then, based on the RRA, I revisited the developed criteria to select community forests for detailed study. Primary data was collected from interviews, observations and surveys. During the vegetation and wildlife survey, GPS locations were recorded. Spatial data on land use and climatic data on precipitation, relative humidity, temperature were collected from different institutions.

Data Analysis Procedure

Chunks of information and material were accumulated from multiple data sources and research methods. These materials were reviewed and the second phase of data collection was carried out in order to collect the missing data. After reviewing and verifying the data, the qualitative analysis method was utilized for the data reduction. Miles and Huberman (1994: 10) define data reduction as "the process of selecting, focusing, simplifying, abstracting, and transforming the data that appears in written up field notes or transcription". After managing the data, it was developed into the form that could be analyzed.

Marshall and Rossman (1999:152) explain six phases of data analysis procedures: organizing the data; generating categories, themes, and patterns; coding the data; testing the emergent understanding; searching of the alternative explanations, and writing up the report. Based on this procedure, I developed the data analytical procedure for this research (figure 17.3).

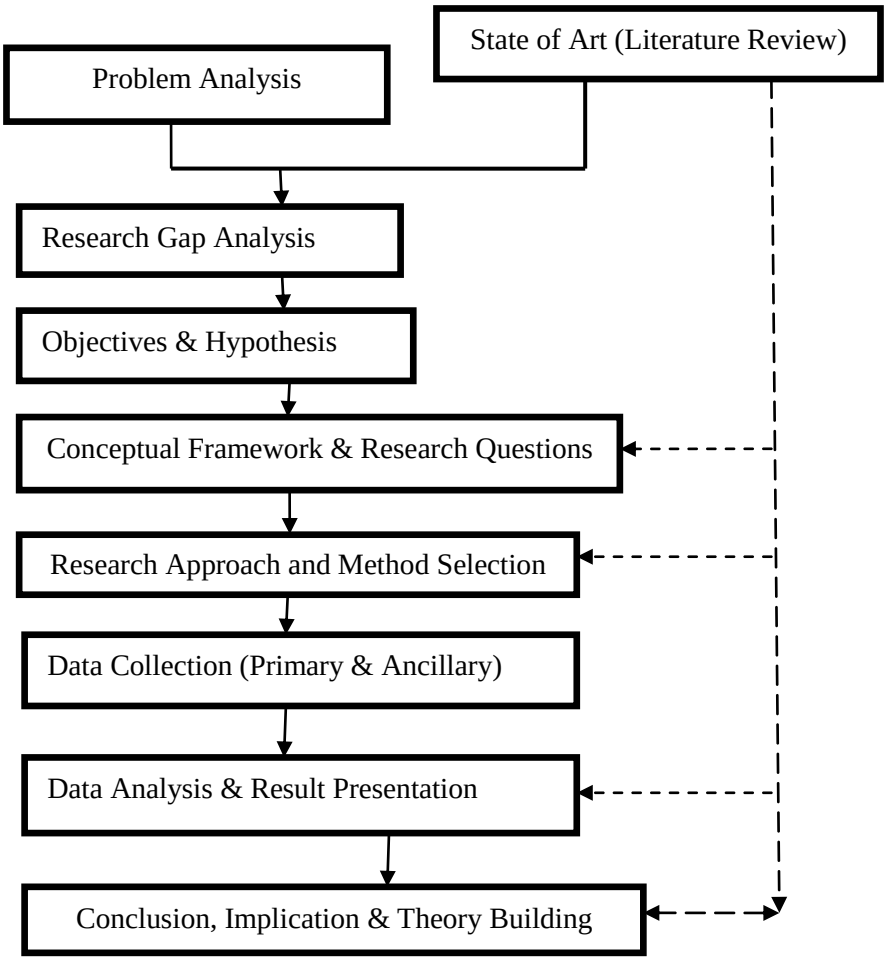
Figure 17.3 Data analysis procedures with different phases



Source: Constructed based on Marshall and Rossman (1999)

Land use pattern of intensive study area (Banke NP and its buffer forest) was analyzed by ArcGIS 9.3 and quantitative data was analyzed by using Statistical Package for Social Sciences (SPSS 16.0 Inc.) and MS-Excel 2007 programs. After the data interpretation, results were presented and discussed with other researcher's findings in the similar field. Hence, I again consulted the literature and developed a new concept. Finally, a draft report was finalized and submitted to my supervisors for final comments. Hence, the research followed the literature review, field study, data analysis, result presentation, implication and theory building in the following sequential order (figure 18.3):-

Figure 18.3 Research process



Source: Researcher's construction

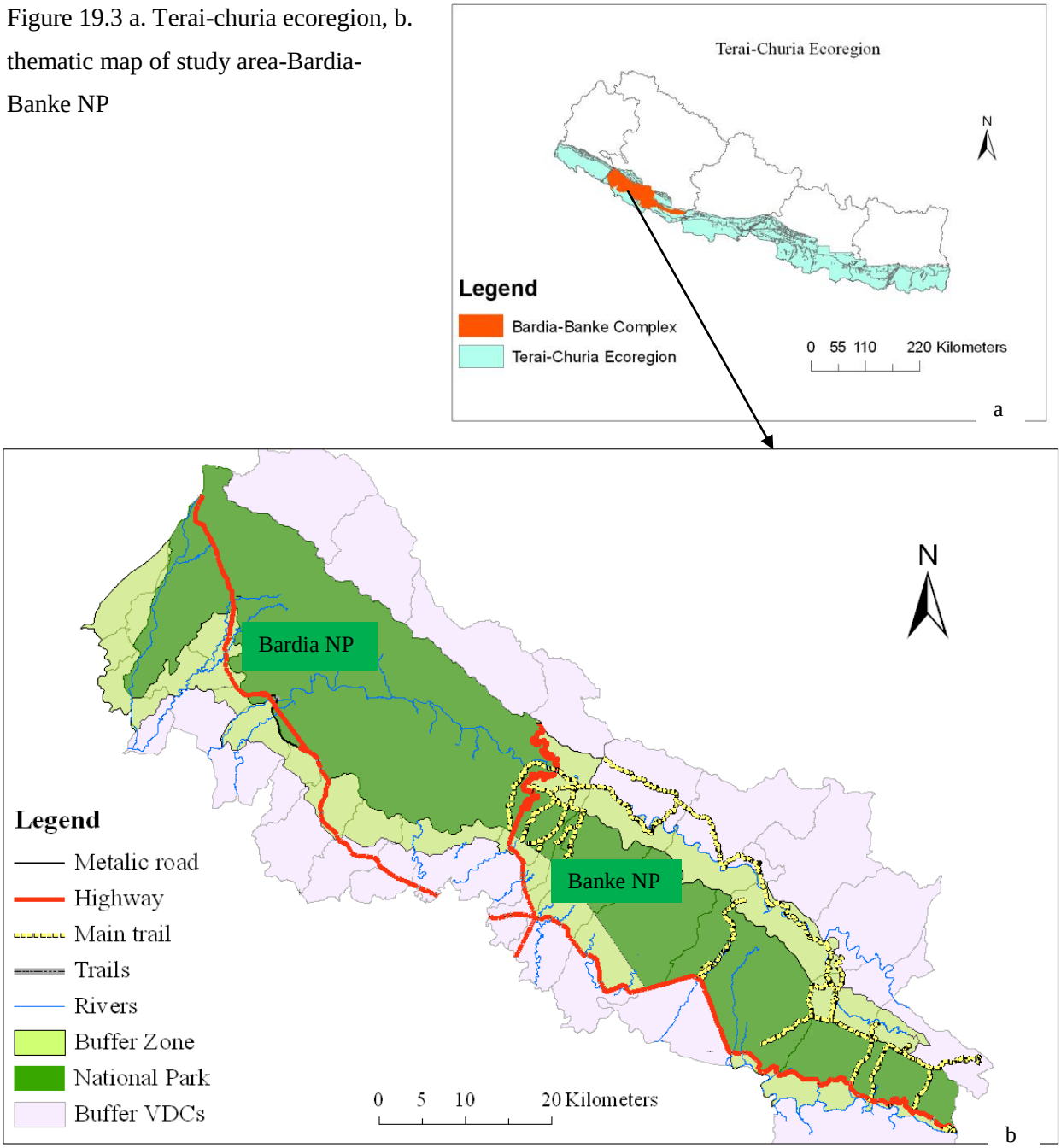
3.3 Study Area: Terai Landscape as the Research Area

Nepal is a mountainous landlocked country with the high Himalaya, Mountains in the north and plains/ lowland in the southern part. Since 1960s, research has been conducted on natural and social sciences due to its diverse land topography, flora and fauna with multicultural human society within its small land area (147,181 sq km). One of the reasons is the close interrelationship among humans, nature and natural resources in Nepal (HMGN/MFSC 2002). But in recent years, intentional or unintentional human interventions have led to the degradation and loss of natural resources (HMGN/MFSC 2004). Some species are on the verge of extinction and some have become endangered. Among them, the globally magnificent tiger, an endangered species, is found in the Terai landscape. Many researchers (McDougal 1977, Sunquist 1981, Shrestha 2004, etc.) have studied the ecology and habitat of tiger. However, research on forest habitat restoration and tiger as an indicator species has not been conducted in Nepal so far. The Terai landscape is a potential and suitable habitat for tiger, however, it is isolated (Smith et al. 1998), and various forest restoration projects/ programs have been launched to extend the habitat since 2001. Hence, I prefer the Terai landscape as a suitable research area focusing on forest restoration and tiger conservation.

Physical Description

The Terai-Churia eco-region, based on altitude (<1200 m) covers twenty districts and some parts of eight districts in southern Nepal (figure 19.3a). Among them, the Terai Arc Landscape (TAL) covers the lowland and Churia Hills in 14 districts (i.e. Kailali, Kanchanpur, Banke, Bardia, Dang, Kapilvastu, Rupandehi, Nawalparasi, Chitwan, Palpa, Bara, Rautahat, Parsa and Makawanpur) from far-western to mid-western Nepal. Within the TAL area, there are three corridors (Laljhadi, Basanta and Katarniyaghat) and three bottlenecks (Mahadevdpuri 1 VDC, Lamahi 4 VDCs and Dovan 1 VDCs) identified, where various conservation and livelihood upliftment projects are being implemented (WWF 2002b, MFSC 2006). In the mid-western Terai region, two national parks covering more than 1,500 sq km provide shelter for wildlife. The first one - Bardia National Park (BNP), 968 sq km, was declared so in 1976/ 88, while Banke National Park (BaNP) was declared in 2010 (Figure 19.3b). BNP buffer zone, declared in 1997, covers an area of 328 km² and has the buffer area of about 180 sq km including four Village Developent Committees (VDCs) of Surkhet District (extended in 2010) (DNPWC 2010).

Figure 19.3 a. Terai-churia ecoregion, b. thematic map of study area-Bardia-Banke NP



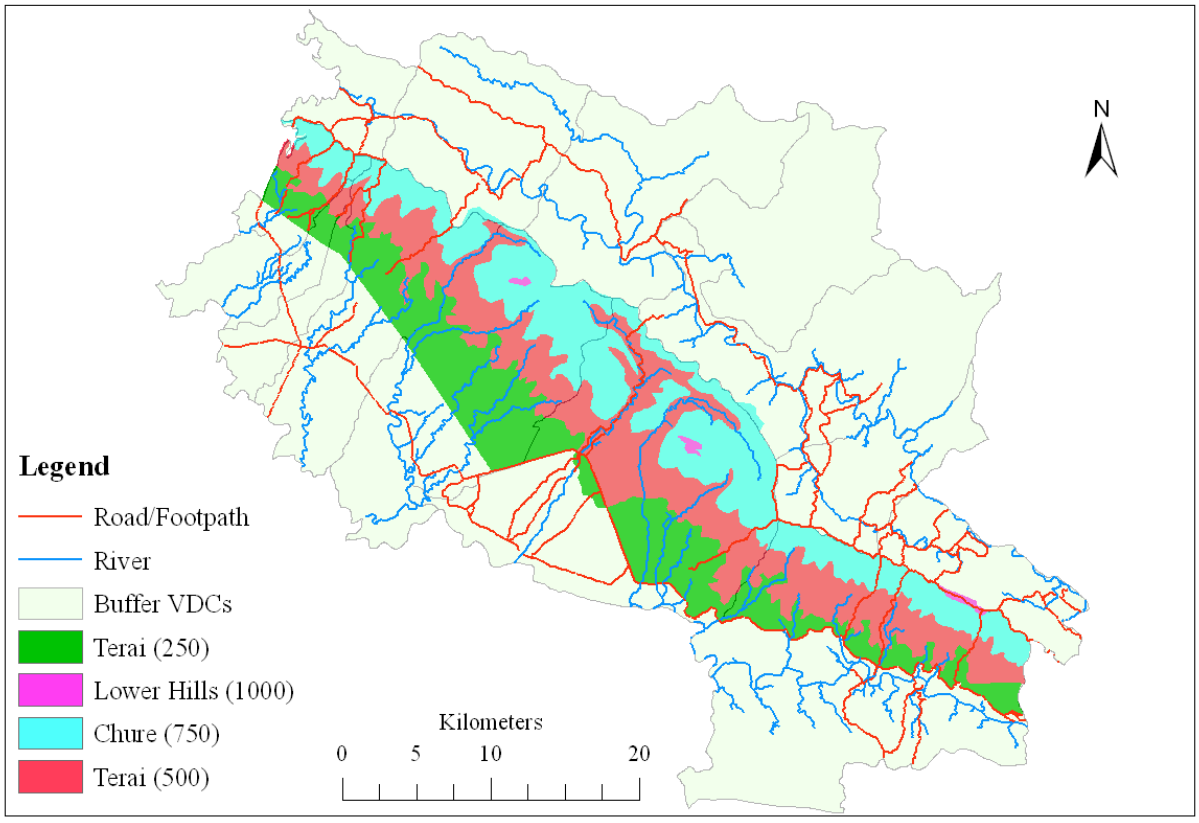
Source: Data of Survey Department, and LRMP (1986)

Among the twenty VDCs that are located in and around BNP, four VDCs of Surkhet (Hariharpur, Lekhgaun, Taranga, Chhinchu) lie in the north Siwalik range, four VDCs (Manau, Gola, Pashupatinagar and Patabhar) lie west of the park boundary and two VDCs (Beluwa and Chisapani) lie on the eastern border. The remaining ten VDCs (Suryapatuwa, Thakurdwara, Neulapur, Shivapur, Bagnaha, Motipur, Baniyabar, Magaragadi, Dhadabar and Dekhala) are situated in the south of the national park. Among them, Suryapatuwa and Beluwa VDCs have been taken as the reference site for the purpose of this study.

Intensive Study Area

The intensive study area is Banke National Park (BaNP), a forested area that is located between 27°58’ to 28°21’ north latitude and 81°39’ to 82°12’ east longitude in Mid-Western Region of Nepal (Basnet et al. 1998) gazetted in July 2010 as a new national park. It has a total core area of 550 sq km and lies on the eastern side of Bardia National Park. The buffer zone with 14 VDCs of four districts (Kasakusma, Kachanapur, Mahadevpuri, Rajhena, Chisapani, Kohalpur, Naubasta in Banke District, Goltakuri, Purandhara, Panchakule in Dang District, Kalimati Rampur, Kalimati Kalchhe, Kavrechaur in Salyan District and Beluwa in Bardia District) covers 343 sq km of area (figure 20.3). There are 4,861 households with 35,712 people who depend on the buffer forest resources (DNPWC 2010).

Figure 20.3 Thematic map of Banke National Park



Source: Data of Survey Department, Kathmandu and LRMP (1986)

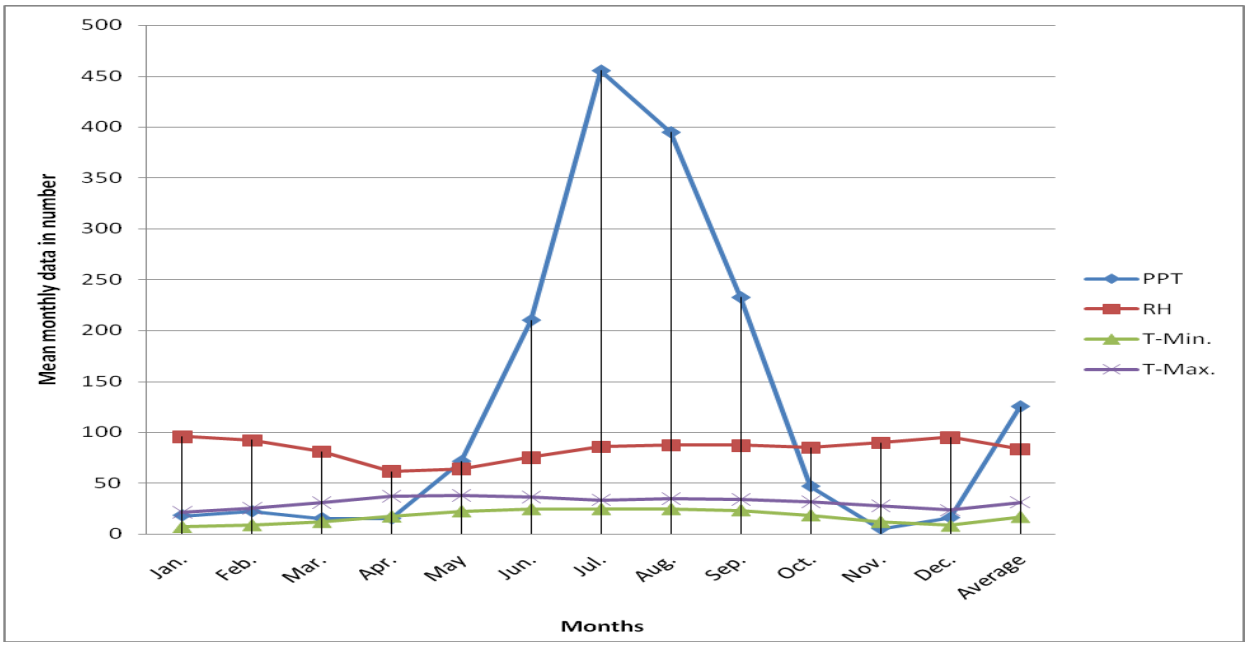
Physical Description

The land topography of Banke National Park varies from plains and river valleys to the Churia Hills with distinct Churia Ridge, Bhabar and plain zones. The elevation ranges lowest at 153m near Dhakeri village to highest elevation 1,247 m at Kuine Ridge/ Phurkesalli. The soil type

and structure is varied at different levels. The Churia Ridge (elevation >600-1219 m) is made up of fine grained sand stone with clay, shale, conglomerate and freshwater limestone, The Bhabar zone (250-600m) consists of boulders, cobbles, gravel and coarse sand, and the plain land (153-250m) is made up of alluvial fertile soils (Basnet et al. 1998).

Climate - BaNP has a sub-tropical monsoon climate. There are three distinct seasons: hot and dry season (from February to mid-June), monsoon (from mid-June to early October), and cold and dry season (from early October to February) (Basnet et al. 1998). Based on the climatic data at Sikta, Banke (1979-2009), variation in precipitation is high ranging from 5.22mm in November to more than 450mm in July, relative humidity is 61.46% in April to 95.89% in January, minimum temperature is 6.97°C in January to 25.56°C in August and maximum temperature is 23.42°C in December to 37.9°C in May (figure 21.3).

Figure 21.3 Monthly average precipitation, relative humidity (at 8.45 AM), and maximum-minimum temperature at Sikta, Banke



(Note: PPT- Precipitation, RH- Relative Humidity, T-max./T-min.- Temperature Maximum/Minimum)

Sources: Department of Meteorology and Hydrology, Kathmandu

Rivers - There are two major rivers: Rapti and Babai in BaNP, where there Rapti River demarcates southern and the Babai River makes the northern boundary. Other main rivers and streams are Dunduwa, Jhinjhari, Baghsala, Munguwa, Khairi, Sukhar, Bairiya, Malai, etc. These rivers/ streams originate from the Churia Hills, where thevolume of water is very high in the monsoon season, and a few of them have a nominal discharge in the plains and some have no discharge in the summer season (April to June) (Basnet et al. 1998).

Biological Description

Dinerstein (1979) has categorized vegetation and its changes into six types: *Shorea robusta-Buchanania latifolia* forest, *Dalbergia sissoo-Acacia catechu* forest, *Ficus glomerata-Mallotus philippinensis-Eugenia jambolana* forest, Bombax-savannah grassland, Ecotonal-secondary open mixed hardwood forest, and *Saccharum spontaneum*-Tamrix floodplain forest in southwestern corner of Bardia NP. Jnawali and Wegge (1993) classified forest habitats into seven different types. Similarly, Stainton (1972) explained Sal (*Shorea robusta*), Khair (*Acacia catechu*), Sissoo (*Dalbergia sissoo*) forest with Savanna and grassland and mixed forest. Basnet et al. (1998) recorded more than 124 plant species (i.e. 83 trees, 5 climbers and 36 shrubs) in Banke NP. They divided forest communities into six categories i.e. Sal forest, upper Churia forest, mixed hardwood forest, riverine forest, flood plain forest and grassland community: brief description of which are as follows (Basnet et al. 1998:44):-

Sal forest community – A forest that is dominated by sal trees falls under the Sal forest community. It is divided into Sal forest and Bhabar/ Churia foot hill forest. Sal forest is dominated by Sal (*Shorea robusta*) and other major species consisting of *Terminalia tomentosa, Terminalia belerica,* etc. The Bhabar hill of Churia forest is composed of *Shorea robusta, Lagerstroemia parviflora, Terminalia tomentosa, Anogeisus latifolia,* and other species.

Upper Churia forest - It includes three types of forest, namely the upper Churia, foothills/ lower Churia and hill Sal forest. Both broad and needle leafed tree species are mixed in the Churia forest, this mainly consists of *Pinus roxburghii, Bauhinia varigata, Terminalia tomentosa,* and other species.

Mixed hardwood forest - It is composed of various species where less than 50 percent are Sal (*Shorea robusta*). Major two species, *Casearia tomentosa* and *Schleichera trijuga* grows on drained and plain areas with other species (e.g. *Buchania latifolia, Terminalia tomentosa,* etc.).

Riverine forest - Riverine forest consists of moist forests along the rivers beds and river valleys, dominated by other mixed species mainly broad leafed evergreen tree species. It is divided into two types - deciduous riverine forest and riverine evergreen forest. Most of the species of deciduous riverine forest are *Acacia catechu, Dalbergia sissoo, Garuga pinnata,* etc. and riverine evergreen forests are *Ficus glomerata, Eugenia jambolana,* etc.

Flood plain forest - It is a newly developed forest on the flood plain of the rivers, which is dominated by *Acacia catechu* and *Dalbergia sissoo* with *Anogeisus latifolia, Zyzyphus jujube.*

Grassland community - There are two types of grassland communities - small wooded grasslands in degraded areas and grasslands in the flood plains. Major grass species are *Imperata cylindrica, Saccharum spontaneum, Erianthus ravennae, Phragmites karka,* etc.

Wild animals - Bardia NP is home for 59 mammals, 407 birds, 52 herpeto and 124 fish species including many endangered and rare species (Bhuju et al. 2007). Important species, such as tiger (*Panthera tigris*), elephant (*Elephas maximus*), swamp deer (*Cervus duvuaceli*), hispid hare (*Caprolagus hispidus*), Gangetic dolphin (*Platanista gangetica*), rhinocereos (*Rhinoceros unicornis*), and other abundant wildlife, such as spotted deer (*Axis axis*), wild boar (*Sus scrofa*), samber (*Cervus unicolor*), etc., are found in BNP (Upreti 1994). Similarly, Banke NP is also rich in wildlife having 34 mammals, 22 reptilian, 7 amphibian and more than 300 bird species including some endangered species (DNPWC 2010). Major mammal species are chital (*Axis axis*), barking deer (*Muntiacus muntjac*), sambar (*Cervus unicolor*), four-horned antelope (*Tetracerus quadricornis*), tiger (*Panthera tigris*), striped hyena (*Hyaena hyaena*), fox (*Vulpes bengalensis*), goral (*Nemorhaedus goral*), common leopard (*Panthera pardus*), sloth bear (*Melursus ursinus*), jackal (*Canis aureus*), jungle cat (*Felis chaus*), wild boar (*Sus scrofa*), rhesus monkey (*Macaca mulatta*) and porcupine (*Hystrix indica*) (Basnet et al. 1998).

Socio-economic Condition

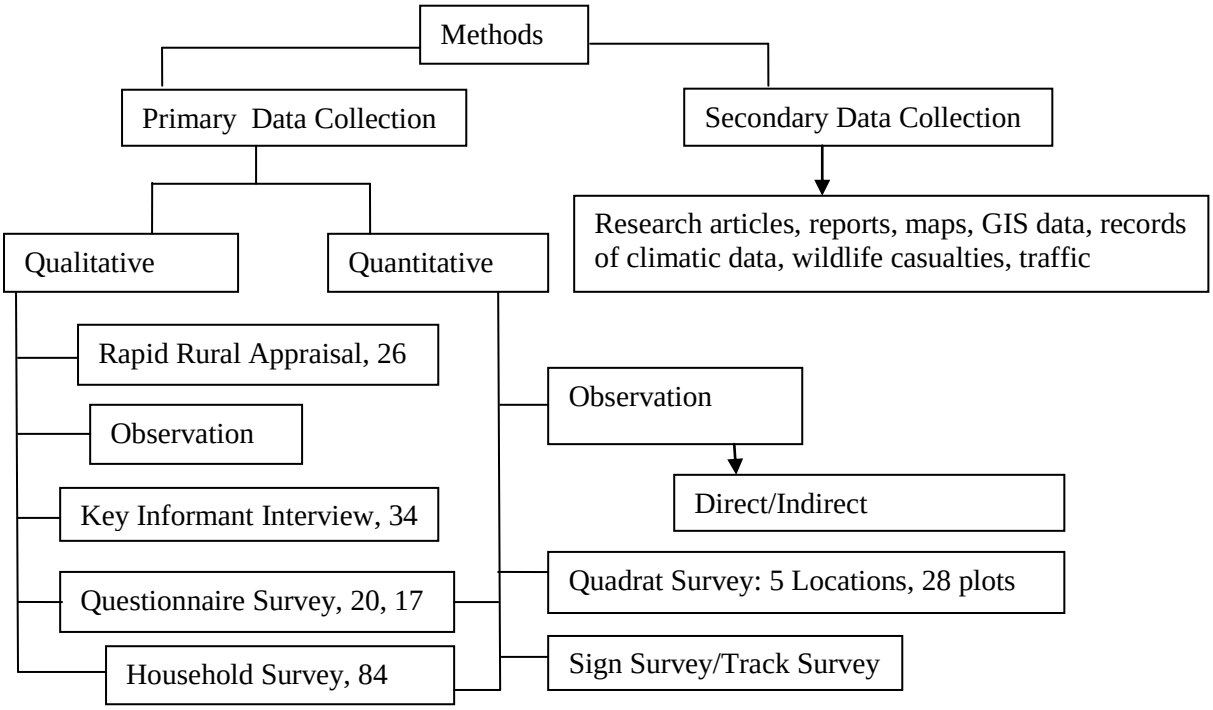
The total population of Bardia District is 426,946 (i.e. male = 205,096, female = 221,850) while the total population of Banke is 493,017 (i.e. male = 245,004 and female = 248,013) having 211 density/ km in both districts (CBS 2011). There is about 51 percent of forested land and 49 percent consists of agricultural fields and settlements in and around the Bardia NP. The majority groups are Tharu (60%) and the remaining others are immigrants from hill regions (GoN 2007, c.f. Bhattarai 2009). Similarly in Banke NP, Tharu, Majhi, Brahmin, Chhetri, Tamang, Gurung, Magar are the major ethnic groups. The subsistence is agriculture (89.5%) with an average 0.65 ha land holding per household and a few people have jobs, a trade, or are laborers (9.5%) (DNPWC 2010). Principal crops are rice, wheat and maize; lentils, mustard, linseed and potatoes are also cultivated. After the Terai Arc Landscape program began, various governmental and non-government organizations assisted in cash crops cultivation such as mentha, chamomile and asparagus, which have a lower risk of damage by wildlife (WWF

2001). The majority of households own livestock such as cows and/or buffalo, goats and pigs. Livestock is also an important source of household income in the study area.

3.4 Methods

The research has used the mixed research method to collect multiple data (i.e. social and ecological, climatic). To reduce the biases and increase the validity, crosschecking at different stages (e.g. interview, observation, coding) of data collection and processing was used during the field study. In order to achieve the overall objective of the study, I included both the primary and secondary data collection methods (figure 22.3).

Figure 22.3 Methods applied in the research



3.4.1 Data Collection Technique

Secondary Data

For the ancillary data, documents reviewed during previous research, published and unpublished reports on forest restoration, participation, and biodiversity conservation were referred to. Additionally, the relevant policies, acts, buffer zone regulations, project evaluation reports, species action plan, Terai Arc Landscape strategic plan, Bardia National Park-extension Area report, etc. were studied in detail. Relevant studies in various parts of Nepal were taken as the base to draw comparative backup to the Terai landscape. Topographic maps,

spatial data of land use, demographic data, climatic data and information on the socio-economy of the community were collected from related governmental (e.g. Department of Survey/ Meteorology and Hydrology) and non-governmental organizations such as WWF Nepal, the National Trust for Nature Conservation and other related institutions, for instance, Community Forest Coordination Committees.

Primary Data

Primary data collection was based mainly upon the components as proposed, with reference to the previous scientific methods. Bogati and Basnet (2001), Gurung (2002, 2008), Basnet et al. (1998), and Shrestha (2004) have conducted research on species/ forest resources outside the protected areas. Hence, for the purpose of this study, I included the methods used in these studies and also added few methods/ tools (e.g. time budget, household survey). For the intensive study, buffer forests in Mahadevpuri bottleneck and Ranjha of Bardia were selected. For the data collection, rapid rural appraisal, interviews, observations and survey methods were used.

3.4.1.1 Rapid Rural Appraisal

Rapid Rural Appraisal (RRA) emerged in the late 1970s as a quicker and cost-effective method (Chambers 1992) of primary data collection. He characterizes it "as a form of data collection by outsiders who then take it away and analyze it". It was introduced as a training for baseline data collection of socio-economic and target group identification (Duggan 1994), used for analyzing community based agro-ecosystem (Ortega-Espaldon and Florece 2001), analyzing community based resources management (Zanetell and Knuth 2002), etc. This technique is used in quantitative measures which is more relevant in research for social and ecological processes. Further, it is more appropriate to analyze and triangulate the involvement of local rural resource users in group activities (Frey and Fontana 1993, c.f. Zanetell and Knuth 2002:25). Therefore, it is taken as the participatory research method to gather information about a natural resource in this study area, within the limited timeframe.

During the RRA, a short interview (n = 26) was conducted to trace information about the study area and wild animals, based on which the intensive study area was selected. Objective type questions were asked about the restoration activities and the presence or absence of wild cat and its prey species in the community forests/ buffer zone and national forest (annex i).

Utilizing the purposive random sampling technique, data was collected from teachers, community people and other key persons in and around the Bardia and Banke NPs.

3.4.1.2 Interviews

i. Key Informant Interview

A key informant interview is conducted with the person who is related to the research subject (Hawkins 2010). The interviewee can be any person (15-35 interviewees) who can provide information, ideas, and insights that are needed for researchers (Kumar 1989). To find out basic information regarding the extent of participation, restoration, conservation planning and monitoring, and impact on wild cat conservation, key informant interview was performed. A total of thirty four personnel from among the officials of the Ministry of Forests and Soil Conservation, Department of National Parks and Wildlife Conservation, District Forest Office, Ilaka Forest Office, Warden Office of Bardia and Banke National Park, WWF/ TAL Program, National Trust for Nature Conservation, and experts, local conservation organizations, school principals and local leaders were taken as the key informants, who were then interviewed using the semi-structured questions (annex ii).

ii Questionnaire Survey

Sample size depends on the experience of a researcher or skills, budget, and elements of the research (Kumar 1999). The sample size also depends on the decision of the researcher regarding the needs, interest and coverage of area (Liamputtong and Ezzy 2005). But in the experimental research, representative sample is important rather than large numbers (Fitz-Gibbon and Morris 1987). The survey sampling can be designed for descriptive sampling through simple random sampling or systematic or stratified sampling (Eberhardt and Thomas 1991). Sample survey is "appropriate to determine the prevalence of some phenomenon within a population over a specified time frame" (Ellis 1994:163). Therefore, I took a minimum sample size sixteen (+-1) for one purpose. For the intensive study on participation, restoration activities, planning, monitoring and attitude toward restoration and tiger conservation, twenty respondents were sampled from the Community Forest User Group Committees using purposive sampling method, where the semi-structured and open questions were used (annex iii).

In order to understand the level of road disturbances, questionnaire survey with drivers and roadside dwellers nearby Ratna (Kohalpur-Surkhet) highway at Chisapani were conducted. For this method, seventeen respondents were selected, among which eleven were drivers and six were local residents. Closed questions were used for this too (annex iv).

iii. Household Survey

A total of eighty four (+- 10) household respondents out of 632 were selected from the simple random sampling considering the distance from forest edge and representation of all locations. Among them, forty two were chosen from each buffer village in order to study participation, attitude and perception on restoration and wildlife conservation. Structured open and closed questions were used for the household survey. Words, feeling, and expressions of the respondents during interviews were also noted as they are useful to measure attitude (Henerson et al. 1987). The survey was done with the assistance of a field enumerator and myself. For this, a house survey form was used that contained ranking as well as prioritization as the major tools to verify the attitude of the respondents (annex v).

3.4.1.3 Observations

Observation can be performed through direct and indirect ways. Researchers can participate to observe situations without influencing the observed subjects directly (Epstein and Tripodi (1977). Participant observation is used to "generate practical and theoretical truths about human life grounded in the realities of daily existence" (Jorgensen 1989:14). It can be used in evaluation research (Weiss 1998). In this research, I participated in two community forest coordination meetings and two Community Forest User Groups meeting and one annual meeting of the users group. During the meetings of the user's groups, I observed their decision making process and made a note. Besides this, community people's attitudes during informal discussions or interviews and while accompanying them during their work (for example I accompanied them while they were looking after their grazing cows/ox/goats), were noted.

a. Direct Observation with referring to Time Budget Method

For the first time, time budget research was published by Geroge Bevans in 1913 (Bevans 1913) however, large scale research was performed only in early 1920s in a Soviet town by an economist, Stanislav Strumilin (Szalai 1984b:39) and used by Lundberg and others in the 1930s (Lundberg et al. 1934, c.f. Andorka 1987). Regarding this, Szalai (1984a:19) states that

"it consists in its most elementary form of a log, diary, or protocol that lists the sequence, duration and timing of the activities an individual has performed over a specified time period, typically the 24 hours of a given day". It is used in mass media contact, studies regarding the demand for cultural and other leisure goods and services, planning, etc. The data can be collected by different methods including ancillary data for the analysis of space, activities and time, spatial information, and it can also be analyzed by using the Statistical Package for Social Sciences (SPSS) program (Elliott 1984:194).

In natural science, Lott and McCoy (1995) observed the behavior of rhinoceros with response to disturbances from tourists in Chitwan National Park, Nepal at different time interval (5 and 20 min. intervals). Weathers et al. (1984) observed the daily behavior and energy expenditure in birds utilizing 10 minute intervals. Similarly, Seidensticker (1976), while studying the ungulate population in Chitwan National Park, used systematically alternated four hours observation techniques for one hour. If the sampling intensity be higher, the time interval may be shorter. Hence, direct observation reffering to time budget method can be used to observe social activities of human as well as animal behavior.

I collected data of disturbances of human and livestock in two forest habitats (buffer zone/ community forest) by counting the numbers at 6:00 AM, 10:00 AM, 2:00 PM, and 6:00 PM for one hour. Data was collected at four hours interval in each place and recorded on the form (annex vi). The process was repeated three times randomly within the period of three months.

b. Indirect Observation-Presence/Absence of the Wild Cat

The number of wild cat (tiger and common leopard) can be estimated by direct or indirect methods where direct census is more difficult due its nocturnal, shy and aggressive behavior (McDougal 1977). Indirect information can be collected using signs such as pugmarks, scratches, and scats that indicate the presence and number of wild cat (Smith et al. 1998). Some researchers in the past have used camera trapping technique (e.g. Karanth and Nichols 1998, Wegge et al. 2004), but it needs technical manpower, a secure place and it is also costly. The radio-collar method has been used by some researchers to study dispersal, home range and other social behavior of wild cats in different habitat quality (Sunquist 1981, Smith et al. 1998) but it might effect the ecology of species. Sign survey and transect walks are also reliable methods for wild animal counting. I followed the forest roads, dusty trails, and streambeds in and around the study area in order to find out the presence and absence of tiger (Smith et al.

1998). Beside this, I collected information from local residents, especially herders and dwellers around the community forest and recorded in the survey form (annex vii).

The study regarding the status and dispersal of tiger followed the methods utilized by Bogati and Basnet (2001) and Gurung (2002) in the same area. The same key respondents used during 1999/2000 were used to collect data of kills made by wild cat (annex viii) in order to facilitate the comparison and wider understanding. One person was not available, therefore, a new respondent having similar responsibilities and/ or performing similar tasks was considered. The criteria (size of pugmark and kills) used by Bogati (2012) and Gurung (2002) was followed in order to determine whether the killings are made by a tiger or leopard. The track with a pad width of 7cm or less is a leopard and bigger than 9.7cm is a male tiger and smaller than 9.3cm is female tiger (table 11.3) (McDougal 1999). Scat diameter greater than 4cm is considered to be a sign of tiger (McDougal 1999). Tiger surveys were conducted in the intensive areas between October and January 2011.

Table 11.3.Size criteria used to discriminate tiger (male & female) versus leopard pugmarks

Wild cat species	**Pad Width**		**Total Width**
	Front	**Rear**	**Rear**
Leopard	<7.0 cm	<6.0 cm	< 10 cm
Tiger (average)	≥8.5 cm	≥7.5 cm	> 12 cm
Adult male (tiger)	≥9.7 cm	≥8.5 cm	> 11 cm
Adult female (tiger)	<9.3 cm	<8.5	< 1 l cm

Source: McDougal (1999), WWF (1998)

3.4.1.4 Survey: Quadrant Survey

A survey is taken as a "research strategy in which quantitative information is systematically collected from a relatively large sample taken from a population" (De Leeuw et al. 2008:2). The sampling design depends on the type of monitoring species, distribution of species, sampling variances, logistics and effectiveness of field techniques (Block et al. 2001). The following quadrat survey was applied in the research.

i. For Measuring Plant Species and Habitat Disturbance

The intensive vegetation data were collected from October 2010 to January 2011 in government managed forest, buffer forest (BF), and the community forests (CF) of Bardia and Banke Districts. The data of plantation and the number of species were collected from the

District Forest Office and the Community Forest Coordination Committee Office. I selected five locations: Gauri Community Forest (CF) and Shiva Buffer Forest (BF) adjoining Bardia NP, and Shiva BF, Janasakti BF and one location in the Khairi area in Banke NP in order to collect vegetation data. All sampling quadrats (plots) were selected between 500-1,000m except Khairi (>1,500m) from the forest edge. The size and the number of samples were determined by considering Mishra et al. (2008) and ANSAB (2010). The measurement of the trees' diameter was taken 1.3m from the ground level (HMGN/MFSC 2005). A total of 3-5 quadrats in circular plot size of $100m^2$ (r = 5.64m) were laid systematically in each location. The intervals of two quadrats were 50m (Aide et al. 2000) in order to assess tree species with a diameter at breast height (dbh) >5cm and $25m^2$ (r = 2.82 m) quadrats for sapling (>2.cm to < 5cm), and seedling (>30cm and <100cm height) in each habitat patch (Basnet et al. 1998). Each quadrat (n = 28 plots) was systematically surveyed and the number of each saplings and seedling of plant species were counted and recorded in the form (annex ix). However, the sampling intensity, interval of quadrats and size depend on the forest type and area (HMGN/MFSC 2005). Similarly, plant species inside the quadrats were identified with the help of references (e.g. Shrestha 1989, Howland and Howland 1994, Basnet et al. 1998, Kayastha 2002) and consultation with experts in the Central Department of Botany, Tribhuvan University.

The physical condition of each individual plant present inside the quadrat (100 m^2) were noted under normal and damaged categories. The individuals that were standing dead, cut stumps and lopping/chopping were recorded for disturbance pattern (Sapkota et al. 2009).

ii For Measuring Abundance of Tiger Prey Species

Quadrat and track survey were used to measure the abundance of fauna, which was selected through random sampling. The distribution and the abundance of ungulates were determined by pellet and track counting method (Dinerstein 1980). Wegge et al. (2009) obtained ungulates population by flushing out the animals from vegetation patches surrounded by roads or dry riverbeds and counted the flushed and unflushed animal. The number and distribution of ungulates can be determined by counting pellet groups during a transect walk (Seidensticker 1976, Dinerstein 1980). I used the same quadrat size ($100m^2$) and intervals (50m) as vegetational survey and counted the number of pellet fall inside it by randomly using $10m^2$ (r = 1.79m) sized quadrats inside the bigger one.

3.4.2 Data Analysis

Restoration data can be analyzed by using the group comparison (e.g. ANOVA, t-test), ordinations or linear comparisons (Ruiz-Jaen and Aide 2005a). The quantitative data of vegetation and fauna obtained from the field study was analyzed by using the Statistical Package for Social Sciences (SPSS 16.0 Inc.) for important value index, abundance/ density, correlation coefficient, Chi-square test and t-test. Social data such as attitude were analyzed using the Likert scaling technique. Other qualitative type of data was interpreted through simple descriptive and triangulated with other sources of data. ArcGIS 9.3 has been used to analyze land cover changes and habitat patches through GIS maps.

3.4.2.1 Likert Scaling

Summated rating method (Likert 1932) has been frequently used to measure attitude. Likert rating method is used to measure the variation in the possible scores, by coding from "strongly agree" to "strongly disagree" (Bailey 1982). With the help of the Likert technique, five sets of attitude statements based on forest restoration and wildlife were asked to express agreement or disagreement on a five-point scale. Each degree of agreement were given a numerical value from one to five (strongly disagree to strongly agree) and the total numerical value was calculated from all the responses in order to derive conclusions.

$$\text{Respondent value} = \frac{\text{(sum of) response value}}{\text{Total maximum value}}$$

and index by,

$$\frac{\text{Value of respondent 1+ 2 + ……...n respondent}}{\text{Total value of respondents}}$$

3.4.2.2 Vegetation Analysis

Tree density, basal area and frequency were calculated. It is the similar analysis technique as used by Dinerstein (1979) and Basnet et al. (1998) but the former used relative dominance instead of stem basal area. The formula used for calculation are: Density = number of individual species/ total number of quadrats* size of the quadrat (expressed in per hectare), Basal area = $\pi(DBH/2)^2$, Frequency = Presence of an individual species/no. of plots studied*100, Relative density = Density of an individual species/ Density of total species*100, Relative basal area = Basal area of individual species/total basal area of all species *100,

Relative frequency = Frequency of an individual species/ Frequency of total species *100 (Basnet et al. 1998:32), Important value index = sum of basal area + sum of density + sum of frequency. Abundance of species = Total number of individual of species/ Number of quadrats. The forest quality index (FQI) was calculated (FQI = (Important value index + sum of sapling + sum of seedling) – sum of forest disturbances. Likewise, forest disturbance was calculated (Forest disturbance = total disturbed (total chopping + total felling)/ total standing plants (trees + sapling + seedling). The forest quality index was compared in terms of the reference site (Gauri) with other locations (Balapur and Ranjha). Regeneration activities were measured on the basis of controlled burning, grazing, bush clearing and clearing invasive plant species, using different criteria and values (table 12.3) (ANSAB 2010).

Table 12.3 Criteria of regeneration

Plant form	**Status of regeneration in the forest**		
	good	medium	low
Regeneration	>5000/ha	2000-5000/ha	<2000/ha
Sapling	>2000/ha	800-2000/ha	<800/ha

Source: ANSAB (2010:23)

3.4.2.3 Presence/ Absence of Tiger and Abundance of Prey Species

The contemporary data of tiger signs (e.g. pugmarks, scratches, scats) and kills from the indirect observation, and the data obtained by Bogati and Basnet (2001) were compared in order to determine whether the number/ mobility of tiger has increased or decreased. Similarly, for prey species, the classification of pellet was done referring to Shrestha (2004). He grouped them into small, medium and large prey classes and species such as barking deer and four-horned antelope, chital and hog deer, sambar deer, swamp deer and blue bull are categorized under these groups respectively. Nevertheless, I categorized the data only into ungulates and wild boar species. Data found from the quadrat survey were counted and the density of pellet groups per 100 m^2 was calculated as an index for the abundance of prey species (abundance index = total frequency + total abundance) in the study area.

Frequency = Presence of an individual prey species/ no. of plots studied x 100.

$$\text{Density} = \frac{\text{Total number of pellet groups present in all studied plots}}{\text{Total plots studied}} \times 100$$

3.4.2.4 Correlation Coefficient

Correlation is used to "measure the relationship between two or more variables from the knowledge of independent variables" (Walpole 1974:257). The vegetation, wildlife, anthropogenic disturbances, etc. are the variables that were compared with one habitat patch to another. It is used to test the hypothesis of 'there is significant relationship between forest quality index and tiger prey species abundance in restored forest patches'.

For this, the variables X and Y will be used to calculate the correlation coefficient (r) (Zar 1974) (at 0.05 significance level).

$$r = \frac{\Sigma XY}{\sqrt{\Sigma x^2 \Sigma y^2}}$$

where, X = one variable and Y = another variable

The value of 'r' can be either positive or negative but it can never be greater than 1.0 nor less than -1.0. A positive value of 'r' indicates that an increase in the value of one variable increases other variables too, a negative value indicates that an increase in the value of one variable is accompanied by a decrease in the value of the other variable (Zar 1974:237).

3.4.2.5 Student's t-test

It was first presented as the 't' distribution by William Sealy Gosset, and published it under the pseudonym "student" (Student 1908) which refers as "student's t-distribution" or "student's t-test" (Zar 1974:86). It is used to measure distribution and test the hypothesis. Normally, it applies if the sample size is small ($n \leq 30$). If all possible random samples of size 'n' are drawn

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n)}}$$

with replacement from a finite population of size 'N' with '$\bar{x}$' mean 'μ' and, standard variance 's', then the student's t-test (Zar 1974:87) is used.

In this research, t-test is used to test the hypothesis 'undisturbed, bigger and connected habitat is the best' for sustainable tiger conservation, which indicates its dispersal behavior in and around the protected areas.

3.4.2.6 Chi-square

Chi-square statistics, which was introduced by Karl Pearson, is used to determine the 'goodness of fit' (Pearson 1900). It is used for testing hypothesis which is tested by null hypothesis and an alternate hypothesis. The χ (chi) is used to measure the deviation of sample distribution from a theoretical distribution as follows:-

$$\chi^2 = \sum_{i=1}^{k} \frac{(f_i - F_i)^2}{F_i}$$

Where, f_i is the frequency, or number of counts, observed in class i, F_i is the frequency expected in class 'i' if the null hypothesis is true, and the summation is performed over all k categories of data (Zar 1974:42). The hypothesis 'human disturbance on national forests/ NPs has reduced after the restoration of community forests' was tested by using the chi-square analysis. This test was based upon the data of household survey, which was measured at p = 0.05 significance level.

3.4.2.7 Triangulation

The term 'triangulation' (Webb et al. 1966) has been used since the 1960s. Denzin (1970) advocates for triangulating in various forms such as data, theoretical, and methodological aspects. The multi-sources of data and instruments make the results 'more dependable and validity' and can compare/ contrast results through triangulation (Miles and Huberman 1994:273). Triangulation can be used in various data sources within qualitative research or between qualitative and quantitative methods (Denzin 2010). Within the qualitative method, interviews of different respondents such as key informants, experts, households can be interpreted to conclude a single result. Likewise, qualitative information of these different sources of data can be triangulated with analytical results. I tried to triangulate the different methods and findings on how community people have restored the forest and the major implications identified to conserve the target species. Hence, data obtained from the key informant interviews, questionnaire and household survey was triangulated with the field test i.e. observations and quadrat surveys. Then the findings of different themes were triangulated and synthesized in a single theme i.e. forest habitat restoration: sustainability and impacts for tiger conservation.

Chapter IV

Attitude and Perception towards Forest Restoration and Wildlife

4.1 Introduction

The exigent task entails the establishment of the protected area and reintroduction of large carnivore/ wild cat species (e.g. tiger). These large carnivores are the 'emotional keystone species' for restoration. However, people do not accept the conservation idea of ecologists and conservationists and they need the assistance of sociologists/ anthropologists for transforming their understanding (Breitenmoser 1998). Reintroduction or protection of these species in the reserves is crucial for sustainability despite the increasing human-wildlife conflict in and around the protected areas (Conforti and Azevedo 2003, Wang and Macdonald 2006, Sangay and Vernes 2008). For instance, depredation of livestock by leopard in and around the national park leads people to become negative toward the protected area and leopard (Dar et al. 2009). Further, human life loss from tiger has increased after buffer zone restoration (Gurung 2008) and victimized families did not receive the demanded compensation (Bhattarai 2009). From such grounded issues, people oppose the protection of carnivore species near their farmlands or settlements (Graham et al. 2005). Hence, conservation attitudes of local people determine the sustainability of conservation and management of resources in and around the protected areas (Baral and Heinen 2007).

An understanding of conservation attitude is vital in restoration and conservation. At present, the concept of conservation has shifted from a 'protectionist form of preservation toward sustainable utilization with participatory management' (White et al. 2005). Local people's attitudinal survey on resource use is significant for promoting sustainable development (Hartup 1994). It is also essential to know the attitude and conservation knowledge of children where conservation education plays a positive role on resource utilization and exploitation (Mulder et al. 2009). A motivated person can restore resources through understanding the idea of multipurpose utility, Ecological restoration efforts can also be done by non-ecologists (e.g. ranchers) in the private sector by developing grazing management practices through behavioral change (Cairns and Pratt 1995). Nevertheless, attitudinal assessment about changing behavior

is complicated in communities where it requires good knowledge in socio-economic and cultural influencing factors (Holmes 2003).

The conservation attitude is influenced by the affluence of local people, resources use patterns and problems and relationship among protected area employees with communities (Newmark et al. 1993). Poor socio-economic status and lack of opportunities will drive negative attitudes toward wildlife conservation whereas education (Infield 1988, Conforti and Azevedo 2003) and incentives for consumptive use develops positive attitude (Abdullahi et al. 2007). Some communities have perceived that crop damage will increase and resource uses will be restricted after the establishment of protected areas, where they undervalue future use of the areas, for instance, ecological goods and services (Coad et al. 2008). Hence, an attitude toward natural resources management is established by knowledge and socio-cultural factors (McFarlane et al. 2006). Furthermore, people have different attitudes toward wildlife (e.g. carnivores), from ecological to utilitarian value, and their own welfare (Kellert 1985). A positive attitude toward protected areas and wildlife is important in conservation, which retains resource restoration.

In this context, an empirical research pertaining to the attitude of local people is crucial. Nevertheless, nominal research has used interviews and questionnaire techniques to evaluate perception and measure socio-economic perspective in the restoration (Aronson et al. 2010). The Terai landscape program, conducted for forest management and wildlife conservation since 2001, facilitates the establishment of local people's conservation attitudes and perceptions. Hence, this chapter is designed to understand the attitude of community people toward forest restoration and wildlife in the mid-western Terai region of Nepal. It will provide a fundamental initiative for conservation planners and restoration practitioners for sustainable resource conservation.

4.2 Methodology

4.2.1 Study Area

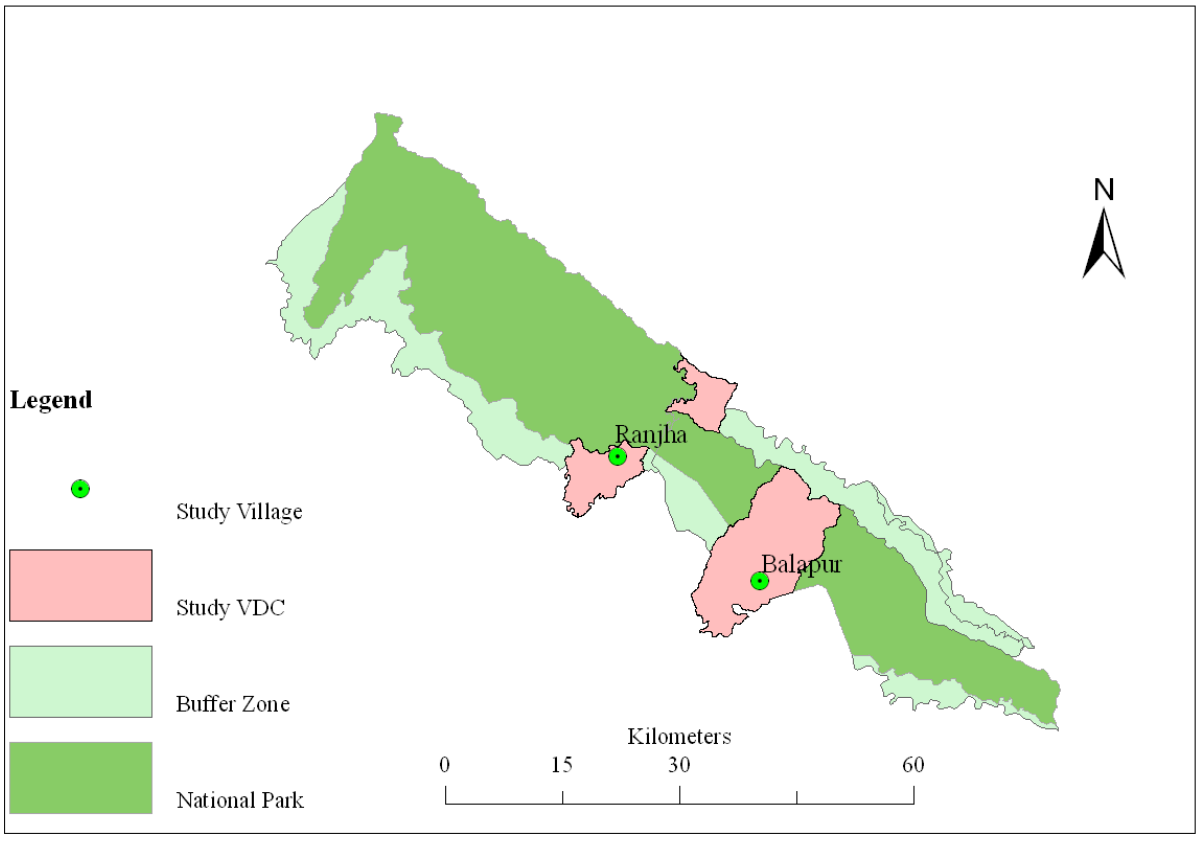
Survey villages were selected after the Rapid Rural Appraisal (RRA) in and around Bardia and Banke National Parks. Based on similar settings of land topography (e.g. surrounded by buffer forest with intact national park), socio-cultural status (e.g. most of the inhabitants are the immigrants from the hills), ecological settings (e.g. possible tiger habitat nearby buffer forest, restored after TAL) and other criteria (e.g. size of forest >100 ha), I chose Ranjha of Beluwa VDC, Bardia District and Balapur of Mahadevpuri VDC, Banke District (figure 23.4). However, some aspects are different such as education status, establishment of buffer forest, funding, etc. (table 13.4). An attitudinal survey of forest users and committee members was conducted in these two buffer villages, where Ranjha lies in the eastern part of Bardia National Park and Balapur is located in the southern side of Banke National Park.

Ranjha Buffer Forest Users Committee (RBFUC) is formed under the Bagkhor Buffer Forest Management Committee (BRFUC). Under the RBFUC, there are four sub-committees, namely, Sworgadwori, Jaljala, Shivasakti and Bhagawati. A total of 432 households with 2,232 inhabitants (49.06% female and 50.94% male) having 1,649 livestock (four livestock per household) live in this area. Based on land holding, food security, type of house, job and capacity, the identified economic classes are:- strong (13.42), medium (20.14) and weak (66.44) (BFCC report 2009). All people have migrated from the hilly areas, mostly Dailekh, Rukum, Salyan and Surkhet Districts since 1967 and the process is continuing. Among the people are those from Thakuri, Malla, Shahi, Hamal, Chand, Bohara, Khadka, Oli, Damai, Kami and other castes. The buffer forest covers 930 ha area and the main wildlife species such as blue bull, wild boar, rhesus macaque, common leopard, jackal, spotted deer, four-horned antelope, mongoose, etc. are found in the forest.

Mahadevpuri VDC has a total of fourteen Community Forest Users Groups (CFUGs) that have been formed, overseeing forests ranging in size from 36 to 292 hectares of forest, with 36 to 294 household members. Balapur is one of the wards (Ward no. 6) of Mahadevpuri where 200 households with 1,148 inhabitants (51.74% female and 48.26% male) live. Most of them are Chettris (Kusari, Oli, Khadka, Khanal, Basnet, etc.), Magar (Pun), Damai, Kami, Tharu and Badis. Based on land holding, food security, type of house and property, job and capacity of

leadership, the economical classes are stratified where 25, 36.5 and 38.5 percent households are strong, medium and weak respectively. Their main subsistence depends on agriculture where they have less than 0.40 ha land on an average. They have 2,025 livestock, which is ten livestock per house. The education status is low where forty percent of the people are literate, twenty percent have basic knowledge, thirty percent have schooling above Class 10 and ten percent have more than a School Leaving Certificate (SLC) (CFUGC report 2005). All of them have migrated from nearby hill districts mainly Rukum, Surkhet, Pyuthan, and Jajarkot since 1971, and the trend is still continuing. Initially, these settlements were used as temporary hunting camps. In the beginning, the Community Forest had a total area of 160 ha, but now they are conserving 304.26 ha. Wildlife species such as wild boar, rhesus macaque, common leopard, jackal, spotted deer, etc. are found in the forest.

Figure 23.4 Locations of study area in buffer villages with national park and buffer zone



Source: Data of Survey Department, Kathmandu

The immigrants from hilly districts had settled down in the lowland by clearing/ slashing/ burning the existing forest areas. Most of these early birds have a wealth of experience of forest clearing, firing, logging, wildlife poisoning, etc. (per. com.). Even today, these activities are prevailing in some areas. After the establishment of the national parks and involvement of

various institutions (e.g. WWF, NTNC), they have felt it imperative to change their attitude toward conservation activists. Nevertheless, a very few became involved in conservation.

Table 13.4 Comparison between Ranjha and Balapur Buffer villages

	Ranjha	Balapur
Location (latitude, longitude)	28°17'N, 81°36' E	28°09' N, 81°47' E
National Park	Bardia	Banke
National Park Gazetted/ extend	1976/88	2010
Area (NP+BZ in Km^2)	968+508	550+ 343
Buffer Forest Gazetted/extend	1997/010	2010
Buffer Forest (Area in ha)	928	304.25
Households	432	200
Total Population (F/M in percent)	2232 (F- 49.06, M- 50.95)	1148 (F- 51.74, M- 48.26)
Total Livestock (per hh)	1649 (4)	2025 (10)
Settlement (around)	1967	1971
Economic condition (in percent)	s-13.42, m-20.14, w-66.44	s-25, m-36.5, w-38.5
Institutions to assist Restoration	WWF, NP, WTLCP, NTNC	WWF, DFO

Note- (° ') degree and minute, NP- National Park, BZ-Buffer Zone, ha- hectare, F-female and M- male, s-strong, m-medium, w-weak, hh-household, WWF- World Wide Fund for Nature, WTLCP- Western Terai Landscape Complex Project, NTNC- National Trust for Nature Conservation, DFO- District Forest Office

4.2.2 Methods

Semi-structured, open ended and structured close ended (e.g. multiple choice) questions for using both qualitative and quantitative methods (Creswell 2009) and observation of the respondent's activities were used to understand the attitude and perception of local communities. I selected major post holders from among Forest User Group Committee (FUGC) members (n = 20). Further, a simple random sampling technique was used to select forest users (n = 84) as interviewees from Ranjha and Balapur buffer villages. Questionnaires were focused on the motivation toward restoration, the importance of restoration, and wildlife, disturbances from wildlife and its tolerance, like/ dislike of wildlife and agree/ disagree to support wildlife conservation (annex iii and v). Each interview was estimated to be of 40 minutes and questions were asked in the Nepali language. A few sample questionnaires were tested during the Rapid Rural Appraisal (RRA) in September 2010 and after minor editing the questionnaire was used for interview between October 2010 and January 2011.

4.2.3 Data Analysis

After translating the data from Nepali into English all survey forms were checked and incomplete forms (seven were incomplete and one respondent was of less than 18 years) were omitted. After entering into the computer, data was coded using different numbers (e.g. sex code: 1 = Female, 2 = Male, age group code: 1 = "18-19 yrs", 2 = "20-39" yrs, 3 = "40-59" yrs, 4 = "above 60 yrs" , education code: 0 = "Never went to school", 1 = "Training", 5 = "Primary", 8 = "Lower secondary", 10 = "SLC/Secondary", 12 = "Higher Secondary", 15 = "Bachelor", 17 = "Master", occupation code: 1 = "Farmer", 2 = "Worker", 3 = "Job holder", 4 = "Student", 5 = "Small entrepreneur"). Multiple choice questions were coded on a scale from 1 to 5 with 1 = strongly disagree to 5 = strongly agree (McFarlane et al. 2006). For the education code, illiterate was used for 'never went to school', 'training' was used for informal class and other codes were used as academic year to complete education in Nepal. One answer related to motivation was quantitized and coded as 1 = to get grass, firewood, timber, 2 = to conserve environmental elements, 3 = to conserve biodiversity, 4 = conserve wildlife, 5 = to save for next generation, 6 = for global concern.

For the Likert scaling technique (Likert 1932), values were added and divided by the maximum value of each questions and attitude index was prepared. A few qualitative answers were 'quantitized' (Teddie and Tashakkori 2003) for analysis in statistical purpose. Microsoft Excel 2007 and SPSS 16.0 program were used to calculate and analyze the data mainly using t-test, chi-square test and correlation coefficient. The variables were categorized as an ordered form, therefore, Spearman's rho was used for analysis of bivariate correlation for association of attitude index with age, sex, occupation and education. In the case of a sample size less than 30, parametric two samples 't-test' was used and in case of a sample size more than 30, non-parametric Mann-Whitney (chi-square) test was used to compare two forest users groups attitude thereby considering the distribution of data (Gupta 1999, Griffith 2007).

4.3 Findings

4.3.1 Respondents

4.3.1.1 Forest User Group Committee Members

Out of the thirteen members in the Forest User Group Committee (FUGC), the ten main post holders were interviewed. Most of the interviewees were males, with ages ranges between 27 and 66, the majority of them were farmers and education level was higher in Ranjha than Balapur (table 14.4).

Table 14.4 Comparison between two FUGC in terms of sex, age, occupation and education

Variables	Components	Ranjha (n)	Balapur (n)
Sex	Female	-	1
	Male	10	9
Age	Minimum	36	27
	Maximum	55	66
	Mean + St. deviation	44.3+- 6.49	39.6+- 11.99
Occupation	Farmer	6	8
	Job holder	2	2
	Small entrepreneur	2	-
Education	Training	-	3
	Primary	-	1
	Lower Secondary	3	2
	Secondary	5	4
	Higher Secondary	2	-

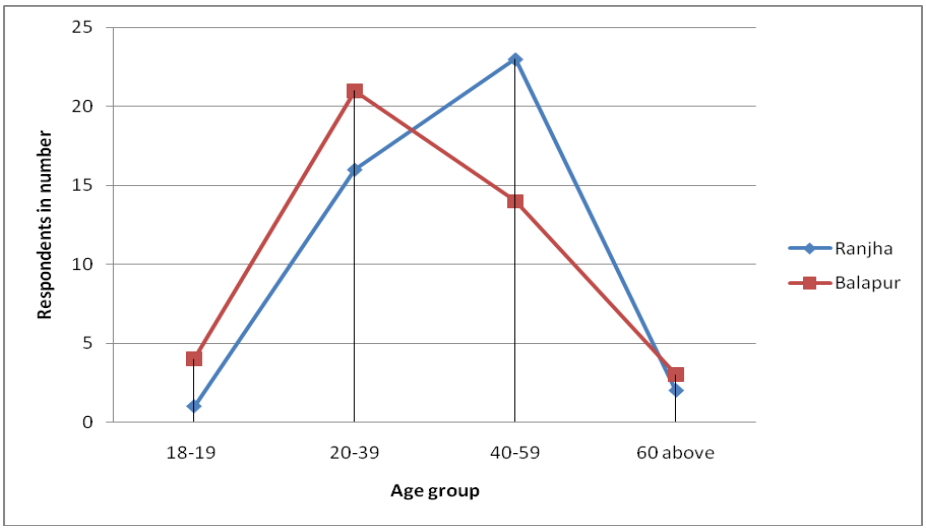
Source: Field survey 2010

4.3.1.2 Forest Users

The respondents were 9.7 percent in Ranjha and 21 percent in Balapur of the total households. In the beginning the respondents of Balapur hesitated to response, suspecting I was government staff, coming because of their opposition to the government's decision to establish national park, which was declared in July 2010. They also didn't want to accompany me inside the forest as they were afraid their illegal forest activities would be seen. I hired a person from next village as a forest guide. After participating in the monthly meeting and general assembly of their FUG committee, they responded me as a student.

The respondents were mainly male (i.e. 37 = 88.1% in Ranjha, 31 = 73.8% in Balapur) in both villages. Among them, the respondent of Ranjha were of the age group 40-59 (23 = 54.8%) while in Balapur it was 20-39 (21 = 50.0%) (figure 24.4).

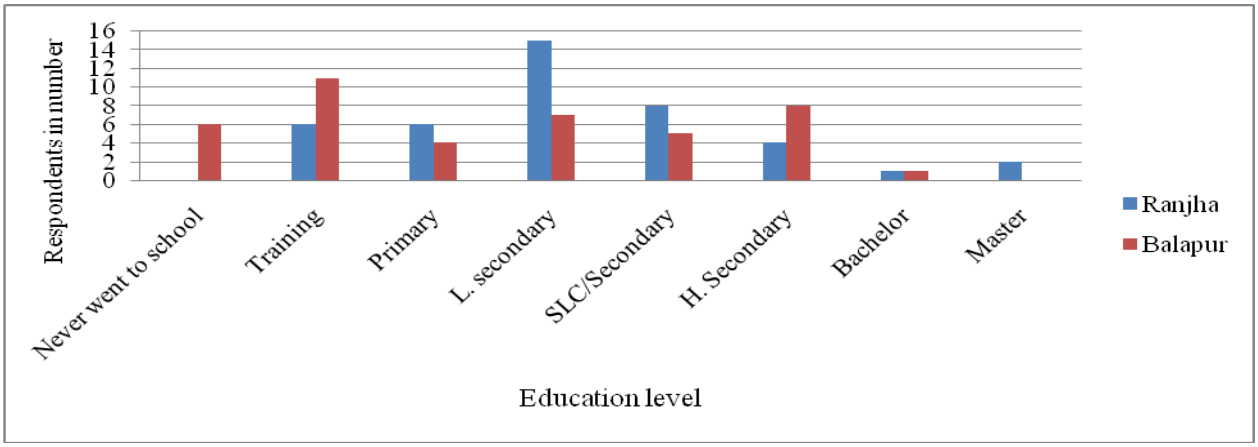
Figure 24.4 Age group



Source: Field Survey 2010

The educational attainment of forest users was higher in Ranjha than Balapur. In Balapur, some respondents never went to school, (17 = 40.5%), no one had a master degree and only a few had completed school level education (14 = 33.3%), whereas in Ranjha, each respondent went to school where a few (3 = 7.2%) completed higher education. Six = 14% did not get any formal education (figure 25.4).

Figure 25.4 Educational attainment of respondents

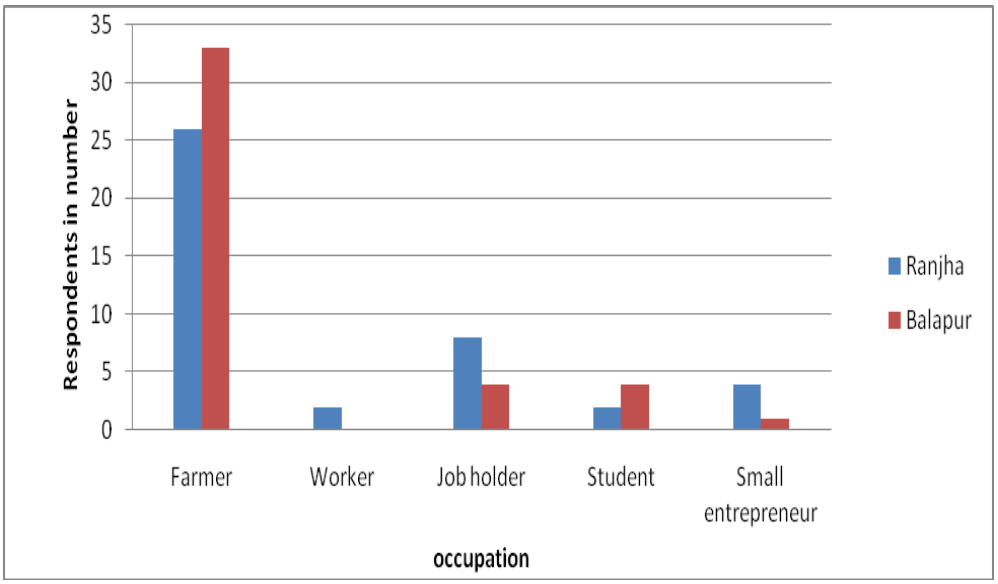


Source: Field Survey 2010

The main livelihood of respondents was diverse. The majority of them were farmers in Balapur (33 = 78.6%) and in Ranjha (26 = 62%) (figure 26.4). Few respondents were job holders (4 = 9.5% in Balapur and 8 = 19% in Ranjha) and some were students (4 = 9.5% in Balapur and 2 = 4.8% in Ranjha). Very few were involved in entrepreneurship i.e. shops or household business

on a small scale. Those who did not have land were depending on temporary jobs abroad, mainly in India.

Figure 26.4 Occupation status

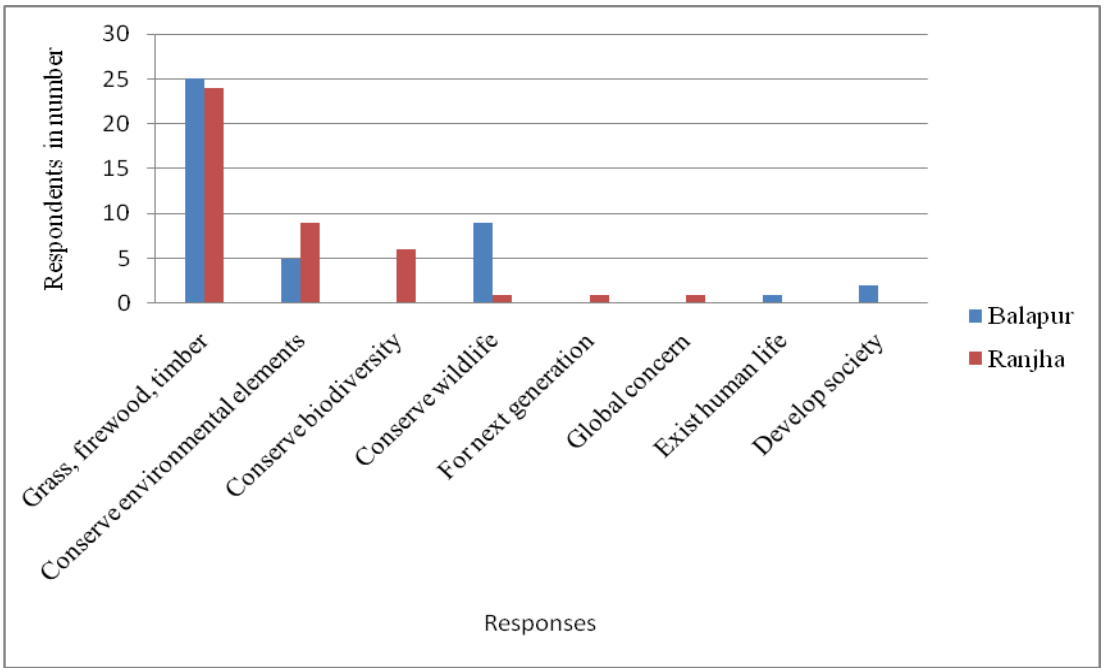


Source: Field Survey 2010

4.3.2 Restoration Motivation

Balapur FUG started forest conservation in 1996 which, however, did not continue. However, after the introduction of the Terai Arc Landscape program in 2001, local people were motivated to restore forest for various purposes. The majority of the respondents (25 = 59.5% in Balapur and 24 = 57.1% in Ranjha) were motivated in order to get firewood, grass and timber in both villages. Other respondents (9 = 21.4%) had conserved the forest for environmental elements (i.e. soil, air, water) and (6 = 14.3%) in Ranjha for biodiversity conservation. In Balapur, a few respondents (5 = 11.9%) mentioned that the forest is conserved for environmental elements, and a few others (9 = 21%) for wildlife. Very few have perceived the importance of restoration as an attempt to handover to the next generation, address global concerns, develop society and to sustain human life (figure 27.4). Many respondents in Ranjha (15 = 35.7%) had more environmental knowledge where they used the technical term 'biodiversity' and environmental elements than in those in Balapur (5 = 11.9%). Some respondents (9 = 21.4%) also emphasized wildlife conservation. The rate of information dissemination by the FUG committee was low in both villages. Only 17 (40%) in Ranjha and 23 (55%) in Balapur were informed of regular meetings held by the FUG committee, while other were informed about the bi/annual meeting only.

Figure 27.4 Motivation of respondents towards forest restoration (n = 42 & presented in number)



The motivation attitude of people toward restoration is significantly correlated with education and occupation (p = 0.01) in Ranjha and with education in Balapur (p = 0.05), but there is no correlation with age and sex in both villages (table 15.4).

Table 15.4 Relation between restoration motivation and age, sex, education and occupation (n = 42)

Variables	**Ranjha**		**Balapur**	
	Correlation coefficient	Sig. (2-tailed)	Correlation coefficient	Sig. (2-tailed)
Sex	0.081	0.609	0.066	0.679
Age	-0.141	0.373	-0.124	0.433
Education	0.451	0.003**	0.327	0.035*
Occupation	0.511	0.001**	0.396	0.009**

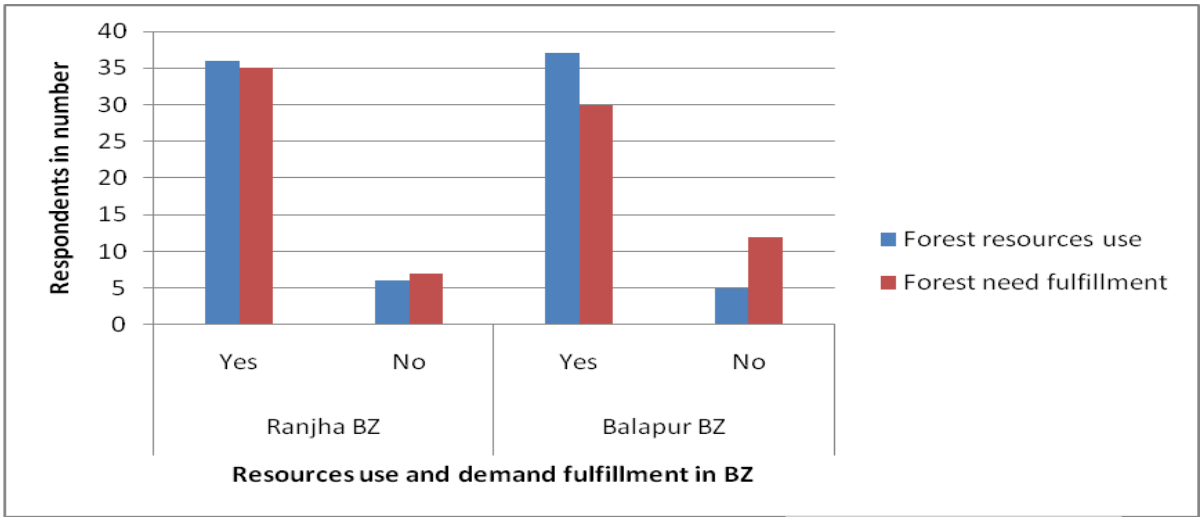
Note-** Correlation is significant at p = 0.01 level and, * Correlation is significant at p = 0.05 level

4.3.3 Forest Resource Uses

From the household survey, I found that the community people used the buffer/ community forest for collecting firewood, fodder, timber, leaf litter and medicinal plants, and grazing. Most of them (36 = 85.7% in Ranjha and 37 = 88.1% in Balapur) use these products (figure 28.4). The others, who have permanent houses, use alternative sources of energy (e.g. biogas), have trees on their own land and are located far from the forest edge, do not use the forest for firewood and fodders, but they use the forest as the source of community income. There is no significant relation in forest product use in the two villages ($\chi 2$ = 0.148, d.f. = 1, P = 0.701). Buffer/ community forests fulfilled their forest needs; as was agreed by 35 (83.3%)

respondents in Ranjha and 30 (71.4%) in Balapur, and rest of the others used the national parks for their forest needs. There is no difference in forest product fulfillment of two villages ($\chi 2$ = 0.820, d.f. = 1, P = 0.365 and Z = -1.213, P = 0.225). Therefore, the hypothesis that 'human disturbances on national forest/ national park have been reduced after community forest restoration' in Balapur Community Forest is rejected.

Figure 28.4 Responses of forest users and fulfillment of forest needs in buffer villages



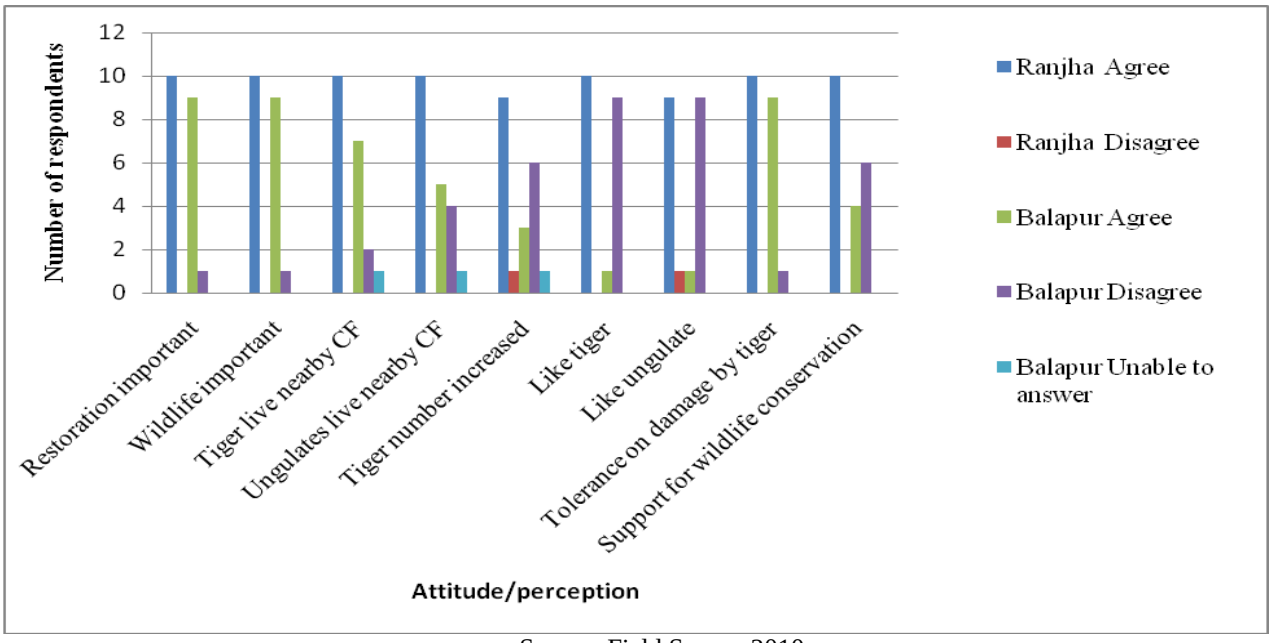
Source: Field Survev 2010

4.3.4 Community People's Attitude towards Forest Restoration and Wildlife

4.3.4.1 Attitude of FUG Committee Members

Forest User Group Committee members are aware of the restoration and wildlife conservation. All respondents (10 members) have perceived the importance of forest restoration and wildlife in Ranjha, but most of them (9 members) do not like tiger and ungulates because they fear the depredation of livestock by tiger, and crop damage by deer in Balapur. All of the respondents (10 members) agree that the tiger and its prey (ungulates) are present in the nearby community forest and their population has increased in Ranjha. Contrarily, in Balapur, only seven respondents agree on the presence of tiger and its prey species and three respondents agree on the population increment. All of the respondents are in favor of protecting these species in and around their community forest in Ranjha whereas only four respondents in Balapur (figure 29.4) are in different.

Figure 29.4 Attitude/ perception of CFUC towards restoration and wildlife in Ranjha and Balapur

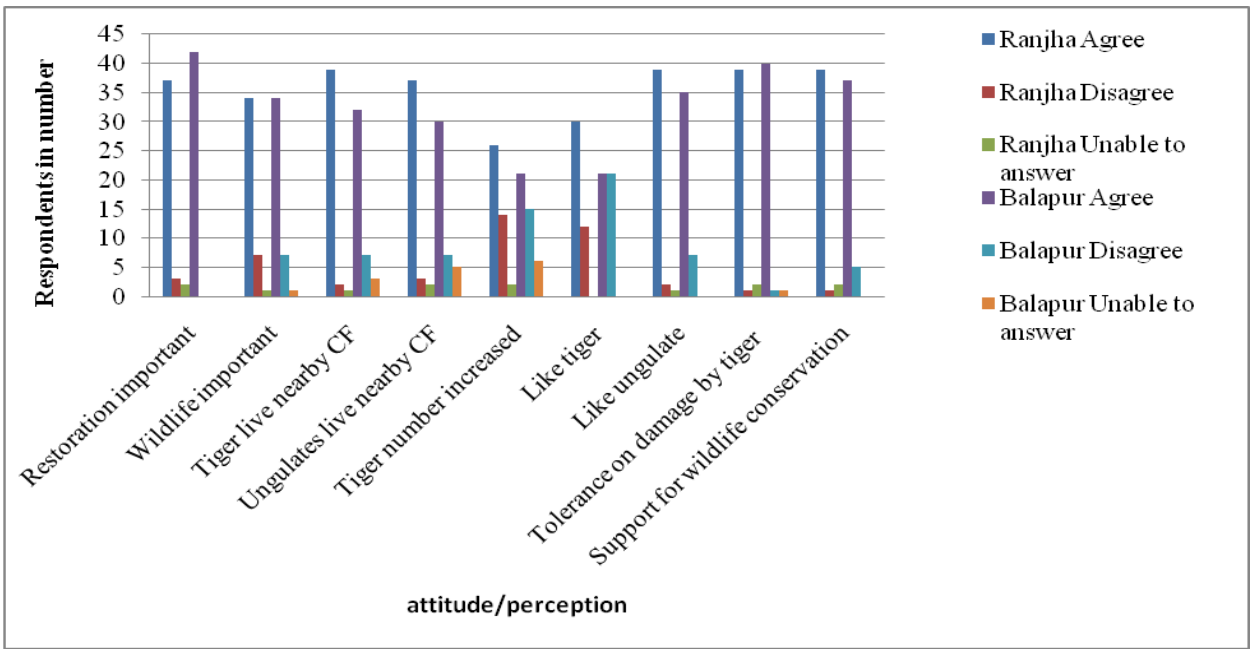


Source: Field Survey 2010

4.3.4.2 Attitude of Forest Users

Respondents have different attitude toward restoration and wildlife in both villages. Most of the users (i.e. 37 = 88% in Ranjha and 34 = 81% in Balapur) agree that restoration and wildlife are important for them. Similarly, most of respondents (37 = 88%) agree that tiger and ungulates (deer sp.) live in the nearby buffer forest in Ranjha whereas fewer respondents (30 = 71%) agree in Balapur. In Ranjha, a higher number of respondents (26 = 61%) agree that the tiger population has increased after forest restoration than in Balapur (21 = 50%). In Ranjha, more respondents like tiger (30 = 71%) and ungulates (39 = 92%) whereas in Balapur, fewer like tiger (21 = 50%) and ungulates (35 = 83%). Most of them (39 = 92% in Ranjha and 40 = 95% in Balapur) agree to have requested compensation after tiger killed their livestock. Very few (2 = 4.8%) are aggressive toward tiger. Most of them (39 = 92% in Ranjha and 37 = 88% in Balapur) are in the favor of supporting wildlife conservation in both villages (figure 30.4).

Figure 30.4 Attitude/ perception of forest users towards restoration and wildlife in Ranjha and Balapur



Source: Field Survey 2010

The attitude index of forest users (n = 84) is not associated with age (r = 0.002, sig. = 0.986), sex (r = -0.038, sig. = 0.734) and occupation (r = 0.113, sig. = 0.304) significantly but is associated significantly with education (r = 0.319, sig. = 0.003, p = 0.01). The attitude index between two groups is not associated (Mann-Whitney U = 635.5, sig. = 0.027) significantly (table 16.4).

Table 16.4 Attitude index towards restoration and wildlife in Balapur BZ

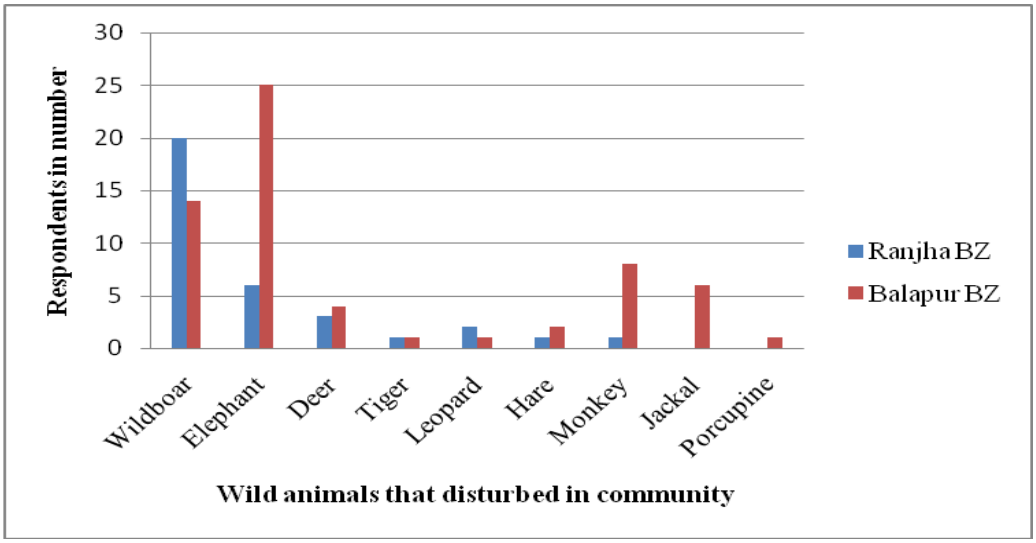
Questions	**Ranjha**	**Balapur**	**Chi-square test**
Restoration important	0.919	0.957	Mann-Whitney U = 635.5 Asymp. Sig(2 tailed) = 0.027
Wildlife important	0.914	0.861	
Tiger lives in nearby CF	0.895	0.785	
Ungulates live in nearby CF	0.89	0.761	
Tiger increased	0.709	0.676	
Like tiger	0.828	0.719	
Like ungulate	0.914	0.842	
Tolerance on tiger attack	0.79	0.79	
Support for wildlife conservation	0.914	0.909	
Average	7.773	7.3	

Source: Field Survey 2010

4.3.5 Wildlife Disturbances and Perception toward its Control Measures

In both FUGs, wildlife disturbs their normal social life. The majority of the respondents (30 = 71.43% in Ranjha, 34 = 80.96% in Balapur) mentioned that they are disturbed by wildlife species such as wild boar, elephant, deer, tiger, leopard, hare, monkey, jackal and porcupine (figure 31.4). They bear negative attitude toward wildlife, especially wild boar, elephant, deer, tiger/ leopard because they destroy their crops/ kill livestock and sometimes attack people. The remaining households, who do not use forest products daily and live far from the forest edge, do not feel disturbed by wildlife.

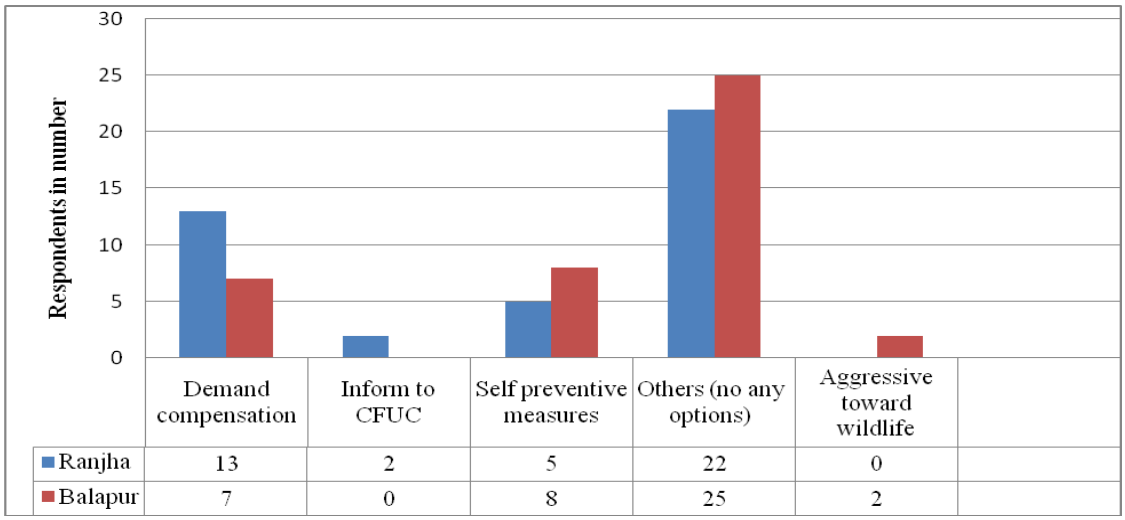
Figure 31.4 Wildlife disturbances



Source: Field Survey 2010

To control wildlife disturbances, mainly crop damages, the majority of the respondents (22 = 52.4% in Ranjha and 25 = 59.5% in Balapur) do not believe any options. They answer that compensation could not be received easily, and could not control wildlife hazards particularly elephant and wild boar. Few respondents mentioned that they try to control wildlife themselves and demand compensation or inform community forest user committee (CFUC). However, some respondents were more aggressive in Balapur toward wildlife and said that 'if it does not run away, I will kill it' (figure 32.4).

Figure 32.4 Perception towards wildlife disturbances control measures



Source: Field Survey 2010

4.3.6 Sustainability of Resource Conservation and Restoration

After the assistance of governmental and non-governmental organizations, Community Forest User Committees (CFUCs)were formed. These committees brought awareness to the local people and conducted development activities. After the implementation of the TAL program in 2001, community forests have been well institutionalized in both villages. Education and awareness programs have been conducted at the local level and, as a result, people are informed about the importance of forest and wildlife, and they have a feeling of ownership. Based on their management rules, they opened the forest for firewood collection once a year and opened it for grass cutting with the permission of the CFUC. Community people have changed their attitude from that causing destruction to resources, toward wise use. Particularly, those who have benefited from restoration have developed a positive attitude. One of the respondents stated:-

> *"Before the establishment of the community forest, I did not get involved in conservation, I did not care about the forest and wildlife, now I love wildlife and forest"* (per. com. a Forest Guard in Balapur).

Community members were involved in training and income generating activities, which has brought positive attitude toward restoration. But community forests have failed to fulfill their needs and people used the national forests/ national park to fulfill their extra needs. As a result, human pressure has increased on the national forests/snational parks.

Most of the old farmers did not like the concept of having wildlife especially tiger/ leopard in the nearby community forest. Few people were against conserving forest closer to their settlements. These people thought that wildlife will increase with the increase in forest areas and ultimately create trouble. For this reason, local people adjoining to the national park, northern part of mid Ranjha, cleared the restored buffer forest after elephants entered their village and damaged property in 2007 (per. com. in Ranjha). Those who are victimized from wildlife or threatened regularly, but did not get any compensation/ incentives or went through a lengthy process to get nominal compensation have developed a negative attitude. In this regard, one victim said:-

> *"I lost NRs. 15,000 (150 €) of paddy field and tried to get compensation. I went to the national park office five times but it was useless - I only lost lost days of work and transportation cost. In the end, I got NRs 1s500 (15€) through a member of the Buffer Zone Management Committee, then how could we support wildlife conservation?"* (per. com. in Ranjha).

During the same year, a group of elephants had entered Balapur village and damaged houses and crops, and the community people shot at one elephant with a gun (per.com. in Balapur). Furthermore, one farmer said that:-

> "*One buffalo was killed by tiger in 2009 and one was wounded, then I lost near about NRs. 30,000 (300€) but I did not get any compensation*" (per. com. in Balapur).

Those who lost property, did not get compensation and are highly threatened by wildlife have a negative attitude, which ultimately affect the conservation endeavor. Insufficient compensation and the hierarchical management system of government institutions has made a complex situation in establishing positive attitude which has created problems in the sustainability of resources.

4.4 Discussion

4.4.1 Restoration Motivation and Resources Use

Study locations and interview groups were selected after the rapid assessment from rapid rural appraisal that had the well determined criteria of social, ecological and physical features,

which reduces bias. I used both the qualitative and quantitative data collection methods for descriptive and analytical analysis of social and ecological array. Standard open and close questions were used for interviews that were standardized through several consultation with supervisors, PhD colleagues and experts, and pre-test. After the data collection, I performed data management and analysis carefully concerning the reliability (Bailey 1982). Mixed method research was used to triangulate the findings, making the research more valid (Cohen 2008, Weiss 1998).

Community people are informed about the importance of restoration and wildlife conservation. Different institutions/ programs such as the Terai Arc Lanscape (TAL) program, national park (NP), World Wide Fund for Nature (WWF Nepal program), National Trust for Nature Conservation (NTNC), Western Terai Landscape Complex Project (WTLCP) in Ranjha, and TAL and the District Forest Office (DFO) in Balapur have given support in infrastucture development, education and management of forest and wildlife conservation. With the assistance of these institutions, Forest User Groups (FUG) Committees have formulated the rules and regulations of community forests. Further, FUGS have tried to use forest resources wisely.

In Balapur, community people were busy with agricultural work during October/ November and most of the adults had moved inside the park for collecting thatch during December and January. As a result, some interviewees were younger. More of the respondents were motivated to restore the forest for collecting firewood, thatch, grass and timber in Balapur than Ranjha (figure 27.4). Most of them were farmers with low education level in Balapur compared to Ranjha which is the reason behind this difference. A few job holders and educated persons mentioned that they are motivated toward conservation for its environmental value (i.e. soil, air, water), wildlife conservation for next generation, global importance and tourism. From these responses, I summarized that they were motivated and have perceived the importance of restoration for the value of utilitarian/ services, environmental/ functional, conservation, global concern, economical and socio-cultural value. In this context, Kellert (1985) categorizes the attitude of people towards wildlife into naturalistic, ecologistic, humanistic, moralistic, scientific, aesthetic, utilitarian, dominionistic and negativistic. The result regarding attitude differs with the sampling size, education, and location, therefore, in this study, the result might have been affected by the smaller sample size and low education status of the respondents.

The forest need of majority of the respondents (more than 80 percent in Ranjha and 70 percent in Balapur) have been fulfilled from the community forest and rest of the others used national park/national forest. The attitude of community people is positive toward community forest and do have the feeling of ownership, but they are not much responsive toward conserving national forest. As a result, they abundantly use resources of the park and forest, particularly in Balapur area. Hence, when the people understand the importance of restoration and get incentives, their feeling of ownership will extend (Shono et al. 2007) and will contribute in resources conservation.

4.4.2 Attitude and Perception towards the Restoration and Wildlife

Most of the FUG Committee members have a positive attitude towards forest restoration in both the villages. However, more respondents bear positive attitude toward wildlife conservation in Ranjha than Balapur (figure 29.4). Committee members are more educated in Ranjha and have received some incentives from the park. However, in Balapur, people have had experiencs of property loss from wildlife particularly tiger/ leopard and elephants, and are more aggressive with the decision of government for establishing the new 'Banke National Park'. It indicates that the government should execute plans for providing compensation for the people of Balapur. Therefore, these people will be excited to accept the proposal of the government, i.e. "Banke National Park". Most of the forest users advised that the local settlements should be translocated into another safe location or the government's decision to establish a new national park should change.

The forest users are more positive toward restoration and wildlife conservation in Ranjha than in Balapur, where more respondents are negative toward wildlife (figure 30.4). There are more social problems in Balapur, for instance, lack of a compensation scheme, insufficient resources, low awareness, etc. Baral and Heinen (2007) also found that the people of Bardia National Park Buffer Zone had a more favorable conservation attitude than Suklaphanta Wildlife Reserve due to difference in received training, compensation of damage by wildlife and less conflict in resources use. In Balapur, people have a low education status, most of them are farmers, and the government hardly consulted people while gazetting the new national park and this was what led in part to the negative attitude. In other areas, low education and economic loss have influenced the perception of people toward carnivores (e.g. jaguars and pumas) and contributed the negative attitude (Conforti and Azevedo 2003). Similarly, socio-

economic, cultural, and education factors influence attitudes (Parry and Campbell 1992, c.f. Holmes 2003) that can create a negative attitude toward wildlife conservation.

Beside social factors, wildlife disturbances persuade the attitude of people toward the wildlife, which is higher in Balapur. Most of the people have been affected by more than two wild animals (figure 31.4), they have lost their livestock, had their crops damaged, have been threatened by these animals, and did not get any compensation or other incentives, as result they have a negative attitude toward wildlife. Similar findings are derived by Bhattarai (2009) who mentions that people are unsatisfied with the compensation and could not tolerate human casualties by tiger in Bardia National Park. Decker et al. (2008) also found that the formation of attitude depends on the damage to property or lifestyle change and fear of large herbivorous (*Bison bonasus*) as seen in restoration in Germany. Hence, wildlife-human conflict is another considerable factor in establishing attitude toward restoration and wildlife.

4.4.3 Sustainability of Restoration and Resources Conservation

Results show that the respondents who have benefited (e.g. job, income from forest products, poverty reduction programs, etc.) from TAL and other conservation programs have developed a positive attitude and those who are victimized or had property losses and did not get any incentives have developed a negative attitude in both villages. People expected more economic benefit from forest restoration without any loss from wildlife, which is quite difficult for managers or conservationists. Nevertheless, as very few people benefited, changing the attitude of other marginal and wildlife vulnerable people is still difficult yet vital in conservation and sustainability of resources.

Local participation in decision making and political stability is another factor for sustainability of resources. The government has gazetted the national park but the local communities are not convinced with such a decision and therefore, they have formed anti-national park protest groups to give pressure to the government; some opposition parties have politicized this issue. At the same time (in January 2011), a tiger was translocated to Bardia National park from Chitwan National Park, and the people of Balapur thought that a tiger would be released in Banke and they would loose their property. In addition, the FUG of Balapur was not interested to conserve forest in 2010 due to the fear of wild animal and the government's decision to establish a national park. This shows that central decision making affects the sustainability of restoration and resources conservation.

4.5 Summary

This chapter is designed to analyze the attitude of community people toward forest restoration and wildlife in and around the newly gazetted Banke National Park' in the lowland of Nepal. I used semi-structured, open and close questions to interview the buffer/ community Forest User Group Committees (FUGC) and forest users from Ranjha and Balapur buffer villages, I also directly observed the local communities. This data was analyzed using descriptive and analytical (e.g. Likert scale, t-test, chi-square) methods.

The members of the FUGC were positive toward the forest restoration in both villages, however, more FUGC members were negative in relation to wildlife conservation in Balapur than Ranjha since the majority of the respondents were farmers, had a lower educational level and had a fear of human and livestock loss. Most of the respondents were motivated to restore forest for firewood, grass and timber in both villages and a few others were motivated toward conserving the environmental elements (i.e. soil, air, water), biodiversity and wildlife. Most of them used the community forest to fulfill their forest needs. The attitude of forest users is positive on forest restoration; it is not significantly associated with age, sex, occupation and education. Most of the farmers were concerned about property loss associated with the increased wildlife population, whereas job holders and other respondents emphasized the importance of wildlife and environmental conservation. Hence, wildlife problems such as loss or damage of crops and threatened human life, and inadequate compensation lead to a negative attitude among those who most depend on farming for their livelihoods.

Chapter V

Forest Management Planning, Restoration and Conservation Issues

5.1 Introduction

Conventional, top-down planning has been replaced by a participatory planning approach in different sectors since the 1980s (Amler et al. 1999). Systematic planning is expedient where local implementing institutions and users groups are consulted. Then, integrated land use plan (Pierce et al. 2005) is developed. Besides the participatory approach, the decision analysis method is valued to make the decision of restoration priority where the 'integration of ecological theory, objective ecological data and subjective expert opinion' are considered (Cipollini et al. 2005). A restoration plan is also an integrated management plan that has goals, methods and detailed procedures for monitoring progress and recovery of species (Atkinson 1994, DellaSala et al. 2003). Hence, 'interdisciplinary collaboration' is appropriate in the planning to deal with the complex issues efficiently and promote 'the scientific knowledge' (Wright 1987).

Landscape level forest restoration planning is essential to restore the degraded or deforested lands and to improve the livelihoods of local people (Aldrich et al. 2004). In practice, planted forest plays a vital role in forest landscape restoration which contributes to ecological integrity (Maginnis and Jackson 2003). If the conservation of the target species is challenging because of crops/ livestock damage or threatened human life, systematic participatory planning is a proper way to assess the acceptable interventions (Treves et al. 2009). When priority is given to the conservation of species such as tigers, snow leopards, etc., the existing individual isolated parks and protected areas cannot support for them in long run (Chettri et al. 2007). Therefore, they should be linked through corridors at landscape level. These corridors provide and maintain habitats for migratory or refuge wildlife (NBH 2004). For this, it is essential to design landscape level conservation for the refuges of wildlife and for effective protection, off-reserve land use and management strategies in buffer/ community forestry, which facilitates dispersal of wildlife, particularly tiger, from the core areas (Wikramanayake et al. 2004).

Furthermore, participatory decisions of various actors should be included in the fragmented ecosystem conservation and highly attributed area of biodiversity at regional level (Opdam et al. 2008). In conservation planning, scientists use biological information of focal species to restore and manage habitat (Chase and Geupel 2005). However, the ecological, social and economic goals should include and all these three aspects; 'triad approach' is apt in planning (Sarr and Puettmann 2008). During planning, priorities of goals, identifying major threats and opportunities, selecting appropriate activities, developing systems to monitor their impacts and improving the program management are the major steps to be included (USAID 2005). In passive wildlife restoration, strategic planning is also vital that contributes to maximize the potential for colonization in fragmented landscape and the value of each restoration activities to the target species (Scott et al. 2001).

Plantation and management in community forestry has played a significant role in Nepal, contributing to large scale conservation and restoration with a little effort (Lamb and Gilmour 2003). However, inequitable distribution of benefits and motivation in the Forest User Groups (FUGs) is still impeded (Lamsal et al. 2010), and lacks systematic conservation planning (Shrestha et al. 2010b). To use the experience of community forest, and to address the issues of wildlife and its habitat conservation (e.g. fragmentation, degradation, illegal activities), the Terai Arc Landscape Strategic Plan (2004-2014) was formulated. For this, special focus has been given on the restoration and management of off-reserve forest and conservation of wildlife through the fulfillment of local needs and attaining their participation (HMGN/MFSC 2004). After the implementation of this strategic plan, its impact will be reflected in a more effective and efficient manner in different aspects of conservation. Therefore, research on the participation of FUGs in planning is required. This research is designed to assess the community level forest management planning process and to address restoration and conservation issues, the findings of planning process will be useful to the planners and implementing institutions.

5.2 Methods

The research on forest management planning was conducted in Ranjha and Balapur buffer villages of the mid-western Terai landscape of Nepal. A questionnaire survey with the members of Forest Users Group Committees (FUGCs) and a household survey with forest users were used to inquire about participation in the decision making process. Similarly, semi-structured questions were used for key informant interviews mainly the local leaders, school

principals and officials in the national park and forest offices. I also collected ancillary information on forest management planning from the forest and park offices. At the same time, I participated in the annual meetings of Ranjha and Balapur Community Forest User Groups (CFUG), Khata and Mahadevpuri Community Forest Coordination Committees (CFCC), and Balapur CFUG in order to observe and note their views.

Data obtained from the forest user groups committees were interpreted using simple descriptive method, and data of forest users were used for analytical test and the comparison was made between the two buffer village user groups. For the analysis of the household survey, I divided the participation of forest users into four levels, i.e. do not participate (inactive), participate only in biannual and annual meeting (low), participate in other monthly meetings (2-6 times) or get indirect information (medium) and participate in all monthly meeting (7-12) or get direct information from the committee (high). The code from 0-3 was used to denote inactive, low, medium and high participation respectively. Furthermore, based on the observation during the general assembly of Balapur CFUG, I divided the forest users into three groups i.e. answering the questions (consultative), just audience (passive), and providing advice for the development of activities and upcoming plan (interactive) (Pretty 1995:1252). This data was calculated and presented in percentage, diagrams, charts, and non-parametric test (Chi-square) using SPSS 16.0 and MS-Excel 2007.

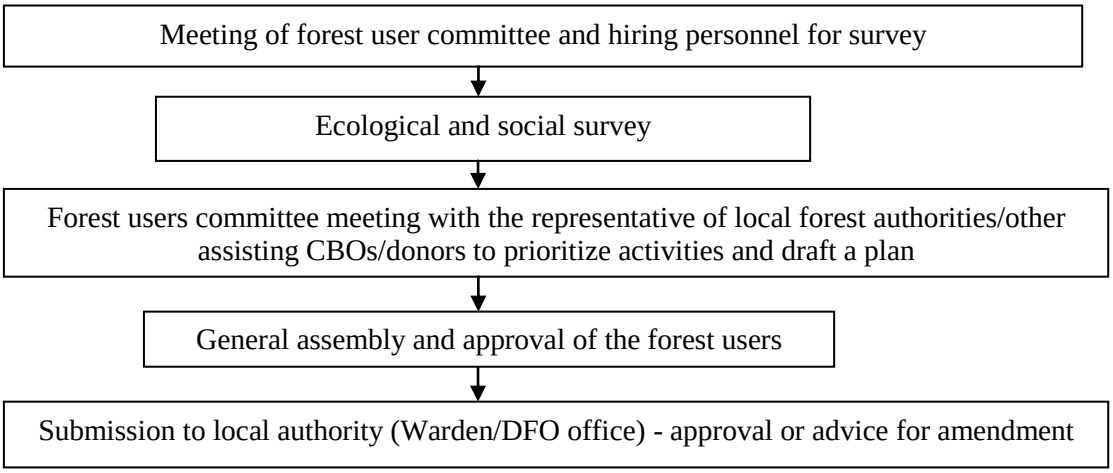
5.3 Findings

5.3.1 Forest Management Operational Plan

I collected information on the forest management operational planning process from the presidents of FUGCs (Gamand Chand of Ranjha and Prithivi Bahadur Khatri of Balapur) and reviewed their current management plan. There were thirteen members in the FUGC (i.e. president, vice-president, secretary, treasurer and other members). The president and secretary have the major role in calling meetings and office management, the treasurer handles the financial section and the other members participate in meetings and support the work of the committee. The warden office and its range posts are responsible in protected areas and buffer zone for forest management and wildlife conservation. Similarly, the District Forest Office and its range posts are responsible for the management of national forests and community forests. I also interviewed the Warden of Bardia and Banke, and Assistant District Forest Officer in Banke as key informants.

From the interviews with committee members, I found that the planning process of the forest management plan was complicated (figure 33.5). They need technical support for vegetation and wildlife survey (plant types, density, wild animal species, etc.) and other social surveys (education status, income groups, etc.).

Figure 33.5 General process of Forest Management Operational Plan



Source: Field Survey 2010

In Ranjha, they had hired a ranger and local teacher. After collecting data, they conducted meetings with the representative of the range post, local educated persons and local organizations, and prepared the draft management plan. Then the committee called an annual meeting of forest users, where the committee presented their plan with the objectives and

activities. There were four buffer forest sub-committees under Ranjha buffer forest group committee. At the beginning, these sub-committees had individual meetings followed by a meeting with the main committee where they incorporated the views of forest users and altered or approved their proposed agenda. In Balapur too, they hired a person and prepared a draft management plan similar to Ranjha. Finally the committee in Ranjha prepared a final plan and submitted to the park office, whereas in the case of Balapur the plan was submitted to the DFO for approval. After receiving approval of the plans, they started to implement programs.

From the review of plans, I found that both the FUGCs have prepared a five year forest management operational plans (FMOP) where they developed 13 objectives in the forest plans (table 17.5).

Table 17.5 Objective of buffer/community forest operational management plan

Ranjha BFUG	Balapur CFUG
1. To provide necessary forest products to local people easily and in a sustainable way	1. To conserve, manage and properly use forest
2. To reduce pressure on the NP	2. To control forest degradation
3. To support in biodiversity conservation	3. To use forest as constitution and work plan
4. To conserve wildlife and its habitat	4. To conserve wildlife
5. To develop eco-tourism	5. To fix the value of forest products, and prepare forest work plan and implement it
6. To control soil erosion and landslide	6. To balance environment by controlling unbalanced degradation
7. To increase income, and develop social and economic development	7. To export excess forest products after fulfilling the needs of local users
8. To participate community in conservation education, awareness, self-income generating activities	8. To invest in local development that are being received from the forest products
9. To ensure participation of local people in environment conservation	9. To conduct income generating activities
10. To conserve forest as a gift of nature for the next generation	10. To replant fast growing and locally acceptable plants in barren land
11. To conduct poverty reduction programs for poor people	11. To conserve water sources
12. To maintain good governance	12. To control hunting in forest
13. To support NP for anti-poaching activities	13. To cooperate and coordinate CFCC for biodiversity conservation

Source: Translated from Buffer/Community forest management plan of Ranjha (2009) and Balapur (2005)

Ranjha buffer forest committee prepared a plan as per the Guideline of the Buffer Zone Regulation (1996) in 2009 and Balapur prepared it as per the Guideline of Community Forest (1995) in 2005. The structures of the plans were quite similar, they mentioned the name, area, objectives, division of forest into four plots, socio-economic status, forest and wildlife status, forest management activities, estimated budget and social development activities. The plan of Balapur CFUG was approved by the District Forest Office, Banke and the plan of Ranjha

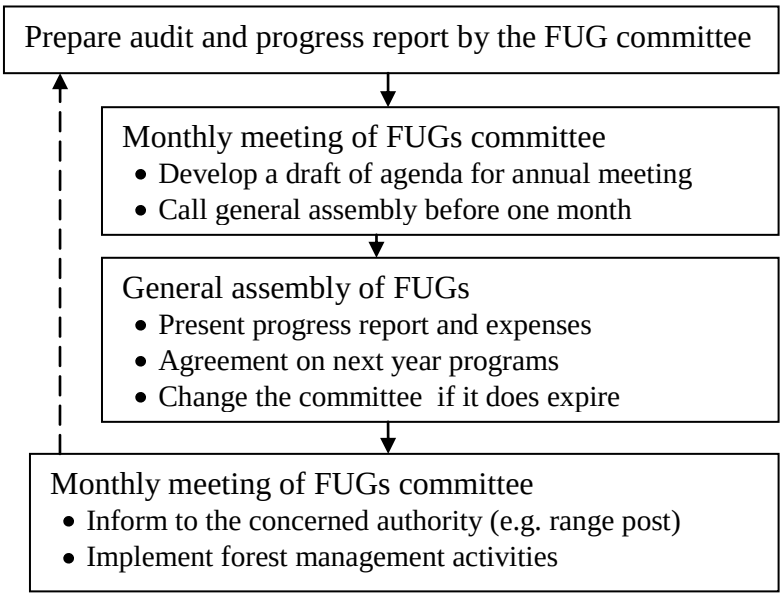
BFUG by Bardia National Park. However, the next forest operational plan of Balapur is to be registered in the recently created Banke National Park.

5.3.2 Forest Management Working Plan

Based on the operational plan, the annual forest management working plan has been developed by both Forest Users Groups (FUGs). FUGC members conduct meetings every month and all biannual and annual meeting with users. In the biannual meeting, they present their progress and evaluation, and in the annual meeting or general assembly, they present the progress and expenses of the previous year, and the proposed programs for the coming year. Annual working plan are prepared by the Buffer Forest User Group Committee with the assistance of Bardia National Park, the Terai Arc Landscape (TAL) and the Western Terai Landscape Complex Project (WTLCP) in Ranjha, while in Balapur, the plan was prepared by the members themselves with the assistance of the Community Forest Coordination Committee.

I participated in the monthly meeting and the general assembly of Balapur FUG and found that the committee developed an agenda for the next year and called the general assembly after the preparation of the audit and progress report for the previous year (figure 34.5).

Figure 34.5 Process of forest working plan



Source: Field Survey 2010

The general assembly of forest users is the authoritative meeting which can change members or amend the constitutions, if necessary. It is the normal process of FUGs. At least 66 percent of the total forest users should be present at that assembly, if the number is not met, then the

meeting is cancelled and new date fixed. In the second assembly, presence of 51 percent of the users is enough to meet the quorum, depending on the constitutions of that FUGs. Due to the absence of the required members in the previous month, Balapur CFUG had to call its general assembly for the second time in November 2010.

During the annual meeting, facilitation was done by a representative of the Community Forest Coordination Committee and the Federation of Community Forestry Users, Nepal (FECOFUN). They presented the evaluation of the activities conducted by the FUGs during the previous year based on transparency, responsibility, participation and reliability. Similarly, the president presented the progress report and proposal for the next year while the treasurer presented the expenses (budget) of the previous year. Local users commented on their presentation and the facilitator coordinated it. Each comment was responded to by the president. Some forest users alleged that the committee members did not play an active role in forest management. Furthermore, the users said that they neither were informed about the regular programs nor were told about the budget and expenses of some activities.

5.3.3 Restoration Activities and Wildlife Conservation Issues in the Plan

The major restoration activities in the plans are plantation, control of grazing, thinning of forest, awareness and social development in Ranjha. The major wildlife conservation issues are human-wildlife conflict and poaching. To control these issues, there is a compensation scheme and anti-poaching unit, but decisions on compensation is made by the park office. In the plan, there was not any definite monitoring scheme of forest and wildlife. They demarcated the forest into four parts (232 x 4 ha) for grazing and forest resources use. The plan mentioned that forest development activities will depend on the park income, where they will get financial support of 30-50 percent from the income of national park.

In Balapur FUGC, the major restoration activities included thinning, control of grazing, income generating activities, and trench construction. The major wildlife issues were human-wildlife conflicts and hunting, there were not any compensation schemes and anti-poaching units. Instead, there were two forest guards to monitor forest activities, however without good evaluation schemes in the plan. They also divided the forest into four parts (79+76+72+77 ha) for forest use. Most of the forest restoration activities depend on exporting timber, which was their main income source.

5.3.4 Participation of Forest Users in Decision Making

5.3.4.1 Household Survey Analysis

From the household survey, I found that the forest users acknowledged the information of the decision and management activities of the committee. However, most of the respondents (i.e. 25 respondents) did not know every decision and the activities of the committee, only 17 knew about this in Ranjha, whereas 19 respondents did not get information and only 23 were informed in Balapur. Based on their responses, I categorized that more respondents (9) were inactive in Ranjha than Balapur (1), and do not participate in the meeting of FUGs (table 18.5).

Table 18.5 Responses for participation in the meetings and decision making process

	Ranjha	**Balapur**	**Non-parametric test**		**Ranjha**	**Balapur**
Presence in the meeting	Number (percent)	Number (percent)	Wilcoxon Signed	Participation	Number (percent)	Number (percent)
Inactive	9 (21.4)	1 (2.4)	Z = -1.457	No	14 (33.3)	14 (33.3)
Low (1-2)	11 (26.2)	8 (19)	Asymp. Sig.= 0.145	Yes	28 (66.7)	28 (66.7)
Medium (3-6)	9 (21.4)	25 (59.5)				
High (7-12)	13 (31)	8 (19)				

Source: Field Survey 2010

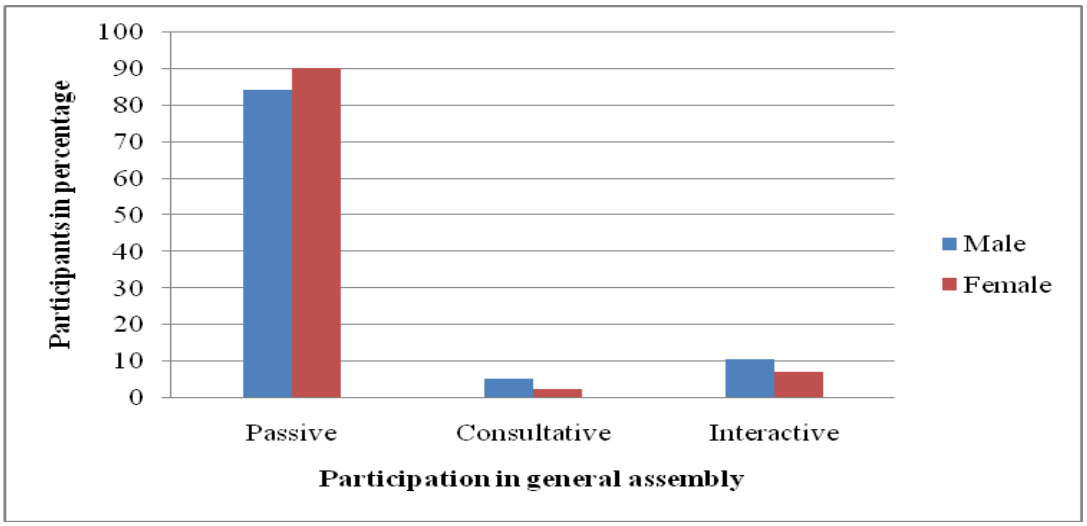
Only thirteen respondents in Ranjha and eight in Balapur mentioned that they participate in all of the meetings held. Rest of the other participates in biannual or annual meetings and a few others in monthly meetings. For the decision making process, the majority of users (28) reported that they provide advice to the committee in biannual or annual meeting in both areas, while others (14) do not take part in the decision making process. There is no significant association between the two forest user groups to participate in decision making (Z = -1.457, sig. = 0.145).

5.3.4.2 Observation at General Assembly

Out of the 200 registered forest users, 117 users were present in the general assembly of Balapur Community Forest Users Groups in November 13, 2010. Among them, 76 (65%) were male and 41 (35%) were female. The majority of the male and female participants were passive i.e. male 64 (84%) and female 37 (90%) and they followed the decision of the committee

members. Few participants i.e. male 4 (5.26%) and female 1 (2.44%) were consultative participants, where they asked about the expenses and commented on the activities of committee members. The rest of the other participants i.e. eight males (10.53%) and three female (7.32%) played interactive role and advised for making appropriate annual plan (figure 35.5).

Figure 35.5 Participation of forest users in annual meeting



Source: Field Survey 2010

5.4 Discussion

5.4.1 Forest Management Operational and Working Plan

The research method was mainly qualitative where I used open questions and the analysis was descriptive. However, a qualitative answer has been quantitized (i.e. participation in decision making) to use an analytical technique in the analysis (Teddie and Tashakkori 2003, Borrego et al. 2009). The multi-sources of data within the qualitative method i.e. key informants, questionnaire survey, ancillary and observation were analyzed using the concept of triangulation to make the result more reliable and valid (Rossman and Wilson 1985, Creswell 2009), and suitable for research in forest resources management (Zanetell and Knuth 2002).

The forest management operational plan is an integrated plan including social, economic, and ecological components with land use plan. However, both FUGCs had not incorporated the forest plan into the land use plan of village development committee. The operational plan designates the role of the Forest Department authorities and the Forest User Groups (FUG) for forest management and resources utilization (Ojha et al. 2009), but the groups were not

satisfied with the assistance from the forest office. A ranger was hired, even although he worked in the same area as the range post, the reason being technical manpower to carry out a plant survey is not available in all communities. However, in some areas of the TAL Program, facilitation was done by the Buffer Zone Management Committee (BZMC) and the Community Forest Coordination Committee. Communities of some areas are unaware of and have less access to such assisting institutions (Acharya 2002). This complexity of FUGs is recognized and seized on by the timber mafia, whereby, they form a new committee and complete all the processes within few months, which normally takes a year in the DFO office. Soon after this, they start to cut down trees to pay their loan (per. com. in Mahadevpuri), which is one of the reason behind the acceleration of community forest deforestation.

The operational plan preparing process is a participatory approach. It includes mapping, forest resources assessment, needs assessment, objective setting, activity selection and scheduling and monitoring through the consultation of forest users, which was done in both of the FUGCs using the same process. It is a common process of forest planning which is being practiced in community forest management (Branney et al. 2001). However, the community people do not know of these steps, therefore, they need to hire technical persons and use their knowledge for plan preparation. Community forest programs are successful in hill regions (Ebregt et al. 2007), however, such plans are unable to address the needs and issues of forest users. Implementation of such technically prepared scientific operational forest management plans were not successful in the Terai region (Baral 2002). Weak consultation with actors and lower fulfillment of local needs might be one of the reasons behind it. Hence, the management plan is crucial for the institutionalization of FUGs and forest management, but the planning process is often too complicated for the local agrarian community.

The forest management annual working plan is prepared based on the operational plan. The Ranjha FUG committees prepared a plan by consulting with the Forest Users and Buffer Zone Management Committees. Plans are prepared by integrating conservation and development in the buffer zone. In Balapur, the CFCC encouraged FUGCs to audit and renewed the institutions on time but they delayed this process because of their general unwillingness and low level of support from users. But, the CFCC can become active only in the presence of donors because these are registered as NGOs. Further, the forest regulation allocates certain amounts to invest in various elements (Paudel et al. 2007), for instance, the buffer zone regulation suggests a plan of expenses in conservation (20%), community development (30%), income generation and skill development (20%), conservation education (10%), and

administration (10%) (HMGN 1996). In practice, their plans are not visualized, which was also agreed by the key informant in Banke Forest Office. BZMC supports users groups for planning and monitoring, however it has limited power to distribute revenue (Acharya et al. 2010) and the buffer zone policy gives the power to the Warden for decision making (Heinen and Mehta 2000) which made the community feel controlled, ruled and therefore, having less ownership.

5.4.2 Restoration Activities, Conservation Issues and Decision Making in Planning

FUG plan includes restoration activities along with the social development. But the main goal of forest management was to fulfill the forest needs and improve the livelihood of community people. The major restoration activities was becoming slim because they get firewood from it and other activities like controlled grazing, and other illegal activities are taking place, where the monitoring scheme does not exist in the plan. Wildlife conservation issues were critical for them because of the human-wildlife conflict such as crop damage, threatened human life, and illegal poaching by outsiders and hunting by FUGC member too (per. com. in Agaiya).

Decision making was participatory in planning, people were suggesting a new working plan in the annual meeting and provided feedback on the previous year's programs. However, the presence of users had decreased in 2010 over the previous years. In Balapur, the committee had to call a second general assembly for this reason. In Ranjha FUGs, the decision making process was elite dominated, and had inequity in benefit sharing where more respondents were inactive than Balapur (table 18.5). Ojha et al. (2009) also reported such FUGs in other regions where elite members were prominent and thus hindering the participation of marginalized members and sharing equally the benefits in community forestry. All people do not receive information on the decision of FUGC, which may affect directly or indirectly the participation of users in the monthly or annual meeting.

There were more passive participants in Balapur. Based on the users' participation in the FUG general assembly, I divided the participants into passive, consultative, and interactive (figure 35.5). Pretty (1995) further divided participation into manipulative (pretaining for representatives), functional (present to achieve goals), and self-mobilization (initiatives independently). These types were not distinctly observed in Balapur. It indicates that there was no full pledged participatory process where community people were less empowered and illiterate. People were confused over the newly formed buffer community forest and the old community forest and felt less ownership after the buffer forest was declared. Park authority

was unable to convince or disseminate information to the community people in this area. At the same time, the Government of Nepal has banned the harvesting forest products for few months due to severe illegal activities in community forests. This contradiction in government decisions makes them passive in participation. Similarly, there are some contradictions among the policy and decision makers to control local forests, share revenue, and form a district level mechanism (District Forest Coordination Committee) (Jamarkattel et al. 2009) which will hinder the participation and feeling of ownership by the community. Hence, although conservation issues and restoration activities are addressed in the planning, participatory decision making in conservation and restoration has not been fully practiced at community.

5.5 Summary

In this chapter, I designed a method to assess the community level forest management planning process, restoration activities and conservation issues in the Mid-Western Terai Landscape of Nepal. I used open questions and conducted interviews with the members of Forest Users Committees, forest users and key informants and participated in the monthly meetings and general assembly of the Forest User Groups. The information was used for the descriptive analysis, analytical test (Chi-square), for presentation in the form of percentages, diagrams and charts.

A forest management plan was found to have been developed by both (Ranjha and Balapur) Forest User Groups. Their plans and planning process are fairly similar, however, Ranjha Buffer Forest User Group has focused on social development, forest and wildlife conservation, whereas Balapur Forest User Group has focused on social development and forest use. The annual forest working plan was prepared from the participatory approach. The decision making process was passive rather than interactive in Balapur Forest User Group in 2010. The level of participation of forest users in the monthly meeting and information sharing was medium (less than six times a year) and most of them participate in decision making process only in the general assembly. Plantation, controlled grazing, thinning and awareness raising were the major restoration activities that were included in the plan, while human-wildlife conflict and poaching/ hunting were the conservation issues. Hence, the selection of objectives, decision making, including restoration activities and conservation issues are difficult tasks during the planning. If the forests are degraded and fragmented, and wildlife species are endangered, conservation and restoration should be considered at the landscape level.

Chapter VI

Human Interventions in Forest Restoration and Wildlife Conservation and Barriers

6.1 Introduction

Social and economical constraints influence the implementation of restoration and conservation programs in a larger landscape (Dudley and Aldrich 2007). Besides that, human disturbances (e.g. road traffic) affect wildlife (Eigenbrod et al. 2008) and natural disturbances (e.g. climate change) have a negative impact on natural resources (UNFCCC 2007). In some cases, it is more difficult to recover species and ecosystems due to rapid climate change (Harris et al. 2006). To mitigate/ solve these problems and conserve resources, an ecological sustainability approach will be suitable in the human-dominated landscape (Callicott and Mumford 1997). In this regard, an integrated approach of forest protection, management and restoration, as practiced at landscape level in different nations (Aldrich et al. 2004), is vital. In addition, restoration practitioners should have detailed ecological as well as biological (species) knowledge for the implementation of programs (Clewell and Rieger 1997). The support of local communities is crucial for the long term practice of restoration at landscape level (Cairns 1993). Hence, participatory approach of restoration is momentous for implementing restoration programs in a sustainable way.

Restorations are being carried out through human intervention (i.e. active restoration) or without human intervention (i.e. passive restoration) (DellaSala et al. 2003). Human interventions are crucial to restore degraded ecosystems (SER and Policy Working Group 2004). Some practices such as the assisted natural regeneration approach, which is simple and inexpensive for restoration (Shono et al. 2007), and the natural regeneration approach for tropical secondary forest restoration (Aide et al. 2000) have been used. Active restoration such as thinning and prescribed burning of the forest (Craig et al. 2009), fuel reduction (Kauffman 2004, Pilliod et al. 2006), planting in mining areas (Corbett et al. 1996), and eradication of invasive species (Bay and Sher 2008, Gardener et al. 2009) have also been practiced. Similarly, the ecological engineering approach has been used for cost-effective evaluations, design and construction of large scale restoration (Lewis 2005). Hence, restoration has been practiced on different scales and levels to achieve the common goal of conserving flora and fauna and balanced ecosystem.

Some practices such as fuel reduction particularly thinning, and prescribed burning affect carnivores and their prey species positively (Pilliod et al. 2006). Restoration of forest habitat and reintroduction of some important wildlife species have been practiced in different countries. Among them are helmeted honeyeaters *Lichenostomus melanops cassidix* (Pearce and Lindenmayer 1998), bighorn sheep *Ovis Canadensis melsoni* (Singer et al. 2000), Eurasian lynx *Lynx lynx* (Kramer-Schadt et al. 2005), wild dog *Lycaon pictus* (Lindsey et al. 2005), rhino *Rhinoceros unicornis* (GoN/MFSC 2006), giant tortoises *Geochelone nigra hoodensis* (Gibbs et al. 2008), etc. However, successful translocation of endangered species requires skills and knowledge of researchers and traditional resources managers for the welfare of the animal (Parker 2008).

In Nepal, most of the secondary forests have been rehabilitated through natural regeneration and small portions of community plantations outside the protected areas (Kanel and Shrestha 2001). In the Terai landscape, restoration activities such as plantation, natural regeneration outside the protected areas and nominal amounts of eradication of invasive species inside the park has been practiced (WWF 2001). In some degraded areas of community forests, plantations are essential and have a positive impact on wildlife conservation (KMTNC 2001). However, community forest management practices are more ad hoc because of traditional silviculture, the gap in transformation of knowledge to the practitioners and the fact the elite take immediate benefit from forests (Shrestha et al. 2010a). Besides the conservation of habitat, endangered species, i.e. rhino, are translocated to another suitable place for sustainability or gene pool (GoN/MFSC 2006). Among a total of 83 rhinos translocated, only 27 rhinos are still surviving in Bardia National Park (CMRN 2008). Similarly, a tiger was translocated from Chitwan to Bardia National Park, but it was killed on May 2011 within four months of translocation (Official press released by DNPWC on 31 May 2011). Today problems in restoration and conservation still exist even though various methods of restoration are practiced. In this context, I attempted to interpret the practices of forest habitat restoration and wildlife conservation in the Terai landscape, which will provide facts about the implementation of restoration programs and acknowledgements made by the planners.

6.2 Methods

The research was conducted in and around Bardia and Banke National Parks of the mid-Western Terai Complex, Nepal. An intensive community survey was carried out in Ranjha village of Bardia District and Balapur village of Banke District (description and map are provided in Chapter III and IV).

For the primary data collection, I used open and closed questions for combining both qualitative and quantitative methods to get information from wider perspective and triangulation at analysis (Rossman and Wilson 1985, Miles and Huberman 1994). Particularly, key informant interviews, questionnaire survey, household survey and interview with drivers and roadside dwellers (n = 17) were applied. Besides this, I participated in the meetings of the Community Forest Coordination Committee (CFCC) in Khata Corridor, the Ranjha Buffer Forest User Group, Balapur Forest Users Group and Mahadevpuri Community Forest Coordination Committee, and noted their views on restoration practices and wildlife conservation.

For the observation of human and livestock disturbances, direct observation took place in Ranjha and Balapur. I observed humans and livestock (buffalo, ox/ cow, and goats) for three days (12 hours per day) in Ranjha (November 14 and 16, 2010, and January 6, 2011) and in Balapur (November 1 and 23, 2010 and January 7, 2011). For this method, I sat down at a distance of 20 meters from the main footpath and counted human and livestock movement to and from the forest at 06:00, 10:00, 14:00 and 18:00 for one hour without disturbing them.

Secondary data of road traffic on Ratna (Kohalpur-Surkhet) Highway was collected from the Army camp at East Chisapani, Bardia. I selected three days randomly (August 26, September 25 and December 13, 2010) to count the road traffic. I also collected information on wildlife casualties in the Chisapani area within the period of one year (2009/10). Similarly, I collected climatic data (i.e. rainfall, temperature, relative humidity) of the past 31 years (1978-2009) at Sikta, Banke District from the Department of Meteorology and Hydrology, Kathmandu (annexes xvii-xix). Furthermore, land use data, topographic maps and GIS data were collected from the Department of Survey, Kathmandu.

The responses were coded by ‘0’ for ‘No’ and ‘1’ for ‘Yes’. A simple description was provided for the restoration practices in Forest User Group Committees and participation of forest users

in restoration activities. Based on the key informant interviews, meetings and questionnaires, problems in restoration and wildlife conservation were tabulated and the major problems described. Data on road traffic with wildlife accidents was used for the correlation test. The comparison of participants in restoration practices, and human disturbances between the two forest user groups were done using non-parametric (chi-square) and t-test (if n<30) respectively. Other barriers such as climate were presented with graphs and charts and the results were triangulated via interviews. Similarly, the encroachment in Banke National Park was analyzed comparing the GIS map of 1987 and 1999 and field visit conducted during 2010. The analysis was performed by SPSS 16.0 and MS-Excel 2007 and ArcGIS 9.3 programs.

6.3 Findings

6.3.1 Interventions in Forest Restoration at Community Level

Ranjha Buffer Forest Users Group – has initiated forest restoration and conservation since 1997. There were 12-15 thousand seedling plantations up until 2010. Thinning, controlled grazing, reduced encroachment, control of illegal logging and hunting are the major restoration activities conducted. Normally, thinning is done once a year with rotation in four parts of the forest and the firewood distribution afterwards. They were supported for these activities through training, awareness campaigns and infrastructure development activities such as drinking water, road, etc. by Care Nepal, Bardia National Park, the Western Terai Landscape Complex Project (WTLCP) and the Terai Arc Landscape (TAL) Program.

Balapur Community Forest Users Group - initiated forest restoration and conservation activities in 1997/98, but it could not continue. At the beginning they tried to control grazing and natural regeneration, but it became complicated due to the lack of local support and halted for a while before restoration and conservation restarted in 2001. Now they have provided job for two forest guards to control grazing, illegal logging and hunting. They have undertaken thinning and construction of a fire line. Care Nepal has supported them to construct an irrigation pump, and TAL has supported them in income generating activities and awareness programs. Similarly, the District Forest Office (DFO) has provided training on forest management.

6.3.2 Forest Users Participation in Restoration

From the household survey, I found that most of the respondents (35 = 83.3% in Ranjha and 37 = 88.1% in Balapur) have participated and rest of the others (i.e. 7 = 16.7% in Ranjha and 5 = 11.9% in Balapur) did not participate in forest restoration activities during the fiscal year 2009. Most of them participated in thinning (in Nepali called '*Jhadi safahi'*) while very few were involved in plantation in Ranjha. In Balapur, besides thinning, they were also involved in trench construction to prevent wildfire. The respondents of two forest users are not associated significantly (z = -0.577, sig. = 0.564) regarding participation in restoration activities.

6.3.3 Contribution of Forest Restoration on Wildlife Conservation

Restored forest provides a migratory route or breeding/ resting habitat for some wild animal. In both villages, forest users agreed that the forest density as well as wildlife in the community forest has increased after restoration activities. The forest user community members also said that the status of the forest and wildlife have changed positively. Prey species such as wild boar (*Sus scrofa),* barking deer (*Muntiacus muntjac*), spotted deer (*Axis axis*), etc. have increased and tiger *(Panthera tigris*) has visited the boarder of community forest in Ranjha frequently. Similarly, an increase in wild boar, deer species, jackal (*Canis aureus*), and common leopard (*Panthera pardus*) was reported from Balapur, but, tiger did not visit the community forest. Besides this, I also reviewed the annual report of 20 community forests (CF) in and around Banke National Park that were submitted to the Community Forest Coordination Committee, Mahadevpuri, Banke. It was found that five community forests mentioned the increment of wildlife species such as deer species (*Axis axis, Axis porcinus, Muntiacus muntjac*), porcupine (*Hystria indica*), rhesus macaque (*Macaca mulatta*), blue bull (*Boselaphus tragocamelus*), wild boar, jackal, leopard, etc., whereas only two CF has reported a decrease in wildlife. The others (13 CF) reported no change in the status of wildlife species after the restoration of community forest (annex xiv).

6.3.4 Actors, Their Roles and Issues in Restoration and Wildlife Conservation

Information was collected from various sources, particularly from key informants such as teachers, representatives of community based organizations, government authority officials, I/NGOs officials, FUGC members and forest users (table 19.6). These actors were involved directly or indirectly in restoration (annex xii). Restoration activities were conducted under forest management and conservation programs, not as separate restoration project. Most of the people were involved in some groups (e.g. forest groups, small farmer groups, saving and credit). Different organizations/ institutions conducted different programs (e.g. TAL, WTLCP) (annex xii) to support community people and groups and speed up forest restoration. However, the complex institutional network, various chains of commands, and the different interests of actors influence the coordination and implementation of conservation, management, and restoration programs (per. com. in Dhangadi).

Table 19.6 Actors, their roles and problems

Actors	Roles	Problems
Individual (farmers, teachers, students, entrepreneurs, workers)	Participate in various activities, anti-poaching unit and share information	Involved in illegal activities, hotels use more fuel, negative attitude
Cooperative/ community based organizations	Organize programs, provide funds, and enhance social development	Insufficient and no regular funding sources
Park authorities	Implement and manage conservation programs inside PA and buffer zone	Limited human resources, lack of equipment, insufficient funds
Forest authorities	Implement and manage conservation in national and community forest	Limited human resources, infrastructure, equipment
INGO/ NGO at field office level	Provide funds, assist in government work, conduct programs through CBOs	Coordination between government and other institutions as well as within government body
Nepal Army	Follow strict rules in protected areas, control illegal activities	Equipment
Nepal Police	Civil security and maintain law and order to control illegal activities	Limited human resources, equipment
Village/ District Development Committee	Monitor, coordinate and develop programs and implement them	Political instability, no elected body

Source: Field Survey 2010

Based on the same source of information, I have tabulated the issues in four categories i.e. for institutions/ organizations, local community, forest and wildlife (table 20.6). The issues of

institutions are from the national level (political instability, policy, fund, corruption, etc.) to local level (weak implementation, monitoring, halo effect, unpractical bureaucracy, etc.). The word 'halo effect' has been used to represent a situation where more chances and preferences are given to known persons or relatives in NGOs. The problems of local community are natural (e.g. flood, wildlife disturbances), anthropogenic (population growth, illiteracy, etc.), physical (e.g. infrastructure) and psychological (e.g. social discrimination). The issues of forest restoration are also natural (e.g. climate change, soil erosion) and human induced (e.g. resource uses, infrastructure). The natural (e.g. competition, disease) and direct human activities (e.g. hunting/ poaching) or indirect activities (e.g. infrastructure) are the major issues for wildlife conservation in Terai landscape.

Table 20.6 Issues for restoration and conservation in mid-western Terai landscape

Institution/organizations	**Local community**	**Forest resources**	**Wildlife**
Political instability	Flooding/ disaster	Unusual climate change	Climate change
Inappropriate policy /rule and regulation enforcement	Wildlife damage crops/ property	Invasive/ alien species	Disease/ competition
Insufficient fund	Wildlife threats to human life	Soil erosion	Low quality of resting/ breeding habitat
Inadequate land use planning	Increased human population	Illegal human settlements	Scarcity of food/ water
Ineffective implementation of programs	Illiterate/ unaware people	Encroachment for cultivation	Hunting/ poaching
Weak local implementing agencies	Knowledge gap in forest management	Leaf litter collection	Retaliatory killing
Lack of coordination among institutions	Inadequate infrastructure development	Lifting firewood	Using poison in water sources/ pesticides
Corruption	Insufficient food	Illegal felling of trees	Infrastructural barriers
Techno-bureaucracy	Less /no income sources	Over grazing	Negative attitude of community people
	Poor health	Cutting /lopping grass, fodder and thatch	
	Social discrimination	Illegal mining	
	Hierarchal/ elite decision making	Haphazardly use NTFP	
	Unequal resources distribution	Forest fire	
	Harassing behavior of authorities	Infrastructure development	
	Insufficient forest resources in community forest		

Source: Field Survey 2010

6.4 Barriers for Forest Habitat Restoration and Wildlife Conservation

Based on the aforementioned issues, I selected some major issues as the barriers for restoration and conservation. I analyzed the disturbances created by road traffic, human activities, livestock grazing and encroachment of forest and also tried to interpret the climatic data.

6.4.1 Climate Change

The rainfall (precipitation) was highly erratic within 31 years (1979 to 2009) at Sikta, Banke District. The minimum rainfall was 698 mm in 1992, whereas maximum was 2142 mm in 1981 (mean = 1503.02 mm) (figure 36.6).

Figure 36.6 Average annual precipitation at Sikta, Banke

Source: Dep. of Meteorology and Hydrology, Kathmandu

There was severe flooding after heavy rainfall in the years 1981 and 1993, particularly in the Rapti River and other major streams originated from the Churia Hills, that caused damage to property. The river banks and bed were rising up which causes floods every year in the southern part of Banke National Park (per. com. in Agaiya).

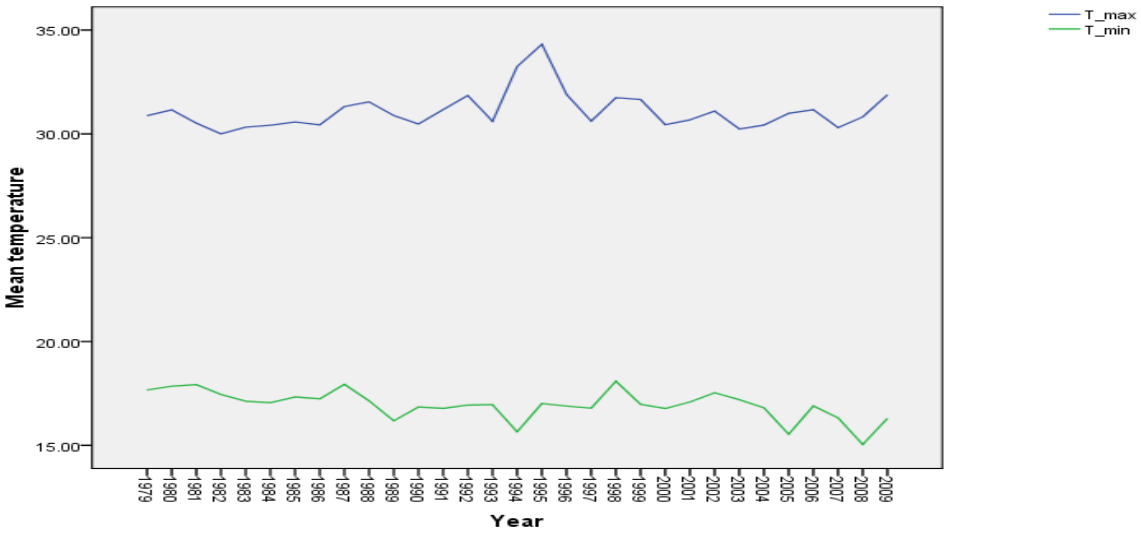
The average minimum relative humidity was 73.33% in 1979 and the maximum was 90.87% in 2008 (mean = 83.29, at 8.45 AM). The average relative humidity increased with fluctuation during 1979 to 2009 (figure 37.6).

Figure 37.6 Average relative humidity at Sikta, Banke (at 8.45 AM)

Source: Dep. of Meteorology and Hydrology, Kathmandu

The temperature also varied every year during 1979 to 2009. The average annual highest maximum temperature was 34.32°C in 1995 (mean = 31.08) and lowest minimum temperature was 15.04°C in 2008 (mean = 16.94) (figure 38.6). The maximum temperature increased by 0.065°C while the minimum temperature decreased by -0.855°C and the difference between the maximum and minimum temperature increased by 0.92°C between the first and last decade within the period of 31 years at Sikta, Banke.

Figure 38.6 Mean annual maximum and minimum temperature at Sikta

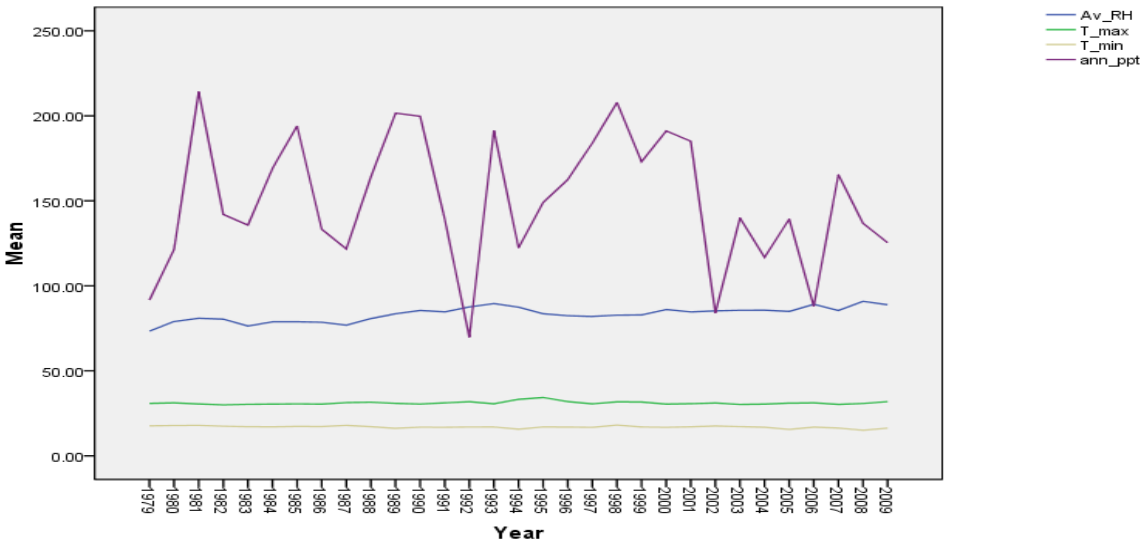


Source: Dep. of Meteorology and Hydrology, Kathmandu

By combining all of the available climatic data, it can be derived that the climatic elements have been changing in the study area, Sikta (figure 39.6). The climatic factors have changed i.e. the maximum temperature has increased, the minimum temperature has decreased,

incidences of too much or too little rainfall has increased and the relative humidity has increased with the increasing temperature. The change in climatic factors may affect vegetation and wildlife directly or indirectly.

Figure 39.6 Average, precipitation, relative humidity, maximum and minimum temperature at Sikta



(Note- PPT is divided by 10 to show in this figure), Source: Dep. of Meteorology and Hydrology, Kathmandu

6.4.2 Road Disturbances

A total volume of 459 vehicles ran in a day through Bardia and Banke National Parks on Ratna Highway where large vehicles (e.g. truck, bus, tipper, tanker) have the higher percentage (39%). I divided the road traffic into six time groups making the interval four hours (table 21.6). The higher number of vehicles i.e. 27% and 21% plied during the evening (17:00-20:00) and early morning (5:00-8:00) respectively. If it is equally distributed, one vehicle will pass in less than every l 2 minutes during the evening and less than every 3 minutes during morning.

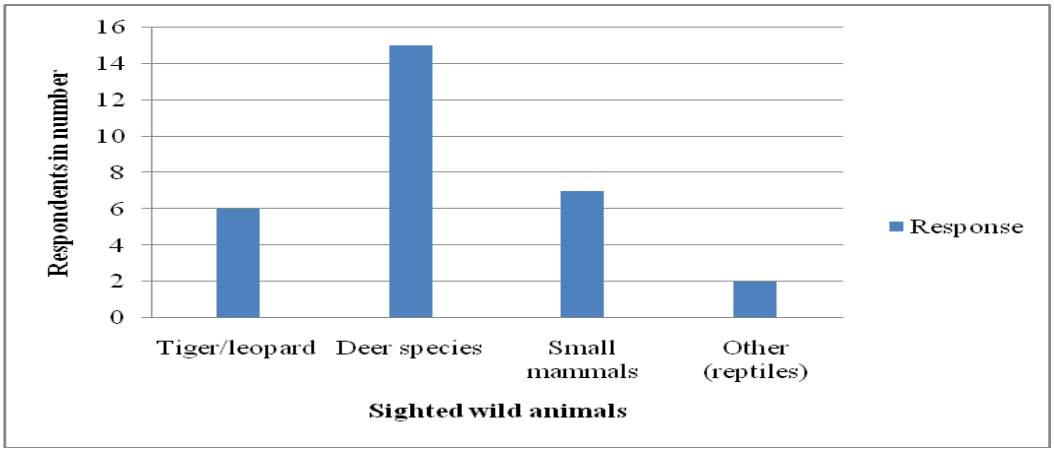
Table 21.6 Traffic in Ratna highway (Kohalpur-Surkhet), Banke

Vehicle types	Number	Percent	Time range	No. of vehicle	Percent	Time interval (min.)
Motorcycle	167	36.38	1:00-4:00	15	3.27	16
Large vehicles (bus, truck, tipper, tanker)	181	39.43	5:00-8:00	99	21.57	2.42
Small (jeep, car, microbus)	101	22	9:00-12:00	95	20.7	2.53
Ambulance	2	0.44	13:00-16:00	97	21.13	2.47
Tractor	8	1.75	17:00-20:00	125	27.23	1.92
Total	459		21:00-24:00	28	6.1	8.57

Source- Recorded data in Army check post, Chisapani, Banke, 2010

From the interview with drivers (n = 11) and community residents (n = 6) living along the roadside I discovered that they also realized the disturbance of the highway on wildlife. Wild animals cross the road to go Banke National Park from Bardia and vice versa. All of the respondents answered that various wild animals crossed the road. Most of them (15 = 50%) saw deer species and some other (6 = 20%) saw tiger/ leopard, small mammals (wild cat, monkey, etc.) (7 = 23.33%), and others (snakes and other reptiles) (2 = 6.67%) (figure 40.6). Among them, 13 respondents sighted more than two species of wild animals.

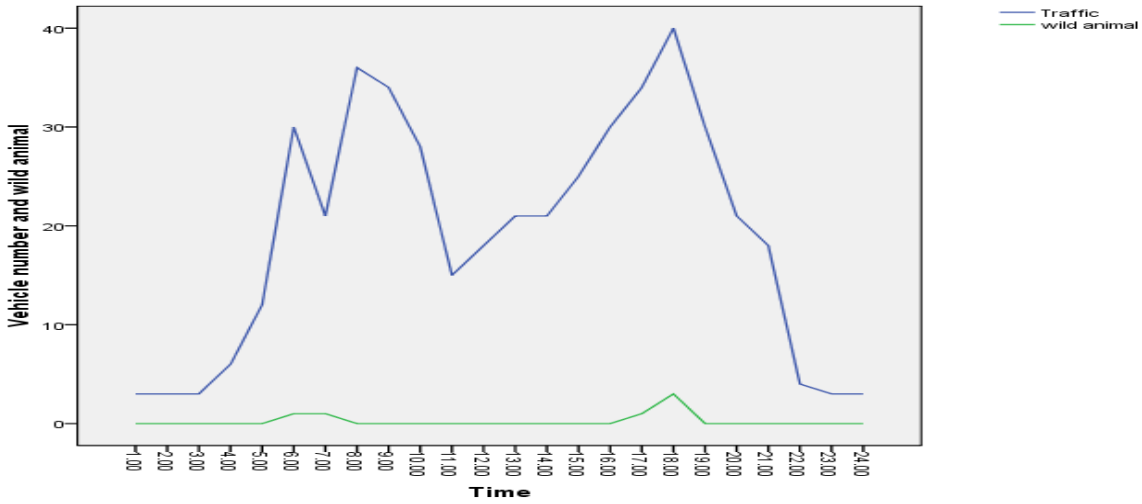
Figure 40.6 Sighted wild animals by drivers/local people during crossing the Ratna highway



Source: Field survey 2010

There were six wildlife casualties within the period of one year (2009) in the eastern side of Bardia National Park, Chisapani. Most of the casualties occurred during the early morning and the evening. These wildlife casualties are related significantly with the volume of road traffic at Ratna highway (r = 0.476, sig. = 0.019, p = 0.05) (figure 41.6).

Figure 41.6 Road traffic and wildlife casualties at Ratna highway, Chisapani

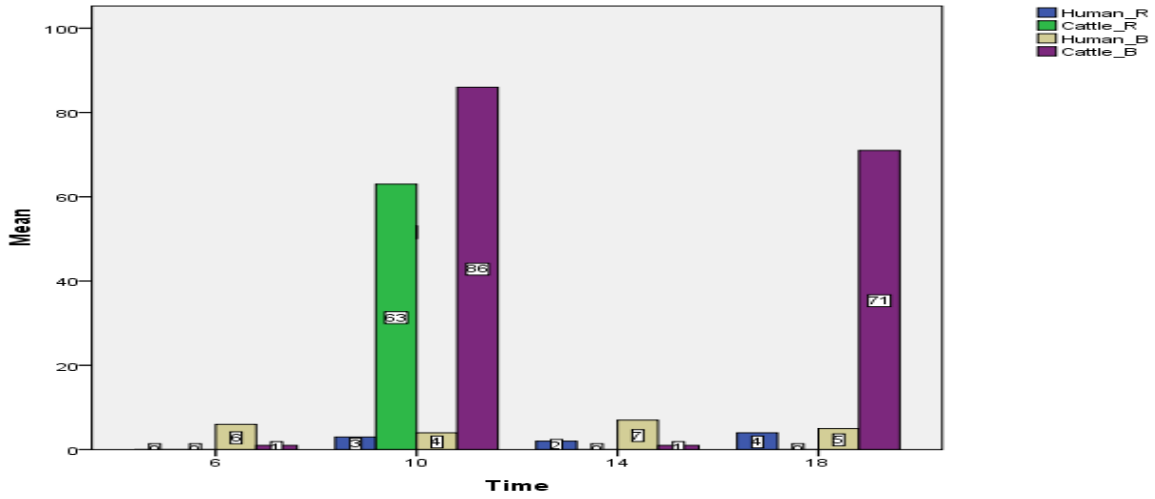


Source: Army Check Post, Chisapani, Banke, 2010

6.4.3 Human and Livestock Disturbances

There were nine human and 63 livestock movements in Ranjha, and 22 human and 159 livestock movements in Balapur ('to and from the forest') in total within a four hour period per day. Normally, people went to the forest to collect leaf litter, thatch, firewood, and for livestock grazing. I found that the people stayed there for at least two hours (for leaf litter collection), with the highest number of hours (10) being used for thatch collection. In the case of livestock grazing, the duration was about 7-8 hours. Livestock reached the forest at around 11:00am and returned before 6pm to Ranjha, but in Balapur livestock returned after 6pm and sometimes livestock such as buffalo and ox/ cow stayed the whole night or a few nights inside the forest. The mobility of human and livestock was higher at 10:00 and 18:00 in both areas with not any movement in Ranjha observed at 06.00 (figure 42.6). The human (t = -2.472, d.f, = 3, sig. = 0.090) and livestock (t = -1.454, d.f. = 3, sig. = 0.242) mobility are not associated in the two forest areas.

Figure 42.6 Mobility of human and livestock in the forest



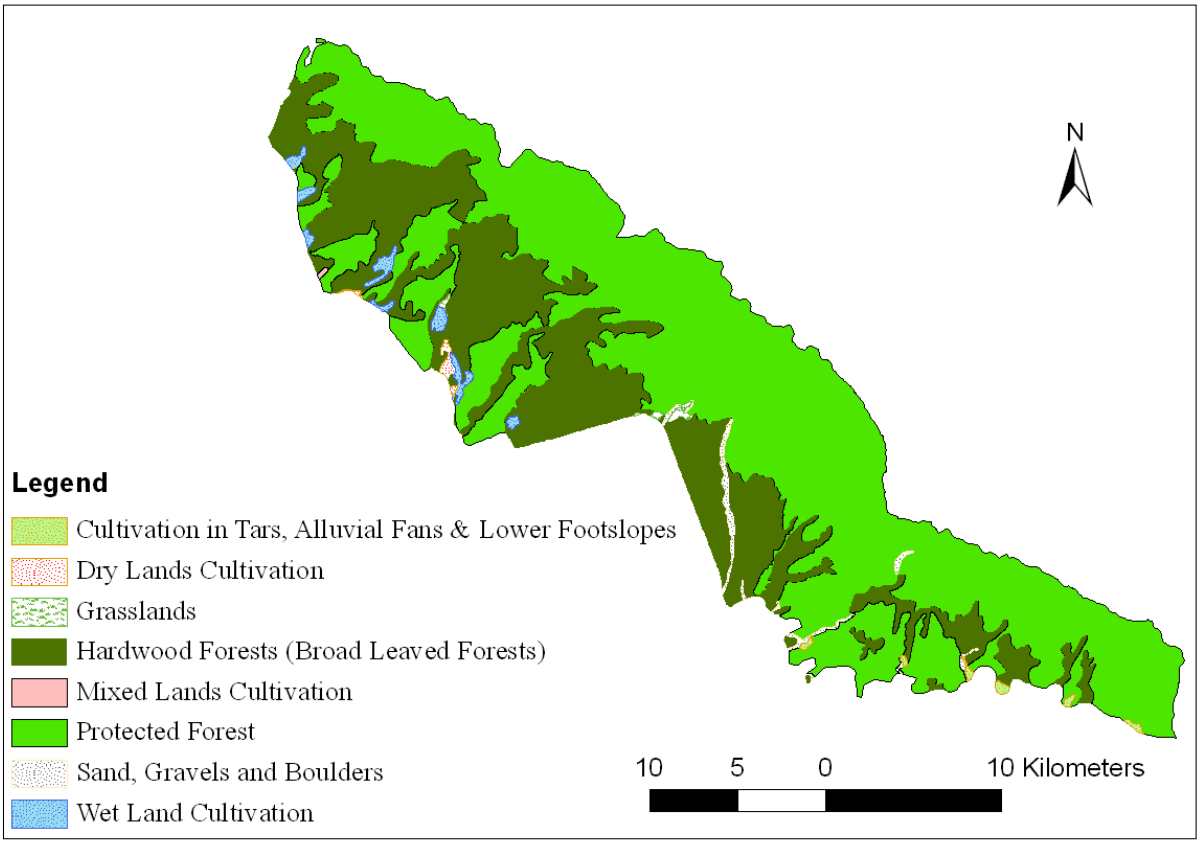
Source: Field survey 2010

6.4.4 Forest Area Encroachment

After the eradication of malaria in 1960s and the construction of the Mahendra (east-west) Highway in 1970s, people started to migrate from the hills to the study area. The eastern side of Bardia National Park (BNP), which was proposed as the extension area in the 1990s (hereafter Banke NP), was virgin forest before the 1980s (figure 43.6). At that time, the cultivated area was around 2,019 hectares only on its southern side.

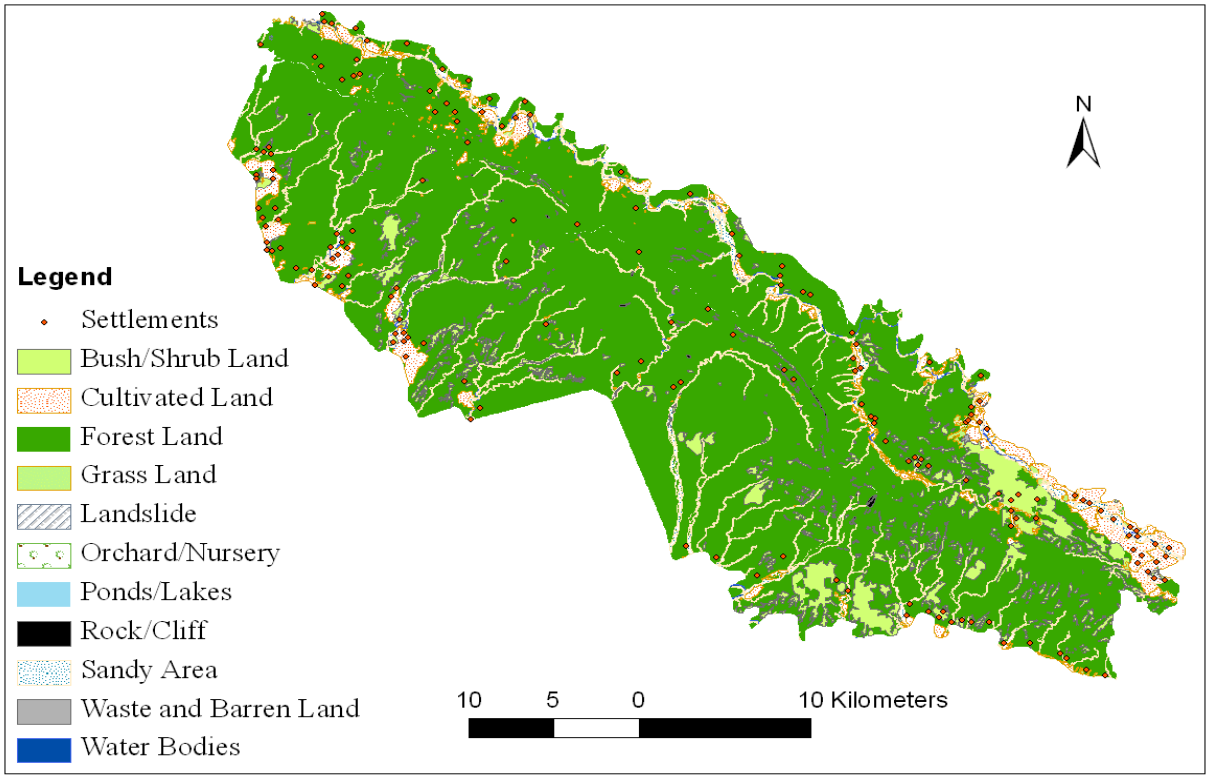
The forest has been massively encroached and the cultivated area has increased by 39,926 ha within a decade. The total cultivated land was around 419,449.23 ha in 1999 (figure 44.6). Most of the land encroachers were immigrants from nearby hill districts. Most of the encroachment occurred in the southern and northern side and few temporary settlements were built nearby the water sources in the foothills, few settlements also found inside the national park in 2010. This area was also used by the tiger to move from Bardia NP to the eastern part of newly gazetted Banke NP.

Figure 43.6 Virgin forests in 1987, Banke National Park, Banke



Data source- Survey Department & LRMP 1986

Figure 44.6 Heavy human encroached forest in 1999, Banke NP



Data source: Survey Department & LRMP (1986)

6.5 Discussion

6.5.1 Interventions, Actors and Issues in Restoration and Wildlife Conservation

I used various techniques (e.g. interviews, observations, ancillary) to collect qualitative and quantitative data which was analyzed using descriptive and analytical processes (Miles and Huberman 1994). These diverse sources of data and findings were elaborated and triangulated (Rossman and Wilson 1985). The empirical data was cross checked with different data sources (e.g. GIS maps and field observations) making the result more realiable.

Forest restoration has been initiated since late 1990s in both buffer villages but it was interrupted for two years in Balapur and restarted in 2001. After the TAL program, community forest and other programs were launched in both villages. Most of the activities such as thinning, controlled grazing, and fire line construction are practiced at community level. This is also because of the strategy of the Terai Arc Landscape Program i.e. protection, management and restoration of forest (MFSC 2006). Most of forest users participated in thinning but a few of them who were not the residents of Balapur at that time did not participate due to household problems. The implication of wildlife conservation was ineffective in Balapur forest compared to Ranjha and the community forest of Bardia National Park. Because of positive changes in

forest restoration, wildlife, particularly tiger mobility, has increased in Ranjha BF. Gurung et al. (2006) also found that because of forest restoration wildlife (e.g. tiger) species have increased in the buffer forest of the protected areas. Most of the community forests in Banke have less wildlife species due to disturbances in and around the community forest, high dependency on national forest to fulfill forest needs and open livestock grazing. Nonetheless, conservation organizations focus their attention on school education, community awareness and formation of anti-poaching units (MFSC 2006). Some programs are donor oriented and under the rule of the elite. This affects adversely the equal sharing of benefits. Moreover, Forest User Group Committees that are prone to these challenges are less transparent (Iversen et al. 2006) which hinders participatory restoration activities.

Various programs by different institutions/ organizations were being conducted for forest restoration and wildlife conservation in the Terai landscape (annex xii).Local actors are playing their roles to restore and conserve forest and wildlife. But these programs are insufficient and their implementation is poor. There are problems within actors and with other actors which could be the reason behind this ineffectiveness (table 19.6). The role of VillageDevelopment Committee (VDC) is crucial for effective implementation, but it is not coordinating fully with the range post. Similarly, Acharya et al. (2010) found ineffective programs in Western Teria Landscape Complex Project areas. Various national/ local and natural /human issues/ problems are the impediments of restoration and conservation (table 20.6), and the anthropogenic aspects are the major influencing factors of the restoration of forest (annex xx).

During the survey period, Community Forest User Committee (CFUC) members of Narti, (located on the eastern side of study area) were arrested due to illegal timber trade from the Community Forest in 2010. Furthermore, the parliamentary committee on natural resources and means has recommended punishing some forest officers of Banke and Bardia Districts for corruption (Bhushal 2010). The role of the government is vital in this situation but there is inadequate coordination among actors and poor monitoring systems (GoN/MFSC 2009). Besides this, community people said that the system in government offices is complex, lengthy and of a dominating nature. The bureaucratic system is process oriented and complex in decision making and it has less willingness to support FUG for innovative actions and entrepreneurship (Giri and Ojha 2010). This will discourage people for participatory forest management practice.

6.5.2 Barriers for Forest Restoration and Conservation of Wildlife

Climatic factors such as temperature, rainfall (precipitation) and relative humidity have been fluctuating every year in the study area. The average increasing temperature was 0.065° Celsius at Sikta. Shrestha et al. (1999) also reported that the average temperature increased by 0.03-0.06°C per annum within 1977-1994 in Nepal (c.f. Gurung and Bhandari 2009). The climatic changes will lead to aridity and loss of organic topsoil (Shrestha 1999), which will affect the vegetation diversity. Vegetation is also associated with type of soils and the intensity of precipitation (Zhou et al. 2008). Every year soil erosion has increased due to deforestation. The amount of rainfall and seasonal flooding will alter the composition of vegetation leading to the succession of forest (Dinerstein 1979). In the Terai area, erratic rainfall is causing problems such as flashflood, sedimentation and water-logging (MoPE 2004). Local farmers have more spare time during the period of low rainfall, which will decrease productivity resulting in food insecurity. In such cases, they use wild animals for bush meat and forest for the collection of non-timber products for income. This has the possibility of increasing forest fires (per. com. in Mahadevpuri).

Roads are barriers for wild animal movement and which also isolate habitats. The traffic volume in the present study (Ratna Highway) was low compared to other research (e.g. 18,300 vehicle/ day, Eigenbrod et al. 2008). However, it has caused wildlife casualties and disturbed the wildlife. Most of the accidents occurred in the morning and evening, which is directly linked with traffic volume (figure 41.6). For instance, one motorcycle rider and a spotted deer were killed when motorcycle struck the deer in April 2010 (annex xiii). Drivers/ roadside dwellers frequently see animals crossing the road from Bardia to Banke National Parks and vice-versa for foraging/ hunting (Figure 40.6). Similarly, European badgers (Clarke et al. 1998), bobcats and coyotes (Riley et al. 2006), amphibians and herpetofauna (Andrews et al. 2006), roe deer (Kuehn et al. 2007), small mammals (McGregor et al. 2008, Bissonette and Rosa 2009), etc. are disturbed by the roads in different countries. Likewise, forest dwelling mice and carabid beetles (Mader 1984), brown bear (Elgmork 1978) and wildlife mortality (Jaeger and Fahrig 2004) have been reported from around the world. Hence, roads are a major barrier for wildlife dispersal and recolonization.

Human activities such as leaf litter/ firewood/ thatch collection and livestock grazing inside the forested area disturb forest habitat and wild animals. Human and livestock mobility was higher in Balapur than Ranjha (figure 42.6) because the main means of livelihood is agriculture and

animal husbandry in Balapur. There are more than ten livestock per house in Balapur. The forest was used as an open grazing area and sometimes domestic animals stayed there for few days. Bogati and Basnet (2001) also found grazing and human disturbances in the same area. Similarly, poaching and livestock grazing (Johnsingh and Negi 2003) disturb forest regeneration (Lees and Peres 2008) and anthropogenic disturbances affect wildlife (Morrison et al. 2009). Hence, an anthropogenic disturbance is another major barrier for forest restoration and wildlife conservation.

A numbers of, now, illegal settlements are located inside the core area of Banke NP and southern side of the forest. The forest area has decreased within a period of ten years massively (figure 44.6) and is still continuing to decrease in the Banke forest. Previous research also recorded (e.g. Bogati 2012) such types of encroachment in the study area. MFSC (2009) reported that the forest cover was decreased at an annual rate of 1.3% from 1978/79 to 1990/91 in the Terai region. Particularly, in the Western Development Region, the encroachment is higher (Adhikari 2002). Similarly, other researchers (e.g. Nagendra et al. 2008, Dixo et al. 2009) found encroachment of forest in Nepal and abroad, which affect wildlife. To conserve wildlife species, the Government of Nepal gazetted the eastern part of Bardia National Park as the new Banke National Park in 2010, after the two decades of its commencement. Most of the temporary settlements inside the core park area were evacuated after the establishment of Banke National Park (per. com. officials of BNP). But currently encroachment still exists at the edge of park and some areas inside the park. Hence, forest encroachment is another main barrier for forest restoration and wildlife conservation.

6.6 Summary

This chapter shows results of the research conducted to interpret the practices of forest habitat restoration and wildlife conservation in the Mid-Western Terai Complex, Interviews with key informants, Forest User Group Committee members, forest users, drivers and roadside dwellers were taken, and observations and collection of ancillary data on climate, GIS and wildlife casualties were performed. This data was analyzed through simple a descriptive method while the analyzed results have been presented through charts, tables and maps by using SPSS 16.0, MS-Excel 2007 and ArcGIS 9.3 programs.

Forest user groups have practiced restoration activities such as thinning, reduction of grazing, and control of illegal logging and hunting. Very nominal plantation and fire line construction has also been implemented. Restored forests provide resting and breeding habitat and/ or safe routes for migration for wild animals and a number of some prey species such as wild boar (*Sus scrofa),* barking deer (*Muntiacus muntjac*), spotted deer (*Axis axis*) and some carnivores such as jackal (*Canis aureus*), common leopard (*Panthera pardus*), etc. have increased in and around the community forest. Various issues/ problems such as political instability, weak implementation and monitoring of programs, the halo effect in organizations, impractical bureaucracy, etc. were imbedded in institutions/ organizations, local community, forest restoration and wildlife conservation. Beside this, climate change, road traffic, human and livestock disturbances and forest area encroachment are the major barriers for restoration and sustainability of wildlife conservation. Hence, active restoration is being practiced through community forest restoration, however, implementation of restoration activities and sustainable conservation are ineffective at community level.

Chapter VII

Tiger as a Forest Restoration Success Indicator Species

7.1 Background

7.1.1 General Meaning of 'SUCCESS'

"Success is like a turtle climbing a mountain,
Failure is like water running down hill"- A proverb, Congdon and Dunham (1999)

Success is considered as the achievement of goals as per the plan. For instance, a person is in a critical state and needs surgery. After a couple of hours, the surgeon states that the 'operation succeeded'. It means the person's life is safe but it does not assure the normal social life because the person is in the Intensive Care Unit and the body systems are functioning with the assistance of equipment. After few hours/ days, the person's health improves and the human system functions normally. The patient moves to the next medical ward which is the second step of success or improvement. After a month/ year, the person moves back into society and initiates a regular social life, which is the next step of success. These medical rehabilitation steps depict that there are certain criteria and indicators of success in each steps, but it varies with the time, skills, facilities and services.

Restoration can be either passive (prevention of any disturbances) or active (promotion/ by interventions). Researchers have used indicators including species diversity, abundance, richness or ecological process for restoration evaluation. For instance, when the degraded forest is restored and an endangered species, for example a big wild cat/ tiger is taken as an indicator species. The indicators and criteria of success vary from place to place and stages of implementation. Hence, success of projects/ programs will depend on goals, rational steps and the process from the beginning (Congdon and Dunham 1999).

7.1.2 Evaluation of Restoration Success

Evaluation of success of restoration depends on the selection of structural and functional 'endpoints' i.e. goals (Palmer et al. 1997). Scientific ecological insights as well as traditional knowledge and local support determine the restoration success (Higgs 2005). The use of both good science and social capital are the fundamental elements of successful restoration (Turner 2005). The positioning of a restoration site in relation to the existing population of species is also an essential component of successful restoration (Morrison 2001). Normally, the restoration success has been evaluated on the basis of vegetation (Longcore 2003, Ruiz-Jaen and Aide 2005b). Some researchers (e.g. Wilkins et al. 2003, Jacquemyn et al. 2003, Hartman and McCarthy 2004, Martin et al. 2005) have used vegetation species diversity and richness as an indicator of restoration success. In the case of wild animals, the indicator species provide a surrogate measure for ecological attribute (Roberge 2006).

The indicator species or group of species whose parameters such as density, presence or absence, or infant survivorship, are used to measure ecosystem conditions (Hilty and Merenlender 2000). Some researchers (e.g. Longcore 2003, Nichols and Grant 2007, Riggins et al. 2009) have used faunal diversity, abundance and composition to measure restoration success. Some researchers (e.g. van Aarde et al. 1996, Jansen 1997, Watts and Gibbs 2002) have used floral and faunal diversity, structure and ordination for restoration success. Very few researchers (e.g. Ruiz-Jaen and Aide 2005b) have measured the diversity, abundance, structure, composition and ecological process of flora, fauna and other environmental elements. Most of the researchers have used quantitative methods such as quadrat survey, transects, observation, etc. and ANOVA as the data analysis tool (table 22.7).

Success of restoration can be evaluated by comparing the reference information with contemporary data (White and Walker 1997) or without comparing the references (Brewer and Menzel 2009). If the success indicator is a wild animal, it will depend on dispersal behavior which is related to connectivity and functional size of the habitat patch (Baguette and van Dyck 2007). Factors that are directly linked with the habitat quality, are also suitable indicators of successful restoration (Lindell 2008). The suitability of wildlife habitat is influenced by the natural and anthropogenic disturbances in spatial and temporal scales (George and Zack 2001).

Table 22.7 Some restoration success evaluation research with indicators

Main theme	Method/analysis	Species/ assemblage	Success indicators	References
Success of grassy woodland	Quadrats, analysis of similarity (ANOSIMs) (Clarke & Gorley), t-test, Tukey's multiple comparisons	Vegetation	Composition and structure	Wilkins et al. (2003)
Patch density and distance from natural forests on colonization success	Historical map, empirical data, systematically walking transects Kolmogorov-Smirnov test, Wilcoxon rank	Vegetation	Species richness, frequency distribution, patch occupancy pattern	Jacquemyn et al. (2003)
Restoration of forest understory after removal of invasive species	Experimental, Sampling of seedling for height and diameter, ANOVA	Vegetation	Effectiveness, density, survival rate, biomass, cost, time	Hartman & McCarthy (2004)
Grassland restoration success	Quadrat survey, ANOVA	Vegetation	Species diversity, richness	Martin et al. (2005)
Indicator of restoration success in sage scrub	Pitfall, diameter and height measurement of plant. Shannon-Weiner diversity, detrended correspondence analysis, multiple regression analysis	Terrestrial arthropods	Species richness, diversity, compositions, abundance	Longcore (2003)
Recolonization in restored Bauxite Mines	Survey, capture (Cage, box, pit traps), analyze with time and number of species	Mammals, birds and reptiles	Number of species recolonize within 30 years	Nichols & Grant (2007)
Wet meadow restoration success	Transect, ANOVA, Shannon index	Soil invertebrate, environmental	Diversity	Riggins et al. (2009)
Habitat rehabilitation on dune forest	Transects, pitfall, flight-intercept, capture with Sherman live traps, Bray-curtis similarity coefficient	Vegetation, beetle, millipede, bird and small mammals	Species richness, relative density, similarity	van Aarde et al. (1996)
Indicator of rainforest restoration success	Distance from road, height of plant, quadrat for litter, General linear models, Chi-square	Vegetation, invertebrates	Diversity of invertebrate, community structure, composition	Jansen (1997)
Revegetation and its effect	Pitfall traps, diameter of vegetation diversity index, Shannon's diversity, analysis of variance, ordination, detrended correspondence analysis	Vegetation and ground dwelling beetle	Trophic structure, diversity, biomass	Watts & Gibbs (2002)
Vegetation structure, species diversity and ecosystems process as restoration success	Transect, DBH, pitfall traps, transect, Bray Curtis Ordination, Sorensen coefficient of similarity as distance measure	Vegetation, ants, amphibians and reptiles, birds, nutrient content, carbon isotope,	Species diversity, structure, abundance, distribution, composition, ecosystem process	Ruiz-Jaen and Aide (2005b)
Quantify woodland habitat indication for species	Quadrat, regression analysis	Vegetation	Species abundance, composition, anthropogenic disturbance	Brewer & Menzel (2009)
Value of animal behavior in restoration success	Review	Invertebrate and vertebrate fauna	Habitat quality and animal behavior	Lindell (2008)
Indicator of community forestry program success	Interviews, SPSS, Likert scale	Community forest user groups	Perception on forest management, resources	Pokharel & Suvedi (2007)

Source: Researcher's Compilation

Besides the experimental or natural science based research, social science is also used as the indicator of successful forest restorations. Pokharel and Suvedi (2007) have conducted interviews with Forest User groups (FUGs) to evaluate the success of a community forestry program and the indicators such as greenery in the area, incidence of forest fire, forest status, women's participation in forestry meetings, access to fuel wood, occurrence of landslides, access to timber and availability of wildlife are measured. Hence, the evaluation of restoration success is performed by using flora/ fauna of single species/ assemblage/ ecological components or multi-indicators.

7.1.3 Single or Assemblage Indicator Species

A species or a group of species 'guild' has a significant role in a certain ecosystems (Block et al. 1987). Some species are vital in such ecosystem and some other species show the trait or characteristics of a particular environment (Martino et al. 2005). It is hard to measure an entire habitat or the population of all species, so the surrogates such as indicator species, umbrella species or guilds are suitable for monitoring (Block et al. 2001). Among them indicator species are used to measure the success of conservation and restoration, where an increase in their population, recolonizations or dispersal of the species, etc. are the criteria (Maes 2004). Indicator species will determine the importance of restoration, restoration strategy and the success. Therefore, habitat restoration mainly focuses on the conservation of a particular species.

Single species or assemblages of wild animals are used as the indicator of restoration success. Some species such as birds (Block et al. 1987), salamanders (Welsh and Droege 2001), herpetofauna (Wilson and McCranie 2003), butterflies (Maes 2004), amphibian (Waddle 2006), large carnivores (Dalerum et al. 2008, Ucarli 2011), etc. are used as the indicator species in restoration and conservation. Some researchers (e.g. Maes and van Dyck 2005, Sawchik et al. 2005) have used assemblages as an indicator. Sufficient space and minimum population are essential for species conservation and their presence in a habitat indicates the success of restoration (Smallwood 2001). However, all single and guild species indicators do not represent another species or another area (Lindenmayer et al. 2000). The surrogate 'indicator or umbrella species' is more appropriate due to cost-effectiveness, prompt research results and easiness in monitoring and evaluation (Block et al. 2001). The conservation of a single species, tiger (*Panthera tigris)* contributes to manage forest ecosystem and are important

for other species in multi-use landscape (Forrest et al. 2011). Hence, such umbrella species that are the target of conservation could be the appropriate indicator species in restoration endeavor.

7.1.4 Brief Summary of Wild Cat

7.1.4.1 Taxonomy and Conservation Status

Wild cats belong to the order Carnivora of the family Felidae with the generic group of Felids which contains three sub-families, namely, Acinonychinae, Pantherinae and Felinae, having 36 species (Wozencraft 1993, c.f. Nowell et al. 1996). These wild cats are grouped into small cats (e.g. jungle cat, marble cat), big cats (e.g. tiger, leopard, lion), and bridge cats (e.g. clouded leopard) between big and small cats (Weigel 1972). Some species (e.g. lion, tiger, leopard, cheetah) have disappeared from North Africa and some part of Asia due to direct human persecution and depletion of prey base (Nowell et al. 1996). Some of these species are critically endangered (e.g. Iberian lynx), endangered (e.g. tiger, snow leopard), vulnerable (e.g. clouded leopard, cheetah), nearly threatened (e.g. puma, lynx) and of least concern (e.g. bobcat, leopard) under the IUCN Red list (annex xv) (Nowell 2002). These including some other cat species (24 species) listed under Appendix-I (threaten and extinction category) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (http://www.cites.org/eng/app/ appendices.shtml, accessed on October 11, 2011). Among the eight sub-species of tiger, three sub-species (i.e. *Panthera tigris virgata, P. t. sondaica, P. t. balica*) have become extinct and the remaining five sub-species (i.e. *P. t. tigris, P. t. altaica, P. t. amoyensis, P. t. sumatrae* and *P. t. corbetti*) are found less than 3,200 in number in thirteen countries all over the world (WWF 2010).

7.1.4.2 Habit and Habitat

Wild cat species are secretive and nocturnal in nature. These carnivores (e.g. tiger) need a large habitat (Miller 1999) with available prey species (Nowell et al. 1996). Normally tiger hunts prey at dusk and dawn (McDougal 1999) and prefers large prey such as deer (e.g. *Axis axis, Axis porcinus, Cervus unicolor*), wild boar (*Sus scrofa*), etc. (WWF 1998). Depending on the availability of prey and habitat type, each tiger establishes its own territory ranging from 7-32 km/night where it roams for hunting (Sunquist 1981, c.f. Khan 2004). The dispersal behavior of the male tiger also depends on the number of female and competition with other males

(WWF 1998). In the case of the tigress, she is very cautious and secretive when she has young cubs. If she feels insecure for her cubs from males and other invaders, she will change her den (Sunquist and Sunquist 2002). Hence, the tiger needs undisturbed dense forest with tall grassland, suitable for hunting with an abundance of prey species, and a large habitat for colonization.

7.1.4.3 Ecological and Conservation Value

The wild cat species can play a vital role in the forest ecosystem restoration and conservation. The carnivore species acts as an indicator of the ecosystem and are potential for the overall biodiversity conservation (Dalerum et al. 2008). Large carnivores control other small carnivores and herbivores which maintains the forest ecosystem (Sunquist and Sunquist 2002). For instance, tiger is the top predator in the forest ecosystems and controls the prey species which contributes to balance the ecosystem (Dinerstein et al. 1997). Its conservation has not only ecological value, but also socio-economic and cultural value (DNPWC/MFSC/GoN 2007). For instance, in Nepal, buffer communities receive 30-50% revenue from tourism in national park. The revenue is used to meet their basic needs and social development such as fuel, timber, schools, health care, etc. (Dinerstein et al. 1997, DNPWC/MFSC/GoN 2007). Likewise, Bardia National Park has become a touristic destination in the recent years due to easy sighting of tiger which is an economic value of conservation (per. com., Park authority). Tiger also has a cultural value in the Hindu religion i.e. Goddess Durga riding a tiger symbols the divine power.

7.1.5 Tiger as Restoration Success Indicator Species for Research

The Royal Bengal Tiger (*Panthera tigris tigris*) is identified through different names such as "keystone species" (WWF 2002b), "umbrella species" (HMGN/MFSC 2004) and "flagship species" (Karki et al. 2009) in conservation. In some cases, it is difficult to choose the right keystone species (Palmer et al. 1997). As all its prey species and large habitat should be protected to conserve tiger, it is better to consider it as an umbrella species (Dinerstein et al. 1997). Government and non-government organizations have emphasized forest restoration by targeting the tiger and some other species (e.g. rhinos, elephants) in the Terai landscape. Hence, if the target of conservation is tiger and its habitat restoration, tiger becomes a suitable indicator species to indicate the success of restoration. I have involved myself in tiger conservation and research in the aforesaid landscape since 1999 and have updated the tiger

dispersal behavior in certain time intervals in the study area. Beside the personal motivation for choosing tiger, the following are the prominent reasons for selecting tiger as an indicator species and preferring it for research:

- It is a conspicuous umbrella species.
- It exists in good quality habitat, which shows a healthy forest ecosystem.
- Its presence suggests good forest management that also benefits other species.
- Its persistence shows the abundances of prey species.
- It reacts to anthropogenic disturbances and changes habitat, which indicates the quality of the forest habitat.
- Its large pugmarks make it easy to identify its presence / absence.
- Detailed research on tiger, its habitat and prey species has been conducted in Nepal and abroad. Therefore, ecological information on tiger is readily accessible.

7.2 Introduction

Realizing the need of maintaining ecosystems and biological resources, the Government of Nepal has adopted different conservation approaches and restoration practices since the early 1960s. At present, twenty protected areas, including national parks, wildlife reserves and conservation areas have been gazetted that cover more than 23 percent of the total land of the nation (DNPWC 2010). Among them, five protected areas (i.e. Chitwan, Bardia and Banke National Parks, Parsa and Sukla Phanta Wildlife Reserves) are the residence of tiger in the Terai region. The Terai landscape is a good habitat for big wild cat particularly tiger. It also has international importance both in terms of the number of globally threatened fauna and flora and unique ecosystems (BPP 1995).

Among the big wild cats i.e. Royal Bengal Tiger (*Panthera tigris*), common leopard (*Panthera pardus*), snow leopard (*Uncia uncia*) and clouded leopard (*Neofelis nebulosa*) found in Nepal, the snow leopard in the mountainous region, the clouded leopard in the mid-hills, and the Royal Bengal Tiger in the Terai region can be considered as indicator species. For instance, snow leopard reappeared in Sagarmatha National Park after 40 years when its habitat and prey species were conserved effectively (Ale et al. 2007). Similarly, after the initiation of a restoration program, forest habitat has been restored and tiger numbers have increased outside the protected areas (Gurung et al. 2006). In this regard, research conducted on tiger/ its prey species (e.g. Seidensticker 1976, McDougal 1977, Dinerstein 1979) were more focused on

biological/ ecological aspects in the 1970s. Thereafter, studies from various dimensions were continued by Sunquist (1981), Tamang (1982), Smith (1984), Smith et al. (1998 and 2001), Shrestha (2004), Gurung (2008), Wegge et al. (2009), etc. in Nepal. Most of the researchers have used radio-telemetry or camera trapping, pugmark and transect while a few others have used empirical methods.

The comprehensive tiger conservation strategy has prioritized the ecological, behavioral, demographic and genetic adaption of tiger in tiger conservation units (Dinerstein et al. 1997). Other various strategies and conservation approaches are in practice all over the world to tackle tiger population loss, and habitat fragmentation and degradation. Most of them belong to the common concepts of habitat protection, management, restoration and reduced anthropogenic disturbances (e.g. hunting/ poaching, logging). In this context, a tiger conservation action plan (2008-2012) has been formulated in Nepal and is being implemented (DNPWC/MFSC/GoN 2007). Various other conservation programs are being conducted to address conservation problems. Among them, the Terai Arc Landscape (TAL) program, restoration of critical biological corridors, elimination of bottlenecks and establishment of the linkages among the eleven transborder protected areas of Nepal and India to maintain wildlife routes by addressing the issues of local people's livelihood are pioneering programs (HMGN/DNPWC 2004). They have been jointly implemented by the Ministry of Forests and Soil Conservation of Nepal (MFSC) and WWF Nepal in collaboration with other governmental and non-governmental organizations since 2001.

The Nepal Government formulated the Terai Arc Landscape Strategy (HMGN/MFSC 2004). The program is of a transdisciplinary nature that includes participatory habitat restoration activities by addressing the conflict between human beings and wildlife in and around the protected areas. Local communities are encouraged to partake in habitat conservation activities and derive benefits through institutionalized community development programs like ecotourism, skill development, income generation, etc. (GoN/DNPWC 2008). Different local institutions such as Buffer Zone Management Committee (BZMC), Conservation Area Management Committee (CAMC), Community Forest Users Groups (CFUGs) and other natural resources users committees and groups have been formed, and are active with the assistance of government and non-government organizations (MFSC 2006). However, tiger as the forest restoration success indicator species has not been studied in Nepal. This research was, therefore, conducted to fill the gap. In this chapter, I analyze the implication of forest

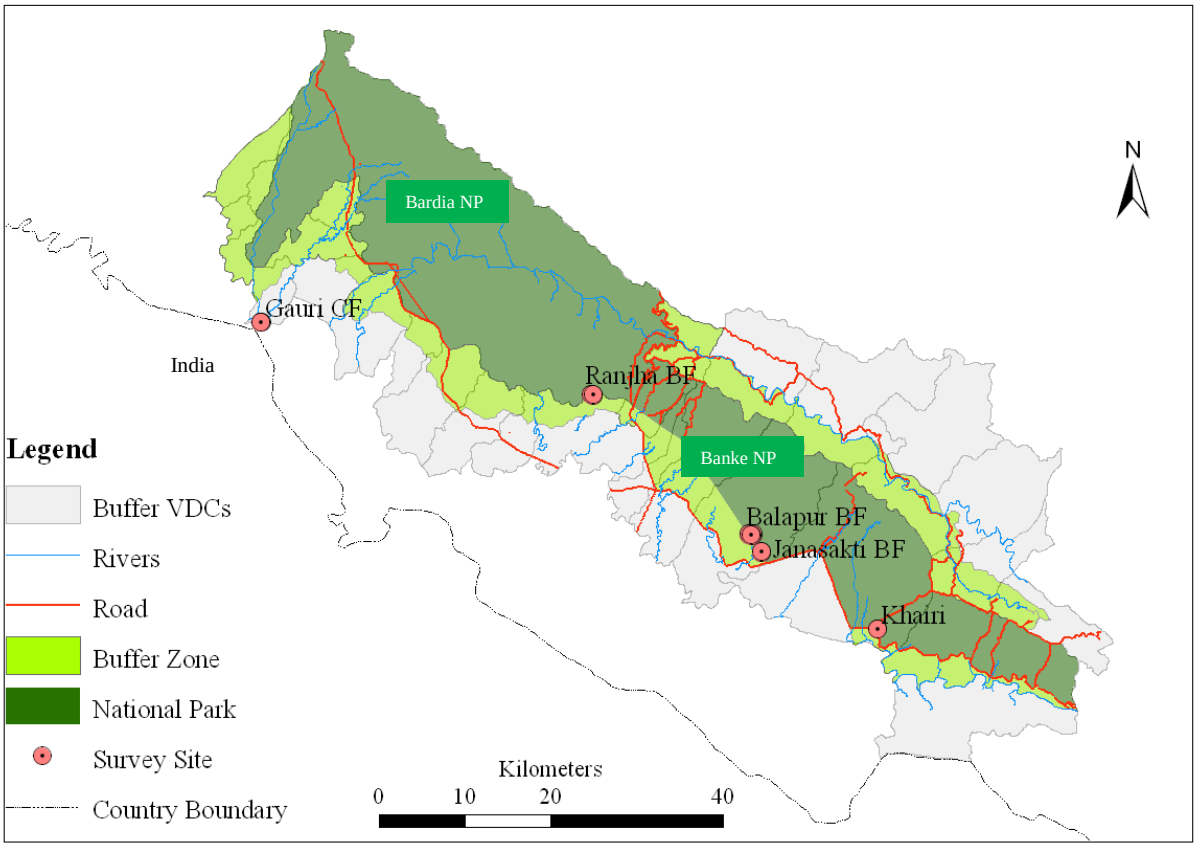
restoration for big wild cat conservation and tiger as the restoration success indicator species in the Terai landscape.

7.3 Methodology

7.3.1 Study Area

Floral and faunal surveys were conducted in the Gauri Mahila Community Forest (hereafter Gauri) in the Khata Corridor, Ranjha Buffer Community Forest in Bardia National Park (hereafter Ranjha), Shivasakti Buffer Community Forest in Balapur (hereafter Balapur), Janasakti Buffer Community Forest (hereafter Janasakti) in the Mahadevpuri bottleneck and Khairi area, Agaiya (hereafter Khairi) in Banke National Park (figure 45.7). The survey of the Khata Corridor is taken as the restoration success reference site. Khata Corridor lies in the southern part of Bardia National Park bordering with Katarniyaghat Wildlife Sanctuary, India (A description of Bardia and Banke National Parks has been provided in chapter III).

Figure 45.7 Survey locations in and around Bardia and Banke NP



Source: Survey Department, Kathmandu & LRMP (1986)

7.3.2 Methods

Field study was conducted from September 2010 to January 2011 during which Rapid Rural Appraisal, key informant interviews and survey methods were used. During the survey, I undertook rapid assessment of flora and fauna (27 October to 3 November 2010, 14 November to 24 November 2010 and 1 January to 5 January 2011) in and around Bardia and Banke National Parks. I conducted a tiger sign survey during October 1999, January, April and September 2000 (Bogati and Basnet 2001) and January 2005 (Bogati 2012) in Banke National Park and during April 2005 in the Khata corridor of Bardia. It is more appropriate to evaluate the previous survey with this contemporary survey when both are conducted during similar months. It is also a suitable time to observe the wildlife signs. The survey of quadrat (plot) was selected between 500-1,000m from the forest edge/ village border using criteria of size, forest type, footpath etc. For the vegetational survey, the quadrat size of $100m^2$ (circular plot) for trees and a $25m^2$ quadrat size for saplings were used. Below the size of sapling, plants were counted as natural seedling (Basnet et al. 1998). This sampling was performed in four quadrats in one location. The interval between the two quadrats was 50m where the Global Positioning System (GPS) (using Garmin-etrex) points were fixed. In each quadrat, plant diameter (DBH) was measured (using measuring tape of 10m with 3m diameter), vegetation species were counted and conditions (lopping/ chopping, burning and felling) were noted (Sapkota et al. 2009).

The quadrat size of $10m^2$ was used for counting wild animal pellets (Joshi 2000) inside the $100m^2$ quadrats and the sampling of $10m^2$ quadrat was repeated four times in each plot. I recorded pugmarks of tiger in Khata corridor and pugmarks of tiger and leopard in Betani and Ranjha buffer zones of Bardia National Park and measured the distance from the villages. I also followed five vertical transect walks totalling 32.95 +- 0.5 km: a) Jhuri Khola, highway to Vitoria Khola Churia, 4.70 km, b) Janasakti Community Forest, Mahadevpuri to Suki Khola Churia, 6.14 km, c) Janasakti Community Forest, Mahadevpuri to Chunbhatti Churia, 9.27 km, d) Shivasakti Community Forest, Balapur to Lutepani Churia, 6.7 km, e) Khairi Khola, highway to Khairi Khola Churia, 6.14 km, along stream banks, main trails and dusty roads for observing signs (e.g. scratch, scats/ pellets, pugmarks) of wildlife in Banke National Park. Further, the Tiger Conservation Action Plan (2008-2012) was reviewed.

7.3.3 Data Analysis

From the methods discussed in the previous chapters (i.e. interviews, Rapid Rural Appraisal and questionnaire survey), I found that community/ buffer forest has been restored and wildlife species has increased in and around the protected areas of the Mid-Western Terai Landscape Complex. To test this preliminary result, I further conducted a vegetational and faunal survey. Obtained data was calculated for stem basal area, density, frequency, Important Value Index (IVI) (Basnet et al. 1998), and disturbances (i.e. chopping, fire, grazing and felling) in all of the five locations. All these values were expressed in per hectare and the value of forest quality index (FQI). The regeneration (seedling and sapling) was classified as high, medium and low (ANSAB 2010). Tiger prey species pellet frequency and abundance were calculated.

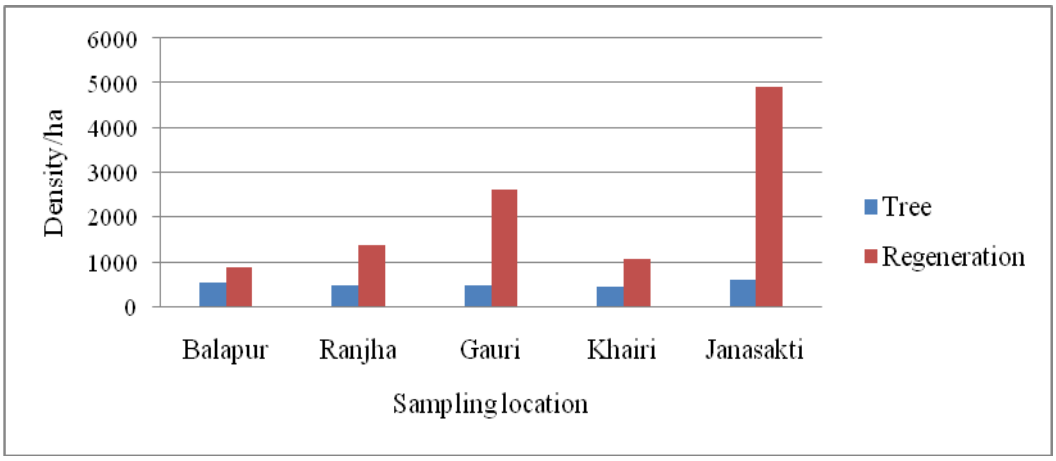
Pellets of prey species were grouped only for wild boar and deer species. All indexes (FQI, disturbance and abundance) were calculated in relative value. The forest quality index was analyzed by comparing Gauri-IVI as equality of variance. FQI was analyzed by relating the area of forest and distance from the government authority office and presented in graphs. Similarly, forest quality and prey species abundance index were analyzed by using SPSS 16.0 program for Student's t-test and correlation coefficient. The presence of tiger pugmarks was analyzed using distance from the forest edge by comparing Gauri reference site and the previous research to find out the dispersal behavior of tiger. Non-parametric test can be used in such type of research due to the independence and different pattern of distribution of ecological data (Siegel and Castellan 1988), but, for this study t-test was used since the sample size was less than 30.

7.4 Findings

7.4.1 Vegetation: Regeneration, Important Value Index, Habitat Quality, Disturbance

The quadrat survey depicts that the density of trees and regeneration (sapling and seedling) was the highest in Janasakti CF (trees = 600, Reg. = 4,900), the lowest number of tree in Khairi (trees = 433) and lowest regeneration in Balapur (Reg. = 866) (figure 46.7). The regeneration status is medium in Gauri and Janasakti CF and rests of the others are low.

Figure 46.7 Trees and regeneration density



Source: Field Survey 2010

The important value index (IVI) varied i.e. the highest in Janasakti Community Forest (CF) (4,247) and the lowest in Gauri CF (2,205). Gauri CF was considered as the reference site and its variance of IVI is not equal to others, therefore, it is insignificant (table 23.7). The forest quality index (FQI) is the highest in Janasakti CF (8,972) and the lowest in Balapur BF (3,873). Forest quality depends on the nutrients in soil, precipitation, light and land topography. In this regard, Gauri CF area has more sandy loam, moisture and plain than other locations.

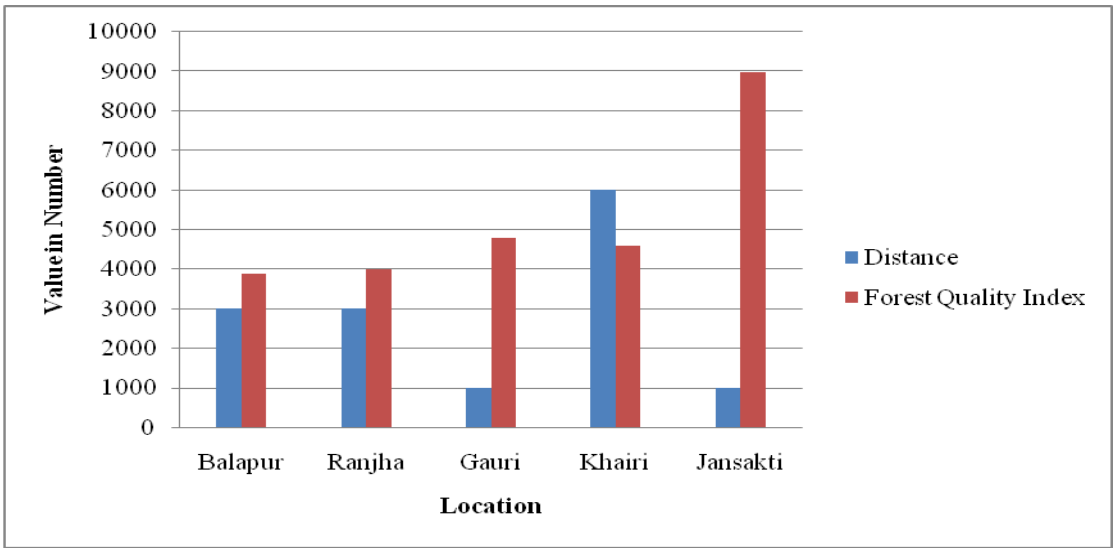
Table 23.7 Forest quality index and tentative distance from government authority

Forest habitat	**Tree species**	**Area (ha)**	**Distance (m)**	**FQI**	**IVI**	**Levene's test for equality of variances (F)**	**Sig.**
Balapur CF	7	304.25	<3000	3873.28	3198.28	1.235	0.303
Ranjha BF	4	928	<3000	3987.18	2667.18	2.603	0.182
Gauri CF	2	48.26	<1000	4780.25	2205.25	=	=
Khairi Forest	9	2000*	>6000	4591.18	3657.85	2.78	0.130
Janasakti CF	11	134	<1000	8972.36	4247.36	0.443	0.519

Note- * estimated area of plain, Source: Field Survey 2010

I assumed that FQI is directly related to the distance from government management authority and area of forest. The relation with distance from government authority and FQI is negative which means greater the distance, lower the FQI value, but it is insignificant (r = -0.488, sig. = 0.404) (figure 47.7).

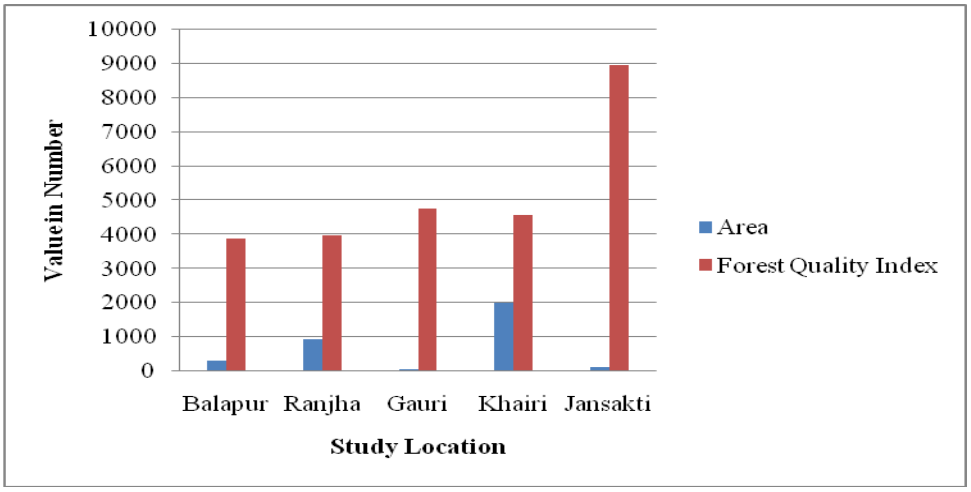
Figure 47.6 Forest quality and distance from Government authority office



Source: Field Survey 2010

Likewise, the relationship between forest quality index and area is also negative which means the higher the area, lower the FQI, but it is insignificant (r = -0.348, sig. = 0.566) (figure 48.7).

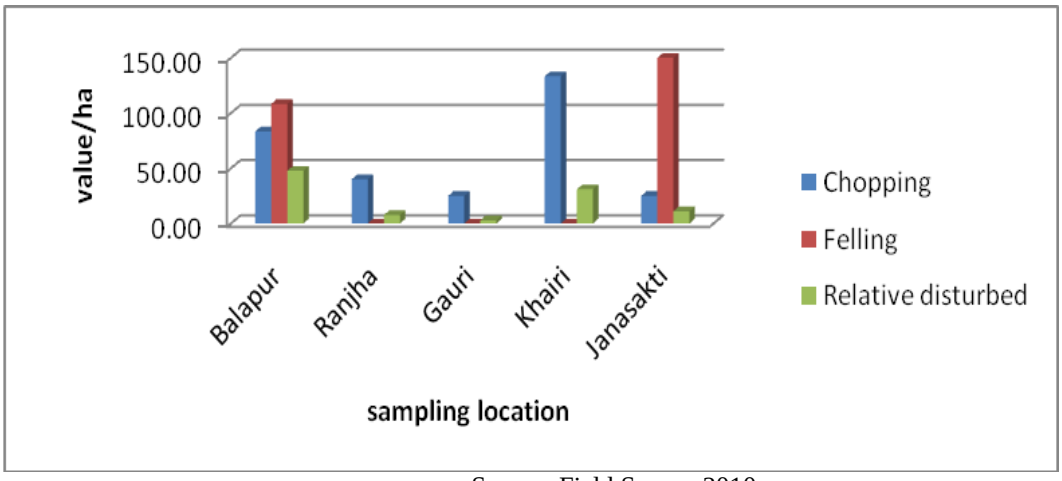
Figure 48.7 Forest quality and forest area



Source: Field Survey 2010

From the quadrat survey, I found that the chopping/ slashing of plants for fodder was the highest in Khairi (133/ha) and the lowest in Gauri and Janasakti (25/ha). Similarly, felling was the highest in Janasakti (150/ha) and nil in Ranjha, Gauri and Khairi (figure 49.7). The total disturbed plants were higher in Balapur which was 13.69 percent of the standing plants. Hence, Balapur CF is relatively the highest disturbed (47.65%) and Gauri CF is the lowest (2.82%). In Balapur, a plot of seedling was burnt completely.

Figure 49.7 Vegetation disturbances



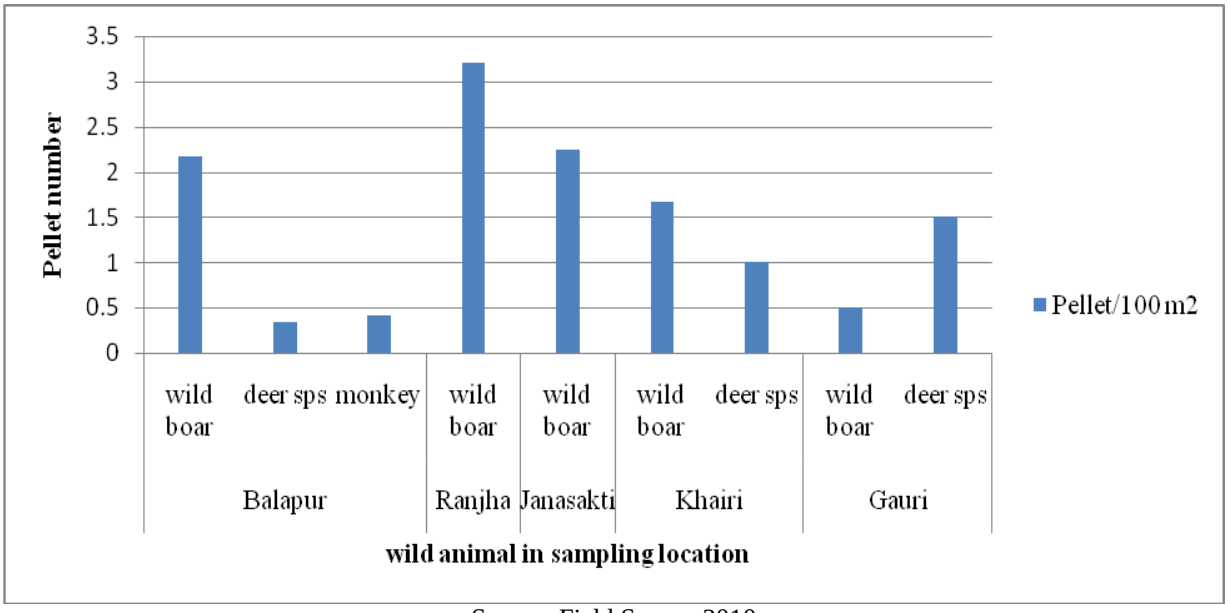
Source: Field Survey 2010

7.4.2 Fauna

7.4.2.1 Quadrat Survey

The pellet of wild animals was highest in Ranjha Buffer Forest (BF) (3.2/100m^2) and lowest in Janasakti CF (2.25/100 m^2). The density of prey species (i.e. deer) pellets was higher in Gauri, although all locations have very low density (figure 50.7).

Figure 50.7 Pellets of tiger prey species



Source: Field Survey 2010

There is not any significant association between the forest quality index and prey species abundance index (r = -0.837, sig. = 0.077). Hence, the hypothesis 'there is significant

relationship between the forest quality index and tiger prey species abundance in restored forest patches' is rejected (at 0.05 significance level).

7.4.2.2 Track Survey

During the track survey, I did not find any signs of tiger in Banke National Park, but there were signs found in 2000. Signs of some other animals such as pugmarks of leopard (*Panthera pardus*), striped hyaena (*Hyaena hyaena*), pellets of sambar deer (*Cervus unicolor*) and blue bull (*Boselaphus tragocamelus*) were found. Further, barking deer (*Muntiacus muntjac*), asiatic wild dog (*Cuon alpinus*), jackal (*Canis aureus*), and large group of rhesus macaque (*Macaca mulatta*) were sighted in Banke. I saw two old oxen in Victoria Khola and four buffaloes in Suki Khola in the early morning which had been living there for a few days. From this evidences, I was assured that there was not any tiger during that time.

The settlement in the Khairi area was evacuated after the establishment of Banke National Park, where vegetation is regenerated. However, a few temporary settlements (Goths) were still present during the research period in Kalapani and Lutepani of Mahadevpuri (table 24.7).

Table 24.7 Track survey records

Tracking location	**Date**	**Sighted**	**Presence**	**Before 2000**
Jhuri khola-highway to Victoria khola Churia, Agaiya	11/19/ 2010	Barking deer, 2 old oxen in Victoria	Pugmark of hyaena, pellet of sambar deer in Victoria khola	Sighted tiger pugmark
Janasakti CF to Suki khola Churia, Mahadevpuri	11/20/ 2010	1 snake, one Goths for slashing thatch, 5 buffaloes, 7 sheep in Suki khola, several group of grazing livestock and Gothalas	Leopard pugmark	Sighted more sps
Janasakti CF to Chunbhatti Churia, Mahadevpuri	11/21/ 2010	Four old Goths, 2 carcass of common langur, poison for fishing	2 sets of leopard pugmark	Sighted tiger pugmark
Shivasakti CF to Lutepani Churia, Balapur	01/04/ 2011	2 Goths in Lutepani, 6 in Kalapani, 8 women- slashing thatch, grazing livestock, felling sal and khair trees, 2 persons for hunting, tractor for mining	Few pellets of deer , 1 set of leopard pugmarks	Sighted more sps., more Goths
Khairi- highway to Khairi khola Churia, Agaiya	01/05/ 2011	1 wild dog, 2 jackal, >100 monkeys, 2 persons for slashing thatch	2 pugmarks of leopards and hyaena blue bull pellet	Sighted tiger pugmarks, built Goths

Source: Field Survey 2010

I also found a carcass of two common langurs *(Presbytis entellus)* and a can of poison that was used in fishing at Kalapani, inside Banke National Park (annex xx). I sighted some felling of Sal (*Shorea robusta*), and Khayar (*Acacia catchu*), tractor for rock mining, two persons

hunting, community people collecting thatch, and a number of livestock and herders (*Gothalas*) in the Mahadevpuri forest.

7.4.3 Restoration Success Indicator: Tiger Dispersal Behavior

I found different dispersal behavior of tiger in Bardia and Banke from the indirect/sign survey. On January 2, 2011, I found a set of tiger pugmark on the banks of the Orahi River, Khata corridor, which were at a distance of less than 500 meters from the village (table 25.7). The tiger had stayed for a few days at Gauri CF, which was then used as a transit to move from/ to Bardia National Park to/ from Katarniyaghat Wildlife Sanctuary of India. Likewise, I found one set of pugmarks a few days old (November 11, 2011), pugmarks of sloth bear (*Melursus ursinus*) at a distance of 1,340 m, leopard pugmarks at 1003 m and tiger pugmarks at 745 m from Betani Range Post. At around the same distance from Ranjha village, tiger pugmarks were found in Bharlako Siran and Bhutya Gauda. The tiger reached there following the fire line from the forest. I did not find any sign of tiger from September to January 2011 in Banke National Park but local villagers mentioned that they had seen tiger pugmarks during June to August 2010 in the Mahadevpuri forest. Similarly, an ox had been killed in Chyama in August 2010. There was not any evidence of recolonization or of tigers living permanently inside any of the community forests researched.

Table 25.7 Tiger sign records in Bardia and Banke NP

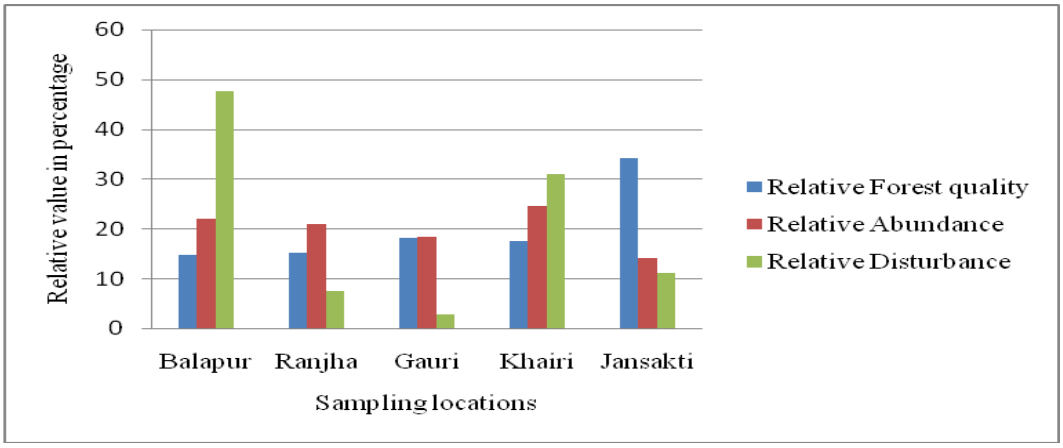
Sign survey area	**Presence-location**	**Distance from forest edge (m)**	**killed**	**Survey year**	**Source**
Gauri-Khata	Pugmark - Orahi river banks	313		2005 & 2010	April (2005) & survey (2010/11)
Ranjha- Bardia NP	Pugmark in sandy soil- nearby Betani, Bharlako siran	745		2010	survey (2010/11)
Mahadevpuri - Banke NP	Pugmarks of one male and one female with 2 cubs in stream banks- Lutepani, Chunbhatti, Jhinjhari	>8600	+	1999/2000 & 2005	Bogati & Basnet (2001) & Bogati (2012)
Khairi, Agaiya - Banke NP	Pugmark in stream banks- Khairi and Jhuri Kola	<3000	+	1999/2000 & 2005	Bogati (2012)
Mahadevpuri and Khairi- Banke NP	No any signs or pugmark during survey but observed by community people	<9300	+	2010/2011	Survey (2010/11)

7.4.4 Sustainability of Tiger Conservation

7.4.4.1 Tiger Prey Species and Disturbances

The disturbance of plants shows that there is high human pressure on forest. It affects all wildlife and forest quality. The relative prey species abundance was lower in Janasakti (figure 51.7). The relation between the plant disturbances is insignificant with prey species abundance index (t = 2.108, d.f. = 4, sig. = 0.103).

Figure 51.7 Relative forest quality index, prey species abundance and plant disturbances



Source: Field Survey 2010

7.4.4.2 Demography of Tiger

I found that tiger population has decreased in Bardia and Banke from the ancillary data and field survey (table 26.7). Particularly, in Banke National Park, it is going to extirpate locally even though it has a large habitat. I was assured that only one tiger is existing there, proven through its pugmarks sighted by the local people in Mahadevpuri and its kill (i.e. an ox) in Chyama.

Table 26.7 Trend of tiger population changes in Bardia and Banke

Tiger habitat	Period	Number	Description	Source
Bardia NP	1980s	50	Estimated	McDougal (1995), c.f. Basnet et al. (1998)
	1990s	28	18 female, 10 male	ITNC (1995) c.f. WWF (1998)
	2005	32-40	adults	DNPWC/MoFSC/GoN (2007)
	2009	18	Camera trap	Karki et al. (2009)
Banke NP	1980s	6-8	Estimated	McDougal (1995), c.f. Basnet et al. (1998)
	1990s	4	1 male 3 female	
	2000	2	1 male and 1 female with 2 cubs	Bogati & Basnet (2001), Gurung (2002)
	2005	1	Permanently live	Bogati (2012)
	2010	1	May be transient	Present research

Source: Field Survey 2010 and ancillary data

7.4.4.3 Connectivity and Habitat Size

From the survey, I found that the habitat of Gauri CF is smaller than other forests. Nevertheless, it offered shelter during mobility and a hunting ground for tiger. It has connectivity with the other community forests and Bardia National Park. Grazing was completely banned where grassland regeneration was higher. The current president of Gauri CF (Bhadai Tharu) had an encounter with a tiger in Gauri CF during 2004 and lost one eye. Despite this, he is intensely involved in tiger conservation. This is an example of the positive attitude of community people. Hence, I considered this CF as an example of successful restoration.

I compared Ranjha and Balapur CF with Gauri in terms of different variables (e.g. distance, area, prey, regeneration, IVI, disturbance, connectivity) (table 27.7). The correlation between Gauri and Balapur and variance is insignificant (r = 0.214, sig = 0.580, t = 0.927, d.f. = 8, sig. = 0.381) whereas the correlation between Gauri and Ranjha is significant (r = 0.893, sig. = 0.001) and variance is insignificant (t = 0.317, d.f. = 8, sig. = 0.760). Balapur CF is smaller in size, more disturbed, less regenerated and has lower prey density than Ranjha. Hence, the hypothesis of optimistic 'undisturbed, bigger and connected habitat is the best' is comparatively justified for Ranjha BF.

Table 27.7 Comparison of study areas

Variables	**Balapur**	**Ranjha**	**Gauri**
Distance from authority (m)	<3,000	<3,000	<1,000
Forest area (ha)	304.25	928	48.26
Prey species pellet/100m^2	2.91	3.20	2.00
Forest disturbance/ha	191.67	40	25
Regeneration/ha	866.67	1360	2600
Connectivity (0 = no, 1 = yes)	1	1	1
Important Value Index	3,198.28	2,667.18	2,205.25
Pugmark presence (0 = no, 1 = yes)	0	1	1
Distance of last tiger pugmark (m)	8,600	745	313

Source: Field Survey 2010

7.4.5 Impact of Forest Restoration

After the start of conservation and restoration activities in 2001, vegetation cover has increased in the buffer zone. However, the community forest is still focused on the productivity of forest in terms of consumption. Forest encroachment has reduced and some degraded forest edges

such as Janasakti, Tara CF, etc. in Mahadevpuri have been planted with new seedling of *Dalbergia sissoo*, fruits species (e.g. *Psidium guajava*), etc. Due to the restoration and management and protection of forest, soil erosion has been reduced, water sources have been preserved, and wildlife species have increased in and around some of the community forests (per. com. in Mahadevpuri).

7.5 Discussion

7.5.1 Vegetation: Regeneration, Important Value Index, Forest Quality and Disturbance

The research approach was quasi-experimental in which a survey was conducted before and after the forest restoration and cause (i.e. restoration interventions) and effects (i.e. tiger prey species, habitat and dispersal behavior) were analyzed using statistical tests (Coughlan et al. 2007, Manly 1992). Such type of experimental research is appropriate in ecological restoration (Block et al. 2001). I used interviews and survey but the research method was primarily quantitative and explorative type. Most of the data were interpreted analytically and in some cases, they were triangulated with the key informant interviews.

The regeneration (sapling and seedling) was higher in Janasakti and Gauri CF than Balapur, Ranjha and Khairi forests (figure 46.7). Both community forests have planted seedling at the edge of forest and have controlled grazing which also controlled the encroachment. But, there was lowest regeneration in Balapur since their focus went on restoring trees of economic importance such as *Acacia catechu, Shorea robust*a and thinning trees of other species. The Khairi area was opened for grazing, but it is far from the human settlements. Forest edge inhabitants in Ranjha have encroached on the forest and have controlled new species due to the fear of elephants coming from the national park (per. com.). Joshi (2000) also found that the forest condition is different in protected and unprotected areas; saplings were more in unprotected areas. Hence, Janasakti and Gauri Community Forests were medium and the rests were low in terms of regeneration.

The important value index was higher in Janasakti and Khairi than in other forests (table 23.7). There are more mature trees which made a higher basal area and wide distribution of species made a higher frequency. Most of the species in Gauri are *Mallotus philippiensis* which has small diameter at breast height (DBH), as a result it has lowest IVI. Basnet et al. (1998)

estimated a higher basal area (i.e. 62485 on the Mahadevpuri plain and 45570 in the Khairi plain) than the present research (annex xvi). They carried out an intensive survey with large areas using most of the higher DBH trees such as *Acacia catechu, Shorea robusta*, *Dalbergia sissoo, Terminalia tomentosa*, etc., which have been cleared within the last 10 years. In the present survey, very few old trees having some deformities (less value for timber) were found. Forest communities and ecosystems are degraded and have changed due to fire, grazing and natural disturbances (e.g. flash flood, soil erosion) which will cause natural succession in Banke (Basnet et al. 1998). The forest quality index was higher in Janasakti and Gauri (table 23.7). It was calculated on the basis of the number of species, basal area, density, frequency, sapling and seedling. The higher value of these DBH and diversity of species gave these two forests with higher Forest Quality Index (FQI). In Ranjha, the basal area and frequency was low, as a result it has lowest FQI value.

The chopping/ slashing of sapling and seedlings was higher in Khairi (figure 49.7). People have had access to Khairi, even though it is a national park. There are economically valuable trees like *Acacia catechu and Shorea robusta* in Balapur and Janasakti. Community invested money in social development such as a school, road, income generation, etc. by exporting these timbers (per. com., Mahadevpuri). As a result, these forests were higher tree felling forests, among other community forests. All seedlings of one plot were burnt completely in Balapur which is another cause of disturbance. Ranjha Buffer Forest does not allow exporting timber and there are no valuable trees in Khairi. Community members were more motivated toward conservation in Gauri and they got support from many non-governmental organizations (per. com., Khata), as a result, it has no felling of trees. Comparatively, Balapur forest is the highest disturbed with respect to standing plants, which indicate a higher degradation rate instead of restoration.

7.5.2 Fauna: Quadrat and Track Survey

The pellets of wild boar were higher in Ranjha Buffer Forest (BF) but there was not any of deer species (figure 50.7). The lowest number of pellets of prey species was found in Janasakti Community Forest (CF) and there too, deer species were absent. Shrestha (2004) estimated a higher number of ungulate pellets in the buffer zone (i.e. 0.5+-0.05/10 m^2) and national forests (0.41+- 0.02/10 m^2) in the Terai landscape; higher than in the present research (i.e. Balapur = 0.29, Ranjha = 0.32, Gauri = 0.2, Khairi = 0.27, and Janasakti = 0.23 per 10 m^2). The present research undertook a rapid assessment. Gauri CF was opened for slashing thatch during the

survey period, and hunting of wildlife has increased in Banke, which may be the reasons behind the difference in results.

The track survey showed no tiger pugmarks were found in 2010/ 11 and wildlife sighting were very low compared to the survey in 1999/2000 and 2005 (table 24.7). However, a number of illegal settlements have been evacuated and very few temporary settlements (*Goths*) have been built inside the Park at present. The forest office is going to shift from Obhari where the National Park headquarter is situated. Since Banke National Park is a newly established park, it is in a transitional period and is managed through limited human resources. It might be the reason behind the illegal activities. Illegal activities such as rock mining, logging, poaching, fire, etc. inside the forest are the main causes of forest degradation and wildlife depletion (Bogati 2012).

7.5.3 Restoration Success Indicator: Tiger Dispersal Behavior

Tiger pugmarks was found in the Orahi River banks at a distance of less than 500m from the forest edge in Gauri CF where pugmarks were tracked in 2005 too (table 25.7). This forest is used by tiger as a migrating route from Bardia NP to Katarniyaghat Wildlife Sanctuary, India. It started to live there after the forest restoration (Gurung 2002). Tiger pugmarks were found at the distance of 1,000m from Ranjha village in Bardia National Park and buffer forest boarder. However, I did not find any pugmarks in Mahadevpuri and Khairi, whereas I had found them in 1999/2000 (Bogati and Basnet 2001) and in 2005 in the same time period. I did not find any pugmarks in the Khairi area, Agaiya in 2005 (Bogati 2012) either. The tiger has either already changed the dispersal route or has been displaced from this area due to heavy human disturbances after the Sikta irrigation project. The Sikta area was used by the tiger to cross the Rapti River. However, as it has not been seen for a few years, it appears to be absent in this area (per. com., Jaluram Chaudari). One set of tiger pugmarks was found in Sano Khairi during June 2010 (per. com., Ser Bdr. Garti), in Suki Khola during July 2010 (per. com., Hom Bdr. Yogi), and in Lutepani during August 2010 (Chatre Khatri, per. com.), which is more than 6-8 km from the closest village. One ox was killed in Chyama during the first week of August 2010 (per. com., Shanta Ram Chaudari), which was 3-4 km from Bardia National Park and 2-3km from the closest village. This evidence depict that a tiger lives in Banke between June to August, when there is low human disturbances. After August, it will either move to Churia or Bardia National Park.

One male and one female tiger with cubs had lived permanently in Mahadevpuri and Khairi during 2000 (Bogati and Basnet 2001, Gurung 2002). In 1999/2000 a male tiger had used the plain area to move east-west in Banke National Park when community people used Churia for slashing thatch, and it used Churia when livestock and human disturbance was high in plains. (Bogati 2012). Tiger has visited Gauri and Ranjha forests after restoration but there was not evidence in and around the Balapur orest, Mahadevpuri. The forest quality, prey species, and forest type are more or less similar in Balapur, Ranjha and Gauri, but the human pressure and plant disturbances are higher in Balapur. Hence, Balapur forest restoration is less effective in terms of tiger dispersal behavior even though it has launched forest management and restoration programs.

7.5.4 Sustainability of Tiger Conservation: Prey Species, Demography, Connectivity, Habitat Size and Disturbances

Pellets of tiger prey species were lower in all locations compared to other research (e.g. Shrestha 2004). The presence of prey species pellets were lowest in Janasakti (figure 51.7), however, it had higher forest quality. Higher forest quality will contribute to higher prey species, however, it does not apply in all areas. In some higher forest quality area, the presence of prey species was lower. It is caused by the third variable i.e. anthropogenic disturbances. The foraging behavior in habitat will indicate the higher food availability and higher quality habitat (Lindell 2008). Due to low disturbances, Gauri and Ranjha could be possible tiger habitat, provided there is an increased number of prey species.

The tiger population is dramatically declined in Bardia and Banke (table 26.7). It was the habitat of 6-8 tigers in the 1980s in Banke (McDougal 1995, c.f. Basnet et al. 1998) which fell to four in the 1990s, two in 2000 and only one in 2010. However, the area will be enough for 10 tigers (based on the home range 37 $km^{2)}$ determined by Sunquist (1981) in Banke. During the survey, the carcass of two common langurs were found and two persons inside the forest for the purpose of poaching were observed. Poaching/ hunting is higher on the northern side of Ranjha CF, Babai Valley of Bardia National Park (DNPWC/MFSC/GoN 2007, Malla 2009) and non-protected areas of north Bardia National Park, (Paudel 2012) which is not a regular monitoring site of the government authority. Poaching is associated with the socio-economic conditions (Shrestha 1998, c.f. Basnet et al. 1998) of local people and it will continue due to pressure from outsiders or illegal wildlife traders, weak security and weak management (Bhuju et al. 2009). Retaliatory killing of tiger and hunting of other wild animals was recorded in

Banke during 2000 (Bogati and Basnet 2001). Human and other resources were limited and the forest monitoring system of the government authority was poorer during my survey in Banke than in 2000. Hence, poaching, poor park management by the government and lack of public support are the causes of the decrement in the number of tiger.

The Gauri Community Forest (CF) lies in the Khata corridor which is 9 km long and 1-3 km wide, connecting Bardia National Park. Similarly, Ranjha Buffer Forest (BF) has good connectivity with Bardia National Park. Balapur CF lies in the Mahadevpuri bottleneck, which is 3.35km wide and which is also connected to Bardia National Park (Shrestha 2004). Out of the 550 sq km of Banke National Park, approximately 65% (368 km^2) falls in the Terai (based on GIS Map, LRMP 1986). There are more than 50 buffer forests having a total area of approximately 8 km^2 which are the possible refuge habitat for tiger (CF Data of DFO, Banke). Comparatively, Ranjha is bigger, closer to the tiger gene pool, have more prey species, and is more undisturbed than Balapur. Therefore, it has the higher possibility of tiger presence. Hence, 'undisturbed, bigger and connected habitat will be the best' for sustainable tiger conservation. However, all larger habitats are not always suitable areas for tiger conservation (Dinerstein et al. 1997).

Habitat quality also plays a vital role to conserve tigers in a landscape which is determined by various factors. The relation between Gauri CF with respect to the variables: area, disturbances, distances from authority, regeneration, IVI, prey pellet, tiger pugmark (table 27.7) is insignificant, with Balapur and significant with Ranjha CF. The value of correlation co-efficient is lower in Balapur (r = 0.199) than Ranjha CF (r = 0.891). Similarly, the tiger conservation unit (TCU), Dinerstein et al. (1997) have ranked the habitat based on size (<200km^2 to >1,000km^2), isolated/ fragmented, low or high for potential tiger dispersal, and understory forest or impacted by livestock grazing, firewood collection, agricultural activities or manmade fires for degradation. They found that the relationship between the size of a TCU and its rank score was relatively low (r^2 = 0.35).

Prey species, minimum viable population and the large forested areas or connected areas are the fundamentals of sustainable tiger conservation. Both Ranjha and Balapur are adjoining with the national park and bigger than Gauri CF. If they are connected with another community forest and protected area where there is a possibility of gene pool, the tiger will live in the forest no matter how small the area is. This is proven by Gauri CF. Similarly, tiger has returned to the Barandabhar corridor and buffer forest of Chitwan National Park after

restoration (Thapa and Basnet 2008) and some other buffer forest of the Terai landscape (Gurung 2002). Tiger has used some of the intact parts of Ranjha Buffer Forest with national park, nevertheless, no signs of tiger pugmark were observed in Balapur forest.

Connectivity and the size of habitat do not only determine the presence of tiger, anthropogenic disturbance is also a major factor for it. Among all locations, Balapur forest was more disturbed (figure 49.7). There were high plant disturbances such as felling and slashing/ chopping. Shrestha (2004) also reported these disturbances in Mahadevpuri (Samsergunj) forest. Poor quality habitat and low prey species hinder the persistence of tiger. At the same time, anthropogenic disturbances (e.g. hunting, logging, slashing, open grazing, infrastructure) and the poor management by the government authority also influence it. There is high disturbance near Khairi, Agaiya from the Sikta irrigation construction work. Hence, the population of tiger and its prey species has been reduced each year in Banke due to such problems creating a complex situation in sustainable tiger conservation.

7.5.5 Impact of Restoration and Tiger Conservation Strategy

The population of some wildlife species increased in the buffer/ community forests after the restoration of forest. This will not only have a positive impact but also a negative one because of the increase in human-wildlife conflicts (Gurung 2008). The management of this conflict is a major conservation issue. At the same time, Community Forest User Groups use their forest wisely, controlling grazing and other illegal activities. But some people particularly the poor or traders have shifted their activities (e.g. firewood collection, timber, non timber forest products, hunting) to the national forest. Furthermore, the government forest authority has become ineffective, less accountable and has been pressurized from political decisions to establish human settlement in and around the forested land (per. com. in Mahadevpuri). Hence, the national forest has become more degraded and fragmented, whereas the community forest has been restored in the study area. As a result, wildlife has been displaced from some parts of the national forest/ national park.

The tiger action plan strategies (2008-2012) are focused on international, national, park and community level programs. There are six efforts and achievements (i.e. conservation policy, management, global commitment, human resources development, field implementation and institutional strengthening) (DNPWC/MFSC/GoN 2007) where field implementation is more post-reactive and provides compensation only for human and livestock loss. Its goal has

emphasized on building partnerships with community people and it has developed five objectives (i.e. tiger and prey information, habitat management, conflict resolution, anti-poaching and anti-trafficking operations, and transboundary cooperation). Among them, habitat management practices such as reducing human pressure, constructing watchtowers, constructing a cattle pool, etc. were less effective in Ranjha BF. The variable of success of the indicator is not to arrest more smugglers and poachers, but rather to reduce the poaching or killing of wildlife.

Resources used by the community indicate another sign of success. For instance, when the forest office mobilized resources in the Khata corridor and Gauri CF conservation, it was ineffective. But once the community received resources and utilized them, a feeling of ownership developed, the attitude of people changed, and as a result success in restoration has been achieved (per. com. Khata). Education and awareness are not the means and end of changing attitudes where other social factors (e.g. decision making, resources use) are associated with it. In the tiger action plan, more financial resources are allocated to be utilized by the government authority which directly will not change the attitude of the community people.

According to the strategy of doubling the tiger population by 2022, a tiger named 'Namobuddha' was translocated from Chitwan to Bardia in January 2011 (DNPWC 2011). But a question has been raised: did the authorities conduct a program to change the attitude and perception of the people in and around the area before the translocation of tiger? If yes and if the community people were assured compensation for any livestock killings, they would not put poison on its kills (i.e. cows). The present study area, Balapur is located at a distance of more than 30km from this translocated tiger habitat. But, the community people are terrified, they think that the next tiger will be released in Banke National Park which will threaten both people and their livestock.

The success of translocation of carnivore species will depend not only on the biological aspects such as genetics, demographics, behavior, disease and habitat but also on social factors (Miller et al. 1999). For the 'Namobuddha' tiger translocation, experts and authority used high technology (i.e. VHF and Satellite radio collar) for monitoring and have considered the biological factors but might not have considered the social factors. As a result, the tiger was lost within the period of four months and economic loss took place. It is a lesson for

conservationists and restoration practitioners that socio-economic factors are equally important for tiger conservation as biological.

7.6 Summary

Single or assemblage species and ecological elements such as soil nutrient, water quality, etc. have been used for the evaluation of successful restoration. Most of the researchers have used plant species, a few researchers have used invertebrates and a nominal number have used vertebrate fauna for the indicators of success. Tiger, an umbrella species of forest ecosystem and target of conservation, has not been used as the indicator of restoration success. Hence, I conducted this research to analyze the implication of forest restoration for tiger conservation and it is taken as the restoration success indicator species. The research was conducted in and around the Bardia and Banke National Parks in the Mid-Western Terai Landscape of Nepal. I used quadrat and track survey and other indirect sign survey (e.g. pugmark) methods. Data was presented by calculating density, frequency, Important Value Index (IVI), Forest Quality Index, abundance of tiger prey species, dispersal behavior of tiger using analytical (e.g. t-test) and simple descriptive techniques.

Forest has been restored and encroachment has been reduced in and around Mahadevpuri bottleneck, Banke NP. From the quadrat survey, I found that the vegetation regeneration was medium in the buffer forest of Bardia National Park (e.g. Gauri CF) and low in Banke National Park (e.g. Balapur). The forest quality index was lower in Balapur than Ranjha Buffer Forest (BF). Forest quality varied due to the difference in basal area, number of species, density, IVI, disturbances, soil type, land topography, distance from government authority, etc. The density of tiger prey species was not only related to the forest quality but also depended on the connectivity, area, disturbances, and management practices that were lower in buffer forest of Banke than Bardia. From the track and indirect sign survey, I found that the tiger dispersal was seasonal or transient in Banke National Park. The number of tiger and dispersal has decreased due to poaching and anthropogenic disturbances. Forest restoration has positive impacts on wildlife conservation where it provided migratory route (e.g. Gauri CF) and prey species has increased in some community forests (e.g. Ranjha BF). However, tiger habitat was more disturbed in and around Balapur, Banke National Park and the abundance of prey species was lower, as a result the sustainability of tiger conservation is more critical in the area.

Chapter VIII

General Discussions, Conclusions, Recommendations and Theory Building

8.1 General Discussion

8.1.1 Methodology

The research used the quasi-experimental approach (Adelman 1991, Glass 1997, Ellis 1994) to evaluate the cause (i.e. restoration interventions) and effects (i.e. tiger prey species, habitat change and its dispersal behavior). It has captured both the social and ecological arrays and formulated objectives, research questions and hypotheses for measuring both the qualitative and quantitative methods. Two villages were selected for interviews based on their similarities in ecological, social and land topography, data was collected by using open questions, interviews (annex iii, v, xxi), direct observation (e.g. decision making at monthly meeting, general assembly), document review, and analysis was made by interpreting the results as simple descriptive method that has some attributes of the qualitative method (Silverman 1993, Patton 2002). The research approach was quasi-experimental, data was collected from surveys (annex vii, ix, xxii), predetermined questions, indirect observations, attitudes of people, and analysis was performed using statistical techniques and testing of hypotheses that also have some attributes of quantitative method (Coughlan et al. 2007, Burian et al. 2010).

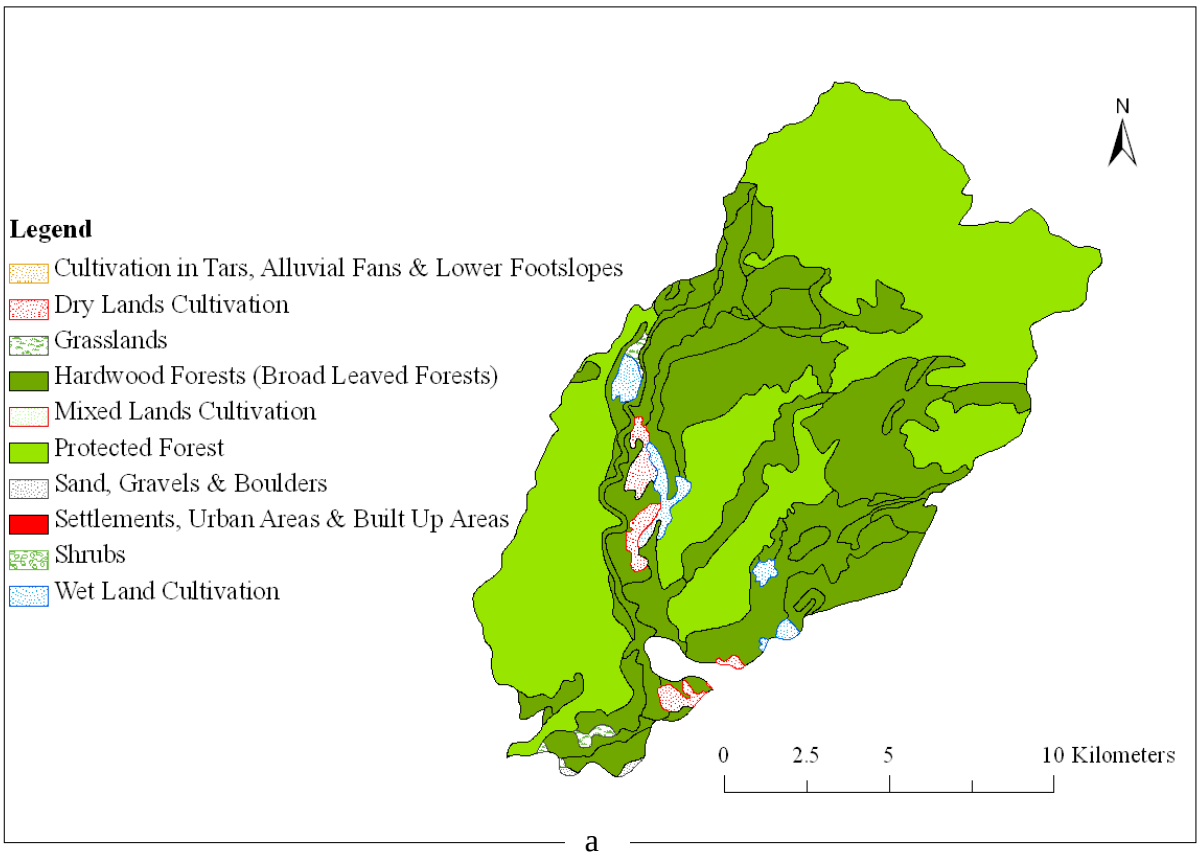
I used both open and closed questions and the research was conducted by using qualitative and quantitative data in a sequential order (Bryman 2008, Creswell 2009) and a cross-section study of social (planning, practices of restoration) and natural science (e.g. vegetation and faunal survey). Some qualitative answers were ‘quantitized’ (Teddie and Tashakkori 2003) for analysis and the responses were used for the analytical test. The forest restoration success indicator ‘tiger as an indicator species’ was taken as a typical research. This can be applied to other cat species in other similar places. While using both the qualitative and quantitative methods, I triangulated different methods and sources of data which incorporates the whole process (i.e. methodology) of research design, data collection and analysis (Creswell 2011). Hence, the analysis of data was concurrent during triangulation which is an attribute of mixed research method (Cohen 2008, Teddie and Tashakkori 2011).

8.1.2 Triangulation of Findings

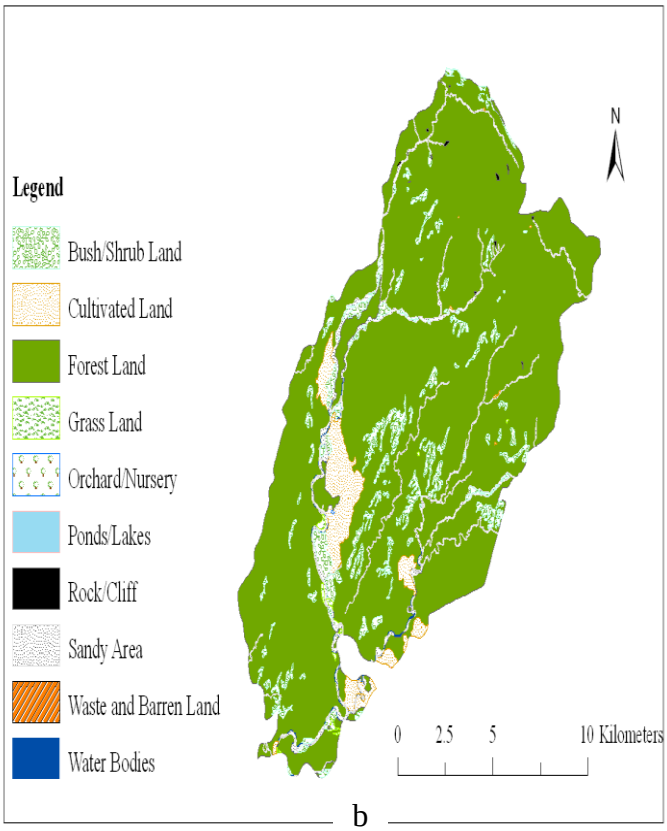
8.1.2.1 Forest Habitat in and around Mahadevpuri Bottleneck

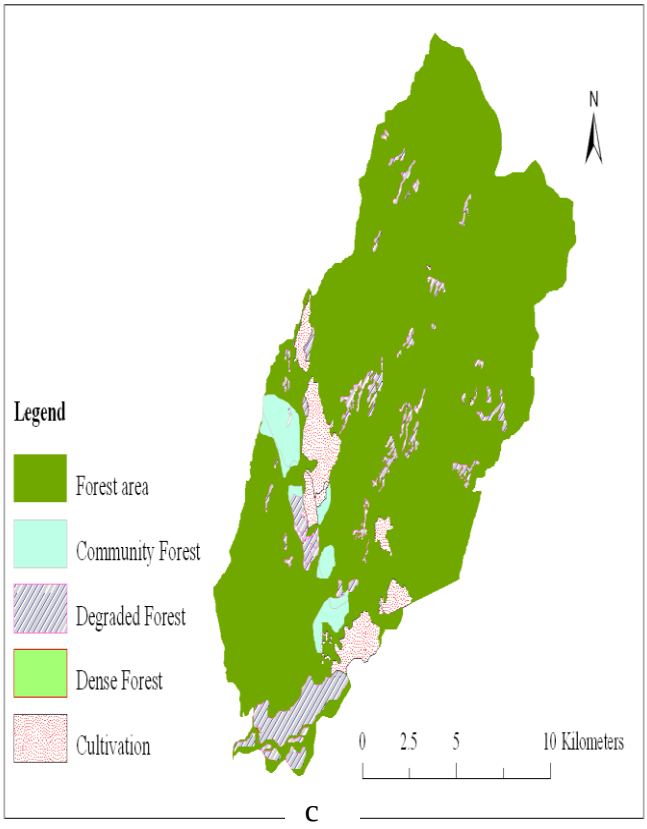
Forest habitat has changed in Mahadevpuri and Banke National Park, particularly intact community forest. From the GIS map, field observation and interviews. I found that the forest edge has been restored and encroachment has been reduced. The national forest was more degraded in some parts, particularly in temporary settlement areas but the evacuated areas (e.g. Khairi area) have been restored. However, there were more hardwood and Sal forests in Mahadevpuri bottleneck in 1987 (figure 52.8a) that were cleared within the period of the next 23 years. Settlements were very few at that time but increased during 1990s (figure 52.8b). Some parts have been restored, but forest degradation was still there in 2004 (figure 52.8c). Forest edge degradation was higher in community forests in 1999 due to free grazing, but it was not the case during the time of field visit. The community forest was restored in 2010 with reference to the Khata corridor (Plate 8.1, 8.2). Nevertheless, human pressure and grazing have increased in and shifted to the national forest/ park.

Figure 52.8 a. Mahadevpuri bottleneck and land use in 1987, b. land use 1999 and c. land use in 2004 and plates of forest change



a





(Sources: Map a and b are prepared based on Survey Department & LRMP 1986 and c is digitized based on WWF (2004)

Note: The first map shows that there is lower encroachment, the second map shows the higher encroachment, expanded cultivation area and changed hardwood forest, and the third map shows the restoration of previously degraded forest through community forestry.

Plate 8.1 Cleared ground before restoration of forest in 2000, Khata corridor, photo by NTNC Bardia

Plate 8.2 Revegetation after forest restoration in 2010, Khata corridor, photo by researcher

8.1.2.2 Attitude and Perception towards Restoration and Wildlife

I asked same questions to the Forest User Group Committee (FUGC) members (n = 10+10) and forest users (FU, n = 42+42) in Ranjha and Balapur buffer villages in order to understand their attitude and perception on restoration and wildlife. All FUGC members (10) and most of the forest users (FU) (37 for restoration, 34 for wildlife) in Ranjha, and nine FUGC members and majority of FU (42, 34) in Balapur perceived the importance of restoration and wildlife. In Ranjha, nine FUGC members and 30 FU like tiger and nine FUGC members and 39 FU like ungulates in Ranjha whereas one FUGC member and 21 FU like tiger and one FUGC member and 35 FU like ungulates in Balapur. All members of the FUGC and 39 respondents were in favor of protecting these species in and around their community forest in Ranjha, whereas only four members of the FUGC and 37 FU in Balapur (figure 29.4 and 30.4) had such an opinion.

Aforementioned examples show that the attitude and perception of FUGC members and FU varies within and between the two areas. Socio-economic conditions, family structure, culture, information, resources use, wildlife disturbance, etc. influence the attitude of people. Indigenous people (e.g. Tharu) living in Terai for many years had a more positive attitude toward the forest and wildlife, however, they have little information and knowledge about contemporary forest management (per. com. in Chyama). Formation of attitude is influenced by multiple reasons such as damage of property, fear of wild animals, etc. (Decker et al. 2008). Those who have alternative sources of energy (biogas) and higher education, do not graze livestock in the forest and were more positive in Ranjha than Balapur, since most of the people in Balapur were ranchers. They used the forest in order to fulfill their needs such as firewood, fodder, and leaf litter. Higher incidences of crop damage and livestock killings by wildlife existed in the areas, but no compensation was provided. Agro-pastoralists that are living in and around the protected areas have a negative attitude toward wildlife due to the loss of livestock (Oli et al. 1994), economic losses (Lindsey et al. 2005) and human life loss (Gurung 2008). Positive attitude and constructive perception play a vital role for sustainability of restoration and wildlife conservation. This can be built from awareness, incentives, compensation and motivation along with socio-economic development and environmental programs.

8.1.2.3 Forest Management Planning and Conservation Issues

From the document reviews and interviews with the FUGC members, I found that the forest management operational plan and working plan have been formulated in Ranjha and Balapur. Ranjha FUGs formed the buffer forest in 1997 and Balapur was declared as a buffer community forest in 2010. The planning process and the elements of planning were similar since they are mentioned in the government guidelines. However, focus in these two places was different, for Balapur was still working with the Community Forest Management Operational Plan. The focus of Ranjha forest was in fulfilling the local needs and conservation but in Balapur the focus was in fulfilling needs as well as exporting the extra resources. They included thinning, plantation, controlled grazing and illegal hunting in the plan, with wildlife-human conflict being the major conservation issue.

From the key informant interviews, household surveys and observation, I found that the people's participation in planning, monthly and biannual/ annual meetings was decreasing. I observed the general assembly of Balapur FUGs in November 2010, which was the second time the general assembly was called due to the absence of the majority of forest users in the first meeting. During the meeting, 117 users (out of 200, 65% male and 35% female) were present. The majority of them (64%) were passive participants and only about 20 percent were interactive (figure 35.5). I got similar results from the household survey of both the buffer villages where most of the respondents (28) participate in biannual or annual meeting and the others do not take part in any meetings (table 18.5).

The local forest management plan is guided by the national policy and regulations. The Forest Act and policy have been amended many times (table 5.2) to fulfil the needs of the people, along with their participation. Similarly, the National Planning Commission has taken forest as a means of livelihood and poverty reduction (NPC 2007). Foresters have also focused on the productive use of community foresta and have considered them as a source of income. Terai land is fertile and has been contributing to the food supply of the entire country. Due to its productivity, some economists and planners have suggested the conversion of Terai forests into agricultural land (Ghimire 1992, c.f. Shrestha 2004). But conservation organizations and biologists/ ecologists are strongly against this and have advocated for the extension of forest outside the protected areas in order to conservation the mega fauna e.g. tigers, rhinos. To attain these productive and protective purposes, community people should prepare the plan. For this, local communities need technical manpower to develop the plan, which is not an easy job for

agrarian people. The community forest management planning practices are 'too rigid and unrealistic', therefore the complete participation of local forest users is not guaranteed (Malla et al. 2002).

Participation in forest management planning depends on education, economic status, leadership and interest. These features are found mainly in elite people, which was observed in the Ranjha FUG Committee. Diverse groups of people including fuel wood users/ sellers, timber user/ sellers, non-timber forest users, landless people, conservation activists, etc. live in the community. Incorporating the interests of all people in the plan is therefore, difficult (Ojha et al. 2009). FUGCs try to focus on conservation but these diverse interests ultimately hinder the selection of restoration activities. If they do not obtain any benefits from the forest, poor people will not participate (per. com. in Mahadevpuri). In this regard, one of the respondents in the general assembly mentioned *"I took one goat from the community forest cooperative but it has died and now I am not in the position to pay money".* On the other hand, some people undermine the ecological and conservation value of forest and thought that it is only for committee members and active persons. This feeling was expressed by one of the participants in the general assembly of Balapur. This indicates that the forest management plan is vital for sustainable forest conservation, although complying with the plan is challenging.

8.2.1.4 Human Interventions in Forest Restoration, Wildlife Conservation and Barriers

Interviews with the presidents of Forest Users Groups (FUGs), members of Community Forest Coordination Committees and the officials of relevant organizations as the key informants, members of Forest User Group Committees (FUGCs) and forest users as other interviewees, as well as field observation for assessing human interventions in forest restoration, were conducted. Key informants and FUGC members mentioned that plantation, thinning, pruning, controlled grazing, illegal logging/ hunting, fire line constructions, training, awareness, anti-poaching, etc. were major restoration activities. FUGC members also reported that forest areas were conserved, plant and wild animal species have increased, community awareness has been raised, positive attitudes of people has developed, the participation level has increased, and that infrastructures has been developed. However, there has been no change in the income of community people since 2000. From the interview with the forest users and direct observation, I found that many people did not participate in restoration. Only nominal plantation was conducted at Ranjha, a fire line was constructed once in Balapur, thinning was performed once a year in both villages and controlled grazing was practiced (see some interventions, annex

xxiii), but other activities were not practiced at community level effectively. Regarding the wildlife, I did not see any animals in the early morning and late evening except for a few fresh pellets of deer, wild boars, and pugmarks of leopard in both of the forests. This indicates that the planner's view, the plan itself, and the implemented activities are different.

Besides the data sources mentioned above, I interviewed the drivers/ local road side dwellers (n = 17), directly observed human and livestock mobility (12 hours), obtained ancillary data such as wildlife casualties, and GIS and climatic (i.e. temperature, rainfall, relative humidity) data covering 31 years from various sources in order to understand the barriers to restoration and wildlife conservation. FUGCs and forest users criticized the attitude of government officials, who mentioned that they are decadent and bureaucratic. However, officials denied this impute and said that the communities do not act as per the forest management operation plan and do not invest in conservation programs. This is also because of the political instability (frequent change of the government) and poverty of local people (per. com., Banke DFO). From interviews with drivers, I found that the road has disturbed wildlife mobility (figure 40.6) resulting in wildlife casualties due to road traffic on the Ratna Highway (figure 41.6). Regarding this, the views of forest official and community people conflicted and they accused each other of being less accountable.

Encroachment inside the forest increased at the end of 1990s (figure 43.6 and 44.6), but it decreased after the establishment of Banke National Park in 2010 (per. com., park official). I found more than twenty illegal settlements (*Goths*) inside the forest in 1999/2000 (Bogati and Basnet 2001) but less than ten in 2010, which depicts that encroachment has reduced. The illegal activities such as logging and hunting have increased in Banke and in the north-eastern part of Bardia where I saw huge amounts of timber in front of the community forest and range post offices. Human and livestock mobility was higher in Balapur than Ranjha, (figure 42.6) which disturbed vegetation and wildlife. The climatic data shows that the temperature has increased (0.06°C) within the last 31 years (figure 38.6) and the distribution of rainfall was erratic (figure 36.6). As a result, sporadic flooding occurred and the productivity of crops decreased. Hence, there are different issues in restoration and conservation (table 20.6), which should be addressed effectively for the sustainable restoration and wildlife conservation.

8.2.1.5 Tiger as the Forest Restoration Success Indicator Species

i. Vegetation, Fauna and Habitat Quality

I used a quadrat survey for the plant density and forest quality, and quadrat, track and indirect signs surveys for faunal research. I had prior information on some plants and wild animals from the rapid rural appraisal (RRA), and key informants, FUGCs and FUs interviews. Besides Ranjha and Balapur Buffer Forests (BFs), I selected three more locations for vegetation and animal survey. Gauri Community Forest (CF) was taken as the restoration success site, which made the comparison of results more reliable. Most of the FUGCs members and FUs agreed that the plants have regenerated and wildlife has increased. From the quadrat surveys, I found that the regenerated forest is lower in Balapur than in other study areas (figure 46.7) and has high disturbances (figure 49.7). The important value index (IVI) is lower in all locations (table 23.7) compared to the previous research (e.g. Basnet et al. 1998) because of high felling of mature trees in recent years. Pellets of tiger prey species (e.g. deer, wild boar) were also found to be less in Janasakti and Balapur (figure 50.7). During the track survey, I found few signs of wild animals such as leopard, sambar deer, barking deer, wild dog, jackal, wild boar, etc., where I directly observed some of these species in 1999/2000 (Bogati and Basnet 2001). The pellets were less in comparison to other research in Mahadevpuri bottleneck (e.g. Shrestha 2004).

I did a rapid assessment and noticed evidence of high hunting in Banke forest, where I found two carcasses of common langurs (*Presbytis entellus)* killed by poachers. The forest quality is higher in Janasakti than other forests (table 23.7), which depends on the distance between the forest and office of forest authority (figure 47.7), the area (figure 48.7), and human disturbances. The forest quality, plant disturbances (e.g. logging, slashing of plants, fire), human and livestock disturbances also determine the abundance of tiger prey species. I discussed these issues with the key informants, who mentioned that there is a high rate of poaching and logging in Banke. Basnet et al. (1998) found the analogous of human disturbances such as hunting, logging, livestock grazing and fire in Banke. Hence, different data sources show diverse results with regards to the status of revegetation, tiger prey species and forest habitat quality, which indicate the success of restoration and conservation of tiger.

ii. Tiger Dispersal Behavior and Impact of Restoration

I used a sign survey or indirect observation such as pugmarks and scratches, collected information of tiger killings from the local tiger survey/ monitoring representative and key informants, and conducted RRA for the study of tiger dispersal and number. I found that the dispersal of tiger was distant from Balapur community forest compared to Gauri CF (table 25.7), where it has been reduced since the previous surveys in 1999/2000 and 2005 (Bogati 2012) and the number of tigers has decreased (table 26.7). From the key informants and RRA, I also found that the number of tigers has reduced and it is only transient in Banke. Livestock killed by tiger is nominal (2) compared to the previous research conducted in 2000 (Bogati and Basnet 2001) and the dispersal has limited in comparison to other research (e.g. Gurung 2002). The decreasing number and shrinkage of tiger dispersal in Banke forest was due to high human disturbances including illegally built settlements inside the forest. The tiger was found outside the protected area after restoration, thereby increasing human-tiger conflicts (Gurung 2008), in the context of high demand for tiger body parts in the international markets (Shepherd and Nijman 2008). This is one of the reasons behind the decrease in tiger population. Hence, tiger dispersal has reduced in Banke National Park, even though restoration and conservation activities have been conducted.

Lamsal et al. (2010:3) evaluated the projects (i.e. Terai Arc Landscape Program, Sacred Himalayan Landscape and Northern Mountain Conservation Program) and found that *"the impacts of the projects were reflected in a more effective and efficient manner on several aspects of conservation particularly, conservation of forest, biodiversity, wildlife and their habitat, reduced poaching and increased wildlife movement, increased supply of basic forest products and increased availability of environmental services and improved livelihoods".* However, I did not find such positive impacts on livelihood, forest and wildlife conservation in Ranjha and Balapur. The livelihood of people has been enhanced slightly, the abundance of prey species was low and the number of tigers has reduced drastically in Banke National Park. Hence, either the statement was prepared on the basis of interviews conducted with the actors from the focuse area, or the programs of highly funded areas were reviewed, to show more effectiveness and efficiency in the programs, or the findings from the microscale research were generalized. Another mid-term evaluation report from the WTLCP is more close to the findings of this research which mentions that there is an improvement in forest cover and grassland management in and around the protected areas, but most of the programs are site activity driven which does not meet the whole landscape conservation concept for

"establishing integrated planning and management systems" (Acharya et al. 2010). To meet the strategy of doubling the number of tigers '250 tigers in 2022', a tiger was translocated from Chitwan to Bardia, but was killed within the period of four months through poison being put on its kills (DNPWC 2011). The incident shows that management by the government and local people's involvement in wildlife conservation is inefficient.

From triangulating the research questions, methods, data sources and findings, the conclusion can be drawn that there are some improvements in restoration and conservation (table 28.8). However, restoration will not be successful and have a positive impact unless attitudes/ perceptions are changed and community people's livelihoods are enhanced. They will only accept such programs when they are involved in planning and share benefits equally without government interference. If the dependency of community people on forests is reduced, through alternative means of energy sources and income, if they have positive attitudes/ constructive perceptions, and the challenges are faced, restoration will be sustained and positive impact on conservation will be achieved by integrating people, forest and wildlife.

Table 28.8 Triangulation of findings with tools/methods, data sources and interpretation

Ch.	**Research questions**	**Tools-methods**	**Data source – interpretation**	**Findings**
iv	What is the extant attitude/perception of community people toward forest restoration and wildlife?	Interviews-qual+quan	Primary- answers of FUG committee (FUGC) & forest users (FU)	1) Motivated for resources use, 2) attitude- more positive of FUGC and FU in Ranjha than Balapur, 3) perceived the importance of restoration in both villages but less importance of wildlife in Balapur
v	What is the process of forest management planning at community level?	Interviews/ direct obs. – qual embedded	Primary- answers of FUGC & FU, notes of field obs.	1) Participatory planning in FMOP and working plan, 2) decision making of FU- passive and less interactive in Balapur, 3) elements-plantation, thinning, controlled grazing 4) conservation issues- human-wildlife conflicts and poaching/ hunting
vi	What are the human interventions on forest restoration and wildlife conservation, and its hindering factors?	Interviews/ obs./ doc. review-qual+ quan	Primary and ancillary- answers of key informants, drivers & FUGC, field obs., records from authority, GIS map	1) Practices- thinning, controlled grazing & illegal logging/hunting, plantation, fire line 2) hindering factors- socio-economic, political instability, climate change, road traffic, human and livestock disturbance, forest encroachment
vii	Can active forest restoration contribute to conserve a wild cat (tiger) and its habitat?	Observations/ document. review/ survey- quan embedded	Primary and ancillary- vegetational and faunal data, evidence from the field, previous research	1) Active restoration contribution– provided resting and refuge habitat, increased forest cover & prey species, reduced the pressure on core area 2) Balapur forest area has less contributed to tiger conservation than Ranjha

	Has the tiger occupied the restored space after enhanced forest habitat restoration?	Survey/observations/ interview/ doc. review- quan+qual	Primary and ancillary- presence of signs, answer of key informants & FUGC, previous research	1) Tiger dispersal- shrinkage of the distribution, decreased the number, no evidence of reoccupied/ colonization 2) Human disturbances was higher in Balapur than Ranjha
viii	Sustainability of forest habitat restoration and impact on tiger conservation		1) Forest habitat is being restored in the Terai landscape, 2) Challenges in sustainability- high demands of social needs, poor implementation and monitoring of programs, weak coordination among institutions, community forest was more productive purpose, 3) impacts on tiger conservation- positive impact intact buffer forest and protected areas some CF like Khata corridor, but conservation programs were more donor motive	
viii	How can people, forest and wildlife integrate in the restoration?		Theoretical implications and postulate a new concept on restoration ecology and sustainability science	

Source: Researcher's construction

8.2. Conclusion

8.2.1 Attitude and Perception towards Forest Restoration and Wildlife

Community people are aware of forest restoration and wildlife conservation in both (i.e. Ranjha and Balapur) of the buffer villages. The majority of the community people were motivated to restore forests for fulfilling their forest needs (e.g. firewood and fodder). Few of them have perceived the importance of the forest for environmental and conservation value. Those who are mostly ranchers and people having low levels of education, have more negative attitudes toward tiger and its prey species, something which was more prominent in Balapur village than Ranjha. However, the attitude and perception of forest users toward restoration and wildlife has no significant relationship with age, sex, occupation and education. Economic loss (e.g. livestock and crops), insufficient compensation and wildlife disturbances (e.g. threaten to human) form the negative attitudes of community people. Efforts of the government and non-governmental institutions are insufficient, although they are trying to change the attitude through institutionalization, participation and programs related to education, community development and income generating activities.

8.2.2 Forest Management Planning, Restoration and Conservation Issues

Forest management plans including the operational plan and annual working plan have been prepared in both (i.e. Ranjha and Balapur) of the Forest User Groups. They have developed

plans through the participatory approach although the participation of forest users has decreased in the recent years. The operational planning process is complicated and costly for them. Restoration activities such as plantation, thinning, controlled grazing, and controlled hunting has been incorporated in the plan while human-wildlife conflict and poaching were the major wildlife conservation issues. The annual working plan of Balapur Community Forest has focused on the economic motive of forest rather than conservation. Most of the users were passive participants and few were interactive, which is the most important aspect for planning. A less empowered and less equipped community and inadequate information sharing are the reasons behind the decreased participation and passiveness of community people.

8.2.3 Human Interventions in Forest Restoration, Wildlife Conservation and Barriers

Forest User Groups have practiced various activities such as thinning, plantation, controlled grazing and stoping illegal logging for forest restoration. Forest areas were revegetated in degraded areas or rehabilitated in intact forest/ protected areas which provide resting or breeding habitat or migratory routes for some wildlife. However, hunting/ poaching and other human disturbances caused the shrinking of wildlife distribution. Various issues/ problems (e.g. social, environmental, managerial) were imbedded in institutions, local communities, forests and wildlife. In addition, climate change, forest encroachment, road traffic and direct human/ livestock disturbances are major hindering factors for forest restoration and wildlife conservation. To address these barriers, various programs are being implemented. As the coordination among institutions and the monitoring of these programs is weak, implementation of restoration is ineffective.

8.2.4 Tiger as the Forest Restoration Success Indicator Species

Forest regeneration (i.e. sapling and seedling) was lower in Balapur CF, and the disturbance on vegetation was higher in comparison to other forests (Ranjha Buffer Forest (BF) and Gauri Community Forest (CF)). Forest quality was also lower in the community forests of Banke National Park than Bardia National Park. Pellets of tiger prey species were less in Banke. Most of the species were wild boar and a few deer species. The presence of prey species is not related significantly with the forest quality and distance from the management authority. The tiger dispersal behavior more distant in the Balapur area than in Gauri and Ranjha and there was seasonal movement (June to August) due to anthropogenic disturbances. The number of

tigers was decreasing and dispersal was limited, which indicate that the forest habitat restoration was ineffective in Balapur, Banke National Park although the habitat in community forests have been restored. The sustainability of tiger conservation is influenced by forest quality, prey species abundance, connectivity, size of the habitat and anthropogenic disturbances. To address these elements, a tiger strategy plan was formulated, however, the implantation was ineffective and the focus was made on biological than the socio-economic factors.

8.2.5 Synthesis

Forest Habitat Restoration: Sustainability and Impact on Tiger Conservation

Forest has been restored outside the Bardia and Banke National Parks and provided habitat for wildlife after 2000. Forest management plans were prepared, community people participated in restoration interventions such as thinning, plantation, control grazing, etc. for forest restoration, and government and non-government organizations assisted in these restoration activities. Nevertheless, the forest regeneration was lower and vegetation disturbances were higher in and around the Banke National Park. Besides this, climate change, infrastructure development (e.g. road, irrigation canal), anthropogenic disturbances such as encroachment, logging, hunting, fodder collection, livestock grazing, etc. hinder the restoration of forest and wildlife conservation.

The quadrat/ track surveys and observations evince that there was a low important value index of plants, minimal abundance of tiger prey species and tiger dispersal has reduced in Banke National Park. The restored forest has again been deforested in some areas (e.g. Majatol in Ranjha) due to the fear of wildlife disturbances such as loss by crop damage and threats to human life. These disturbances, lack of/ insufficient compensation and low awareness impelled a negative attitude. Due to these cases, the majority of the people were more negative toward wildlife, particularly tiger and its prey species, in Balapur than Ranjha. The monitoring of programs and coordination among organizations is weak. As a result, illegal activities such as logging and poaching are prevailing at the local level. Hence, the sustainability of forest restoration is being challenged and the persistence of tiger is uncertain in and around Banke National Park. Nevertheless, improvement of the situation after the establishment of a fully functioning national park authority is anticipated.

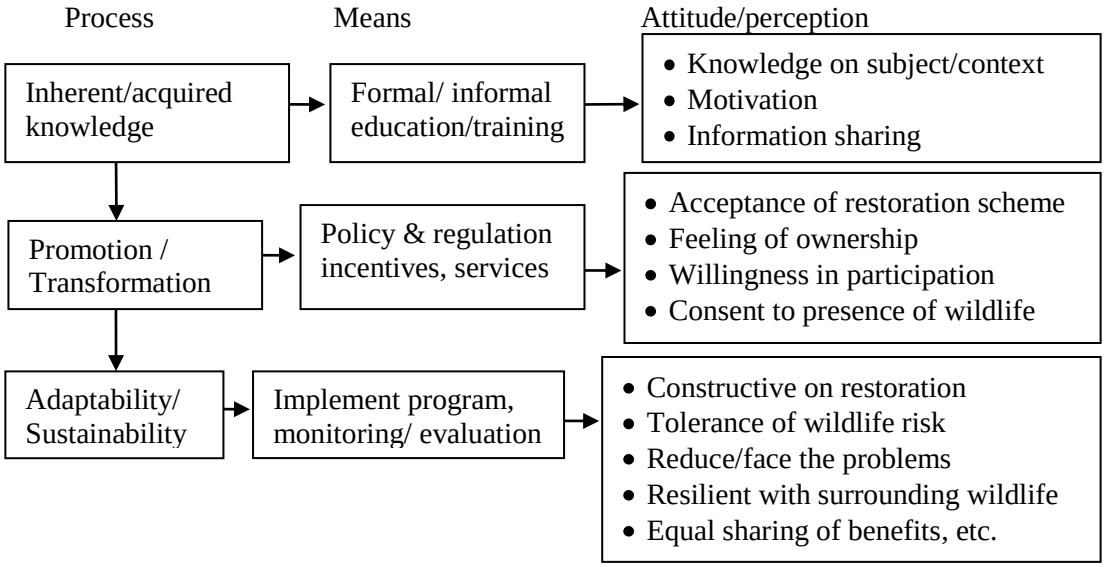
8.3 Implications and Recommendations

8.3.1 Conceptual Implications

8.3.1.1 Transformation of Attitude/ Perception towards Restoration

Priority has been given to education, training and social development in order to change the attitude and perception in both villages. However, attitude of some community people is still negative toward wildlife conservation. To reduce wildlife disturbances, responsible institutions should make efforts to address the issues of vulnerable people residing in intact forest. The government should formulate appropriate policy and regulations, institutions should provide incentives, technical and financial support for their livelihoods, and educational programs. At the same time, people should have the willingness to participate and accept the existence of wildlife in and around the community forests. The main issue here is how people adapt themselves in this situation and how the resources can be sustained at the local level. For this, at least three programs should be launched with their focus on restoration and changing the attitude and perception of community people. This might motivate locals to restore forest and wildlife, accept the challenges, tolerate wildlife risk to some extent, solve the problems and share the benefits of forest equally (figure 53.8). A positive attitude and constructive perception among community people will contribute in sustaining forest resources.

Figure 53.8 Process/steps for attitude/perception change

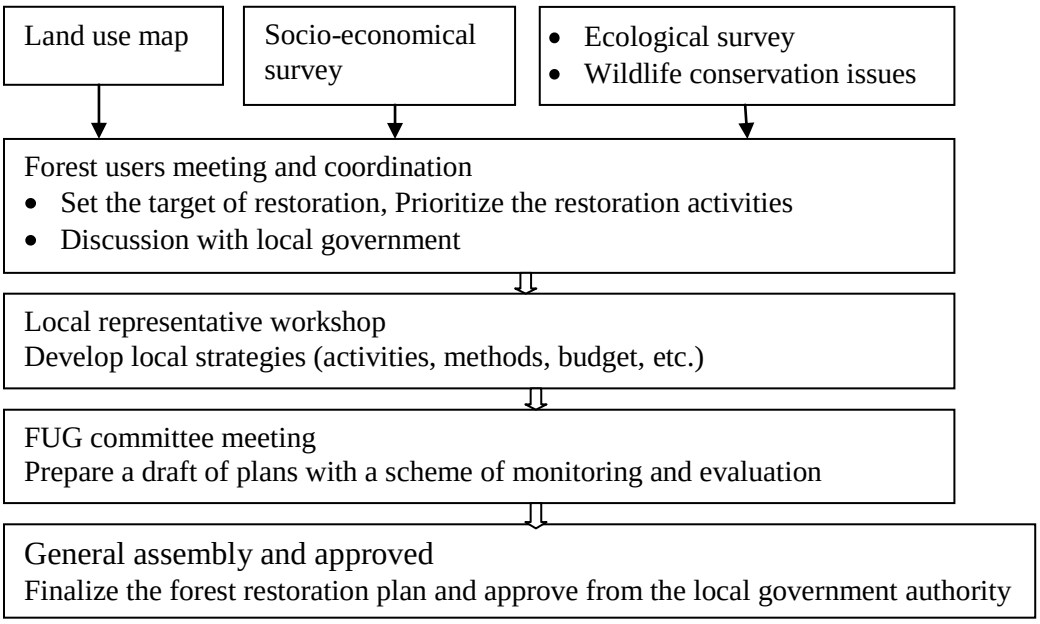


Source: Researcher's construction

8.3.1.2 Forest Management Planning Focusing on Restoration

The approach was participatory in forest management planning but it was inadequate for restoration. Consultation and interaction with forest users was not enough, which is most important. The forest users should be involved from the beginning of restoration planning so that scientific knowledge and local knowledge can be integrated in the plan (figure 54.8). Awareness raising and education campaigns should be conducted prior to the planning and there should be the selection of a representative from each tole (at least one member from 15-25 households). These representative members will inform other households and collect their views. The workshop or meeting should be conducted to include experts, local representatives and Forest User Group Committee Members and prepared the draft plan which will be presented in the general assembly. Hence, plans should be formulated by the forest users themselves. This will create the feeling of ownership instead of being prepared solely by the committee or outside experts. The plan should also include the target of restoration, regular monitoring and final evaluation schemes.

Figure 54.8 Steps of participatory forest restoration planning



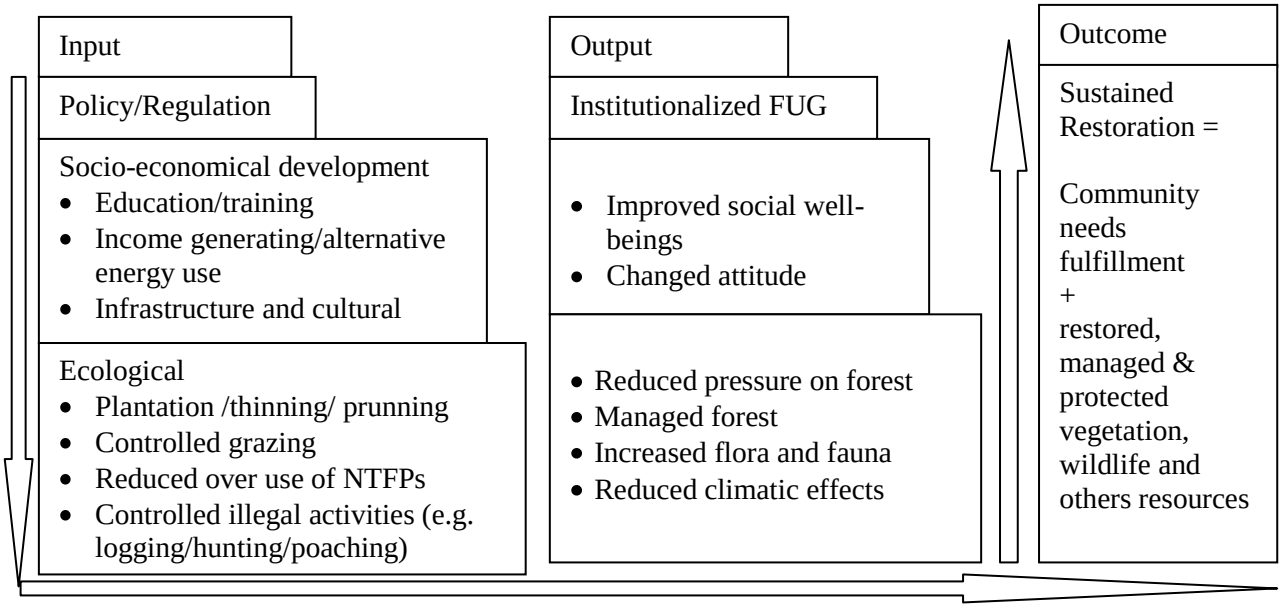
Source: Researcher's construction

8.3.1.3 Interventions and Sustainability of Restoration

Community people are practicing different restoration activities and various institutions/ organizations are advocating for the appropriate policy and regulations. Various educational and social development activities and forest management programs were being carried out, nevertheless, it did not work as was expected. After the democratic movement in 1990s, a good initiation was taken in policy making (e.g. Forest Act 1993, Community Forest Regulation 1995). Despite this high degradation of forest resources and loss of wildlife species occurred during the decade of the late 1990s and 2000 due to political instability, social conflicts, lack of clear vision of policy makers, weak government and climate change. The degradation might continue during the decade from 2010 onward too for the same reasons. Moreover, the existing issues of federalism, new constitution and unsolved social problems such as poverty, unemployment, corruption, etc. can worsen the situation. The decade of 2020s can be considered hopeful if there is positive change in development and conservation endeavors. This may be possible because the current young generation have a more positive conservation attitude and will have the political and administrative power. However, by then, it could be too late and restoration of forest and wildlife could be difficult and costly from all aspects.

Hence, a long term (at least 30 years) plan to restore, manage and protect forest and wildlife is urgent. Appropriate policy and regulation should be formulated and social development and ecological programs should be launched as inputs. From these efforts, some positive changes such as the formation of Forest User Groups running with their own rules and regulations (i.e. institutionalization), good cooperation with different ethnic people and networks with institutions (i.e. social capital), changed attitude of community people, wise use of resources, proper management of forest, increased forest density and wild animals and application of some mitigating measures of climate change (e.g. used alternative energy, plantation) could be observed as outputs. To sustain the resources, forest and social needs of the community should be fulfilled, forest resources should be restored and protected, and wildlife should be conserved. These effects are the outcomes. When the inputs are increased, automatically the outputs and outcomes will increase (law of equilibrium) and the possibility of sustainability of restoration is higher (figure 55.8).

Figure 55.8 Interventions and sustainability of forest restoration and wildlife conservation



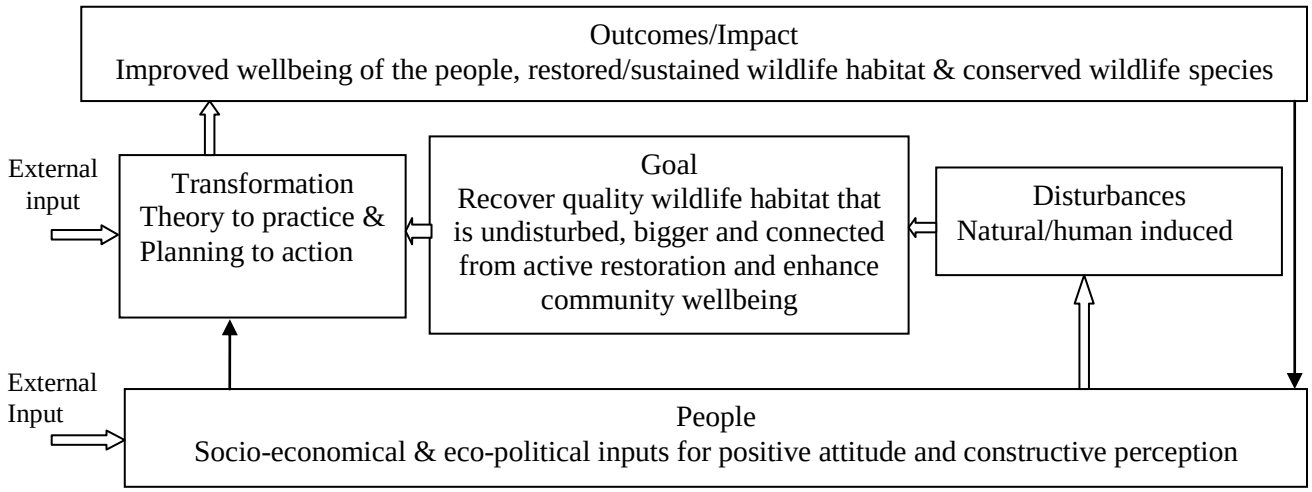
(Note- arrow pointer shows the higher value) Source: Researcher's construction

8.3.2 Pragmatic Implication for Tiger Conservation and Conceptual Framework

Various research has been conducted, and action plans and strategies have been formulated and implemented at local level for forest management and tiger conservation. The attitude of some community people was negative toward authority and wildlife. They felt that the attitude of the government authority is more toward controlling and mastery, rather than providing services and being cooperative. The social-economic improvement and appropriate incentives will change the attitude of people toward wildlife particularly tiger, this requires direct funding and programs to vulnerable communities. The attitude of community people and government authority should be changed as well. The plan should address the welfare of the people and programs should be implemented effectively. Hence, participatory planning should be prioritized thereby controlling the anthropogenic disturbances for tiger conservation.

From the findings and ancillary sources, the conceptual framework provided in chapter II (figure 14.2) of the present research can be reformulated in a simpler form through the reduction of the components (figure 56.8). The attitude and perception of community people will change through the application of various external and internal inputs, tracing out the natural or manmade disturbances, setting a main restoration goal, and preparing a plan and implementing it in order to achieve the desired outputs/ outcomes. Based on this concept, I have built up a concept of integration of restoration ecology and sustainability science.

Figure 56.8 Conceptual framework (Revised)



Source: Researcher's construction

8.3.3 Recommendations

8.3.3.1 Policy Makers and Planners

The Local Self-Governance Act (LSGC-1999) has decentralized power to local government body i.e. Village Development Committees (VDCs) and District Development Committees (DDCs) for planning, resources, management, etc. But the plans on the forest sector are prepared by the range post and the district forest offices and are submitted to the DDC council as a formality.The Forest Act (1995) has given authority to the Forest User Group Committee. The authority has been misused by some committees causing heavy deforestation due to the poor monitoring system or involvement of the foresters. This calls for the amendment of policy itself. The Forest Master plan (1989) was terminated in 2010 and the government tried to amend forest regulation in 2011, which has been opposed by some of the unions within the government institutions. In practice, effective coordination between various actors does not exist although a District Forest Coordination Committee has been formed in Terai districts at local level. Action plans on the forest sector and wildlife species have been prepared by experts or high level government and non-government officials, but there is less participation of community people in this process. Hence, the policy should be amended, sectoral plans should be integrated, and the participation of actors including community people should be enhanced in the planning process. Furthermore, extensive land use planning and formulation of a long term strategy of restoration and use of natural resource is essential in the Terai landscape.

8.3.3.2 Practitioners

Community based organizations and CFUCs have emphasized more on the direct economic return from forest and have undermined the ecological and conservation value. Forest users and managers should also consider this value during local planning and implementation of the programs and change their attitude for rational use of resources. Before 2010, they had given more priority to forest management than conservation and less priority to restoration i.e. **MANAGEMENT-Conservation-**restoration. Now, it is the time for prioritizing restoration of forest, firstly due to high degradation, then management and conservation i.e. **RESTORATION-Management-protection,** but concurrent programs are needed.

8.3.3.3 Researchers

The present research focuses on the general restoration process and has evaluated it only in terms of sustainability and impact of various cross-cutting issues. Some of these issues are required to be researched in detail, which are as follows:

- Detailed research on anthropogenic disturbances (e.g. excessive forest use, fire) and natural disturbances like climate change in forest restoration.
- To understand the extent of undisturbed, connectivity, size and quality of habitat for tiger conservation, further detail research is recommended.
- I recommend research on socio-economic constraints for restoration and efficiency of forest restoration programs, which is crucial for the sustainability of restoration and wildlife conservation.

8.4. Integrative Perspective of Restoration Ecology and Sustainability Science

8.4.1 People: Psychology in Restoration

People can play an indispensable role in active restoration. But they should know how to restore renewable resources. Before this, they should also understand why restoration is important. However, it is a measurable question ‘would people take risk from wildlife?’ From the statement *“government does not need people, so it prefers wildlife”,* expressed by the residents when the government declared Banke National Park in 2010, we can guess their

attitude. Furthermore, they perceived that *"when the forest is restored, wildlife will increase and it will destroy our crops, kill our livestock, and threaten us too".* Hence, it is essential to change such types of attitudes and perceptions in a positive and constructive manner.

From the insight of 'moral attitude positivism', the changing of attitude is moral and law (Holton 1998), and attitude is the ideological criticism of work that analyzes it to relate the surrounding society (Olsen 2008). Positivist has the characters that are "an allegiance to complete knowledge and understanding, and include risks, ventilation and inclusive in discussions" (Elzinga 1997, c.f. Turner 2005:169). However, in practice it is hard to find such positivist in society due to weak social structure (e.g. execute of law) and lack of education. After post-positivism and modernization, some people have the feeling that poverty and lack of awareness create negative attitudes. But locally rich and educated people have negative attitude toward wildlife whereas some poor and illiterate people are positive in the study area.

Political decision is criticized by the opposition group in society and they do not think of the 'rule of law' or community law. For instance, the Terai forests were a safe home to wildlife before the 1960s. After this, clearing of forest for settlement took place. The government formulated rules and implemented then through the community to control such illegal activities. But it did not work properly even though forest rules and regulations were executed. Hence, the changing of attitude is not only due to morals and law, but also from the family, i.e. where it is located, how it is formed and how it is run, etc. The family group makes up a community and functions as per the rules of the community or state law /regulation. Development of a personal attitude is influenced by family members, surrounding community or personal access to the community, resources used, and source/ level of information (table 29.8). For instance, people who live closer to the forest, are in need of more forest products and disturbed by wildlife will have a more negative attitude toward wildlife than other distant residents. Those who are educated and have a higher excess of resources (e.g. income) can migrate to a safe place and have a positive attitude toward restoration and wildlife. Persuasion is vital to change attitudes in the desired direction, which is possible only in special situations (i.e. proper coordination among recipient, source of information and context) (Brinol et al. 2009), and will also depend on the availability of resources and the way of executing the law. Hence, attitudinal change is influenced by the community structure and function.

Table 29.8 Possible altering factors of attitude with available of resources and information

Family member	Local resource	Community rule			
Family member	Com. member	Local resource	Local inf./law		
Family member	Com. member	Local resource	Local inf./law	Nat/int. inf.	
Family member	Gr. of com. member	Local resource	Nat/int. inf./law	Nat. resource	
Family member	Multi-com. member	Nat. resource	Nat.inf./law	Int.inf.	
Family member	Multi-com. member	Nat. resource	Nat. inf./law	Int. inf./law	Int. resource

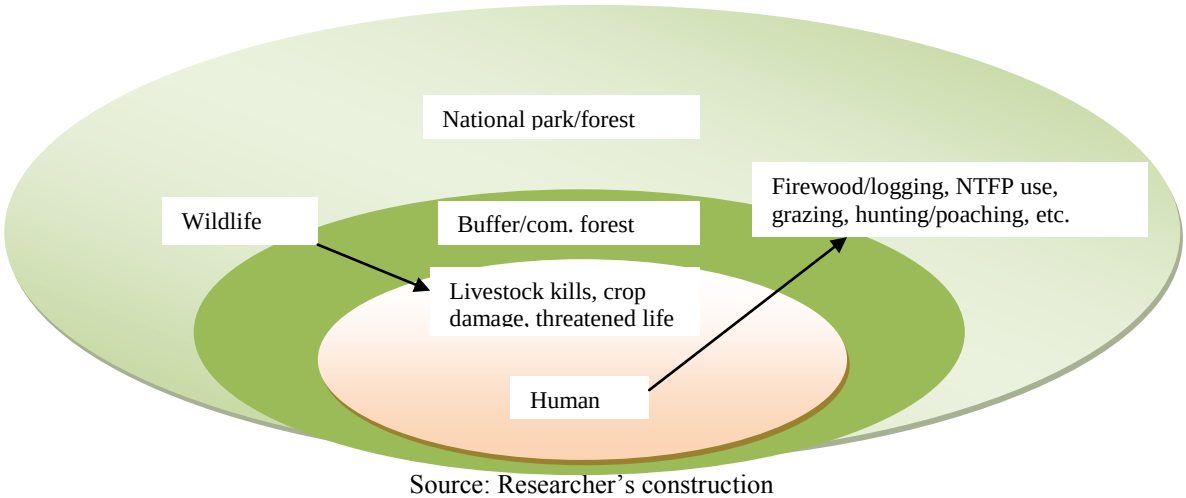
Source: Researcher's construction (Note- com.- community, Gr.- group, inf.- information, Nat.- national, Int.- international)

Perception starts from objects and further explains in the mind (Olsen 2008). The thinking on such object 'constructs a concept of knowledge' (von Glasersfeld 1990). Hence, perception is the way of receiving information and constructing and deciding psychologically. Psychology is used here to link biological and social aspects to establish attitude and perception. In practice, the performance of cordiality, consultative expression, interactive role for altering any action, etc. are taken as the view of constructivist. But this cognitive perception is also determined by the usefulness or harm of entities. If it harms personal or social life, he/ she will perceive it in a destructive way and will try to avoid/ ignore or purge it. Hence, the attitude and perception is the prominent element for sustainability of restoration and conservation.

8.4.2 Resilience: Disturbances in Restoration

In resilience, an ecological system has the capacity to recover from disturbances (Holling 1973). However, at present it is not only applied in ecological systems, but also used in other areas such as economics, politics, mathematics, etc. (Walker et al. 2002). Natural and anthropogenic disturbances play major roles to alter the composition of ecosystems and their functioning (Hobbs and Huenneke 1992). In and around the protected areas both human and wildlife are disturbed by each other. Natural disturbances such as climate change, flooding, soil erosion, etc. are the barriers of forest restoration where succession will occur from it. Other barriers such as firewood, leaf litter and non-timber forest products (NTFPs) collection, livestock grazing, logging, poaching, fire, infrastructure development, etc. are anthropogenic. Community people are also disturbed by wildlife as it kills livestock, damage crops and threaten social life (figure 57.8). Vegetation is restored through human interventions and life of vulnerable people will recover from the changing social management systems.

Figure 57.8 Human disturbances in forest and wildlife disturbances in human settlement



Source: Researcher's construction

Those areas which are surrounded or adjoining the forest are more disturbed by wildlife. Likewise, communities with insufficient forest products will disturb national park/ forest and wildlife habitats, where activities like livestock grazing and other human activities take place. Hence, resilience is used both in social and ecological arrays and disturbances should be considered in ecological restoration.

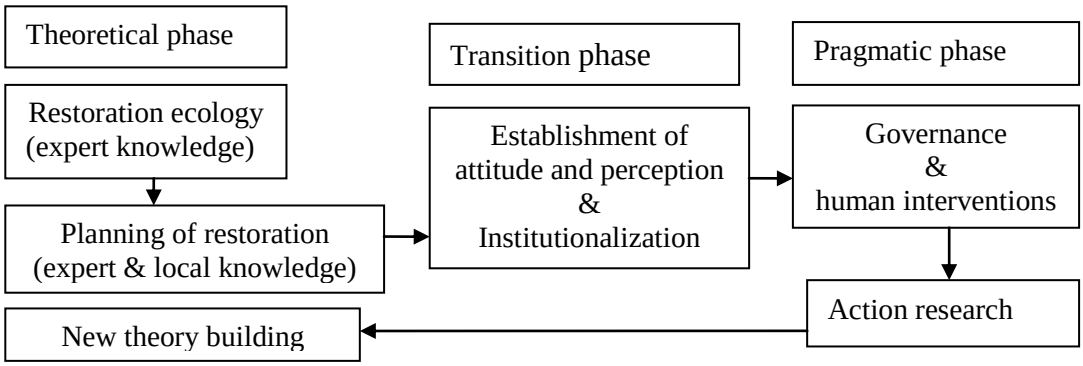
8.4.3 Transformability: Pragmatism in Restoration

Ecological restoration is the applied science of restoration ecology. For its practice, it requires different actors from planning to action. It also needs knowledge and an appropriate situation for transformability and the complexity of the situation should be solved (Walker et al. 2004). They define transformability as "the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable". It is used in the ecological, social, economical areas in various ways. Olsson et al. (2004) divide it into three phases i.e. preparing the system for change, seizing a window of opportunity and building socio-ecological resilience of the new desired state for social-ecological transformation.

The youngest subject, habitat restoration, is still in developing or is in an immature stage. It is a part of socio-ecological systems where pragmatic action is in the core of restoration. Pragmatism accentuates the "importance of the research questions, value of experiences, and practical consequences, action, and understanding of the real world phenomena" (Creswell 2011:276). Hence, transformation of expert knowledge to pragmatic action through local actors

is complex for restoration practitioners. It can be divided into three phases i.e. knowledge, transition and pragmatic. In the first phase, the restoration plan is prepared on the basis of scientific ecological theory. The environment is created for the implementation of restoration programs by training implementing organizations, educating community people, and formulating a local committee of user groups in the second phase. In the final phase, the actions like empowering organizations, extending networks, restoration practices, monitoring and evaluation, etc. along with action research will be conducted. After the implementation of programs, impacts on the social, economical and ecological arena will be assessed and new concepts will be formulated or the old ones will be modified. Then, and the same process will be restarted (figure 58.8) to transform expert knowledge to pragmatic action in other fields.

Figure 58.8 Transformability for restoration



Source: Researcher's construction

8.4.4 Sustainability: Indicator Species in Restoration

It is hard to restore ecological elements, harder to sustain the restored components and harder still to conserve endangered wildlife species due to natural and anthropogenic disturbances. Sustainability science deals with the resolution of the issues/ problems for balancing ecological systems (Clark and Dickson 2003), which is important for solving human and natural disturbances. If the restoration vision or target is conservation, the sustainability of the species is important. It is essential to find out the indicator species since the monitoring and evaluation of the whole ecosystem or all species is difficult. The indicator species may signify environmental conditions (Block et al. 1987) or the health of an ecosystem (Simberloff 1998). The tiger is an umbrella species in conservation that indicates the health of forest ecosystem, and is useful as the restoration indicator species. Such types of species are crucial for ecologists and forest managers for sustainable forest management and conservation at the landscape level (Lindenmayer et al. 2000). It will be applicable for maintaining connectivity

and structural complexity of forest landscape (Lindenmayer et al. 2006). For maintaining these attributes, human intervention is imperative. Hence, indicator species and sustainability of the forest have a close interrelationship in the socio-ecological system. The restoration will be sustained when the anthropogenic disturbances are controlled and some remedies of natural disturbances are applied. Indicator species, particularly mega faunal species (e.g. tiger), will be conserved when the quality of habitat is maintained through connectivity and the extension of habitat beyond the protected areas. The inputs in the social and ecological systems should be increased and the well being of community people should be enhanced for the sustainability of restoration (figure 55.8).

8.5 Summary

The research was conducted by using a 'mixed research method' (i.e. qualitative and quantitative) since the study covered both the social and ecological array. Findings of different data sources i.e. interviews, observations, surveys and ancillary were triangulated in order to make the results more reliable and valid. The same questions and methods were used in two buffer villages where attitudes and perceptions differed, due to variations in perception of different groups of people and social status and influencing factors such as education, economical factors, occupation, etc.

The forest management plan had been formulated and implemented for some restoration activities such as thinning, controlled grazing, awareness, etc. The forest areas had been restored outside the protected areas and the population of some wildlife species (e.g. wild boar, common leopard) has increased. In spite of this, tiger dispersal and numbers have shrunk due to human disturbances and low prey species abundance in Banke National Park. For the sustainability of tiger conservation, conservation strategy should not only focus on the biological factors such as habitat, prey species, demography, etc. but also should address socio-economic changes of the community people. Attitude and perception should be changed in a positive way to support the restoration and conservation constructive. For resolution of human-wildlife conflicts, participatory planning should be enhanced, specific restoration programs should be implemented effectively, quality of forest habitat should be maintained and indicator species should be monitored. A new approach, 'integrative perspective of restoration ecology and sustainability science' has been introduced by integrating social and ecological science for sustainable forest restoration, conservation of wildlife and enhancement of people's wellbeing.

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Annexes

Procedure

Rapport building/establishment: Good morning/afternoon/evening. I am Ramji Bogati, a PhD student in the Department of Spatial Planning, TU Dortmund. In my research, I will ask the people of the Terai landscape or those who are related to it, how they are restoring forest habitat and conserving wild cats particularly the tiger. This information is very important for conservation planning as well as scientific researches.

Your answer is vital to this PhD research because it represents hundreds of other which are not in my sample. The information provided by you will not be used for any other purposes other than the academic and it will be kept confidential. Furthermore, your name will be in no way connected to the finding of this research. (I used same procedure to conduct each interviews, questionnaire and household surveys for the purpose of my research).

Annex i. Questionnaires for rapid rural appraisal

Name of the respondent: Address:

Occupation: Age:

1. How many forests are located nearby this community?.....
2. Do you know the name of community forest that belongs to this village? Yes/No
3. Do you know any restoration activities that are being done in this forest? Yes/No
4. Do you participate in the restoration of forest? Yes/No
5. Do you know the kind of animals that are found in this forest? ……
6. Have you seen any ungulates (deer sps.)? Yes/No
    a) If yes, what, when, where, and how many have you seen?.....
7. Do you think that there are tigers/leopards in this community/buffer zone? Yes/No/I don't know
    a) If yes, how many tigers/leopards are there?.....
8. Have you seen pugmarks or any other signs? Yes/No
9. Have you seen tiger/leopard in the area? Yes/No
    a) If yes, how many times and when?.....
10. Are they just visitors (V) or permanent residents (PR)? V/PR

11. If visitors, where does the tiger come from and go to?

    a) From and to the national park b) From and to the National Forest c) From and to the Indian border d) Others

12. Why don't the tiger/leopard stay for a longer time in this area?

    a) Human disturbance b) lack of suitable habitat c) lack of prey species d) others

13. Do you know any death/killing of tiger/leopard/ other wild animal? Yes/ No

    If yes, what/when/where did it happen? …….

14. Did the tiger/leopard kill any livestock in this area? Yes/No

    If yes, what/when/where did it kill?.....

15. How did you know when the tiger killed your livestock?

    a) Seen b) presence of pugmarks c) big holes on throat d) other signs

16. Have you seen or heard any incidents of human attack by the tiger/leopard? Yes/No

    a) If yes, when and where did it happen?.....

17. Do you have any other problems due to these wild animals?

    …….

18. Would you like to make any more comments on the restoration and tiger conservation?

    …….

Thank you

Annex ii. Interview guide for the key informant

Interview no.: Date:

Office: Address:

Name of the respondent: Designation: Sex:

1. What is your/organization's role in order to restore forest?
2. What sorts of activities are being practiced in forest habitat restoration?
3. In general, who are the actors/stakeholders in it?
4. What type of perception/attitude do these actors have in restoration?
5. What is the level of local community's participation in forest restoration in terai landscape?
6. Do people participate voluntarily? Yes/no/not at all
7. How are they motivated in restoration programs?
8. Do they make the restoration plan by themselves or just implement the plans prepared by other individuals/organizations? Yes/No
9. If yes, how do they make a restoration plan? (please explain briefly)
10. Which are the indicator species in terai landscape?
11. Have you noticed any changes in the status of indicator species after TAL Program?
12. How is the participatory habitat restoration contributing to conserve indicator species in this region?
13. Do you know if the tiger exists in Banke National Park? Yes/No
14. If yes, what are the requirements to have the persistence of tiger in this area?
15. What are the success indicators of forest habitat restoration, considering tiger as the indicator species in landscape, Nepal?
16. How would the restored habitat be sustained?
17. In your opinion, how would the forest restoration planning and tiger conservation strategy be more appropriate?
18. Do you have any comments/recommendations regarding the forest habitat restoration and tiger conservation in lowland Nepal?

Thank you very much

Annex iii. Questionnaires for the member of forest user's group committee

Interview no.: Date: Time:

Town/village: Name of the respondent: Position:

Sex: Age: Occupation:

1. What is the level of your education?

    a. Did not attend school at all b. Vocational training

    c. Primary d. Lower/Secondary/Higher secondary e. University

2. Are you a permanent resident of this area? Yes/No

    a. If yes, how long have you been the resident of this area?

    b. If no, from where and when did you come from and to this village?

Participation and institutionalization

1. What is your role in this forest user's committee?
2. How many members are there in your group?
3. Are all local people the member of this community forest? Yes/No
4. If no, why not?
5. What does this committee do for the members?
6. Are the members participating voluntarily in forest restoration? Yes/No
7. What are the motivating factors for the members to participate in restoration?
8. Do all members have right to participate in decision making process? Yes/No
9. How does the committee make decision to govern forest?
10. Do all members know about the income and expenditure of your organization? Yes/No
11. How do you audit the expenses of this organization?
12. How many times did your organization call meeting last year?

Forest restoration, services and contribution for conservation

1. How did you consider that it is important for you to restore forest?
2. From when did you start to conserve/manage this forest?
3. How did you initiate to restore this forest?
4. What kind of activities are being undertaken to restore this forest?
5. Did you replant new native species? Yes/No
6. How much seedlings have you planted until 2010?
7. Do you have any problems in forest restoration? Yes/No
8. If yes, what are the hindering factors to restore it?
9. How did you tackle it?

10. Does any organization provide support to your community?

    If yes, what kind of support did you receive?

    a) training b) education c) funds e) developmental work f) others. ……

11. Are you using any forest products now? Yes/No

    If yes, what kind of services and goods are the communities getting from it?

    a) fire wood b) timber c) medicine d) water catchment conservation e) soil protection f) wildlife protection

12. Is this forest resource enough for fulfilling the resource needs of members? Yes/No
13. If not, from where are they fulfilling their additional needs?
14. How does the restored forest help to conserve wild animals?
15. What is your opinion regarding the restoration and conservation?

Planning and monitoring

1. Do you make any plans for restoration? Yes/No
2. If yes, do committee members prepare themselves? Yes/No
3. If no, who helps you to do it?
4. How do you design restoration activities?
5. Do you have any conservation measures? Yes/No
6. If yes, how do you incorporate it in forest management plan?
7. Do you have any monitoring measures? Yes/No
8. If yes, what kinds of measures do you apply to monitor forest?
9. How do you decide regarding the use of forest resources?
10. Has the forest area changed since 2001 (within the last 10 years)? Yes/No
11. If yes, what are the changes in the followings?

Particulars	**During 1990s**	**After 2000 (till 2010)**
Forest area		
Plant species		
Wildlife		
Education/awareness		
Participation level		
Income of local people		
Attitude of people		
Other social development		

Attitude toward restoration, wild animal and conservation

1. How important is the forest habitat restoration for you?

    a) very important b) important c) not important d) not important at all e) unable to answer

2. How important are the wild animal for you?

a) very important b) important c) not important d) not important at all e) unable to answer

3. Do you agree that the tigers/leopards live in this forest?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer
4. Do you agree that the ungulates live in this forest?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer
5. Do you agree that the number of tigers has increased after restoration in this forest?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer
6. Do you like tiger?
   a) like very much b) like c) don't like d) don't like at all e) unable to answer
7. Do you like ungulates?
   a) like very much b) like c) don't like d) don't like at all e) unable to answer
8. After the restoration, tiger population will be increased in this forest. If it kills your livestock or attacks you, what will you do?
   a) I will not do anything b) I will request for compensation c) I will make it run away d) I will kill it e) I don't know
9. Do you agree that you will support to protect wildlife in this area?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer

Thank you

Annex iv. Questionnaire for the drivers/people living alongside the road

Interview no.	Date:
Name of the respondent:	House/vehicle no.
Sex:	Age:
Occupation:	Education:

1. How long have you been the resident/driver in this area?.....years
2. Do you know that the tiger/leopard live in this forest? Yes/No
3. Have you seen or heard any wild animal crossing the road? Yes/No
4. If yes, which animal have you seen?
    a) Tiger/leopard b) ungulates c) small animals e) others (reptiles) d) not any animal
5. If No, why didn't the animal cross this road? Due to:
    a. road traffic b) wide road c) no animal in this area d) other…….
6. Have you had or heard any kind of accidents due to wild animals? Yes/No
7. If yes, when and where did it happen? .....
8. Do you think that this road disturbs the tiger in this area? Yes/No
9. If yes, how does it disturb? .....
10. In your opinion, how can this road disturbance for wildlife be reduced?

Thank you

Annex v. Questionnaire for household survey

General information:

Interview no.:	Date:
Time:	Town/village:
Name of the respondent:	House no:
Sex:	Age:

Occupation:

1. What is the level of your education?
   a. Did not attend any school at all b. Vocational training
   c. Primary d. Lower/Secondary/higher secondary e. University
2. Are you the permanent resident of this area?
   a. If yes, how long have you been the resident of this area?
   b. If no, from where and when did you come from to this village?

Participation and Perception

1. Are you a member of any organization related to forest and conservation? Yes/No
   If yes, which organization and since when are you a member?
   If no, why didn't you become a member?
2. If you are a member, do you participate in the meetings of this organization? Yes/No
3. How often do you participate in the meetings of this organization?
   …… times a year, …. a month, every week,
4. Do you take part in any kind of restoration activities? Yes/No
   If yes, what kind of work did you do to restore forest in the past years?
5. Do you know about all the restoration activities undertaken by the forest user committee? Yes/No
6. Do you participate in the decision making of forest restoration? Yes/No
   If yes, how do you approach in decision making process?
7. Why are you motivated to restore forest in your area?
8. Do you get any goods from the forest after the restoration? Yes/No
   If yes, what do you get from it?
9. Is this forest sufficient to fulfill your forest needs? Yes/No
   If not, how do you fulfill it?
10. What changes have you seen around your house since 2000 (in the last 10 years)?

11. Are you a victim of any wild animals after the forest restoration? Yes/No
    If yes, which wild animal gives you more trouble?
12. What would you do if the wild animals damage your crops?
13. Would you like to make any suggestions regarding the forest restoration, and wildlife conservation and management?

Attitude toward restoration, wild animal and conservation

1. How important is the forest habitat restoration for you?
   a) very important b) important c) not important d) not important at all e) unable to answer
2. How important are the wild animals for you?
   a) very important b) important c) not important d) not important at all e) unable to answer
3. Do you agree that the tigers/leopards live in this forest?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer
4. Do you agree that the ungulates live in this forest?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer
5. Do you agree that the number of tiger has increased after restoration in this forest?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer
6. Do you like tiger?
   a) like very much b) like c) don't like d) don't like at all e) unable to answer
7. Do you like ungulates?
   a) like very much b) like c) don't like d) don't like at all e) unable to answer
8. After restoration, the number of tigers will increase in this forest. If it kills your livestock or attacks you, what will you do?
   a) I will not do anything b) I will request for compensation c) I will make it run away d) I will kill it e) I don't know
9. Do you agree that you will support to protect the wildlife in this area?
   a) strongly agree b) agree c) disagree d) strongly disagree e) unable to answer

Thank you

Annex vi. Form for direct observation

Serial number: Date:

Name of the observer: Survey area address:

Observed time:

Site information

- Name of the habitat or forest area:……..
- Distance from the human residence: ……..min walk/GPS location…

For Human (in number)

- In/ toward the forest: male……female……..child……
- Out/ from the forest: male…….female……..child……
- What do they carry or bring with? ……
- Purpose:……..
- (It will be verified at the end, if it is necessary), why did they go and how many hours did they spend inside the forest?

For Livestock (count in number)

- In/ toward the forest: cow/ox……buffalo……goats and others……
- Out/ from the forest: cow/ox……..buffalo……goats and others……

Other remarks or notes: ……

Annex vii. Form for faunal survey

Observation no: Date:

Name of the observer: Survey area:

Observed time: Tools: Quadrat/ track survey

1. Site information

i. Name of the habitat or forest area:……..
ii. Distance from the human residence: ……..min walk/GPS location…
iii. Location: Footpath/ dusty road/ streambeds
iv. Habitat type: Grassland/woodland/riverbeds
v. Surface condition: Soil type: sandy/loam/ clayey
vi. Texture: Fine /medium/ coarse
vii. Moisture level: Moist/wet/slushy

2. Specific sign:

i. Pugmark/pellet: Size: length……..breadth/number……
ii. Kills:…….day(s)/month old
iii. Scratches:……on tree/ground
iv. Fecal matter:…… day(s)/month earlier
v. Other signs:……..

S.N.	Name of the animal	Pugmark/Pellet	Remarks

Annex viii. Livestock kills recording form

Date:

Name of the observer:

1. What did the wild cat (tiger/leopard) kill?
    a) Cow/buffalo b) goat/sheep/pigs c) Calf d) others
2. When did it kill?
    Date: Year: Month: Day:
3. Where did it kill?
    a) Jungle/river bed /path b) at shed
4. If it killed outside the house, how far from the village?
    a) Distance: kilometer (s):……b) ….....min. walked
5. Did wild cat eat the entire carcass? Yes/ No
6. If no, where did the wild cat bite, by teeth to carcass?
    a) Throat b) back/shoulder c) others
7. Which part of the killed livestock did wild cat eat?
    a) Back hip c) front leg c) stomach d) others
8. Were the kills dragged on ground? Yes/No
    If yes, how much: meter(s)…….
9. What did you do the remains of carcass?
    a) Brought at home b) left c) buried d) other
10. How many people went to see the carcass? ……..
11. How did you confirm that the killer is a wild cat?
    a) Presence of pugmarks b) saw tiger/leopard c) other
12. Name of the owner of the killed livestock?
    Name: …….Village: …….Ward no. …….District……

Annex ix. Form for floral survey

Survey no: Date:

Name of the observer: Survey area:

Time: Quadrat size:

1. **Site information**
   i. Name of the habitat or forest area:…….
   ii. Distance from the forest edge: ……..min walk/GPS location……
   iii. Location: nearby footpath/ dusty road/ streambeds
   iv. Habitat type: Grassland/woodland/riverbeds
   v. Surface condition: Soil type: sandy/loam/ clayey
   vi. Texture: Fine /medium/ coarse
   vii. Moisture level: Moist/wet/slushy

2. **Specific records**
   i. Plant: Seedling (number and name)…….
   ii. Damage vegetation: Condition (number and name)……
   ……..…….……

S.N.	Name of the Plant	Diameter	Condition	Remarks

Annex x. Community forest affiliated with Khata CFCC, Bardia

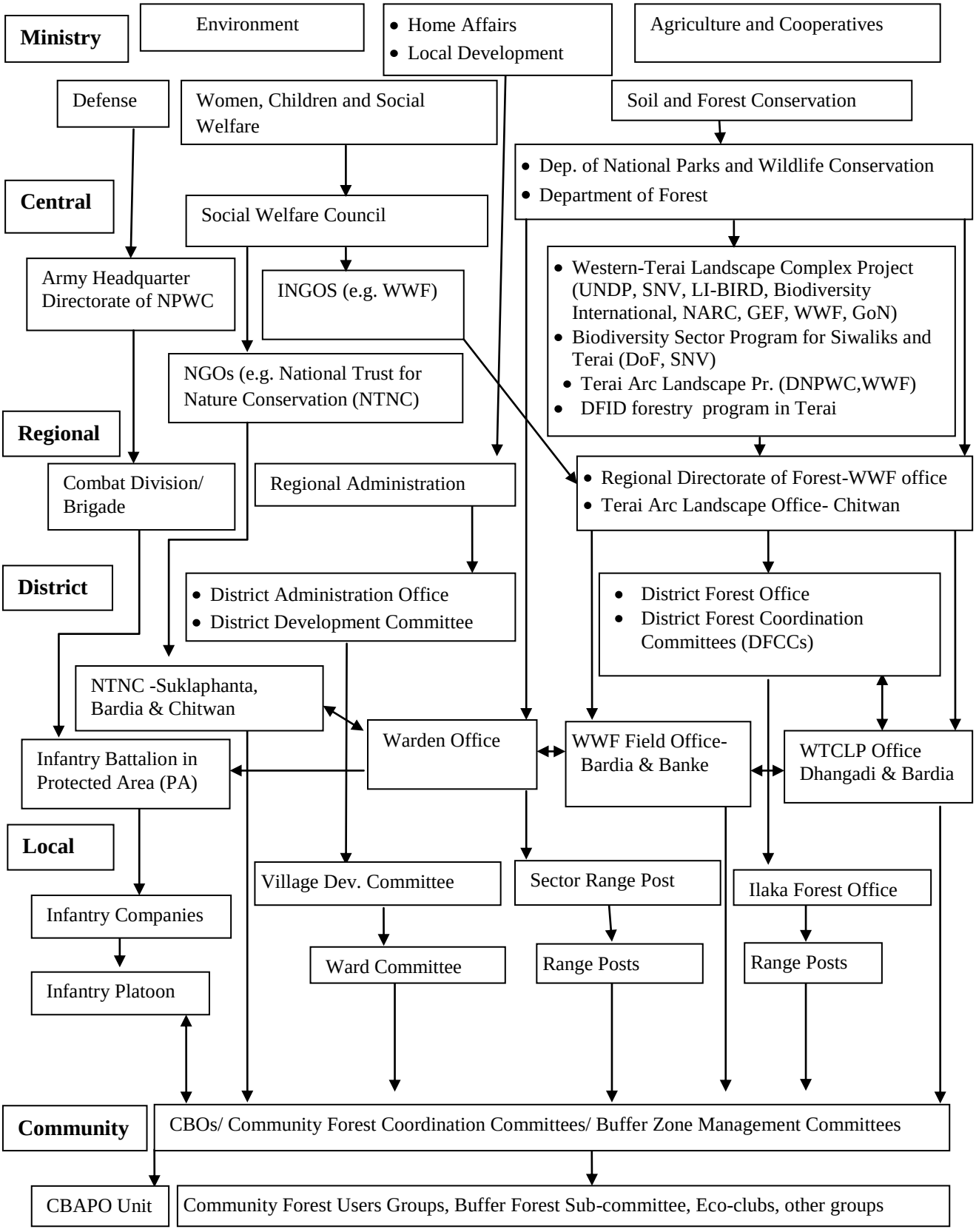
SN	CF name	Address	Registration date	Area (Ha)	Household	Population		
						Female	Male	Total
1	Amar Mahila	Suryapatuwa-6	started CF in 1997 supported by TAL since 2002	178.5	144	382	404	786
2	Balkumari	Dodari-9		26	102	347	393	740
3	Beljhundi	Dodari-4		25	85	258	275	533
4	Bhalunibhatuwa	Suryapatuwa-5		128.25	79	296	311	607
5	Chiraute	Sanoshree-7		46.28	219	625	655	1280
6	Dalit Mahila	Dodari-9		27	33	103	132	235
7	Daande	sanoshree-7		44	178	468	477	945
8	Deurali	Dodari-4		22.5	25	66	70	136
9	Durga	Suryapatuwa-4		34.07	36	122	111	233
10	Fardanga	Suryapatuwa-9		174	122	428	460	888
11	Ganesh	Suryapatuwa-8		28.14	75	256	241	497
12	Ganeshpur	Sisiniya-1		139.13	56	322	251	573
13	Gauri Mahila	Dodari-9		48.26	72	266	280	546
14	Geruwa Karnali	Suryapatuwa-3		24	31	90	100	190
15	Janjagriti	Suryapatuwa-7		34	72	169	176	345
16	Jhuriya	Dodari-9		11.37	30	102	108	210
17	Khaireni	Sanoshree-1		21.75	226	788	840	1628
18	Kotiyaghat	Dodari-9		25.8	30	96	94	190
19	Kusminiya	Suryapatuwa-6		52.4	144	382	404	786
20	Madhuban	Dodari-8		27.5	45	137	140	277
21	Mahila Laxmi	Suryapatuwa-7		9.68	86	311	364	675
22	Orahi	Suryapatuwa-4		66	175	665	623	1288
23	Oralibazaar	Suryapatuwa-7		30.62	37	87	87	174
24	Patbhui	Suryapatuwa-4		47.5	97	348	377	725
25	Pragatisil	Suryapatuwa-1		31.5	80	312	335	647
26	Lalai	Suryapatuwa-6		43.17				
27	Sagun	Suryapatuwa-6		144.75	106	402	384	786
28	Samjhana	Dodari-9		54	45	133	155	288
29	Shiva	Suryapatuwa-4		103.43	89	311	302	613
30	ShreeKrishna	Sanoshree-8		61.5	310	853	832	1685
31	Sirjansil Mahila	Dodari-9		22	33	134	162	296
32	Somalpur	Suryapatuwa-2		113	163	535	566	1101
33	SonahaPhanta	Suryapatuwa-9		105.79	80	284	321	605
34	Teparital	Dodari-4		42.5	132	490	452	942
35	Uttarkausal	Dodari-9, Religious ban		5.9	100			

Source: CFCC, Khata, Bardia

Annex xi. List of plants

S.N	Family	Local name	Botanical name
1	Anacardiaceae	Bhalayo	*Semecarpus anacardium* L.
2	Anacardiaceae	Pyar (Piyari)	*Buchanania latifolia* Roxb.
3	Burseraceae	Dabdabe	*Garuga pinnata* Roxb.
4	Combretaceae	Asna	*Terminalia tomentosa* Roxb. Weight and Arn.
5	Combretaceae	Saj	*Terminalia alata* Heyne ex Roth.
6	Combretaceae	Barro	*Terminalia bellirica* (Gaertn.) Roxb.
7	Combretaceae	Harro	*Terminalia chebula* Retz.
8	Depterocarpaceae	Sal	*Shorea robusta* Gaertn.
9	Dilleniaceae	Agai	*Dillenia pentagyna* Roxb.
10	Ebenaceae	Tidu	*Diospyros tomentosa* Roxb.
11	Euphorbiaceae	Sidure, Rohini	*Mallotus philippiensis* Muell. Arg.
12	Euphorbiaceae	Amala	*Phyllanthus emblica* L.
13	Gramineae	Bans	*Dendrocalamus sp.*
14	Leguminosae	Khayar	*Acacia catechu* (L.) Willd.
15	Leguminosae	Sisau	*Dalbergia sissoo* Roxb. Ex DC.
16	Leguminosae	Sadhan	*Desmodium oojeinnensis* Roxb.
17	Lythraceae	Buddhairo	*Lagerstroemia parviflora* Roxb.
18	Lythraceae	Dhairo/Dhauwa	*Lagerstroemia indica* L.
19	Meliaceae	Bakaino	*Melia azedarach* L.
20	Meliaceae	Tuni	*Toona ciliata* M. Roem.
21	Moraceae	Dumbri	*Ficus glomerata* Roxb.
22	Myrtaceae	Amba	*Psidium guajava* L.
23	Myrtaceae	Jamun	*Eugenia jambolana* Lam.
24	Myrtaceae	Camuna	*Eugenia operculata* Roxb.
25	Myrtaceae	Kumbhi	*Careya arborea* Roxb.
26	Myrsinaceae	Kalikath	*Myrsine semiserrata* Wall.
27	Palmae	Bet	*Calamus tenuis* Roxb.
28	Poaceae	Siru	*Imperata cylindrica* (L.) P. Beauv
29	Poaceae	Babiyo	*Eulaliopsis binata* (Retz.) C.E. Hubb.
30	Poaceae	Kans	*Saccharum spontaneum* L.
31	Rhamnaceae	Khane bayer	*Zizyphus jujjuba* (L.) Gaertn.
32	Rutaceae	Bel	*Aegle marmelos* (L.) Correa.
33	Samydaceae	Pipire	*Casearia tomentosa* Roxb.
34	Verbenaceae	Banmara	*Lantana camara* L.
35	-	Bandar latti	-
36	-	Dudhi	-
37	-	Kadi	-

Annex xii. Actors in conservation of forest and environment in lowland of Nepal



Source: Researcher‘s construction

Annex xiii. Record of wildlife casualty in 2010 at Chisapani area

Date	Time	Particulars
2/14/2010	7:00	One dead spotted deer (*Axis axis*) was found in Kareli khola hanging on wire net.
2/24/2010	18:30	One dead spotted deer was found in Kareli Gaun nearby Kareli khola.
2/25/2010	18:30	One dead spotted deer was found around one and half km from Kareli Gaun.
4/10/2010	6:15	One young dead spotted deer was found in Ratna Highway nearby Haattisar area.
4/19/2010	18:30	One dead spotted deer was found after stroked by motor cycle (Bhe 2 Pa 5426), and driver Anga Rokaya (32 yrs, resident of Humla) also died.
8/23/2010	12:00	One spotted deer died after being biten by domestic dog in nearby Haattisar area.
10/23/2010	7:00	One snake killed on the road nearby village.
2010/9	morning	Bus stroked one rhesus macaque (*Macaca mulatta*), died nearby Hattisar area.

Source- Khadga Dal Gan, Chisapani, Banke

Annex xiv. CF in Forest and Environment Conservation Coordination Committee, Mahadevpuri, Banke

S.N	CF name	Address	Handover date	Area (Ha)	Household	Wild animal status
1	Ashok	Kachanapur-4	5/17/2000	129	84	Increased deer species, wild boar, rhesus macaque, blue bull, leopard
2	Bagesal	Mahadevpuri-2,3	7/16/1999	199	155	Decreased wild boar, deer species and constant tiger
3	Bandevi	Mahadevpuri-9	7/16/1999	57.5	89	No tiger but constant other species
4	Bansakti	Kachanapur-9	6/13/1998	99.5	169	No tiger but constant other species
5	Bhagawati	Mahadevpauri-7	2/20/2004	196	143	No tiger but constant other species
6	Durga Bhawani	Kachanapur-8	7/14/1998	97	137	Constant leopard and other species
7	Haralaphant	Kachnapur-7	5/14/2009	116.8	52	No tiger but constant other species
8	Jalandara	Mahadevpuri-5 & 6	7/14/1998	76	50	No tiger but constant other species
9	Jankalyan	Kachanapur-7	2006	266	NA	No tiger but constant other species
10	Jansakti	Madevpuri-7	5/11/2005	134	117	Increased tiger, wild boar, blue bull and constant leopard
11	Jhijhari	Mahadevpuri-2,3	4/18/2004	292.49	222	Increased deer, blue bull, wild boar and constant leopard
12	Jhijhari Mahila	Mahadevpuri-5	6/27/1999	199	NA	Constant tiger and other species
13	Laligurash	Kachanapur-5 & 6	5/25/2009	193	169	Constant leopard and other species
14	Pragatisil	Mahadevpuri-1	3/28/2004	56.8	70	Decreased leopard and other species
15	Rapti	Kachnapur-8	5/28/2009	197	187	No tiger but constant other species
16	Rimna	Mahadevpuri-5	4/21/1997	73.5	277	Constant tiger and other species
17	Shivasakti	Mahadevpuri-6	6/8/2006	304.25	200	Increased jackal, porcupine, wild boar, deer species, rhesus macaque and constant tiger
18	Shramjibi	Mahadevpuri-1	4/21/2005	74.37	61	Increased porcupine, rhesus macaque, and decreased wild boar, deer
19	Siddhasahikumari	Kachanapur-7	4/3/2006	119.75	94	No tiger but constant other species
20	Taradevi	Mahadevpuri-7	4/22/2005	192.43	75	No tiger but constant other species

NA- Not available, Source: Reports submitted by community forest to the FECCC, Mahadevpuri, Banke

Annex xv. Classification of felid species on the IUCN Red List 2002

Critically endangered	**Endangered**	**Vulnerable**	**Nearly threatened**	**Least concern**
Iberian lynx (*Lynx pardinus)*	Andean mountain cat (*Leopardus jacobitus)*	African golden cat (*Profelis aurata*)	Geoffroy's cat (*Leopardus geoffroyi*)	Bobcat (*Lynx rufus*)
	Borneo bay cat (*Neofelis diardi)*	Asiatic golden cat (*Catopuma temminckii*)	Jaguar (*Panthera onca*)	Canada lynx (*Lynx Canadensis)*
	Snow leopard (*Uncia uncia)*	Black-footed cat (*Felis nigripes*)	Lynx (*Lynx lynx*)	Caracal (*Caracal caracal)*
	Tiger (*Panthera tigris)*	Cheetah (*Acinonyx jubatus)*	Manul (*Otocolobus manul*)	Jaguarundi (*Puma yagouaroundi*)
		Chinese mountain cat (*Felis bieti*)	Oncilla (*Leopardus tigrinus*)	Jungle cat (*Felis chaus*)
		Clouded leopard (*Neofelis nebulosa*)	Pampas cat (*Leopardus pajeros*)	Leopard (*Panthera pardus*)
		Fishing cat (*Prionailurus viverrinus*)	Puma (*Puma concolor*)	Leopard cat (*Prionailurus bengalensis*)
		Flat-headed cat (*Prionailurus planiceps*)	Sand cat (*Felis margarita*)	Margay (*Leopardus wiedii*)
		Guigna (*Leopardus guigna)*		Ocelot (*Leopardus pardalis*)
		Lion (*Panthera leo*)		Serval (*Leptailurus serval)*
		Marbled cat (*Pardofelis marmorata*)		Wild cat (*Felis silvestris*)
		Rusty-spotted cat (*Prionailurus rubiginosus*)		

Source: Nowell (2002:4)

Annex xvi. Forest structure of study area

Area (sample)	Scientific name	BA/ha	RBA	Density / ha	RD	F (%)	RF	IVI	R-IVI
Balapur (12)	*Acacia catechu*	149.67	6.11	75.00	14.06	25.00	11.54	249.67	31.71
	Diospyros tomentosa	7.21	0.29	8.33	1.56	8.33	3.85	23.88	5.70
	Mallotus philippiensis	393.31	16.07	225.00	42.19	58.33	26.92	676.64	85.18
	Melia azedarach	7.08	0.29	16.67	3.12	16.67	7.69	40.41	11.11
	Lagerstroemia parviflora	170.23	6.95	50.00	9.38	25.00	11.54	245.23	27.87
	Lagerstroemia indica	166.61	6.81	83.33	15.63	25.00	11.54	274.94	33.97
	Terminalia alata	1554.17	63.48	75.00	14.06	58.33	26.92	1687.50	104.46
	Total	**2448.28**	**100.00**	**533.33**	**100.00**	**216.67**	**100.00**	**3198.28**	**300.0**
Ranjha (5)	*Eugenia jambolana*	704.02	35.07	60.00	12.50	40.00	22.22	804.02	69.80
	Lagerstroemia indica	674.34	33.60	260.00	54.17	80.00	44.45	1014.34	132.21
	Lagerstroemia parviflora	153.90	7.67	140.00	29.16	40.00	22.22	333.90	59.05
	Shorea robusta	474.92	23.66	20.00	4.17	20.00	11.11	514.92	38.94
	Total	**2007.18**	**100.00**	**480.00**	**100.00**	**180.00**	**100.00**	**2667.18**	**300.0**
Gauri (4)	*Garuga pinnata*	932.92	59.04	200.00	42.11	75.00	50.00	1207.92	151.14
	Mallotus philippiensis	647.33	40.96	275.00	57.89	75.00	50.00	997.33	148.86
	Total	**1580.25**	**100.00**	**475.00**	**100.00**	**150.00**	**100.00**	**2205.25**	**300.0**
Khairi (3)	Badar latti*	28.85	1.00	33.33	7.69	33.33	10.00	95.52	18.69
	Diospyros tomentosa	694.00	24.01	33.33	7.69	33.33	10.00	760.67	41.70
	Kadi*	791.54	27.38	33.33	7.69	33.33	10.00	858.21	45.07
	Myrsine semiserrata	35.82	1.24	33.33	7.69	33.33	10.00	102.49	18.93
	Lagerstroemia indica	308.57	10.67	66.67	15.38	66.67	20.00	441.90	46.06
	Lagerstroemia parviflora	181.86	6.29	133.33	30.79	33.33	10.00	348.53	47.07
	Desmodium oojeinnensis	820.59	28.38	33.33	7.69	33.33	10.00	887.26	46.07
	Terminalia alata	18.90	0.65	33.33	7.69	33.33	10.00	85.57	18.34
	Dhudi*	11.05	0.38	33.33	7.69	33.33	10.00	77.72	18.07
	Total	**2891.18**	**100.00**	**433.33**	**100.00**	**333.33**	**100.00**	**3657.85**	**300.0**
Jansakti (4)	*Acacia catechu*	44.25	1.41	75.00	12.50	75.00	15.00	194.25	28.91
	Buchanania latifolia	21.81	0.69	50.00	8.33	50.00	10.00	121.81	19.03
	Careya arborea	15.89	0.51	25.00	4.17	25.00	5.00	65.89	9.67
	Dillenia pentagyna	59.51	1.89	50.00	8.33	50.00	10.00	159.51	20.22
	Garuga pinnata	38.46	1.22	25.00	4.17	25.00	5.00	88.46	10.39
	Lagerstroemia parviflora	19.62	0.62	25.00	4.17	25.00	5.00	69.62	9.79
	Mallotus philippiensis	179.37	5.70	50.00	8.33	50.00	10.00	279.37	24.03
	Phyllanthus emblica	205.13	6.52	50.00	8.33	50.00	10.00	305.13	24.85

	Semecarpus anacardium	33.17	1.05	25.00	4.17	25.00	5.00	83.17	10.22
	Shorea robusta	2333.90	74.15	175.00	29.17	75.00	15.00	2583.90	118.32
	Terminalia alata	196.25	6.24	50.00	8.33	50.00	10.00	296.25	24.57
	Total	**3147.36**	**100.00**	**600.00**	**100.00**	**500.00**	**100.00**	**4247.36**	**300.0**

BA - basal area, D - density, F - frequency, IVI - important value index, R - relative

Annex xvii. Meteorological data on temperature (maximum and minimum in °c) at Sikta, Banke

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		Annual	
	max.	min.	max.	min.	max.	min.	max	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
1979	22.8	8.2	22.7	9.3	29.5	11.5	37.4	19	39.1	22.3	37.1	25	33	26	33.5	26	34.2	22.8	30.2	18.4	28.1	14.5	22.9	9	30.9	17.7
1980	22.3	6	25.7	9.1	31.2	12.1	39.4	18.5	39	25.3	35.2	26.2	33.2	26.2	33.2	25.9	32.6	24.5	30.8	19.4	27.6	11.8	23.7	9.2	31.2	17.8
1981	21.4	7.9	25.8	9.2	29.8	14.2	35.4	20.1	36.9	23.8	37.1	25.5	32.9	25.8	33.7	25.5	31.8	24.8	30.7	18.2	26.3	12.6	24.4	7.5	30.5	17.9
1982	22	8.4	22.5	9.7	28.1	13.4	35.8	17.4	37.3	21	35.3	25.2	34.6	26.1	33.8	25.4	31.8	23.4	30.3	17.8	26	13.9	22.5	7.7	30	17.5
1983	20	6.8	23.3	7.2	30	11.7	33.9	17.2	35.9	22.7	38.6	24.8	34.4	25.3	34.1	26	32.6	24.9	30.7	19.7	27.5	12.1	22.9	7.1	30.3	17.1
1984	21.5	5.8	23.9	7.6	31.6	12.8	37.8	18.9	38.5	24.6	33.1	25	31.8	24.8	34.4	24.9	31.7	22.7	30.9	18.4	26.8	11.3	23	7.9	30.4	17.1
1985	22	7.1	25.1	7.5	33.2	12.5	36.6	17	38.8	24.5	36.2	25.2	31.7	24.9	33.7	25.1	31.5	23.5	29.4	19.2	26.5	11.9	22.2	9.6	30.6	17.3
1986	22.4	7	24.1	9.1	31	12.7	35.6	17.2	36.2	21.2	36.7	24.9	32.7	25.2	34	25.4	31.8	23.4	30	18.4	27.5	13.3	23.2	9.1	30.4	17.2
1987	22.1	7.9	26.4	10	31.6	12.6	36.8	17.6	37.2	21.4	40.3	27.9	33.5	25.4	33.5	25.4	30.5	24.8	32.4	20.6	27.7	12.4	23.8	9.1	31.6	17.9
1988	23.2	7.3	26.9	9.7	30.9	10.9	37.7	18.3	39	23.8	36.3	24.4	33.6	23.4	33.2	25.1	33.4	24.1	32	18.1	27.9	10.9	24.4	9.7	31.5	17.3
1989	20.5	6.7	29.9	6.4	30.4	12.8	37.2	14.4	38.8	23	34.5	22.8	32.7	23.3	33.6	24.1	31.9	22.1	31.4	18.4	27.5	11.2	22.2	9	30.4	16
1990	22.5	8.4	24	9.7	28.4	12.9	35.8	16.9	35.1	21.9	36	24.7	32.5	23.5	34.7	24.1	33.7	23.7	30.3	17.4	28.2	11.7	24.5	7.3	30.5	16.8
1991	21.1	6.2	26.5	8.4	31.4	10.1	37	16.7	39.7	23.8	36.3	25.5	34.8	26.3	33.5	24.9	32.7	23.3	32	18.3	26.3	10.8	22.7	7.1	31.2	17
1992	21.1	7.7	22.6	8.1	29.4	11.5	39.1	16.4	38.4	21.6	37	24.4	33.2	24.4	33.5	25.1	43.8	23.6	33.1	20	27.8	12.6	23.2	7.9	31.1	16.8
1993	19.6	6.7	26.6	9.9	28.9	11.7	35.8	17.8	37.3	21	36.3	24.5	33.8	25.4	33.2	24.8	32	23.4	31.6	18	27.7	12.6	24.5	7.7	30.6	17
1994	22.7	7.4	23.9	8.6	31.9	11.5	36.9	14.3	39.6	22.6	37	23	35.1	23.8	43.8	22.5	43.9	20.5	31.5	16.2	27.4	10.7	25.3	6.7	31.8	15.7
1995	21.8	4.8	25.1	7.4	30.9	14.1	38.6	16.6	39.8	21.5	36.6	26.6	35.7	25	53.4	25.1	43.4	24.4	33.1	19.2	28.9	12.2	24.5	7.3	32.1	16.8
1996	22.2	6.8	25.7	8.6	32.4	11.6	38	17.6	41.5	22.4	36.2	24.9	33.6	25	34.2	24.7	34.8	23.9	30.2	19.4	28.6	11.6	25.4	6.2	31.9	17.1
1997	21.5	5.9	24.8	6.6	31.7	11.5	34.2	18.2	38.7	20.1	38	24.7	34.1	25.7	33.6	24.7	32.6	24.1	30	16.6	27.7	13.5	20.5	9.9	30.7	16.8
1998	19.4	8.1	25.6	8.8	28.4	12.1	35.7	17.5	39.4	24	40.3	26.1	33.9	25.7	34.1	25.2	35.3	25.1	33.4	21.1	30	15.2	25.4	8.2	31.8	18.1
1999	21.1	7.3	26.8	9.6	33.3	10.6	39.8	17.3	37.9	23.5	36.2	23.1	33.6	24.1	33.9	23.7	33.3	23.2	31.9	19.7	28	12.7	24.1	8.9	31.6	16.9
2000	20.1	7.3	23	7.8	30.3	10.7	37	17.3	35.5	22	33.6	24.6	33.4	24.6	33.5	23.7	32.8	23.2	33.1	18.8	28.4	13.7	24.6	7.6	30.4	16.7
2001	21	6.5	25.9	8	31.9	11.7	37.8	16.5	35.5	23	33.5	24.9	33.4	25.4	34	24.8	32.8	23	32.3	19.3	27.8	12.7	22.2	9.3	30.6	17
2002	21.9	7.3	25.6	9.8	31.5	13.1	36	18.7	36.3	23.1	37.3	25.1	34.5	25.8	33.9	25.1	32.9	23.1	31.7	18.4	28.2	12	23.4	8.9	31.1	17.5
2003	16.6	7.6	24.6	9.4	29.1	12.9	37.1	18.1	39.5	21.7	35.8	24.2	33.6	25.4	33.7	25.4	32.5	23.1	31.8	18.1	27.1	12	21.4	8.5	30.2	17.2
2004	19.1	7.8	25.7	9.4	33.8	13.1	36.8	19.7	37.6	20.8	34.3	23.5	33	23.9	34	24.3	32.8	22.9	29.9	17.3	26.1	10.8	22	8.2	30.4	16.8
2005	20.7	7.3	24.1	11	30.5	11.9	36.5	15.4	38.5	21.6	40	22.6	33.1	23.2	33.1	23.3	33	23.2	30.8	16.8	27.8	3.3	23.8	7.2	30.9	15.5

2006	22	5	28.2	12	30.3	11.7	36.1	16.6	36	22.8	37.7	24.2	33.9	25	34	24.2	32.9	22.7	32.4	19	27.1	11.8	23.4	8.1	31.1	16.9
2007	21.4	5.2	23.9	9.8	28.2	11.3	37	17.5	36.4	21.6	36.3	23.6	32.7	22.8	33.2	22.2	32.2	23.6	31.2	18.7	28.3	12.1	22.8	7.5	30.3	16.3
2008	21.5	6.1	23.8	6.7	31	12.4	36.9	15.3	38.2	21.4	33.4	20.3	32.8	17.7	33.9	20.3	33.6	21.3	31.6	16.2	28.6	12.8	24.5	10	30.8	15
2009	23.6	7.8	27.8	7.9	33.3	9.5	38.9	15.3	37.6	20.3	38	23.2	34.7	24.9	33.4	24.7	33.3	24.1	31.8	17.4	27.5	12.6	22.7	7.9	31.8	16.3
	21.3	6.97	25.2	8.8	30.8	12	36.9	17.3	37.9	22.4	36.45	24.5	33.5	24.6	34.68	24.6	33.8	23.4	31.4	18.5	27.6	12	23.42	8.2	30.92	17.14

Source: Department of Meteorology and Hydrology, Kathmandu, Nepal

Annex xviii. Annual average precipitation (mm) at Sikta, Banke

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1979	22	43	2	8	18	62	382	283	17	44	0	35	916
1980	0	2	10	0	41	208	385	381	182	6	0	0	1215
1981	30	0	13	80	59	153	459	691	598	0	54	5	2142
1982	23	1	41	0	100	139	229	376	431	42	30	8	1420
1983	20	2	0	7	85	38	349	301	328	190	0	37	1357
1984	40	0	0	0	52	455	574	142	377	30	0	21	1691
1985	9	0	0	0	17	216	513	475	525	163	0	22	1940
1986	0	92	0	33	54	361	238	333	183	3	0	36	1333
1987	0	0.8	0	17.3	71.2	34.8	648.6	288.7	144.8	0	0	10.5	1216.7
1988	0	0	38.5	15	26.5	228.9	741.2	467.9	61.4	15.4	0	46.8	1641.6
1989	41.3	0	0	0	20.1	297.4	805.1	451	351.7	20.9	17.6	10.5	2015.6
1990	0	84	44.3	0	211.9	190.7	919.5	398.1	66.8	39.1	0	43	1997.4
1991	25	31	12	0	19	117	111	523	391	0	0	165	1394
1992	7	18	6	5	38	97	185	261	54	17	10	0	698
1993	0	8	50	14	155	201	435	773	271	6	0	0	1913
1994	44	34	0	0	32	377	271	312	154	0	0	0	1224
1995	38.1	37.6	10.5	0	151.9	192.2	362.7	539.7	93.2	39.5	24.6	0	1490
1996	38	73.6	0	25.8	0	404.5	462.3	365.5	83.7	171.5	0	0	1624.9
1997	21.8	0	10.4	45.2	59.4	204.9	752.3	472	155.3	50.2	20.8	47.1	1839.4
1998	0	17.7	23.5	49.3	48.2	232	881.4	580.7	156	84.6	5	0	2078.4
1999	24.1	0	0	0	108	316.5	341.2	512.1	310.9	117.2	0	0	1730
2000	29	43.6	26.2	37.6	114.1	459.8	431.3	451.8	317.4	0	0	0	1910.8
2001	0	0	0	0	263.1	271.4	554.1	412.8	348.9	0	0	0	1850.3
2002	20.7	24.2	10.2	20.2	65.5	132.2	231.9	214	100.8	21.3	0	0	841
2003	42.8	63.8	2.2	0	0	248.5	423.1	234.9	374	10	DNA	DNA	1399.3
2004	29.1	0	0	6.2	121.2	145.4	502	172	91.2	100.2	0	0	1167.3
2005	59.2	49.4	29.6	8.6	20.7	76.8	452.1	352.3	253.8	90.4	0	0	1392.9
2006	0	0	56.2	17.6	73.8	62.4	419.3	130.7	102.4	8.1	0	9	879.5
2007	0	63.4	87.8	44.6	134.2	165.5	416.4	400.3	305.3	36.6	0	0	1654.1
2008	0	0	0	38.8	0	293.5	330.4	464.5	173	67.5	0	0	1367.7
2009	0	0	0	0	54	131	310.2	476.5	203.4	78.7	0	0	1253.8
Average	18.19	22.22	15.27	15.26	71.41	210.1	455.35	394.7	232.4	46.84	5.22	15.99	1503.02

Source: Department of Meteorology and Hydrology, Kathmandu, Nepal

Annex xix. Relative humidity (%) recorded at 08:45 at Sikta, Banke

S.N	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	1979	87	75	74	46	45	65	79	86	73	77	83	90	74
2	1980	96	84	64	51	61	72	84	88	84	86	84	94	79
3	1981	95	90	85	60	56	59	86	86	86	86	92	90	81
4	1982	96	94	80	57	55	68	83	87	87	82	83	93	80
5	1983	92	85	66	52	56	60	77	84	86	83	85	90	76
6	1984	93	85	73	48	62	81	86	82	84	77	84	91	79
7	1985	92	88	73	54	56	73	84	86	88	87	77	88	77
8	1986	90	87	79	59	52	68	84	83	79	83	90	89	76
9	1987	90	85	65	49	50	66	84	81	84	77	94	97	81
10	1988	92	86	77	56	62	77	77	87	85	81	91	98	84
11	1989	95	89	79	56	63	80	89	89	89	87	94	93	86
12	1990	98	96	81	65	75	83	88	86	85	88	89	92	85
13	1991	95	95	83	67	62	81	85	91	92	87	85	93	87
14	1992	93	95	92	69	80	86	89	90	89	85	89	94	89
15	1993	95	94	88	82	83	87	89	94	92	85	91	95	88
16	1994	94	92	83	73	76	86	90	92	92	90	90	91	84
17	1995	94	93	84	54	58	85	84	86	87	88	92	98	84
18	1996	99	96	81	52	44	70	86	93	90	90	94	94	83
19	1997	98	96	79	64	56	64	82	82	87	84	94	98	83
20	1998	99	96	91	75	56	59	85	86	80	84	84	98	83
21	1999	97.8	94.5	76.7	49.1	64.8	71.2	86.6	86	86.2	88.3	93.7	99.6	82.8
22	2000	99.3	93.4	84.2	69.1	67.2	81.5	87.2	86.7	86.6	86.1	96	95.4	86
23	2001	98.1	96	81.3	47.9	66.9	79.2	86.8	89.4	89.5	85.5	95.5	99.5	84.6
24	2002	99.5	96.1	86.4	64.3	69.6	76	85.6	89.3	87.3	82.7	87	99.3	85.2
25	2003	99.6	97	85.6	64.4	63.4	83.1	85.5	87.3	86.7	83.4	93.2	98.4	85.6
26	2004	99.5	93.8	85.5	68.4	71.1	77.9	88.2	84.9	89	83	91	95.5	85.6
27	2005	97.7	93.9	84.5	62.4	69	69.2	86.1	88.6	87	87.7	93.7	99.1	84.9
28	2006	99.8	97.8	93.8	80.2	76.8	74.4	88.2	86.3	91	90.5	92.5	98.3	89.1
29	2007	99.8	98.5	88.1	56.1	70.7	76.2	91.8	85.4	88.6	87.9	85.6	96.8	85.4
30	2008	99.8	99.4	84	81.2	73.3	90.1	93	89.7	94.6	91.2	95.8	98.3	90.8
31	2009	98.9	99.6	86	73.2	80.2	84.2	85.4	94.6	90	85.8	90.9	97.7	88.8
	Average	95.9	92.3	81.1	61.5	63.9	75.3	85.7	87.32	87	85.1	89.67	94.96	83.8

Source: Department of Meteorology and Hydrology, Kathmandu, Nepal

Annex xx. Plates: Disturbances for forest restoration and wildlife in Banke National Park

Heavy logging in community forest, Banke

Livestock entering forest to grazing, Banke

Illegally built *Goths* inside Banke NP

Poached common langur & its carcass, BaNP

Annex xxi. Some plates showing the interviews and meetings

Key informant interview, Mahadevpuri

Rapid Rural Appraisal, former tiger monitor

Interview with forest user committee member

Household survey, Banke

Participated in meeting with CFUCC, Khata

Participated in general assembly of CFUG, Balapur

Annex xxii. Plates regarding the some of the methods used for floral and faunal survey

Few days old tiger pugmark, Gauri CF, Khata

Fresh tiger pugmark, Ranjha BF, Bardia NP

Measuring the plot to conduct quadrat survey

Measuring DBH of tree, Banke NP

Sign survey for animal in Khairi, Banke NP

Tiger's sign survey in Khata with Bhadai Tharu

Annex xxiii. Plates demonstrating the restoration and conservation related activities

Plantation in forest edge at Mahadevpuri

Controlled grazing in grassland, Khata

Electric fencing in Khata, Bardia

Community forest guard guiding in the forest

Watchtower to observe wildlife movement

Income: preparing oil from lemon grass at Mahadevpuri