Hariyo Ban Program

CHITWAN-ANNAPURNA LANDSCAPE
A RAPID ASSESSMENT

USAID
FROM THE AMERICAN PEOPLE

WWF

care

FECOFUN

TRUST FOR NATURE CONSERVATION
NEPAL 1982

Hariyo Ban Program

CHITWAN-ANNAPURNA LANDSCAPE
A RAPID ASSESSMENT


Published by
WWF Nepal, Hariyo Ban Program
This publication is also available in www.wwfnepal.org/publications

PO Box: 7660
Baluwatar, Kathmandu, Nepal
T: +977 1 4434820, F: +977 1 4438458
hariyobanprogram@wwfnepal.org, www.wwfnepal.org/hariyobanprogram

Authors
This report was prepared by the Kathmandu Forestry College, Koteswor, Kathmandu.
The assessment team comprised: Ambika P. Gautam, Bhesh R. Thapa, Bishnu H. Pandit, Bishnu M. Dhungana, Krishna R. Tiwari, Menaka P. Neupane, Mohan K. Balla, Murari R. Joshi, and Uday R. Sharma.

ISBN: 978-9937-8154-9-9

Photo credits
Cover photo: © Gangapurna Glacier and glacier lake, Annapurna region - © Neyret & Benastar/WWF-Canon
Children playing by a river, Chitwan National Park - © Simon de TREY-WHITE/WWF-UK
Gharial, Chitwan National Park - © Michel Gunther/WWF-Canon
A woman in Jumdanda, Tanahu district and Sal Forest in Terai - © WWF Nepal, Hariyo Ban Program/Pallavi Dhakal
Red Panda - © Gerald S. Cubitt/WWF-Canon
Annapurna Conservation Area - © James W. Thorsell/WWF-Canon

Disclaimer
This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of Kathmandu Forestry Collage (KAFCOL) and do not necessarily reflect the views of WWF, USAID or the United States Government.

Publication Services
Design and Layout: Digiscan Pre-press Pvt. Ltd.

Other publications in this series
Chitwan-Annapurna Landscape: Biodiversity Areas and Linkages
Chitwan-Annapurna Landscape: Drivers of Deforestation and Forest Degradation

Government of Nepal
Ministry of Forests and Soil Conservation

Ph. 4211567, 4211892, 4211928, 4211936, 4211742
Fax. 4211862, 4211868

P.O.Box No. 3987
Singha Durbar, Kathmandu

Ref. No.

Date :- 14 August 2013

FOREWORD

With its diverse topographical, geographical and climatic variation, Nepal is rich in biodiversity and ecosystem services. It boasts a large diversity of flora and fauna at genetic, species and ecosystem levels. Nepal has several critical sites and wetlands including the fragile Churia ecosystem. These critical sites and biodiversity are subjected to various anthropogenic and climatic threats.

The Government of Nepal is working with a number of development and conservation partners to conserve Nepal's natural heritage. USAID funded Hariyo Ban Program, implemented by a consortium of four partners with WWF Nepal leading alongside CARE Nepal, FECOFUN and NTNC, is working towards reducing the adverse impacts of climate change, threats to biodiversity and improving livelihoods of the people in Terai Arc Landscape and Chitwan-Annapurna landscape.

This set of publications – A Rapid Assessment, Biodiversity Areas and Linkages, and Drivers of Deforestation and Forest Degradation – mark a major step forward in developing a greater understanding of a key north-south linkage in Nepal that connects the Terai to the mid-hills and the mountains through the Gandaki River basin. It provides an important insight into the unique biodiversity and ecosystem services, current land uses, core biological areas and corridors, and drivers of deforestation and forest degradation. The Government of Nepal, Ministry of Forests and Soil Conservation appreciates the multi-disciplinary approach taken by the Hariyo Ban Program to understand the importance of this region. While all the three reports serve as a base to guide the work of Hariyo Ban Program for the coming years, they also provide information that will be useful to academia, local and international organizations and the government.

I would like to thank all institutions and individuals involved in undertaking this set of three studies, including the USAID and the Hariyo Ban Program consortium partners WWF Nepal, CARE Nepal, FECOFUN and NTNC.

Krishna Prasad Acharya
Joint Secretary

Government of Nepal
Ministry of Forests & Soil Conservation
Singhdurbar, Kathmandu

Foreword

The Government of Nepal has identified landscape level planning and conservation as a broad strategy to conserve biodiversity and improve livelihoods of local communities dependent on natural resources. It has therefore recognized two landscapes in Nepal, the Terai Arc Landscape (TAL) in 2000 and Sacred Himalayan Landscape (SHL) in 2006, to help establish east-west connectivity that is crucial for biodiversity conservation. WWF Nepal is an active partner of the Government of Nepal and works closely with conservation agencies and local communities in both the landscapes to conserve the rich biological diversity of Nepal.

Recognizing the need to develop a north-south linkage that is vital to provide a safe passage along river and forest corridors for wildlife, migratory birds and aquatic animals, the Chitwan Annapurna Landscape (CHAL) was envisioned. CHAL is not a new concept. It is based on the Chitwan-Annapurna Linkage for which WWF Nepal had produced a report, 'Biodiversity Assessment and Conservation Planning', in 2000.

Since 2011, through the Hariyo Ban Program funded by the United States Agency for International Development (USAID), WWF Nepal together with the consortium partners – CARE Nepal, FECOFUN and NTNC – has started working in CHAL to empower local communities in safeguarding Nepal's living heritage and adapting to climate change through conservation and livelihood approaches.

The three CHAL reports – A Rapid Assessment, Biodiversity Areas and Linkages, and Drivers of Deforestation and Forest Degradation – provide important insights in understanding this important landscape in terms of its rich biodiversity, eco-regions, community and threats to further help develop pathways to build the landscape as a leading example in functional connectivity across multiple ecological communities.

I would like to thank the Government of Nepal for their support and invaluable feedback throughout various stages of this study. I also thank USAID for funding this study under the Hariyo Ban Program, and the Hariyo Ban consortium partners.

Anil Manandhar
Country Representative
WWF Nepal

Preface

The Chitwan Annapurna Landscape (CHAL) supports over 4.5 million people of diverse ethnicities, cultures and religions, many of whom are dependent on forest resources and ecosystem services for their livelihoods and wellbeing. The CHAL is one of two priority working areas for the USAID funded Hariyo Ban program. This remarkable geographic area encompasses an altitudinal range of over 8000m. Comprising the Gandaki River basin in Nepal, the CHAL spans a diverse topography which runs from the trans-himalayan rain-shadow on the Tibet border and part of the Himalaya range in the north, down through the mid-hills and Churia range, to the fertile plains of the Terai in the south bordering with India. This landscape has high biodiversity value and contains seven major sub-river basins: Trishuli, Marsyangdi, Seti, Kali Gandaki, Budi Gandaki, Rapti and Narayani.

Environmental degradation and high poverty rates create a potent mix of threats to both people and biodiversity in the CHAL. These threats are aggravated by limited understanding of the impacts of climate variability and climate change on the people and biodiversity in the CHAL.

In the growing context of increasing temperature and environmental change, the CHAL will play a crucial role in long-term biodiversity conservation and building resilience to climate change in Nepal. The three CHAL reports – A Rapid Assessment, Biodiversity Areas and Linkages, and Drivers of Deforestation and Forest Degradation – are expected to provide an in-depth understanding of the landscape, its biodiversity and threats to help build people's resilience to climate change and conserve biodiversity. USAID intends these reports to form the foundation for long-term conservation and development in the CHAL.

USAID Nepal would like to thank the Government of Nepal for their valuable support and suggestions in developing this study. We also acknowledge the untiring efforts of WWF Nepal, CARE Nepal, FECOFUN and NTNC team along with USAID's Mr. Netra Sharma (Sapkota) to shape, review and enrich this document. While this report and the other related studies will be used intensively by the Hariyo Ban Program as a basis for USAID's future work in the landscape, the information within is intended for use by a much wider audience - e.g., the Government of Nepal, civil society, private sector and donors working in the CHAL area - for the ultimate benefit of the people and biodiversity of Nepal.

Ms. Tahalia Barrett
Acting Director
Social, Environmental and Economic Development (SEED) Office
USAID Nepal

Acknowledgments

I would like to express our great appreciation to the Kathmandu Forestry College team for undertaking the study. The team was led by Ambika P. Gautam; other members were Bhesh R. Thapa, Bishnu H. Pandit, Bishnu M. Dhungana, Krishna R. Tiwari, Menaka P. Neupane, Mohan K. Balla, Murari R. Joshi, and Uday R. Sharma.

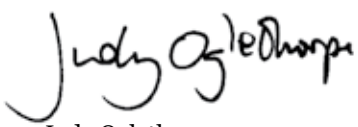
Several organizations and individuals made significant contributions to the study. This work would not have been possible without the support of the Government of Nepal. We would like to thank senior officials in the Ministry of Forests and Soil Conservation (MoFSC) and its various departments for their valuable contributions. Special thanks go to Dr. Rajan Pokharel, Regional Director, Western Regional Directorate of Forests, for his excellent support and coordination with government line agencies. Comments and suggestions provided by Krishna Acharya, Chief, Planning Division, MoFSC, and Dr. Maheshwar Dhakal, Ecologist, Department of National Parks and Wildlife Conservation were very helpful in enriching the reports.

Special thanks also go to the heads of several district level government line agencies, particularly District Forest Offices, District Soil Conservation Offices, District Livestock Offices, District Women Development Offices, and District Development Offices. I would also like to thank individual experts and representatives of various NGOs and civil society who generously provided their valuable time to enhance this report with their insights and suggestions. Representatives from FECOFUN district chapters and Community Forest User Groups made significant contributions during the consultations. Thank you to Purna Kunwar, Dev Raj Gautam, Ganga Neupane, Raj Kumar Gurung and their respective teams in the Hariyo Ban consortium partners for their active participation in the study and support to the consultation meetings.

I highly appreciate the inputs of Hariyo Ban central level team members, in particular Sandesh Hamal, Dr. Shant Raj Jnawali, Dr. Sunil Regmi, Keshav Khanal and Shikha Shrestha for their critical inputs, review and suggestions at various stages of the study. Pallavi Dhakal managed the complex production process. Jayendra R. Koirala, Prabita Shrestha and Salina Shrestha provided administrative and contractual support.

Thank you also to Dr. Ghana Shyam Gurung, Conservation Program Director, WWF Nepal for providing valuable inputs, and to Gokarna J. Thapa for his untiring efforts in GIS analysis and mapping.

Finally, this report would not have been possible without the generous support of the American people through the United States Agency for International Development (USAID). I would like to give heartfelt thanks to Netra Sharma Sapkota, USAID Agreement Officer's Representative (Project Manager) for the Hariyo Ban Program, for his helpful engagement at various times during the study, and suggestions for the final document.



Judy Oglethorpe
Chief of Party
Hariyo Ban Program

Table of Contents

List of Tables

List of Figures

List of Annexes

Acronyms and Abbreviations

ACA	Annapurna Conservation Area
ANSAB	Asia Network for Sustainable Agriculture and Bioresources
ATF	Aviation Turbine Fuel
BOD	Biochemical Oxygen Demand
CAAN	Civil Aviation Authority of Nepal
CARE	Cooperative for Assistance and Relief Everywhere
CBS	Central Bureau of Statistics
CFUG	Community Forest User Group
CHAL	Chitwan-Annapurna Landscape
CLC	Community Learning Center
CNP	Chitwan National Park
CSUWN	Conservation and Sustainable Use of Wetlands in Nepal
DDC	District Development Committee
DFID	Department for International Development
DFO	District Forest Office/Officer
DHM	Department of Hydrology and Meteorology
DNPWC	Department of National Parks and Wildlife Conservation
DO	Dissolved Oxygen
DoA	Department of Agriculture
DoF	Department of Forests
DoI	Department of Irrigation
DoR	Department of Roads
DSCO	District Soil Conservation Office
DSCWM	Department of Soil Conservation and Watershed Management
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
FECOFUN	Federation of Community Forestry Users, Nepal
FUC	Forest Users' Committee
GEF	Global Environment Facility
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flood
GoN	Government of Nepal
HH	Household
IAPS	Invasive Alien Plant Species
ICIMOD	International Centre for Integrated Mountain Development
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
INGO	International Non-governmental Organization

IUCN	International Union for Conservation of Nature
IWMI	International Water Management Institute
LPG	Liquefied Petroleum Gas
LRMP	Land Resources Mapping Project
MoE	Ministry of Environment
MoEST	Ministry of Environment, Science and Technology
MoFSC	Ministry of Forests and Soil Conservation
MRV	Measurement, Reporting and Verification
MW	Megawatt
NAPA	National Adaptation Programme of Action
NEA	Nepal Electricity Authority
NEFEJ	Nepal Forum of Environmental Journalists
NFA	Nepal Foresters' Association
NFI	National Forest Inventory
NGO	Non-governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NPC	National Planning Commission
NRM	Natural Resources Management
NTFP	Non-Timber Forest Product
NTNC	National Trust for Nature Conservation
PA	Protected Area
PES	Payment for Ecosystem Services
REDD	Reducing Emissions from Deforestation and Forest Degradation
SAGUN	Strengthened Actions for Governance in Utilization of Natural Resources Project
SALT	Sloping Agricultural Land Technology
SOM	Soil Organic Matter
SW	Sub-watershed
TA	Technical Assistance
TAL	Terai Arc Landscape
TCN	Timber Corporation of Nepal
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USGS	United States Geological Survey
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WGS	World Geodetic System
WLR	Wildlife Reserve
WWF	World Wildlife Fund

Executive Summary

Background

In 2012 the Hariyo Ban Program commissioned three reports on the Chitwan-Annapurna Landscape (CHAL). This Rapid Assessment Report provides a broad multi-disciplinary overview of CHAL. Two other reports provide more in-depth studies, and together the three study reports will provide the foundation for the future work of the Hariyo Ban Program in this landscape, as well as valuable information for others working in the area.

Hariyo Ban Program

Hariyo Ban is a five year program aimed at reducing the adverse impact of climate change and threats to biodiversity in Nepal through three integrated objectives: (i) to reduce threats to biodiversity in targeted landscapes; (ii) to build the structures, capacity and operations necessary for effective sustainable landscape management, especially reducing emissions from deforestation and forest degradation (REDD+) readiness, and (iii) to increase the ability of target ecological and human communities to adapt to the adverse impacts of climate change. Livelihoods, governance, and gender and social inclusion are three cross-cutting themes to be integrated in all program activities. The program covers two landscapes – the Chitwan-Annapurna Landscape (running north-south) and the Terai Arc Landscape (TAL) (running east-west). This program is funded by USAID and implemented by a consortium of four international and national non-governmental organizations (NGOs): World Wildlife Fund (WWF) Nepal (lead), Cooperative for Assistance and Relief Everywhere (CARE) Nepal, National Trust for Nature Conservation (NTNC), and the Federation of Community Forestry Users, Nepal (FECOFUN). The Government of Nepal and local communities are key partners and beneficiaries of the program, which began in 2011.

Methodology

The study is based on the analysis of secondary data and information collected through literature review available through government departments, agency reports etc. In addition, consultations were held at national, district and community level with stakeholders, government ministries and departments, international NGOs (INGOs) and civil society. The research team worked closely with the Hariyo Ban Program Chief of Party and other staff members, who organized a final landscape workshop with stakeholders to review and provide feedback on the findings.

Landsat Thematic Mapper images and Landsat Enhanced Thematic Mapper Plus satellite images were acquired and analyzed to identify and map critical features of the landscape.

Overview of CHAL

CHAL is located in central Nepal, covering an area of 32,057 square kilometers, with elevations ranging from 200 m to 8,091 m above sea level. The landscape includes all or part of 19 districts and is drained by six major perennial rivers and their tributaries of the broader Gandaki River System. CHAL experiences a range of climates from subtropical in the lowlands to alpine in the high mountains and cold and dry in the Trans-Himalayan region. Divided into the Silwak Hills, midhills, high mountains and high Himal, geology and climate vary considerably.

Ecosystems

Forests, rangelands, wetlands, and agro-ecosystems are the major ecosystems in CHAL.

More than 35 percent of the landscape area is under forest cover which ranges from mixed deciduous in the Siwaliks, through broad-leaved evergreen, mixed broad-leaved, conifer to alpine scrub and meadow in the high mountains. Rangelands of grassland, pasture and scrub land are distributed all over the landscape. The wetland ecosystems are broadly natural wetlands comprising lakes, ponds, riverine flood plains, swamps and marshes, and manmade wetlands. There is a wide diversity of agricultural crops grown in CHAL, a result of the diversity of climate. Traditional farming systems are still very much in use, and play an important role in maintaining agricultural diversity.

Ecoregions

CHAL includes parts of four of the WWF Global 200 Ecoregions: (i) the Eastern Himalayan Alpine Scrub and Meadows, (ii) the Eastern Himalayan Broadleaf and Conifer Forests, (iii) the Terai-Duar Savannas and Grasslands, and (iv) the Western Himalayan Temperate Forests.

Biodiversity

This landscape has much floral and faunal diversity harboring several economically valuable tree species; tropical grasslands and riverine forests; some of the last populations of rhinoceros and tiger; endemic plants; and the flagship red panda and clouded leopard. Sub-alpine and alpine meadows support one of the world's richest alpine floral diversities, along with the endangered snow leopard.

Findings of the Study

Land use

Analyses of changes in major land use/land cover in the landscape for the period 1990-2010 showed that the area under grasslands substantially decreased and agriculture area slightly increased. The forest area remained largely stable during the period. This finding, however, does not mean that there was no forest dynamism in the landscape. Substantial loss of forest area to infrastructure development, resettlement, urban expansion, and agriculture expansion has taken place in the Siwaliks. Similarly, unregulated construction of rural roads has caused forest loss in many locations of the midhills. Forest gain might have occurred in some places, particularly within the protected areas (PAs).

Forests

The forests in CHAL are under six types of management regimes, namely protected areas, government-managed forests, protection forests, community forests, leasehold forests and buffer zone community forests. The protected areas, which spread over all the physiographic zones, are being managed under three main types of management modalities.

Around 29 percent of the forest in the landscape is under the three community based management regimes (community forestry, leasehold forestry and buffer zone community forestry). Three forest complexes, including Barandabhar (Chitwan), Madhane (Gulmi) and Panchase (Kaski-Parbat-Syangja) were declared as protected forests by the government in 2010. The forest areas not covered by any of the management regimes mentioned above are categorized as government-managed forests, which are under direct control of the Department of Forests through respective District Forest Offices, *Ilaka* Forest Offices and Range Posts. These forests are scattered all over the landscape and remain largely open-access and without any scientific management. A total of 654 private forests covering 461 ha were registered with 16 District Forest Offices between 1984 and 2008. No updated information on private forests and religious forests is available.

Some of the key issues that are common to all forests outside protected areas are: (i) forest loss due mainly to encroachment for expansion of settlements and urban areas, infrastructure development, and agriculture, (ii) invasion by alien plant species, (iii) uncontrolled and repeated forest fires, and (iv) inadequate capacities of District Forest Offices and user groups. Non-timber forest product (NTFP) species (including high value medicinal herbs) suffer from inefficient and unsustainable harvesting practices. In addition, there are some issues that are specific to particular forest management regimes.

A passive approach to forest management; inadequate attention to biodiversity and NTFPs; poor financial transparency and monitoring; inadequate technical support from district forest offices due mainly to insufficient staff; poor cooperation between key stakeholders; and frequent changes in government regulations and directives are the main additional issues in community forest management.

Agriculture

Agriculture is the major source of livelihoods for the majority of the landscape's population and livestock is an integral component of subsistence farming. Despite this, only one-fourth (24%) of the surveyed rural population produced food sufficient for whole year, and one-third produced enough food only for six months. This, together with weak rural off-farm economy, indicates a need for increasing investment in the agriculture sector despite its low return.

Labor scarcity due to out-migration by people seeking off-farm and foreign employment has caused temporary abandonment of marginal agricultural lands, thereby increasing scope for introduction of perennial cash crops in private lands. But the decreasing size of households' farmlands due to increasing fragmentation, and increasing food scarcity particularly among land-poor households, have limited the scope for doing so. Decreasing diversity of cereal crops, beans and fruits, and low livestock productivity are other key issues in agriculture management.

Micro-enterprises and Livelihoods

There exist a number of forest-based, agriculture-based and other micro-enterprises in the landscape. There is a high scope for promoting and further expanding these and other green enterprises. However, the general lack of awareness about possibilities and benefits, lack of or inadequate technical and financial capacities and support, problems in transportation and marketing of agricultural products, lack of or poor accessibility to livestock health care services, and low participation of women and *Dalits* in the existing enterprises have undermined the possibility of developing and expanding green micro-enterprises.

Participation of women and other marginalized social groups in natural resources management and other community development activities has been increased over the years. Nevertheless, there is a gap in the process of participation, assignment of clear roles and responsibilities, transparency in work, and equity in benefiting sharing. More concrete efforts are required to increase participation of women and other disadvantaged social groups in all spheres of decision-making, and their economic empowerment.

The landscape includes many popular and tourist destinations and there is scope for further development of tourism and eco-tourism involving local communities. Other areas of potential livelihoods include exploration of mineral resources; however, sufficient environmental safeguards should be applied to protect the natural environment.

Infrastructure and Energy

There are 11 airports and airstrips in the landscape, out of which four are in regular operation and three are operational for chartered flights. The road network comprises 1,260.87 km black-topped roads in 15 districts, 291.8 km gravel roads, and 918.45 km mud roads. Most of the gravel and mud roads have been constructed without proper planning or consideration for the environment. Unplanned and unregulated construction of rural roads by village development committees (VDCs) and district development committees (DDCs) is a major direct cause of deforestation and forest degradation in the midhill districts, which has undermined the positive contributions of community based forestry programs to some extent. Formulation and implementation of inter-agency coordination mechanisms are necessary to mitigate negative environmental impacts of infrastructure development projects (e.g. rural roads, dams) and enhance cooperation for effective enforcement of forestry and environmental legislation.

Around 79 percent of the total energy consumed in 16 districts (excluding Palpa, Syangja and Kaski) in 2008-2009 was based on wood fuel. The district wise dependency on wood fuel ranged from 47 percent in Chitwan to 99 percent in Manang. There is a need and scope for promoting alternative sources of energy. The opportunity for promoting solar power exists throughout the landscape; solar water heaters are already in use some areas. There is good potential for micro-hydropower in the midhills and high mountains, while biogas can be promoted in the midhills and Siwaliks. There is potential for wind power in Mustang Valley. Promotion of these alternative energy sources will help reduce dependency of households on forests to meet their energy needs, help control forest degradation; and help to reduce greenhouse gas emissions. Promotion of more efficient forest product utilization technologies such as bio-briquettes is another necessity.

Natural Hazards and Climate Change

Analysis of long-term (30 year) temperature data from selected meteorological stations in different physiographic zones showed a progressive increase in average temperature in all zones over the years. Similar analysis of long-term precipitation data for the same period did not show a clear trend in average annual precipitation. These findings are in tune with local people's perceptions recorded during the community level consultations.

Weather related extreme events such as very heavy rainfall, longer drought periods, landslides and floods, frequent and severe forest fires, and invasion by alien species are speculated to have links with climate change, with impacts on different aspects of social, economic and ecological systems. Overall, the Siwaliks zone is at higher risk and more vulnerable to the effects of climate change as compared to the other zones. In the mountains, farmers and rural women are more vulnerable to the impacts of climate change. However, in some parts of Mustang and Myagdi Districts, climate change is reportedly having a positive impact on the production of apples (Mustang) and oranges (Myagdi) due to an increased number of warmer days (as per communication with local farmers).

Local people in all physiographic zones have been adopting adaptation measures to reduce the negative impacts of climate change. Government and non-government agencies have also initiated climate change adaptation programs. However, these limited efforts have not been able to produce the desired outcomes due mainly to inadequate knowledge and understanding of climate change impacts and suitable adaptation measures.

Floods, landslides and droughts are the most common climate related hazards in the landscape. The Siwalik Hills are at a higher level of risk from changing climatic conditions as compared to other zones. There is a risk of glacial lake outburst flood (GLOF) disasters in upper catchment areas of the Marsyangdi, Seti and Budhi Gandaki Rivers. Past studies have identified the Thulagi Glacial Lake in the Marsyangdi Basin and many other glacial lakes in the landscape as being potentially dangerous. There is a need for a comprehensive study to fully assess the impacts and severity of climate change impacts on different ecosystems, key species, hydrological systems and people in different physiographic zones.

Recommendations

There is need for further research into several key areas in which the Hariyo Ban Program will be working. These include but are not limited to: (i) investigate more thoroughly the impacts of climate change on different components of the landscape, including forest ecosystems, species, water resources, hydropower systems, and local people (particularly upland farmers and rural women); (ii) Analyze and map more accurately land use and land cover changes using high resolution satellite images, so that there is credible baseline information for planning and possible future comparisons; (iii) undertake thorough research on the current status of CHAL-specific biodiversity (including agro-biodiversity), and trends in diversity of cereal crops and livestock species or varieties in light of perceived recent substantial declines; (iv) use sex-disaggregated data to better analyze, measure and monitor the impacts of natural resources management and climate change on women and men, build capacity and empower women and other disadvantaged social groups to take decision-making positions at different levels in natural resources management, and implement innovative income generating activities.

Community led actions in several areas, for example, community forest management, the promotion of green energy alternatives, and the establishment of climate change mitigation programs are also highly recommended.

There is good scope for implementing REDD+ and payments for ecosystem services (PES) in selected sites within the landscape. Strong political support, involvement of donors and NGOs, conducive policies and plans, and legal involvement of local communities in forest conservation through the widely implemented community forestry program, have created favorable conditions for launching REDD+ and PES projects in the field. A few pilot projects implemented recently have provided useful insights and an idea of the challenges, which can help improve design and implementation of such projects in the future.

1 Introduction

1.1. Hariyo Ban Program

Hariyo Ban is a five-year program, initiated in 2011, aimed at reducing the adverse impacts of climate change and threats to biodiversity in Nepal through three integrated objectives: (i) reducing threats to biodiversity in targeted landscapes; (ii) building the structures, capacity and operations necessary for effective sustainable landscape management, especially REDD+ readiness; and (iii) increasing the ability of target ecological and human communities to adapt to the adverse impacts of climate change. Livelihoods, governance, and gender and social inclusion are cross-cutting themes. The program covers two important landscapes: the Chitwan-Annapurna Landscape (running north-south), and the Terai Arc Landscape (running east-west). The program is funded by USAID and implemented by a consortium of four international and national NGOs: WWF Nepal (lead), CARE Nepal, NTNC, and FECOFUN. The Government of Nepal and local communities are the key partners and beneficiaries of the program.

1.2 Rapid Assessment and its Objectives

A rapid assessment of the Chitwan-Annapurna Landscape was conducted to provide a broad overview of the general environment including hydrology, watersheds and ecosystems; vulnerability and adaptation of people and ecosystems to climate change; and potential for payments for environmental services. The assessment has taken into account changes in land use/land cover, forest governance arrangements, current and planned infrastructure projects, options and opportunities for economic development and livelihood enhancement including green enterprises and tourism, and the status of gender and social inclusion in the management of natural resources.

Two more in-depth studies were carried out in parallel to the assessment by members of the same study team. One identified biodiversity rich areas, biological corridors and climate refugia, and outlined biodiversity threats. The other identified drivers of deforestation and forest degradation. The findings of these three studies are expected to provide a foundation for the work of Hariyo Ban Program and others.

2 Methodology

The study was primarily based on analysis of secondary data and information collected through reviews of relevant literature and secondary data available from different government agencies. Consultations with key stakeholders and individual experts in Kathmandu, districts, and selected rural communities within the landscape formed the major sources of primary data. Information on land use/land cover was primarily obtained from analyses of Landsat satellite images. Both qualitative and quantitative methods were used in data analysis. The following sections provide a brief overview of the methods used in data collection and analysis.

2.1 Literature Review

Relevant literature, including agency reports and reliable material available on the internet, was collected and reviewed to gain knowledge of the bio-physical situation, and the condition of natural resources, including major ecosystems, hydrological systems, watersheds, forests, biodiversity and agro-ecosystems. The assessment team also collected and reviewed, among others, literature related to infrastructure, demography and livelihoods, gender and social inclusion, management and use patterns of different natural resources, and impacts of climate change on the resources and livelihoods of the local people in the landscape.

2.2 Collection and Analysis of Secondary Data

Long-term monthly temperature and precipitation data purchased from the Department of Hydrology and Meteorology were used to analyze trends in temperature and precipitation during the last three decades. Other secondary data collected and used in the assessment included demographic and socio-economic data available in the district profiles; community forests and leasehold forests' handover and forest encroachment data available in the Department of Forests; watershed-related data available in the Department of Soil and Water Conservation; and data on road networks and irrigation systems collected from the Department of Roads and the Department of Irrigation.

2.3 Consultations

2.3.1 Consultations in Kathmandu

Consultations with selected government ministries and departments, INGOs, national NGOs, and civil society groups based in Kathmandu took place through informal meetings to pursue specific lines of enquiry such as policies, strategies, programs, projects, future plans, governance and issues related to management of the landscape and its natural resources. Individual experts in various disciplines were consulted on theoretical and technical aspects of landscape management. Relevant experts in the assessment team carried out the consultations. The list of agencies and individuals consulted is presented in Annex 2.1.

2.3.2 Consultations in districts

District level government line agencies, NGOs, civil society groups and other relevant agencies and individuals working in the landscape were consulted through day-long meetings organized in selected district headquarters (Pokhara, Beni, Tansen, Besishahar, Trishuli). For the purpose, the landscape was divided into five river basin clusters and relevant organizations and individuals from adjoining districts were invited to participate in the meetings. A detailed plan, including the river basins and districts included in each cluster, participating

organizations, meeting venues and dates is presented in Annex 2.2. The Hariyo Ban Program field team helped set up the meetings.

The district level meetings were useful in providing a general overview of the plans, programs, issues, challenges and opportunities related to management of natural resources (biodiversity, forest, land, soil, water etc.), local livelihoods, climate change (impacts and adaptation), and opportunities, challenges and threats associated with development of ecotourism and infrastructure in the landscape. In each meeting, the second half of the day was allocated for more structured focus group meetings to explore specific topics (such as to identify and prioritize the drivers of deforestation and forest degradation) using participatory analytical tools and techniques. Checklists were used to make the meetings efficient and objective oriented.

2.3.3 Community level consultations and field visits

A total of 17 community level meetings were organized with the purpose of collecting information on local level management issues, challenges and opportunities. Community Forest User Groups, Conservation Area Management Committees, mothers groups, Water Management Groups, local hoteliers, and micro-enterprises operators were the main groups consulted through these meetings. Group discussions, key informant interviews and other participatory rapid appraisal techniques were used to collect data and information on trends of changes in forest cover and biodiversity, opportunities and threats to biodiversity, local perceptions on drivers of deforestation and forest degradation, impacts of climate change and adaptation strategies of communities and households, governance, and gender and social inclusion related information relevant to the management of community forests, watersheds, protected areas and other natural resources. Separate focus group meetings were organized for women and other disadvantaged social groups in some sites. Checklists were used to make the meetings efficient and objective oriented.

While in the field, the assessment team directly observed and took notes and pictures of features and events of interest, such as invasion of alien species, good and bad land use and natural resource management practices, natural disasters, forest encroachments, and microenterprises in and around the travel routes and visited communities and places. These activities greatly helped enhance the team members' understanding of the landscape features and status of natural resources management in different parts of the landscape.

2.3.4 Interactions and coordination with Hariyo Ban Program staff

The assessment team worked closely with the Chief of Party and other relevant staff members of the Hariyo Ban Program throughout the study period. In the process, the team had at least five formal meetings with the program management and thematic coordinators. In addition, there were several formal and informal communications between different experts in the assessment team and relevant staff in the Hariyo Ban Program. Those communications helped ensure common understanding of the major issues, and content and quality of the reports to be produced. The team also made efforts to coordinate with the study teams of the baseline study and the report on Promoting Community Managed Ecotourism in CHAL and TAL, respectively, which were being carried out in parallel to this study.

2.4 Acquisition, Processing and Analysis of Spatial Data

The main data used in this analysis included Landsat Thematic Mapper images (TM image) and Landsat Enhanced Thematic Mapper Plus satellite images (ETM + image). The images were downloaded free of cost from the Earth Resource Observation System Data Center of the United States Geological Survey website. Five scenes each were acquired for the years 1990, 2000 and 2010 (total of 15 scenes) to cover the entire landscape (Annex 2.3).

The image scenes were ortho-rectified with the help of ground control points and a digital terrain model to remove the distortions arising from variations in topography, and projected into Universal Transverse Mercator zone 44 and World Geodetic System (WGS) 84 datum before classification. Classification was done through visual interpretation of the images. This was carried out due to limited available time for classification and insufficient ground truth data. A simplified flow diagram of the land use mapping and change detection procedure is shown in Annex 2.4.

A total of seven land use classes were considered in image classification, including forest, alpine meadow and scrublands, grassland, agriculture, ice and snow, sand and bare soil, and water body.

The selection of these classes was guided by the objective of the study and the expectation of a certain degree of accuracy in image classification. Relevant and suitable geographic information system (GIS) layers were overlaid with classified images to produce the required maps and to extract the associated statistics. Critical sub-watersheds/ micro-watersheds, major tourism destinations, and major infrastructure were identified and mapped in GIS environment.

2.5 Integrated Analysis and Synthesis of Key Findings

Integrated analysis of spatial and non-spatial data and information collected from different sources by using different methods as described in the preceding sections was carried out to assess conservation and development opportunities in the landscape. Some of the focuses of the integrated analysis were: (i) forest-biodiversity-livelihood linkages and opportunities, (ii) climate change impacts, vulnerabilities, and adaptation opportunities and strategies, (iii) scope and opportunities for integrated river basin management, (iv) opportunities for PES and REDD as means for forest conservation and livelihoods enhancement, and promotion of upland-lowland linkages, (v) scope and opportunities for the development of environment-friendly enterprises, and (vi) opportunities for model sites in the Hariyo Ban Program.

2.6 Presentation of Findings

The key findings of the assessment were presented in a landscape-level workshop organized in Pokhara. A similar workshop for central-level stakeholders was organized in Kathmandu. The feedback received from these workshops was used in refining the reports.

2.7 Limitations

There were some limitations to the study. The satellite images used in the classification and analyses of land use had three major limitations: (i) relatively low spatial resolution (30m), (ii) poor quality caused by the presence of shadows and cloud in parts of the images, and (iii) wide seasonal variations (September to December) among the image scenes used. The limitation in terms of available time did not allow for the collection of a sufficient number of image samples and the classification of these samples for training purposes in the field. Google Earth images could not provide a clear idea of land use, particularly for mountain areas. The results of the land use classification presented in this report can therefore provide only a rough approximation and should not be used as the basis for operational planning. For a more detailed and more accurate classification of land use and land cover, higher resolution images (e.g. WorldView-2 or RapidEye) should be used.

The time available for the assessment had a direct influence on the level of in-depth exploration and analysis of different thematic areas and issues. Experts in the assessment team were from different backgrounds and with different levels of experience, which posed some challenges in coordination. Notwithstanding these limitations, it is hoped that the findings will contribute to better understanding the landscape and provide a foundation for future work by the Hariyo Ban Program and other stakeholders.

Overview of Chitwan-Annapurna Landscape

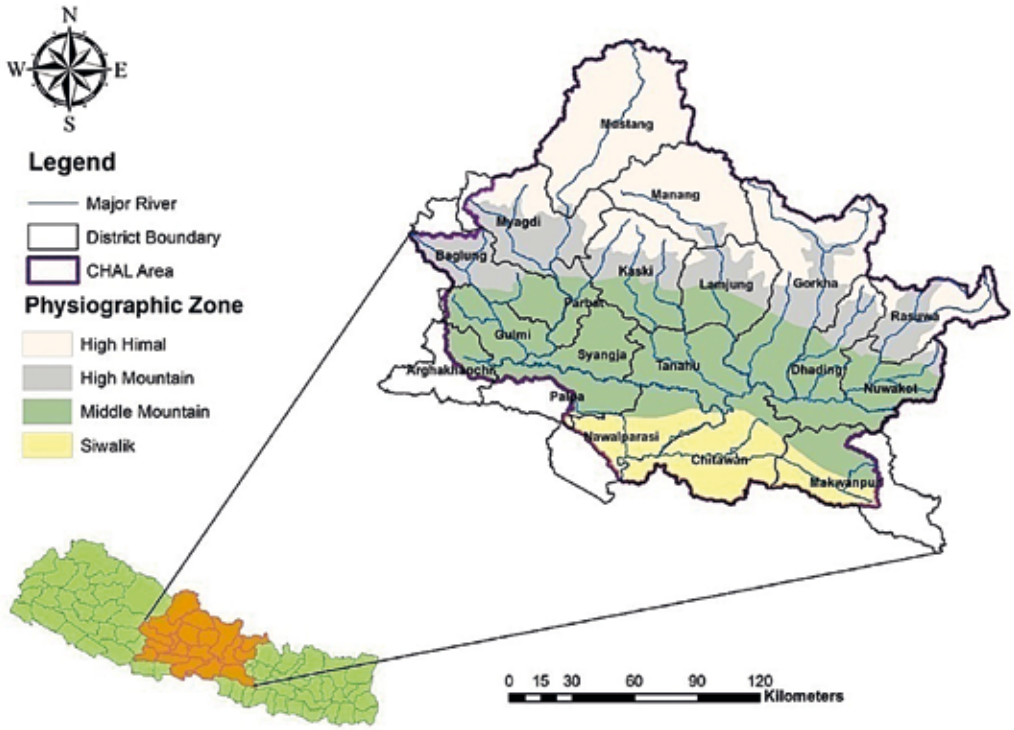
3

3.1 Location and General Environment

The Chitwan-Annapurna Landscape (CHAL) is located in central Nepal between 27035' and 29033' N latitude and 82088' and 85080' E longitude, covering an area of 32,057 square kilometers. Elevation ranges from approximately 200 m to 8,091 m (Mount Annapurna) above sea level. The landscape includes all or part of 19 districts (Dhading, Nuwakot, Rasuwa, Makanpur, Chitwan, Nawalparasi, Tanahu, Lamjung, Gorkha, Manang, Mustang, Myagdi, Kaski, Syanja, Parbat, Baglung, Palpa, Gulmi and Argakhachi). The landscape is drained by six major perennial rivers, namely, Kali Gandaki, Seti, Marsyangdi, Budhi Gandaki, Trishuli and Rapti and the tributaries of the broader Gandaki River system (Figure 3.1).

CHAL experiences a wide range of climates, ranging from subtropical in the lowlands of Chitwan and Nawalparasi districts to alpine in the high mountains and the cold dry climate of the trans-Himalayan in parts of Mustang district. The varied topography, elevation and climatic conditions have contributed to making the landscape one of the key areas in Nepal in terms biodiversity and water resources.

Figure 3.1 ▌Chitwan-Annapurna Landscape in Central Nepal



(Source: Present study; Department of National Parks and Wildlife Conservation)

TABLE 3.1 ▌Physiographic zones in Chitwan-Annapurna Landscape

Zone	Coverage (ha)	Percent Coverage
High Himal	1,029,239	32.1
High mountains	599,849	18.7
Midhills (sometimes known as middle mountains)	1,210,954	37.8
Siwaliks	365,667	11.4
Total	**3,205,709**	**100**

(*Source: GIS analysis of the present study*)

3.2 Physiography

Physiographically, the landscape can be divided into four major zones, including the *Siwaliks*, midhills or middle mountains as they are sometimes known, high mountains, and high Himal (Land Resource Mapping Project (LRMP), 1986; Figure 3.1; Table 3.1). A few small patches of Terai/Inner-Terai areas in the districts of Nawaparasi and Chitwan, which fall within the landscape, have been considered as part of the Siwaliks zone in this study.

The Siwaliks zone (also known as *Chure*) in the southern most part of the landscape (to the north of the Terai belt), consist of steep hills of unstable geomorphology primarily composed of sedimentary rocks and big boulders, and their foothills. The zone experiences tropical and sub-tropical climatic conditions, and provides numerous ecological services, including prevention of soil erosion, recharging ground water for the plains, and preventing natural disaster such as flash floods.

The midhills lie between 600-3,500 m and have a sub-tropical to temperate monsoonal climate and are characterized by intensive farming on hillside terraces. The midhills also includes the densely populated Pokhara Valley. The zone is characterized by a great variety of terrain types and climatic zones.

The high mountains zone is located between the midhills and high Himal and can be characterized by high steep slopes, deep gorges and cold temperate climate.

The high Himal zone, located above 4,000m, comprises sub-alpine and alpine climates and associated vegetation types. Summer grazing pastures are common in lower elevations while high altitude plant species adapted to extremes of cold and desiccation are found at higher elevations. Heavy snowfall occurs in these areas during winter months. Above 5,500 m, the Himalayas are covered with perpetual snow and no vegetation. The zone also includes some dry inner-Himalayan valleys and treeless plateaus in the upper catchment of the Kali Gandaki River. The physiographic zones closely correspond to the six-category bio-climatic classification of vegetation by Dobremez (1970).

3.3 Geology and Soils

Geological composition in CHAL varies across the physiographic zones. The total thickness of the rock strata of the Kaligandaki Basin sequence is between 6,000 m and 7,000 m. This sequence comprises lower, middle and upper sections. The thickness of the lower sequence is 1,400 m, which increases continuously upward and reaches 5,000 m in the Marsyangdi Basin. The thickness of the middle and upper sequence is 3,500 m and 3,000 m, respectively (Le Fort, 1975). The major rock types are schist, gnesis, and marble and quartize in the Kaligandaki section. The Trishuli Basin in the Nuwakot Complex contains no crystalline rocks but only meta-sediments of low metamorphic grade (Stocklin and Bhattarai, 1977). The Nuwakot Complex consists of pelitic and calcareous meta-sediments rarely exceeding sericite-chlorite grade. The age of the complex ranges from Late Precambrian to Late Paleozoic (LRMP, 1986).

The geology of the Trans-Himalayan region is fragile with formations of alluvial, colluvial and morainal depositional surfaces and steeply to very steeply sloping mountain terrain (LRMP, 1986). Ammonites (*saligram*) and fossilized mollusks, which are considered key fossils from the evolutionary biology point of view, are commonly found in this region (Upreti et al., 1980). The age of rocks found in the high Himal is Precambrian to Mesozoic. Radiometric dating suggests that the granite found in this region was intruded in the Tertiary period (MoEST, 2008).

The geology in the high mountains and midhills is relatively stable as compared to the other physiographic zones, and is mainly composed of gneiss, quartzite, mica schist, phyllites, limestone and some granite (MOEST, 2008). The inner valleys of the Marsangadi, Madi, Seti and Trisuli Rivers are composed of stable, older alluvial deposits, which are suitable for crop production.

The Siwaliks have the youngest geological formation, which is fragile and prone to soil erosion. The dominant lithology is composed of very young sedimentary rocks, i.e. mudstone, sandstone, shale and conglomerate (Dahal, 2005). The lower Siwaliks basically consist of fine-grained, hard, red, ash-grey and reddish-brown sandstone with pseudo

conglomerates containing pebbles of clay and shale. These sediments are derived from higher and lesser Himalayan rocks (LRMP, 1986). The inner Terai valleys of Chitwan and Nawalparasi Districts are composed of quaternary alluvial deposits.

The dominant soils in the high mountain and Siwaliks generally have sandy to sandy-loam texture with low fertility and shallow depth. The highly rugged mountainous terrain coupled with high monsoon rains has resulted in a high level of soil erosion and nutrient loss. Soils in the midhills are moderately to slightly acidic, medium to light-textured, coarse grained, sand to sandy-clay-loam. The more stable landscapes (such as the valleys and flat areas in the midhills) have silty-clay-loam (Pokhara Valley) to fine textured clay soils (Raginas *tar*, Lamjung and Madi Valley, Palpa). The river valleys have alluvial deposits with sandy-clay-loam to loamy texture, which are highly suitable for agriculture.

Inceptisol and entisol are the dominant soil types throughout the landscape (LRMP, 1986; Carson 1992). These soils are young and developed from colluvial or alluvial deposits (such as in the Kali, Madi, Seti, and Trisuli River Valleys) and Inner Terai and steep mountains. There are some patches of mature landscape where alfisols with a well developed soil profile are found (some parts of Chitwan Valley and flat areas in the midhills). The dominant soil textures in the high mountains and midhills are sandy to sandy loam, silty loam, sandy loam, sandy clay and silty clay and sandy clay and clay. Soils in the Siwalik hills are predominantly sandy to sandy-loam in texture and are shallow in depth. The alluvial deposits found in the flat areas in Chitwan and Nawalparasi districts are composed of sandy-clay-loam to fine-textured soils, which are moderately fertile. Clay is common in Chitwan National Park (Carson, 1992).

The majority (59%) of the agriculture soils in the landscape are acidic, low in soil organic matter (SOM) and nitrogen, light in texture with low water holding capacity. The soils in Chitwan District are neutral to slightly acidic, medium to low organic matter content, medium in soil available potassium, low in soil available phosphorus, low to medium in total soil nitrogen and high bulk density, which are highly suitable for agricultural intensification with improvement in soil fertility (Karki and Dahal, 2009).

3.4 Climate

Many different types of climate are found in CHAL, ranging from alpine cold semi-desert (in the trans-Himalayan zone of Upper Mustang) to sub-tropical humid in the lowlands of the Siwaliks (Table 3.2). This is due to high variations in elevation and topography from north to south across the landscape. The climate is predominantly influenced by three major factors, namely the Himalaya mountain range, monsoons, and westerly disturbances, and is characterized by four distinct seasons: pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and winter (December-February) (Water and Energy Commission Secretariat (WECS), 2011).

The average minimum and maximum reported temperatures are 4.9°c and 39.9°c, respectively. The mean temperature is above 25°c in the Siwaliks and about 20°c in the middle hills. The average temperature in the high mountains lies between 10°c to 20°c (MoE, 2011). The average annual rainfall ranges from 165 mm at Lomanthang (Mustang) to 5,244 mm at Lumle (highest rainfall in the country; near Pokhara, Kaski). Orographic effects cause high spatial variation in precipitation across the landscape. Nearly 80 percent of the total annual precipitation occurs during the monsoon season between June and September (Practical Action, 2010).

The small amount of winter precipitation is marked by occasional, short rainfall in the Siwaliks and midhills and snowfall in high altitude areas. The winter snowfall in the Himalayas is important for generating sufficient volume of spring and summer melt waters, which are critical for irrigation in the lower hills and valleys where agriculture predominates. District-wise information on climate and water resources is presented in Annex 3.1.

TABLE 3.2 ▌Climate in different physiographic zones of CHAL

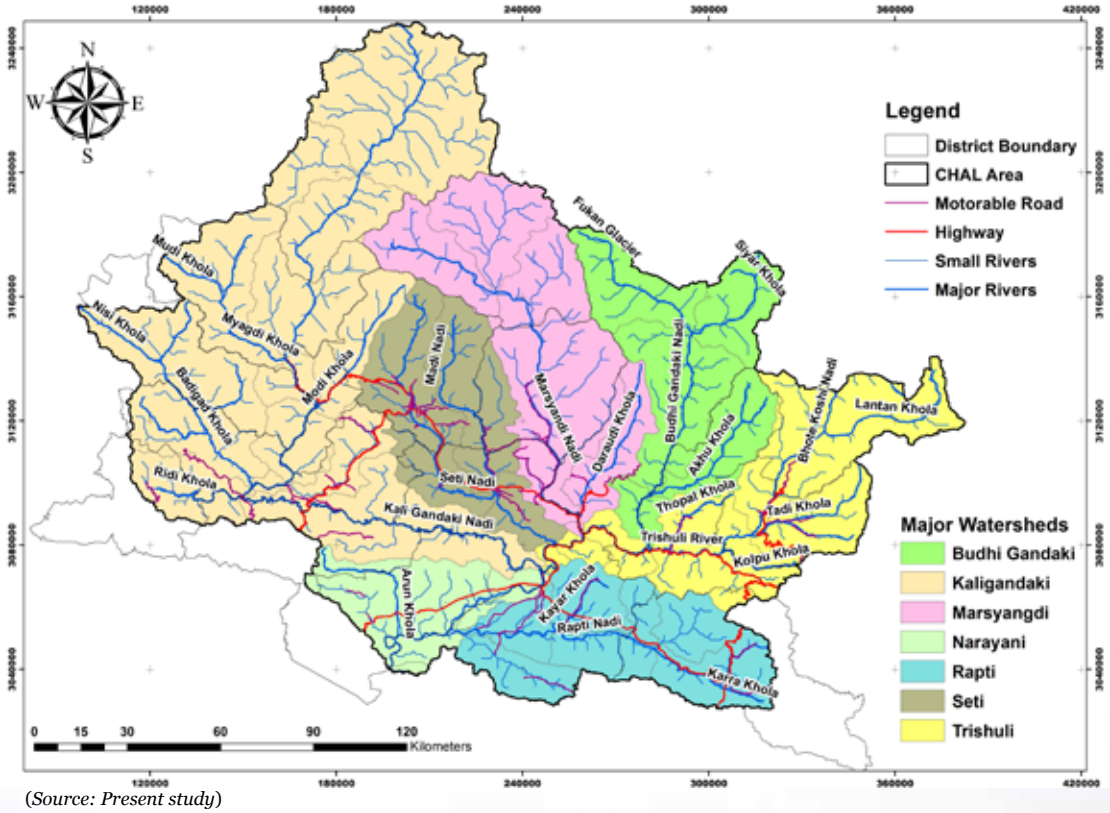
Physiographic Zone	Climate	Average Annual Precipitation (mm)	Mean annual Temperature (°C)
High Himal and high mountains	Arctic/alpine/ sub-alpine	150-200	<3-10
Midhills	Cool/warm	275-2,300	10-20
Siwaliks	Tropical/sub-tropical	1,100-3,000	20-25

(Source: Adapted from Water and Energy Commission Secretariat, 2011)

3.5 Major Rivers and Sub-basins

Kali Gandaki, Seti, Marsyangdi, Budhi Gandaki, Trishuli, and Rapti are the major tributaries of the Gandaki River, which divide CHAL into six major sub-basins (Figure 3.2). Table 3.3 provides a brief description of each of the rivers and further details, including that of the tributaries, are presented in Annex 3.2.

Figure 3.2 ▌Major sub-basins of the Gandaki River System



(*Source: Present study*)

Confluence of Trishuli (right) and Seti Rivers at Gaighat

Photo by: Ambika Gautam

TABLE 3.3 ▌Major sub-basins of the Gandaki River Basin

S. No.	River/Sub-basin	Catchment Area (sq. km.)	Main Characteristics
1	Kali Gandaki	4,618 (at the dam site of Kali Gandaki A hydropower)	Enters Nepal at Photu Pass as Muktinath *Khola*; total length in Nepalese territory is about 300 km; passes through an approximately 548m long gorge, the deepest in the high mountain zone, which practically separates the eastern and western Himalaya high mountain ecosystems; exhibits high fluctuations in average annual flow.
2	Seti	600	Originates from glaciers in the Annapurna range and flows through Pokhara city in a deep gorge, disappearing almost underground for some distance. Total length is 112.7 km; joins Trishuli River at Gaighat.
3	Marsyangdi	2,055	Originates from the south-eastern flank of Muktinath Himal as Jargung Khola and joins Trisuli River at Mugling. Total length is 145 km.
4	Budhi Gandaki	2,960	Originates from Tibet and flows south-west and then south-east as Siringi Khola and drains the eastern slopes of Manaslu and the Ganesh Himal. Total length is 145 km. It joins the Trisuli River upstream of Mugling.
5	Trishuli	1,856	Trishuli originates from Tibet and enters Nepal by crossing the Rasuwa Pass; total length before it joins Kali Gandaki at Devghat is 130 km.
6	Rapti	3,110	Originates at Chisapani Gadhi in Makawanpur District and flows through a fertile valley of Makawanpur and Chitwan districts before joining the Gandaki River. Length is around 122 km.

(*Source: Sharma, 1977*)

The volume and source of water in all these rivers varies substantially during the winter and summer months. For about eight months, most of the rivers and streams derive water from snow melt and groundwater discharge, and for the rest of the period monsoon rains form the major source. During the high monsoon season, the rivers turn violently swollen with floodwater that is laden with sediment. Maximum monthly rainfall and maximum monthly runoff normally occur during the months of July and August respectively, thus showing a time lag. High flows are maintained throughout September and October. Overall seasonal distribution of runoff is influenced by the base flow and snow melt.

Kali Gandaki Gorge at Dana (high mountain), Myagdi

3.6 Demography and Socio-economy

The total population of the Chitwan-Annapurna landscape in 2001 was around 4.3 million, which grew with an average annual rate of 0.41 percent over the last decade (CBS, 2011 and Annex 12.1). The average family size in 2011 was 4.21, which is lower than Nepal's average (4.7). Most of the districts (except Chitwan, Makawanpur, Kaski, Tanahu, Nawalparansi, Palpa and Baglung) had negative population growth during the last decade. The main reason could be the migration of people from the mountains to valleys and the Inner Terai in search of better livelihood opportunities. The male and female literacy rates are 68 percent and 51 percent, respectively. The population growth rate (1.64%) and literacy rate are highest in the Seti River Basin as compared to the other areas.

Agriculture and tourism are among the major economic activities. Remittances, which contribute almost half (46%) of the average household income, have become the most powerful economic force to transform rural life and livelihoods. Agriculture (including livestock), salaried jobs, tourism related business, forestry and wage labour are other major sources of income for rural households. There is a high level of inequality in access to land, which has compelled the poor to look for alternatives to farming, usually in cities but also abroad.

Participation of women and other marginalized groups in natural resources management and other community development activities has been increasing over the years. Nevertheless, there is a gap in the process of participation, assigning clear roles and responsibilities, transparency in work and equity in benefiting sharing.

4 Ecosystems

Forests, rangelands, wetlands, and agro-ecosystems are the major groups of ecosystems in the landscape. There has not been a comprehensive CHAL-level study to identify and document ecosystems within each of these ecosystem categories. However, some of the well known country level studies include: (i) forest ecosystem classification (35 forest types, classified into 10 major groups) based on climate, vegetation and floristic composition; carried out by Stainton (1972); (ii) identification of six levels of bio-climatic zones, 118 ecosystems and 75 vegetation types by Dobremez (1970; 1976); and (iii) grouping of the country's vegetation types into 118 categories by the Biodiversity Profiles Project (1995). In general, forests are relatively well known as compared to aquatic and agro-ecosystems.

4.1 Forest Ecosystems

The Chitwan-Annapurna Landscape had a total of 1.14 million hectares (35.5% of the landscape area) of forest in 2010. There are variations in forest cover, forest vegetation, and trends in forest cover across the four physiographic zones. The Siwaliks harbor economically valuable forests including Sal (*Shorea robusta)* dominated forests. This zone had 58.1 percent of land under forest cover in 2010. The midhills had 42.7 percent under forest. The forests in this zone are scattered, intermixed with settlements and agricultural land, and valued primarily for meeting the livelihood and subsistence needs of the local population. The high mountain zone had around 59.6 percent forest cover, and the high Himal (including the trans-Himalayan zone) had 4.8 percent forest cover in 2010 (Table 4.1).

One of the early studies that has been widely used as a basis for classifying forest ecosystems in Nepal was carried out by Stainton (1972) who developed phyto-geographic boundaries based on climate, vegetation and floristic composition. He classified the country's forests into ten major groups, including tropical; subtropical broad-leaved; subtropical conifer; lower temperate broad-leaved; lower temperate mixed broad-leaved; upper temperate broadleaved; upper temperate mixed broadleaved; temperate coniferous; sub-alpine, and alpine scrub forests. Following Stainton (1972), the forest vegetation of CHAL can be classified into the following major categories:

Tropical forests occur in the Siwaliks where the main tree species include *Shorea robusta*, *Terminalia* spp., *Adina cordifolia*, *Lagerstomia parviflora*, *Bombax ceiba*, *Albizzia* spp., *Eugenia jambolana*, and *Anogiessus latifolia*. *Acacia catechu* and

TABLE 4.1 ▌Forest area in Chitwan-Annapurna Landscape in 2010

Physiographic Zone	Area (ha)	Forest Cover	
		Area (ha)	Percent
High Himal	1,029,239	4,9813	4.8
High mountains	599,849	357,392	59.6
Midhills	1,210,954	516,891	42.7
Siwaliks	365,667	212,614	58.1
Total	3,205,709	**1,136,710**	35.5

(*Source: Present study*)

Dalbergia sissoo, and *Bombax ceiba* are commonly found in riverine forests. The vegetation along the riversides and marshlands of the Chitwan Valley and adjoining lowlands are characterized by a mosaic of tall alluvial floodplain grasslands (mainly *Saccharum* spp., *Narenga porphyrocoma*, *Themada* spp., and *Phragmites karka*), savannas and forests of *Eugenia jambolana*, *Bombax ceiba*, *Trewia nudiflora*, and *Mallotus philippensis*.

Subtropical broad-leaved evergreen forests occur mainly in the eastern half of the landscape between 1,000 m and 2,000 m and are dominated by *Schima wallichii* and *Castanopsis indica*. Riverine forest of *Cedrela toona* is common along the river valley sides of the Kali Gandaki and its tributaries. *Alnus nepalensis* is widespread along streams and moist places.

Subtropical conifer forest is dominated by *Pinus roxburghii* and occurs mainly on the southern dry slopes.

Lower temperate mixed broad-leaved forests are generally confined between 1,700 m and 2,500 m in the moister north and west-facing slopes, with several tree species belonging to the Lauraceae family. *Castanopsis tribuloides*, *C. hystrix* and *Quercus lamellosa* are the main tree species in these forests.

Upper temperate broad-leaved forests are found in drier south-facing slopes between 2,200 and 3,000 m. *Quercus semecarpifolia* is the main tree species in these forests, except in higher rainfall areas such as the hills to the north of Pokhara. The moister north- and west-facing slopes between 2,500 and 3,500 m are dominated by *Acer* spp. and *Rhododendron* spp.

Temperate coniferous forests are commonly found between 2000 and 3000m and are mainly comprised of *Pinus wallichiana*, *Abies spectabilis*, and *Picea smithiana*. Patches of luxuriant *P. wallichiana* forests are found along the Kali Gandaki River Valley in lower Mustang. *Larix himalaica* (Langtang larch) forest occurs in the Langtang and Budi Gandaki valleys, and favors glacial moraine habitats. *Cupressus torulosa* and *Tsuga dumosa* are other common tree species between 2,130 and 3,340 m. *Larix nepalensis*, the only deciduous conifer in the region, is found in Langtang National Park and surrounding areas (Stainton, 1972). Sub-alpine forests occur between 3,000 and 4,100 m and are mainly comprised of small and generally ill-formed trees of *Abies spectabilis*, *Picea smithiana*, *Betula utilis*, and *Rhododendron* spp.

Alpine scrub and meadows occur between the treeline (around 4,000 m) and snowline (around 5,500 m) in the eastern part of the landscape (to the east of the deep Kali Gandaki Gorge). This is a part of the Eastern Himalayan Alpine Scrub and Meadows ecoregion that supports one of the world's richest alpine floral diversities (Mittermeier et al., 2004). Varied associations of *Juniperus* spp. and *Rhododendron* spp. are the main scrub vegetation in this region. These alpine meadows, which display spectacular colorful flowers of alpine herbs during the spring and summer, are heavily grazed during summer and rainy seasons. *Caragana versicolor*, *Lonicera spinosa*, *Rosa sericea* and *Sophora moorcroftiana* are found in areas north of the Dhaulagiri-Annapurna massif (Stainton, 1972).

4.2 Rangeland Ecosystems

Rangeland ecosystems are comprised of grasslands, pastures and scrublands, which are distributed all over the landscape ranging from the tropical savanna in the Chitwan Valley to the sub-alpine grasslands in the high mountain region and alpine meadows above the treeline. The tropical grasslands found in the Chitwan Valley are characterized by a mosaic of tall riverside grasslands (mainly *Saccharum* spp.), with savannas and broadleaf forests of evergreen and deciduous species (such as *Eugenia jambolana, Bombax ceiba*, *Trewia nudiflora*, and *Mallotus philippensis*). These savannas and grasslands are excellent habitat for Bengal tiger, rhino (*Rhinoceros unicornis*), and gharial crocodile (*Gavialis gangeticus*).

The high mountain grasslands and alpine meadows that cover a broad area in the eastern part of the landscape (e.g. Langtang National Park) are exceptionally rich in floral diversity, including numerous species of alpine herbs with colorful flowers. Varied associations of *Rhododendron* spp. and *Juniperus* spp. are found scattered across the meadows. These grasslands are also very rich in faunal diversity, and are home to the endangered snow leopard, Himalayan goral (*Naemorhedus baileyi*), serow (*Capricornis sumatraensis*) and Himalayan tahr (*Hemitragus jemlahicus*).

In spite of the fact that the grasslands are rich in plant diversity, including diversity of economically important medicinal and aromatic plants, they are some of the least studied ecosystems in Nepal (NBS, 2002). The alpine meadows are heavily grazed during summer and rainy seasons. Overgrazing and trampling by large herds of livestock

(especially yak) and the unregulated commercial harvest of medicinal plants are the main threats to biodiversity in this region. Conversion of the grasslands and savannas to agriculture is the major threat to the tropical grasslands.

4.3 Wetland Ecosystems

The wetland ecosystems of CHAL fall into two broad categories: (i) natural wetlands, comprising of lakes and ponds, riverine floodplains, swamps, and marshes, and (ii) man-made wetlands, including water storage areas, ponds and deep-water agricultural lands. Two of the wetlands, including the Beeshazari Lake system located in Barandabhar biological corridor, Chitwan (27° 37'N, 084° 26'E), and Gosaikunda and associated lakes located in Langtang National Park (28°05'N 085°25'E) have been listed as Ramsar Sites (in 2003 and 2007, respectively). Beeshazari and associated lakes cover 3,200 ha, and Gosaikunda and associated lakes (including Bhairavkund and Surajkund) cover 1,030 ha. Two other wetlands, including Sundaha, and Warmi-Paarmi located in the Dhorpatan Hunting Reserve, are known to have been recently surveyed for possible inclusion in the Ramsar list.

Pokhara Valley has nine major lakes, namely Fewa (443 ha), Begnas (37 ha), Rupa (115 ha), Khaste (13.57 ha), Dipang (8.96 ha), Gunde (4.98 ha), Neurani (2.83 ha), Maidi (1.17 ha) and Nandi. Tilicho in Manang is another important lake in the landscape. Some other wetlands that need further exploration include: the Thada Daha in Arghakhanchi; Prabhas, Satywati, Suke, and Madi in Palpa; Banunna Ghol (north of Daunne) and Kudiya in Nawalparasi; Kali Gandaki reservoir at Mirmi, Panchase Lakes, Jagdi and Aandhi Khola in Syanja; Nine Lakes in Kaski; Damodar Kunda in Upper Mustang; Tilicho Lake and Bhu Chhort in Manang; Dudh Pokhari in Lamjung; Panchakanya (in Ratnanagar VDC), Lami, Tamor, Devi, Munda, and Thapaliya *Tals*, and Bhawanipur *Ghol* in Chitwan; Badigad, Kali Gandaki, Theule, Kathe, Jaidi, Hugdi, Nishi, and Bhuji Tals in Baglung; Barah, Bhale Basne and Khaira Baraha Tals (all three in Marchyang VDC), and the Myagdi River and Rahu Khola in Myagdi; and Kamini Daha and Rambhur Bhata in Parsa (within Parsa Wildlife Reserve). The list is not exhaustive, as exemplified by the fact that a total of 44 different sized lakes and ponds have been recorded inside the Chitwan National Park and its buffer zone alone (Annex 4.1; based on pers. comm. with Jhamak Karki, the Chief Warden).

Although there is no CHAL-specific information on the biodiversity of these wetlands, it is widely believed that they are biologically diverse and provide a wide range of goods and services as well as income-generating opportunities for the local people. Many endangered species such as the one-horned rhinoceros, wild elephant, *gharial*, and several species of waterfowl and fish are associated with the wetlands. Similarly, several species of amphibians, fish, and plants are believed to be endemic to these wetlands. Many ethnic groups are directly dependent on wetlands for their livelihoods.

The following are the major issues in the management of wetlands in CHAL:

Photo by Ambika Gautam

Beeshazari Tal (a Ramsar site) in the Buffer Zone of Chitwan National Park

(a) Encroachment: Wetlands are still regarded as wastelands by many and are often drained or reclaimed for agriculture and other use (industrial, urban expansion). In a study of 163 wetland sites across Nepal, International Union for Conservation of Nature (IUCN) (1996) found 43 percent of the wetlands suffering from some degree of drainage. The situation is expected to be similar in CHAL. The high population growth and migration from the hills and mountains have made the Terai wetlands particularly vulnerable to encroachment.

(b) Mining of water, sand and boulders: Excessive extraction of water for irrigation during the dry season and pumping wetlands dry for fish extraction are common problems, particularly in the lowlands of the Siwaliks. These activities have caused severe stress on aquatic life and undermined the natural resilience of many wetland ecosystems. Mining of sand and boulders for construction is a major problem in urban and semi-urban areas.

(c) Alteration of hydrological regimes: Construction of hydropower dams has a negative impact on the ecological integrity of many wetland ecosystems. Such structures cause inundation of important habitats, reduce downstream water flows, alter nutrients dynamics, and act as barriers to migration of species.

(d) Pollution and invasive alien plant species (IAPS): Quality and extent of many wetland ecosystems, including the famous Fewa Lake in Pokhara and Beeshazari Lake in the buffer zone of Chitwan National Park, have been severely affected due to eutrophication and invasion of alien species, including *Eichhornia crassipes, Ipomoea* spp., *Mikenia micrantha, and Lantana camara*. Excessive application of chemical fertilizers along with agricultural intensification, and untreated industrial effluent and domestic sewage and waste are the major sources of wetlands pollution, thereby causing eutrophication and excessive growth of alien weeds.

(e) Overharvesting and destructive fishing: High demand for wetland products, unclear tenure, and weak law enforcement have caused depletion of floral and faunal resources in some wetlands. Moreover, use of destructive harvesting techniques such as poisoning and use of explosives for fish collection cause unintended mass killing of aquatic species.

(f) Siltation and sedimentation: These cause degradation and fragmentation of habitats, and reduce the depth and area of lakes such as Fewa Lake.

Despite their high conservation and use value, wetlands have generally remained a neglected resource. More recently, however, there has been an increased interest in wetlands and some concrete measures have been taken towards conservation and sustainable management of at least some of the important wetlands. The implementation of the "Conservation and Sustainable Use of Wetlands in Nepal" (CSUWN) project by the MoFSC, with financial and technical supports from the United Nations Development Program (UNDP) and Global Environment Facility (GEF) is an example. This was a five-year (2006-2011) project.

The CSUWN project carried out an ecosystem evaluation of Fewa Lake in 2010. Moreover, the project's efforts to build national capacity and improve the legal and policy framework for an ecosystem approach to conservation and the sustainable use of wetlands are expected to have positive impact on the sustainable management of wetlands throughout Nepal (GON/UNDP-GEF, 2007).

4. 4 Agro-ecosystems

The diverse climatic and topographic conditions have enabled a high diversity of agricultural crops, their wild relatives, and animal species in the landscape. The major crops are rice, maize, wheat, millet, and potatoes, followed by sugarcane, barley, legumes, vegetables and fruits. There are differences in traditional cropping and animal husbandry systems across the landscape, to meet with the variations in climatic and physiographic conditions. These traditional farming systems, which use local indigenous knowledge and experience, are assumed to play a great role in maintaining the agricultural diversity. Diversity of horticultural systems is another important component, and there is an urgent need to document these traditional systems.

There have been a few initiatives towards *in-situ* conservation of agricultural biodiversity. Local Initiatives for Biodiversity, Research and Development, together with the Nepal Agricultural Research Council, and the International Plant Genetic Resources Institute have been implementing a project on on-farm conservation of agricultural biodiversity in Kaski and a few other districts since 1997. Some of the activities

under this project include: (i) assessing and demonstrating local crop diversity, (ii) deploying new diversity to farmers through "diversity kits", (iii) consolidating communities' role in the management of agricultural biodiversity through a Community Biodiversity Register, (iv) helping the establishment and management of community seed banks, (v) empowering local communities to manage agricultural biodiversity, (vi) promoting participatory plant breeding, (vii) promoting participatory landrace enhancement, (viii) promoting value addition of local crop diversity, (ix) holding traveling seminars to influence policy, (x) sensitizing farming communities through rural poetry, (xi) broadcasting rural radio programs, (xii) taking a multi-stakeholder partnership approach to on-farm agro-biodiversity management, and (xiii) undertaking intensive data plotting for understanding farmers' decisions on the management of agricultural biodiversity on-farm (Sthapit et al., 2006).

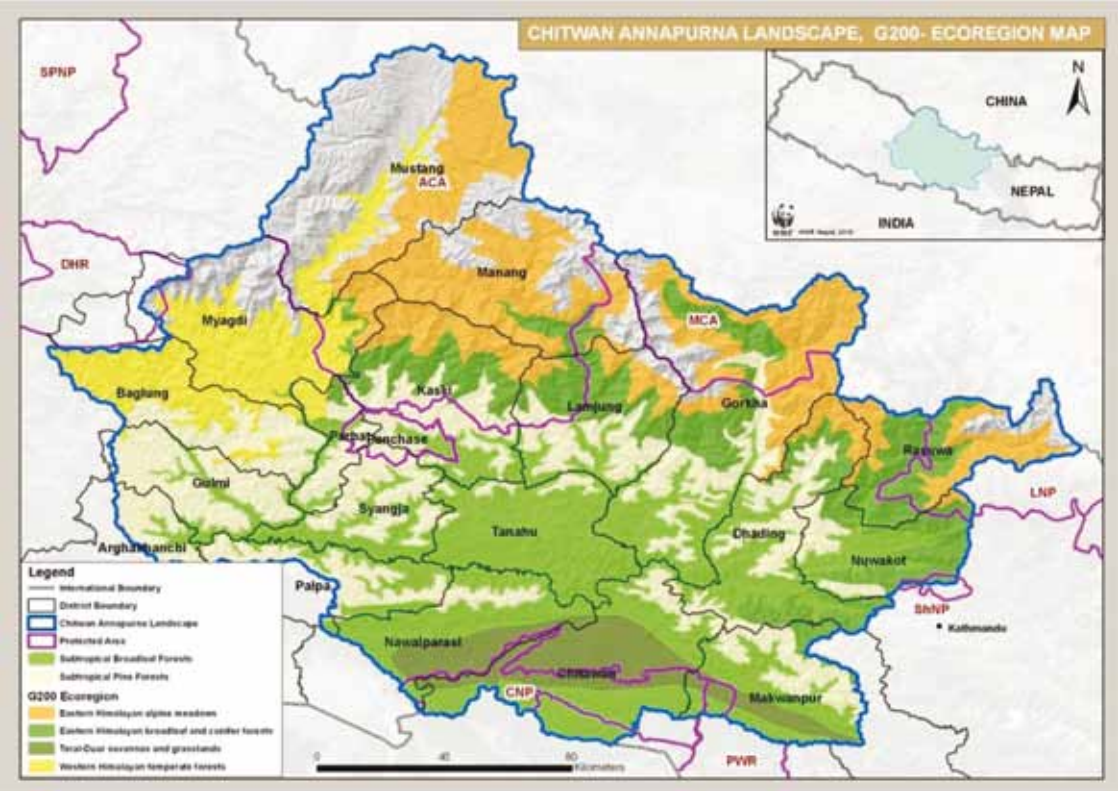
A pilot project on "Conservation and Management of Pollinators for Sustainable Agriculture through an Ecosystem Approach" was implemented in the recent past by the Institute of Agricultural Sciences, Rampur, Chitwan with financial support from the Food and Agriculture Organization of the United Nations (FAO). The project was mainly focused on: (i) survey and needs assessment of crops pollination, (ii) preparation of participatory training sessions, (iii) development of databases for pollination information and management systems, and (iv) preparation of draft management plans and inception reports (Jha et al., 2005). The status of the full-fledged project on the same theme, which was to be started from 2008 with FAO support, is unknown.

4.5 Ecoregions Representation

The Chitwan-Annapurna Landscape includes parts of four of the WWF's Global 200 ecoregions, namely: (i) the Eastern Himalayan Alpine Scrub and Meadows, (ii) the Eastern Himalayan Broadleaf and Conifer Forests, (iii) Terai-Duar Savannas and Grasslands, and (iv) the Western Himalayan Temperate Forests (Figure 4.1).

The **Eastern Himalayan Alpine Scrub and Meadows** ecoregion, which extends eastwards from the gorge of the Kali Gandaki River to Myanmar, supports one of the world's richest alpine floral diversities (Mittermeier et al., 2004). The main scrub vegetation in this region includes varied associations of *Rhododendron* spp. and

Figure 4.1 | Location and coverage of WWF Global 200 Ecoregions in CHAL



(Source: WWF)

Juniperus spp. The meadows display spectacular colorful flowers of alpine herbs during the spring and summer. The ecoregion is also very rich in faunal diversity. The endangered snow leopard, Himalayan goral (*Naemorhedus baileyi*), serow (*Capricornis sumatraensis*) and Himalayan tahr (*Hemitragus jemlahicus*) are some of the important mammals found in this region. Overgrazing and trampling by large herds of livestock (especially yak) and unregulated commercial harvest of medicinal plants are the main threats to biodiversity in this ecoregion. Human-wildlife conflict is a major threat to large predators (e.g. snow leopard).

The **Eastern Himalayan Broadleaf and Conifer Forests** range from around 900m to 3,900m and harbors very high floral and faunal diversities. Broadleaf evergreen trees occur at the lower elevations, and deciduous trees and conifer species occur at higher altitudes. The ecoregion has some 'floral hotspots' that harbor several endemic plant species. Red panda (*Ailurus fulgens*), clouded leopard (*Neofelis nebulosa*), and Himalayan black bear (*Selenarctos thibetanus*) are some flagship mammals found in this ecoregion, which is also home to hundreds of bird species, many of which are endemic to this region.

The **Terai-Duar Savannas and Grasslands** are characterized by a mosaic of tall riverside grasslands (*Saccharum* sp.), savannas and evergreen and deciduous forests. In CHAL, the ecoregion is represented by the grasslands and marshlands of the Chitwan Valley and adjoining lowlands. Tree vegetation comprises mainly of *Eugenia jambolana*, *Bombax* sp., *Trewia* nudiflora, and *Mallotus philippensis*. Sal *(Shorea robusta)* is the dominant tree species in drier and higher elevation areas. These savannas and grasslands are excellent habitat for several endangered species of mammal and reptiles, including tiger (*Panthera tigris*), rhino (*Rhinoceros unicornis*), and Gharial crocodile (*Gavialis gangeticus*). Conversion of the grasslands and savannas to agriculture and other uses is a major threat.

The **Western Himalayan Temperate Forests**, which occur between 600 and 3,800m in the western part of the landscape, can be further grouped into Western Himalayan Broadleaf Forests and Western Himalayan Sub-alpine Conifer Forests. Conifers such as *Pinus wallichiana*, *Picea smithiana*, *Abies pindrow*, and sub-alpine broadleaved species such as *Betula utilis* and *Rhododendron spp*. are some of the main tree species found in this region. Snow leopard, Himalayan tahr, and blue sheep (*Pseudois nayaur*) are some of the flagship mammals there. The ecoregion is also home to several species of pheasants and hundreds of other bird species. Illegal hunting and excessive harvest of NTFPs are the major biodiversity threats in the region. Government-managed forests also suffer from illegal logging and encroachment for agriculture expansion.

4.6 Biodiversity[1]

The Chitwan-Annapurna Landscape is well known for its floral and fauna diversity. The Siwaliks harbor several economically valuable tree species, including *Shorea robusta, Acacia catechu* and *Dalbergia sissoo*. The tropical grasslands and riverine forest ecosystem found in the Chitwan Valley host one of the last remaining populations of rhinoceros and tiger, with a high ungulate density and high number of carnivore species. Fifty-six species of mammals are recorded in Chitwan National Park alone (Department of National Parks and Wildlife Conservation (DNPWC), 2001). The Barandabhar Forest and wetlands of Chitwan National Park and its buffer zone are important bird areas that harbour around 540 bird species (Baral and Inskipp, 2005).

The *Schima-Castanopsis* forests found in the eastern part of the midhills sustain a high number of flowering plants, as well as many important species of wild animals including pangolin, monkeys, leopard, and several other small mammals, birds and reptiles. The broadleaf and conifer forests found in the eastern part of the high mountains harbor very high floral and faunal diversity, including several endemic plant species. Red panda (*Ailurus fulgens*), clouded leopard (*Neofelis nebulosa*), and Himalayan black bear (*Selenarctos thibetanus*) are some flagship mammals found in this region.

The sub-alpine and alpine meadows support one of the world's richest alpine floral diversities (Mittermeier et al., 2004), and are also very rich in faunal diversity. The endangered snow leopard, Himalayan goral (*Naemorhedus baileyi*), serow (*Capricornis sumatraensis*) and Himalayan tahr (*Hemitragus jemlahicus*) are some of the important mammals found in this ecoregion. The wetlands and diverse agro-ecosystems are other repositories of biodiversity.

1 A separate report prepared and submitted by the same assessment team gives a more detailed account of the biodiversity found in the landscape, including information on biodiversity rich areas and corridors, as well as biodiversity threats.

5 Land Use

5.1 Major Categories of Land Use/ Land Cover

In 2010 forest and agriculture were the main types of land use comprising 35.5 percent and 21.1 percent, respectively, of the total landscape area. Grasslands and scrublands combined occupied about 17 percent of the landscape, with about 10 percent of the landscape under snow and ice (Table 5.1; Figure 5.1).

5.2 Changes in Land Use/Land Cover

An analysis of changes in major land use/land cover in the landscape for the period 1990-2010 shows that the area under forest remained more or less stable during the period, while the area under grasslands substantially decreased and agriculture areas slightly increased. The changes in area covered by alpine meadows and scrublands did not show a clear trend (Table 5.2).

Table 5.1: Area under different land use/land cover in 1990, 2000 and 2010

Land Use Class	1990		2000		2010	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Forest	1,133,621	35.4	1,137,718	35.5	1,136,709	35.5
Alpine meadow/scrub	275,518	8.6	251,863	7.9	260,682	8.1
Grasslands	329,662	10.3	334,084	10.4	276,634	8.6
Agriculture	663,505	20.7	675,471	21.1	677,456	21.1
Snow/ice	286,467	8.9	469,907	14.7	304,150	9.5
Sand/bare soil	484,108	15.1	303,838	9.5	517,110	16.1
Water	32,829	1.0	32,829	1.0	32,969	1.0
Total	3,205,710	100	3,205,710	100	3,205,710	100

(Source: GIS analysis of the present study)

Table 5.2: Percent change in major land use/land cover between 1990 and 2010

Land Use Class	% Change in Land Use/Land Cover		
	1990-2000	2000-2010	1990-2010
Forest	0.4	-0.1	0.3
Alpine meadow/scrub	-8.6	3.5	-5.4
Grasslands	1.3	-17.2	-16.1
Agriculture	1.8	0.3	2.1
Snow/ice	64.0	-35.3	6.2
Sand/bare soil	-37.2	70.2	6.8
Water	0.0	0.4	0.4

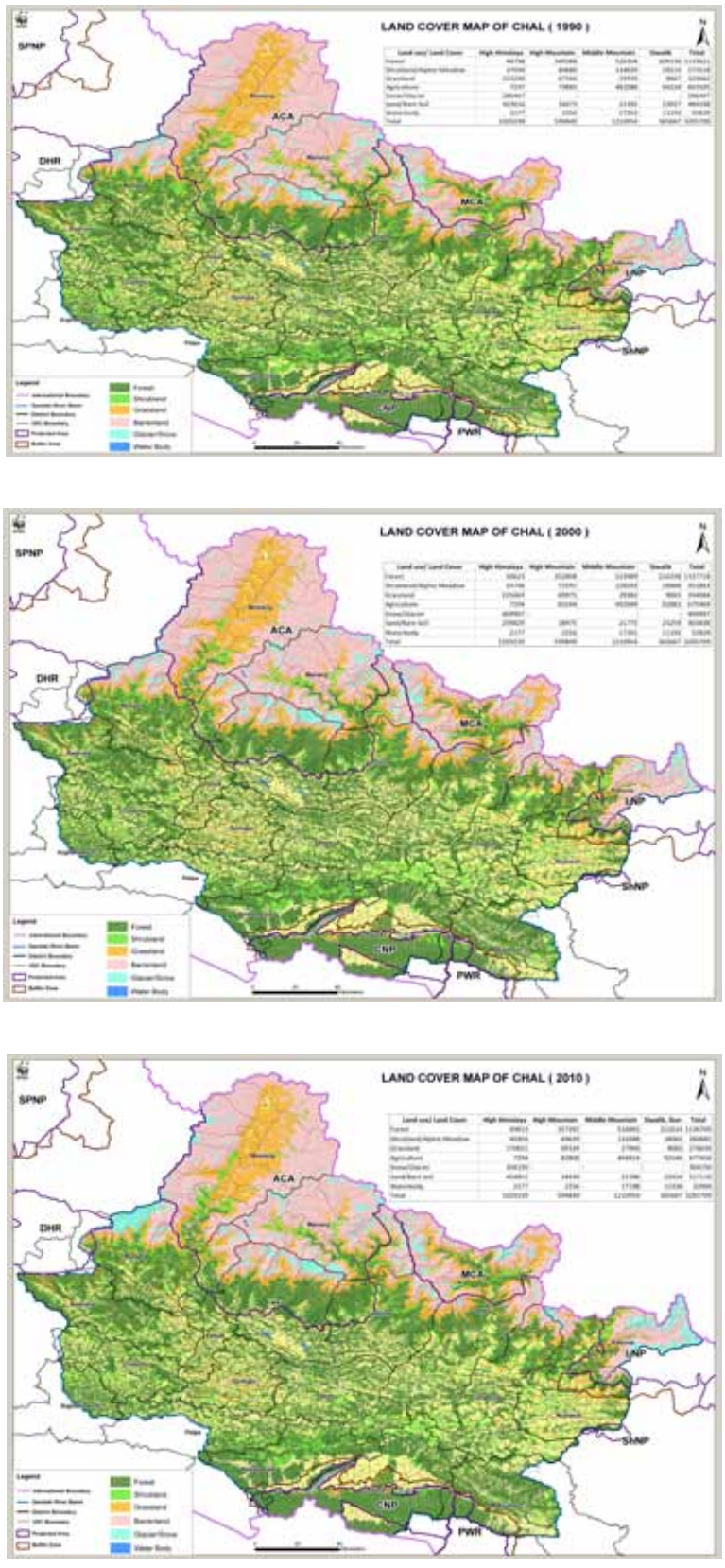
(Source: GIS analysis of the present study)

The finding that forest areas remained largely stable during the period does not mean that there was no change in the forests. Consultations and field observations provide clear evidence of substantial loss in forest area to infrastructure development, resettlement, urban expansion, and agriculture expansion in many parts of the Siwalik lowlands. Similarly, unregulated construction of rural roads has caused forest loss in many locations of the midhills, which has undermined the contribution of community forestry programs in improving forest cover and condition.

Forest cover inside the protected areas has increased in recent years. One clear example is Padampur, an enclave inside Chitwan National Park, which has been changed to forest after resettlement of an entire village of ethnic Tharus in 2004, under a controversial resettlement scheme. Forest regeneration during the period might also have taken place inside the Annapurna and Manaslu Conservation Areas, due, for example, to marginal agricultural land being abandoned because of decreased productivity and shortage of labor as a large number of rural youth temporarily migrated to foreign countries seeking employment.

The difficulty in identifying features during image classification might have caused some errors in land use classification. For example, the findings that areas under sand/bare soil decreased by 37.2 percent between 1990 and 2000 and increased substantially (70.2%) during 2000-2010 could simply be the result of misclassification caused by difficulty in separating bare soil from agriculture lands. Similar mis-classification might have resulted in some other land use classes (e.g. forest and alpine meadows/ scrublands). As discussed above, mapping of land use/land cover for mountain regions using Landsat images has its limitations. High resolution image data should be used for more accurate classification of land use/land cover, especially for large mountainous areas such as CHAL.

Figure 5.1 ▌Area under different land use/land cover in 1990, 2000 and 2010



(Source: Present study)

6 Forest Governance and Management

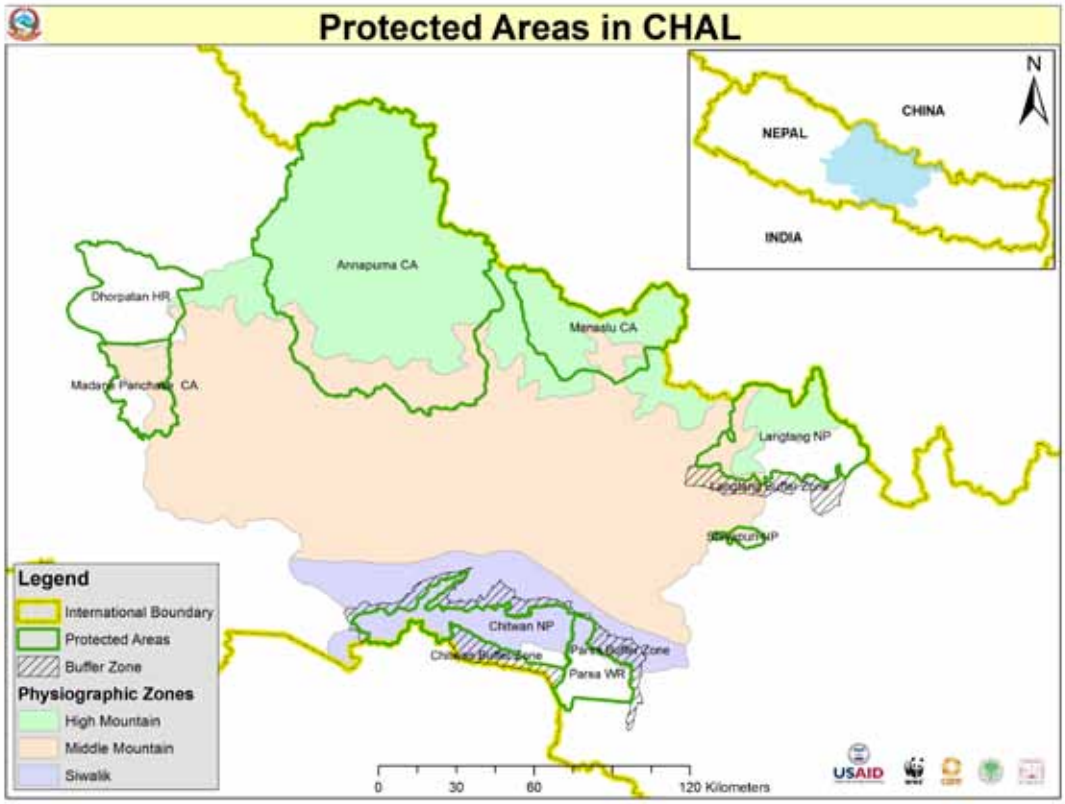
Forests in CHAL are under six types of governance regimes: (i) protected areas (including national parks, wildlife reserves, hunting reserves, and conservation areas), (ii) community forests, (iii) government-managed forests, (iv) protected forests, (v) buffer zone community forests, and (vi) leasehold forests.

6.1 Protected Areas

Currently around 1,124,300 ha (35%) of the landscape is under the protected area system that includes all or part of three national parks (Chitwan, Langtang and Shivpuri-Nagarjun), one wildlife reserve (Parsa), one hunting reserve (Dhorpatan), and two conservation areas (Annapurna and Manaslu). The protected areas spread over all the physiographic zones (Figure 6.1).

The protected areas are being managed under three main types of management modalities. The three national parks, Parsa Wildlife Reserve and Dhorpatan Hunting Reserve are exclusively managed by the Department of National Parks and Wildlife Conservation (DNPWC). The responsibility for the protection of the national parks and wildlife reserve is given to the Nepal

Figure 6.1 | Protected areas in Chitwan-Annapurna Landscape



(Source: Present study; Data source: Department of National Parks and Wildlife Conservation)

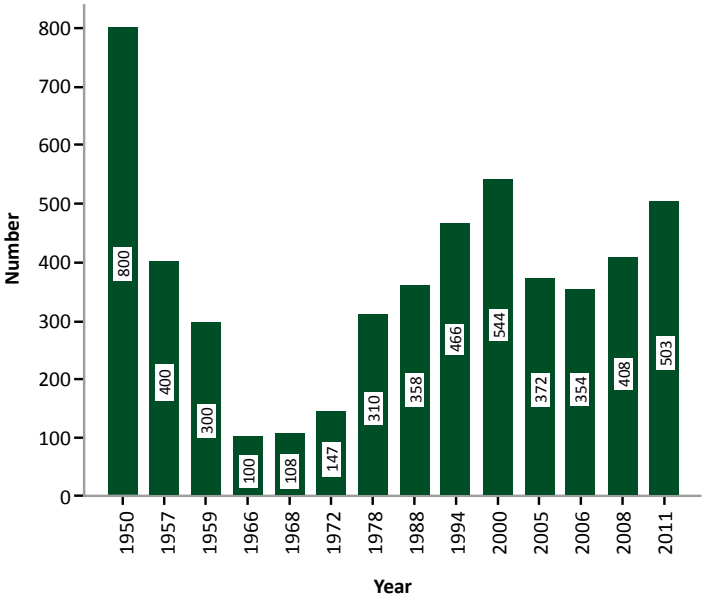
Army. Use of biological and other natural resources inside Chitwan National Park (CNP) and Parsa Wildlife Reserve is strictly prohibited, except for occasional opening of areas for collection of selected non-timber forest products. The rules of use in the mountain parks are slightly different and vary from place to place. For example, in Langtang National Park people can get permission to collect timber and fuelwood. The Annapurna and Manaslu Conservation Areas are managed by the National Trust for Nature Conservation (NTNC) under a multiple use policy. NTNC has established local committees to promote economically viable and ecologically sustainable activities in the conservation areas. Chitwan National Park, Parsa Wildlife Reserve, and Langtang National Park have declared buffer zones.

The protected areas are the key sites for *in-situ* conservation of the landscape's outstanding assemblages of plants, animals, and ecosystems. Chitwan National Park was included in the United Nations Educational, Scientific and Cultural Organization (UNESCO)'s List of World Heritage Sites in 1984 for its natural, cultural and landscape characteristics. Key information on each of the protected areas, including their conservation significance is presented in Annex 6.1.

The following are the main issues in the management of protected areas:
(a) *Illegal hunting and trade of important wildlife species* is prevalent, especially in the lowland areas. Rhino, tiger, and yarchagumba (*Cordyceps sinensis*) are some of the species that are especially at risk from poaching. An analysis of changes in rhino population in Chitwan National Park shows that the number of rhinos in the park decreased rapidly and continuously between 1950 and 1966. The trend was reversed after 1966 and there was a steady increase in the population until 2000. The population again decreased rapidly between 2000 and 2005 due mainly to poaching. According one estimate, at least 104 rhinos in the park were killed by poachers during 2000-2006 (IUCN, 2006). The population has been steadily increasing since 2006 (Figure 6.2).

The anti-poaching campaign implemented under the Rhino Conservation Action Plan (2006-2011) was successful, to some extent, in discouraging

Figure 6.2 ▌Changes in rhino population in Chitwan National Park[2]



poachers. However, despite the efforts of the government and other agencies, wildlife poaching is still a major challenge in conserving important fauna including rhino and tiger. Inadequate funding and lack of essential logistics (e.g. vehicles) are reportedly the major direct obstacles in fully controlling poaching. A porous international border both in the north and south, very high prices for wildlife parts and products in the international markets, inadequate law enforcement, and general lack of knowledge of the legal consequences of poaching, are considered the major factors contributing to this problem.

(b) Human-wildlife conflict, mainly that of crop and livestock depredation, and local nuisance by wild animals is common in most of the protected areas. Every year, wild animals, especially wild boars, porcupine, elephants, rhinos, deer, and monkeys destroy crops, inflicting immense misery on the local farmers. Livestock depredation by large predators, especially tigers and leopards is also common. Human casualties by large animals, mainly tiger, elephants, rhinos and leopard is increasing with the growth in the number of these species. Local villagers occasionally resort to retribution killing in the form of hunting, trapping and poisoning, and such activities are likely to increase in future if the conflict is not resolved amicably.

2 The number before establishment of the National Park in 1973 refers to the population in Chitwan Valley. Figures have been compiled from various sources, including Willan (1965), Gee (1959), Spillett and Tamang (1966), Laurie (1978), Dinerstein and Price (1991), Yonzon (1994), and DNPWC unpublished reports (2000, 2005, 2006, 2008, and 2011).

The DNPWC, in collaboration with buffer zone management councils, is trying to resolve the problem through a system of awareness and cash compensation but the efforts have not yet proved to be effective. The provision for compensation also exists in the Annapurna and Manaslu Conservation Areas but that is reportedly too little and too late due to lengthy administrative processes.

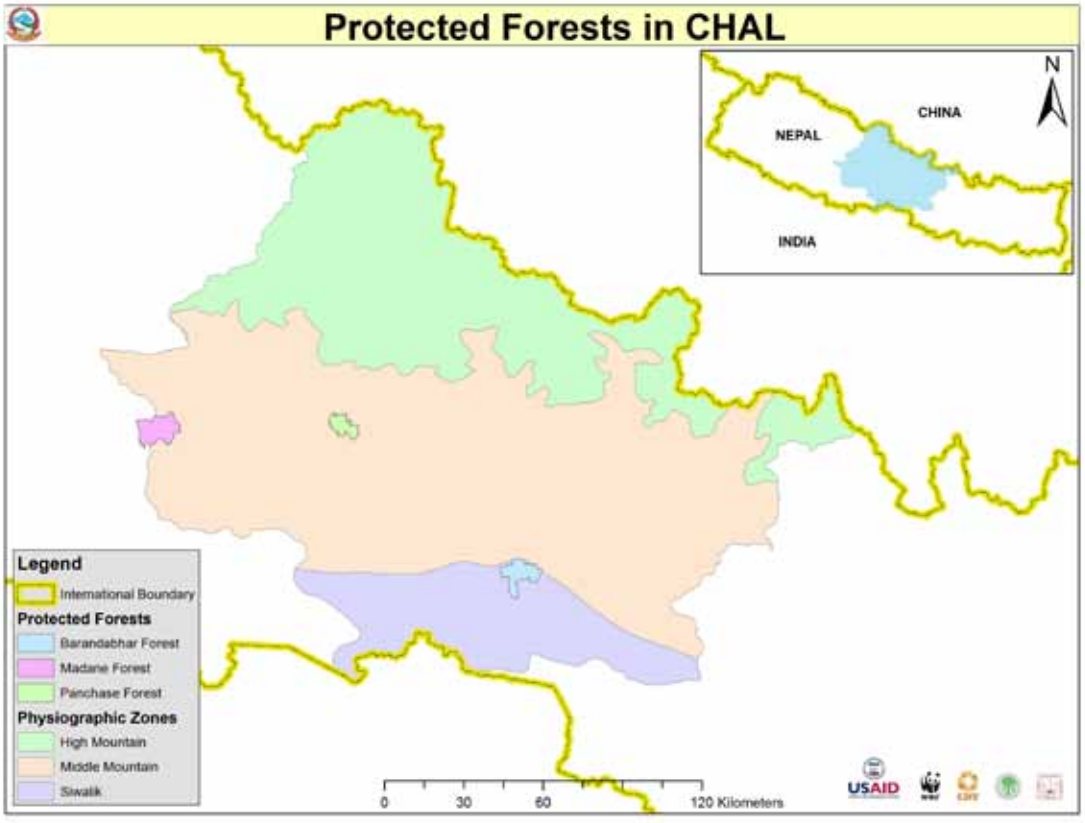
(c) Degradation of habitats is a major issue in sustainable management of protected areas. Habitat degradation due to intrusion and rapid expansion of alien plant species such as *Mikania micrantha, Lantana camara, Chromolina odorata* and decreasing quality and extent of grassland habitats due to invasion by riverine tress species, are major problems in Chitwan National Park. According to an estimate, around 15 percent of tall grassland habitats in the Park, which are ideal habitat for rhino and many other herbivores, have been invaded by riverine trees species in recent years (WWF, 2000). An uncontrolled forest fire is another cause of habitat degradation. The quality and extent of many wetland ecosystems (including the Beeshazari Tal) have been severely affected due to eutrophication and invasion by alien species, including *Eichornia crassipes*. Climate change is expected to have substantial negative impact in future.

6.2 Protected Forests

The Government has recently declared three block forests in CHAL (namely Barandabhar, Madhane and Panchase) as protected forests (Figure 6.3; Table 6.1). The stated objectives of protected forests are: (i) enhancement of biodiversity through rehabilitation of habitats of rare and important species, biological corridors, and wetlands, (ii) achieving self-dependence of forest products through development of multi-storey and multiple use forests, and (iii) enhancing local livelihoods through implementation of income generating activities, including market-oriented green enterprises and tourism (Thapa, 2011).

Each of these protected forests has unique importance. Barandabhar is an important natural forest corridor between Chitwan National Park (CNP) and the Mahabharat Range. This is actually the only remaining natural forest that connects CNP and the Siwaliks Range with the *Mahabharat* Range, thereby allowing the endangered one-

Figure 6.3: Location of protected forests in Chitwan-Annapurna Landscape



(Source: Present study; Data source: Department of Forests)

Table 6.1: Protected forests in Chitwan-Annapurna Landscape

Name	Size (ha.)	Location		Significance
		District	Physio. Zone	
Barandabhar	10,466	Chitwan	Siwaliks	Connects midhills forests to Chitwan National Park; includes several small grasslands and wetlands, including the Beeshazari *Tal*, a Ramsar site; habitat for tiger, rhinoceros, deer, monkeys and several migratory and resident birds.
Madhane	13,761	Gulmi	Midhills (975-2,657m)	Rare and important medicinal herbs such as *Swertia angustifolia* (Chiraito), *Cinnamomum glaucescens* (Sugandha kokila), and 24 species of important wild animals (including beer, leopard cat, red deer) are found here. Serves as a biological corridor linking Dhorpatan Hunting Reserve with natural forests of Pyuthan and Baglung Districts.
Panchase	5,776	Kaski, Parbat, Syangja	Midhills (900-2,800m)	Harbors 589 species of plants, including 113 species of orchids (two endemic), 107 species of medicinal herbs, 56 species of mushrooms, 98 species of fern, and numerous species of wild animals, birds and insects. An important site also from the cultural, religious and tourism point of view.
Total	30,003			

(*Source:Thapa, 2011*)

horned rhino (*Rhinoceros unicornis)*, Bengal tiger (*Panthera tigris tigris*), and many other species of wild animals and birds access to refuge at higher altitudes during monsoon season and other periods of adverse climatic conditions.

The diverse habitat in Madhane (including dense forest, open forest, grasslands, wetlands, agricultural lands) is rich in biodiversity, including rare and valuable medicinal herbs and over 20 types of large wild animals. Moreover, the forest complex includes many features and sites of cultural and religious significance. Panchase is extremely rich in floral diversity. Many important plants and animal species, including 113 species of orchids (of which two are endemic to this area) are found in this forest (Department of Forests (DoF), 2011).

Table 6.2: Community forests in CHAL districts

S. No.	District	Area (ha)	Users	
			No. of FUGs	No. of Households
1	Chitwan	18,055	64	34,056
2	Nawalparasi*	14,891	111	23,395
3	Makawanpur*	34,918	163	30,547
4	Arghakhanchi*	10,096	230	25,962
5	Tanahu	33,229	513	50,097
6	Palpa*	14,567	319	25,213
7	Gulmi*	14,751	363	52,913
8	Baglung*	11,727	332	40,892
9	Parbat	11,815	351	40,069
10	Syangja	10,554	423	45,046
11	Kaski	14,680	421	35,451
12	Lamjung	19,334	304	24,825
13	Dhading	25,241	628	64,799
14	Nuwakot	20,755	277	30,348
15	Myagdi*	19,885	256	29,763
16	Gorkha	21,480	447	53,333
17	Rasuwa	2,580	63	4,972
18	Manang	6,738	19	1,129
Total		**305,296**	**5,284**	**448,753**

(Source: DoF, 2012a)

* Part of the district falls outside CHAL. The statistics, which are computed based on VDCs, can slightly differ as a few VDCs are divided by the landscape boundary.

6.3 Community Forests

Community forestry is the major forest management regime in the midhills and one of the major in the Siwaliks and high mountains. A total of 305,296ha of designated forest land in 18 districts (all except Mustang) is currently (April, 2012) managed by 5,284 registered Forest User Groups, covering 448,753 households (DoF, 2012a; Table 6.2).

The vast majority of stakeholders consulted during the course of this study felt that the community forestry program, implemented by the government with support from several bilateral and multilateral donor agencies, has helped regenerate substantial areas of degraded forests, especially in the midhills. The program also has made contributions to strengthen natural resources governance, livelihood enhancement, and equitable sharing of benefits among the rural populations. The program has been less successful in the Siwaliks and high mountain zones because of different social, economic and other contextual factors in those areas.

The government has recently started "one district, one innovative community forestry program", under which Rupees 50,000-100,000 is allocated to the district forest office to implement the program. Implementation of pro-poor leasehold forestry within community forests is another initiative that has been partially successful in addressing the conflicts between community forestry and leasehold forestry programs.

6.4 Buffer Zone Community Forests

In order to incorporate people's participation in the management of protected areas, the government amended, in 1992, the National Parks and Wildlife Conservation Act of 1973 and introduced a decentralized system for managing forests in buffer zones of national parks and wildlife reserves in 1996. In CHAL, the program has been implemented in Chitwan National Park, Langtang National Park and Parsa Wildlife Reserve. Currently (as of May 2012), 40,303 households residing in these three buffer zones are managing 127 Buffer Zone Community Forests covering a total area of 18,046 ha (Table 6.3).

Table 6.3: Buffer zone community forests in CHAL

Location	No. of BZCF	BZCF Area (ha)	Users	
			No. of house-holds HHs	No. of People
Chitwan National Park	47	8,319.9	24,383	136,740
Langtang National Park	49	1,835.6	5,419	520,00
Parsa Wildlife Reserve	31	7890.7	10,601	555,91
Total	127	18,046.2	40,403	244,331

(*Source: DNPWC, 2012*)

Buffer Zone Management Regulations (1996) and Buffer Zone Management Guidelines (1999), which govern the buffer zone community forestry, are much more restrictive than community forestry regulations. The Regulations and Guidelines prohibit the following activities within the buffer zone: (i) occupying any land without legal ownership or cutting trees, clearing forests or cultivating forestland, (ii) activities damaging forest resources or setting fires in the forests, (iii) excavation of stone, earth, sand or mining or removal of any minerals, earth or other such materials, (iv) use of any harmful poison or explosive substances into the rivers, streams or water sources flowing in the Buffer Zone, and (v) hunting illegally and any acts damaging wildlife. The Buffer Zone User Groups must spend a certain specified percentage of their income on conservation (HMGN, 1999). The Warden retains power at all times to stop projects (Heinen and Mehta, 2000).

6.5 Leasehold Forests

Leasehold is a pro-poor forestry program, which involves 40 year rent free leasing of small areas (up to 10ha) of degraded national forest land to small groups (6-10 households) of local farmers living below the poverty line and with little or no private land resources. The idea behind the program is to provide forest-based economic opportunities to poor hill farmers who are proportionately more dependent on natural resources (International Fund for Agricultural Development (IFAD), 2004). The program is implemented jointly by the Department of Forests and the Department of Livestock. By May 2012, a total of 8,757ha of degraded forest in the Chitwan-Annapurna Landscape had been leased to 2,038 Leasehold Forestry Groups, involving 15,617 households (Table 6.4).

The leasehold forestry program has been partially successful in restoring degraded lands and poverty

Table 6.4: Leasehold forests in CHAL districts

District	Area (ha)	Users	
		No. of FUGs	No. of HHs
Chitwan	1,532	359	2,557
Nawalparasi*	185	16	181
Makawanpur*	2,076	446	3,032
Tanahu	1,889	455	3,315
Palpa*	246	19	227
Gulmi	71	7	71
Syangja	82	8	82
Lamjung	366	110	907
Dhading	1,723	430	3,785
Baglung	4	2	14
Gorkha	583	186	1446
Total	8,757	2,038	15,617

(*Source: DoF, 2012b*)
Note: The area figures, rounded to nearest whole number.
*The statistics refer to the whole district even though parts of the districts fall outwith CHAL.

alleviation. The program can also be taken as a good example of inter-organizational cooperation aimed at meeting the dual goals of improving ecological conditions and alleviating poverty. Effective protection of forests and a zero grazing approach has led to substantial improvement in the condition of many forests, including increments in species diversity (Development Vision, 2005).

Some of the successes of the leasehold forestry program can be seen in Jhirubas, Palpa and Hupsekot, Nawalparasi District where the program has been piloted since 2010 by the technical assistance (TA) component of the Leasehold Forestry and Livestock Program. Hundreds of hectares of shifting cultivated and degraded forest lands in these sites have been planted primarily with broom grass (*Thysanolaena maxima*). Other common species which have been planted include *Zanthoxylum armatum*, *Morus alba, Cinnamomum tamala, Ficus nerifolia, Arundinerea* sp., and *Leucaena leucocephala*. *Asparagus racemosus* has been inter-cropped with *T. maxima* in some blocks.

The pilot program has been successful in enhancing local livelihoods, and pooling resources from various agencies for implementing different rural development programs. For example, in 2011 alone, over the equivalent of rupees 13 million of resources in the four districts of Palpa, Gulmi, Nawalparasi, and Syangja were pooled for different purposes, including solar set installation, drinking water, latrine construction, non-formal education, and NTFP cultivation. Hupsekot Leasehold Forestry Inter-group also won one hundred thousand rupees as a "Mountain Development Award 2011"

Photo by Ambika Gautam

Broom Grass (Thysanolaena maxima) Plantation in a Leasehold Forest at Hupsekot, Nawalparasi

and received a letter of appreciation from the Government of Nepal (Bhattarai et al., 2011). There is good scope for replication of this successful leasehold forestry model in the entire shifting cultivation region that covers parts of Nawalparasi, Palpa, Tanahu, Chitwan and Gorkha Districts.

6.6 Government-Managed Forests

Forests that are not covered by any of other governance regime are directly under the control of the Department of Forests through respective District Forest Offices, *Ilaka* (sub-district) Forest Offices and Range Posts, and are categorized as government-managed forests. These forests, which are scattered all over the landscape, are largely open-access and without any scientific management, except for occasional patrolling by forestry staff and collection of dead trees by the District Forest Office or the Timber Corporation of Nepal.

6.7 Issues and Challenges in the Management of Forests Outside Protected Areas

6.7.1 General issues

(a) *Lack of scientific forest management* is widely believed to be a major reason behind low productivity of the forests in the landscape, which has caused an imbalance in supply of products and less than optimal income from the forestry sector. According to the majority of key stakeholders consulted during the course of this study, the major barriers in implementing scientific forest management include: (i) lack of political will, (ii) weak central forestry administration, (iii) insufficient technical inputs, (iv) inadequate financial and material resources, (v) inadequately trained human resources, and (vi) lack of trust between central and district level authorities, and between government and non-government stakeholders.

Construction of a High School inside a Sal Forest at Arunkhola Nawalparasi

Table 6.5: Forest area encroached in three Siwalik districts

District	Forest Area Encroached (ha)	Main Locations
Chitwan	1,387.7	Jutpani, Shaktikhor, Aaptari (Bharatpur), Korak, Amilepani, Lothar, Dahakhani, Padampur (Thankhola), Ratomate, Chainpur, Bhandara
Nawalparasi	7,836.5	Sunwal, Daunnedevi, Panchanagar, Mukundapur, Rajhar, Tilakpur, Shivmandir, Swathi, Pragatinagar, Gaidakot, Dumkibas, Agyoli, Benimanipur, Divyapuri, Tamsariya, Kohulwa, Makar, Nayabelhani
Makawanpur	1,560.5	Manahari, Raksirang, Sarikhet, Kankada, Basamadi, Manthali, Harnamadi, Hatiya, Shikharpur, Churiyamai, Dhiyal, Gadi
Total	**10,784.8**	

(Source: DoF, 2012c)

(b) *Encroachment* of forest areas for expansion of settlements, infrastructure development, and agriculture is a major issue in Chitwan, Nawalparasi, and Makawanpur Districts. A total of 10,785 ha of forestland is currently illegally occupied in the three districts alone (Table 6.5).

Some of the encroachment is for expansion of local markets and urban areas. For example, in Nawalparasi District alone a total of 1,330 ha forestland in Sunawal, Shiv Mandir, Gaidakot and Kolhuwa VDCs has been encroached for this purpose. The problem, which is more severe along the highways, has now been compounded due to general lawlessness created by political instability, inadequate capacity of district forest offices to deal with the problem, and poor inter-agency coordination. Political initiative is necessary to address this issue.

The problem of forest encroachment is not limited to the Terai and Siwaliks. A recent study conducted by the Western Regional Forest Directorate shows that a total of 4,657 ha of forest is encroached in 12 midhill and high mountain districts in the region (Table 6.6).

Unplanned and unregulated construction of rural roads by Village Development Committees (VDCs) and District Development Committees (DDCs) is a major direct cause of deforestation and forest degradation in the midhill districts, which has undermined the positive contributions of the community forestry program to some extent. Construction of hotels, monasteries and trekking trails in forests is a major issue in high mountain areas (e.g. Annapurna Conservation Area (ACA), Panchase Protected Forest).

(a) Deforestation caused mainly by *expansion of cultivation into forest areas* to meet growing demands for agricultural lands is a major driver of deforestation in almost all parts of the landscape. High reliance of households on agriculture due to very limited alternatives and ever increasing demand for food due to population growth are the main underlying causes behind this expansion. In most cases, the expansion is spontaneous by small farmers, usually driven by underpinning social and/or economic factors. The problem is more severe in the Siwalik lowlands where productivity of land and population density is high, and forestry administration's control over resources is inadequate.

(b) Shifting cultivation on steep hill slopes is a major driver of deforestation in the Siwaliks and adjoining Mahabharat Range, particularly in parts of Nawalparasi, Palpa, Tanahu, Chitwan and Gorkha Districts. Most of the shifting cultivators in this belt belong to ethnic Magar and Chepang communities.

(c) *Invasion by alien plant species* has occurred in most forested ecosystems in the Siwaliks and midhills. Invasion by *Mikania micrantha* and *Lantana camara* already has serious effects on native vegetation and wildlife in some pocket areas within the Chitwan National Park and its buffer zone. Invasion by *Eupatorium adenophorum* is common in the midhills.

Table 6.6: Forest area encroached in mountain districts

S. N.	District	Estimated Forest Area Under Encroachment (ha)	Main Locations (VDCs and Municipalities)
1	Palpa	2,000	Tansen, Baldengadi, Satyawati, Jhirubas
2	Arghakhanchi	1,800	Pattharkot, Gauda
3	Gulmi	128	Ridi, Tamghas
4	Tanahu	300	Debghat, Dulegauda, Aabukhaireni, Bhimad
5	Kaski	120	Pokhara, Lekhnath, Bharatpokhari
6	Gorkha	90	Gorkha, Palungtar, Aabukhaireni
7	Syangja	28	Putalibazar, Waling, Krishnagandaki, Ratnapur
8	Lamjung	24	Besisahar, Bhulbhule, Bhoteodar
9	Baglung	60	Burtibang, Daga, Bihu
10	Myagdi	40	Arthunge, Rakhu, Darbang, Tatopani
11	Parbat	42	Kusma, Shaligram, Phalebas
12	Mustang	25	Lete, Jomsom, Muktinath
	Total	4,657	

(*Source: WRFD, 2011*)

(d) Uncontrolled *forest fire* is an important issue, particularly in government-managed forests in the Siwaliks region. Recurrent forest fires severely damage and prohibit regeneration and growth of seedlings, destroy non-timber forest products and, in some cases, encourage invasive species. Moreover, forest fires are degrading biodiversity, enhancing soil erosion and inducing floods and landslides due to the destruction of the natural vegetation. Deliberate forest fire is frequently used as a method to clear land for agriculture or promote new growth of grass for grazing, particularly in the high mountains. When such fires 'escape', the damage is often catastrophic. Incidences of forest fires are decreasing in the midhills due mainly to community forestry.

(e) *Inadequate technical capacities* of District Forestry Staff and Forest User Groups, such as for scientific forest management, and inadequate knowledge of the mode of propagation and control of invasive alien species is an issue. There is a need to enhance capacities through basic training and/or refresher courses. There is also a need to review and, if necessary, revise the organizational setup and mandate of the Department of Forests and District Forest Offices to orient them on the technical aspects of forest management, with a clear set of responsibilities and authority for offices and staff at different levels.

(f) Other issues, such as *stone mining,* are localized drivers of deforestation in some areas. *Landslides and soil erosion* triggered by excessive monsoon rains, slope and other topographic conditions have substantially contributed to forest loss and degradation in some areas, particularly the Siwalik Hills.

6.7.2 Community Forestry specific issues

(a) *Passive approach to forest management:* Protectionism is a common approach adopted by most user groups in the management of community forests. This may be due to poor knowledge on scientific forest management or simply because of Forest Users Groups' (FUGs) fear of resource degradation. Whatever the reason is, a protectionist approach is having a negative effect on both the quality of forests as well as on meeting the users' needs. This has particularly affected the poorer households who do not have alternative sources to meet their forestry-related subsistence needs. A strategy that balances protection with active forest management would be a strategic solution because it would ensure that a major part of the requirement for fuelwood and other basic products is met from the community forests.

(b) *Poor financial transparency and weak monitoring:* Lack of a uniform policy and guidelines regarding harvest and sales of forest products; lack of a uniform reporting system or format; poor financial transparency; and weak monitoring has led to financial irregularities by some Community Forest User Groups (CFUGs).

(c) *Inadequate attention to biodiversity and NTFP management:* Not enough attention is being given to biodiversity and NTFPs in operational plans of CFUGs. This remains the situation despite the fact that both the government and the international community have put biodiversity conservation high on their agendas.

(d) *Lack of or inadequate technical capacity:* Lack of technical capacity among FUGs for forest inventory, and inadequate staff in the District Forest Offices (DFOs) to assist CFUGs has hampered

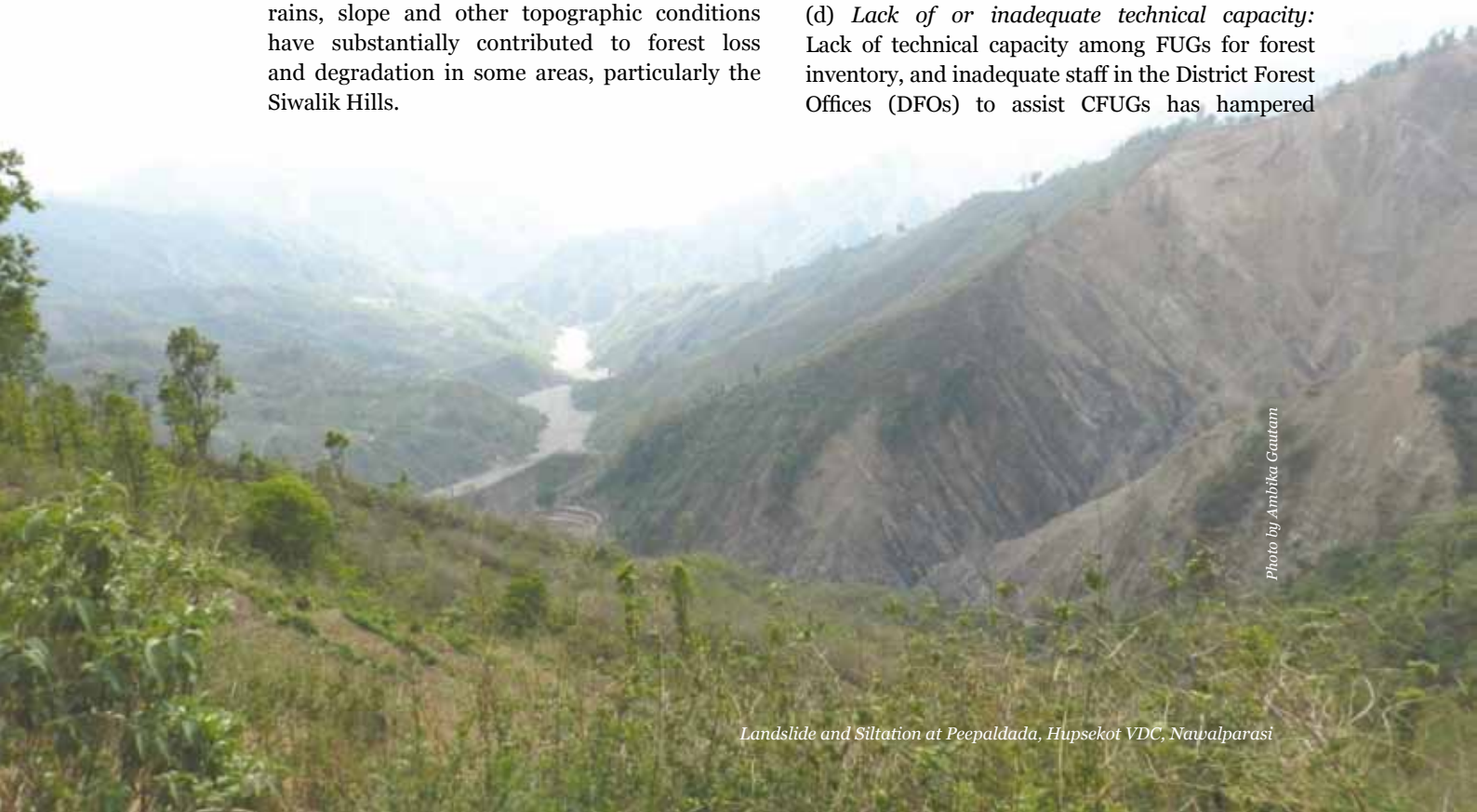


Photo by Ambika Gautam

Landslide and Siltation at Peepaldada, Hupsekot VDC, Nawalparasi

timely preparation or renewal of community forest operational plans. Some CFUGs, which have sufficient income, are hiring independent consultant technicians for the task, but the vast majority are compelled to wait (sometimes for years) for the assistance of the DFO before they can renew their community forest operational plans and harvest forest products. This has, in many cases, also negatively affected DFO-CFUG relations.

(e) *Poor linkage with livelihoods and poverty alleviation:* So far, the community forestry program has been able to bring about positive changes in forest cover but the benefits of the program for the poor have been limited. Making community forestry a strong component of a poverty alleviation strategy through livelihood enhancement and income generation has become a challenge.

(f) *Poor relationships among stakeholders:* There is a lack of consensus among the key stakeholders in many aspects of community forestry governance. A major issue relates to the debate over whether the CFUGs should contribute to the central exchequer and contribute toward the development effort of the country. FECOFUN and other critics argue that the user groups are already contributing to local development efforts (such as schools) in their villages. The government agrees but thinks that variation in income among CFUGs has led some villages being able to develop while others are left behind. The lack of trust between the two key stakeholders is evidenced also by the fact that a recent cabinet decision to amend the Forest Act of 1993 has everted back due to strong opposition by FECOFUN to the proposed amendment (in 2012 a task force at MoFSC was looking at it). There is a need for all stakeholders to come together to work out a consensus on key issues.

(g) *Limited participation of women and other disadvantaged social groups*: Participation of women and other disadvantaged social groups in the decision-making process of CFUGs has increased over the years but it is still less than satisfactory. Community consultations during the course of this study revealed that in some cases (e.g. Rani Ban Community Forest, Kaski) women and *Dalits* (most disadvantaged social group) do not usually participate in decision-making processes despite the fact that their formal representation in Forest Users' Committees (FUCs) is very high (75%). The reason behind the non-participation was reportedly their trust in the other male elders in the FUCs. In some other areas (e.g. Mustang), however, the scenario is changing and women are becoming more and more active in local decision-making.

(h) *Policy and governance-related issues*, including frequent changes in government regulations and directives, and unclear roles and responsibilities of different stakeholders are also issues to be looked at.

6.7.3 Government-managed forest specific issues

(a) *Forest loss and degradation* is an important issue, which is caused mainly by over and unsustainable harvesting of forest products and illegal logging. Excessive extraction of forest products to meet persistently high demands for fuel, construction timber, fodder and other forest products is a major cause of deforestation and forest degradation in most parts of the landscape. In the Siwaliks (Chitwan, Nawalparasi, Tanahu and Makawanpur Districts), the problem is compounded by widespread illegal harvesting of timber for sale. In the high mountains, excessive use of timber for construction of houses and cowsheds, illegal cross-border smuggling of timber to Tibet, and repeated lopping of trees for fodder are some of the major drivers of forest degradation. Non-sustainable extraction, such as intensive harvesting of reproductive tissues, repeated visits and inappropriate harvesting methods have caused degradation of NTFPs (including high value medicinal and aromatic plants) in many areas. Lack of scientific management, poor central planning, lack of political will, conflicting sectoral policies, poor coordination, and the inadequate capacity of the Department of Forests are some important underlying factors of deforestation and forest degradation.

(b) *Overgrazing* has greatly contributed to degradation of many government-managed forests, particularly in the Siwaliks and high mountains. Mismatch between *de facto* and *de jure* property rights and absence of clearly defined grazing rights have resulted in uncontrolled and heavy grazing in high altitude rangelands, thereby causing degradation and/or important changes in the composition of the plant and animal populations in these important ecosystems.

(c) *Perceived open access* has encouraged stakeholders to adopt a short-term economic horizon, since their failure to take immediate financial advantage of the resources likely results in others gaining the benefit. One of the main

possible underlying causes of the perception of an open-access resource is the failure to apprehend and punish many of those who violate regulations. Low risk of capture and punishment may be due to the inadequacies of the DFOs and protected area managers to fulfill such a role due to lack of adequate human resources and logistics. However, it may also often be the result of a perception that the offences being committed are not really significant or important.

(d) *Weak law enforcement* due to insufficient human resources and inadequate district budgets for day-to-day operations (including a vehicle and its maintenance, fuel, collection of seized timber etc.) was identified as a major issue by the participants of district and central level consultation meetings. Excessive political interference, adhoc decisions, and corruption have also contributed to weak governance. Lack of or poor infrastructural facilities (field offices) is a major problem in most districts (many forestry field offices were destroyed during the insurgency period).

(e) *Leakage:* There is a common belief that protection of community forests often promotes degradation of nearby government-managed forests as the local population tries to make alternative arrangements for meeting its immediate fuelwood and fodder needs. This may be especially true in the case of the poorer households who do not have private trees and are forced to depend on non-protected areas (i.e. government-managed forests) to meet their daily subsistence needs.

6.7.4 Leasehold Forestry specific issues

(a) *Poor coordination* between the Department of Forests and the Department of Livestock.
(b) *Inadequate financial resources* for districts other than direct TA implementation.
(c) *Under utilization of products*, for example much fodder (amrisho) created in some sites (e.g. Jhirubas in Palpa), which remains largely unused.

Private forests intermixed with settlements near Tansen. This is common throughout midhills.

Photo by Ambika Gautam

(d) How to expand successful *models* to other areas is an issue.
(e) *Lack of general awareness and capacity* of leasehold forest user groups (including record-keeping).
(f) *Complications in identification* of the poorest of the poor households.
(g) Leasehold forestry only gets *second priority* after community forestry in terms of land allocation. Only degraded forests are available for leasing.

6.7.5 Protected forest specific issues

(a) Insufficient policy and by-laws create difficulties.
(b) *Lack of political commitment* to implement/ update policies etc.
(c) *Inadequate institutionalization* of the forest management related programs and poor implementation.
(d) *Low level of ownership* by stakeholders.
(e) *Human-wildlife conflict*.
(f) *Insufficient budgetary allocation* for program implementation.

Buffer Zone Community Forestry specific issues

(a) There is often a *mismatch in expectation* between Buffer Zone Management Committees and protected area management authorities. The former emphasize more on using forest products and want more support for development work (such as schools, irrigation canals, roads), while the park authorities want to focus on conservation.
(b) *Buffer zones have not been declared* in some protected areas (Shivpuri NP and Dhorpatan HR). Therefore, the benefit accrued from buffer zone management is not available to all the local people who are living around these protected areas.
(c) The design of buffer zone forest management is such that there is *high influence and control by the warden* because the overall responsibility of buffer zone management is vested with the warden by law. This is an issue from the users' perspective.
(d) *Human-wildlife conflict*, poaching of important wildlife species, and habitat degradation are common problems.

6.8 Private Forests

Records available in the Department of Forests show, between 1984 and 2008, a total of 654 registered private forests in 16 districts, covering a total area of 461 ha (Annex 6.2). This statistic, however, does not represent the actual scenario of private forestry in the landscape. Private forests, especially biologically diverse home gardens, are common in most parts of the landscape, which are usually not documented and registered.

In other parts of the midhills, private forests were found to have substantially (more than 30 percent of total need) contributed towards fulfilling household subsistence needs (Gautam et al., 2002). The scenario in CHAL is expected to be similar. Moreover, the importance of private forestry will likely increase in the future because it is by no means clear that community forestry will be able to meet most of the future demand for forest products. There is a need for further research to assess the extent and contribution of private forestry and evaluate how private forestry emerges to cope with the challenges arising from changing dependencies of rural households among community forests, government forests, and private forests.

7 Agriculture and Livestock Management

The agriculture sector is the mainstay of livelihoods for Nepalese. Around 74 percent of the population, mostly marginal farmers, still depends on agriculture for their subsistence, and one third of the Gross Domestic Product (GDP) comes from this sector. The annual growth rate of the agriculture sector was recorded as 2.7 to 2.8 percent in 2007/08 (Karkee 2008). The country's agriculture production is heavily inclined to food grain production, including paddy (in the lowlands), maize and wheat. However, self-sufficiency in food is not ensured.

7.1 Cropping Patterns, Intensity and Production

A conventional tillage, rice-fallow system represents the simplest system for irrigated lands, and is common in most of the midhills districts, including Tanahu, Gorkha and Lamjung. Overall, multiple cropping is the main cropping system in CHAL in which different vegetables, wheat, oil seed crops with peas are grown in the uplands (*bari* lands) after harvesting the maize crop in June-July. In irrigated areas, paddy is followed by wheat or vegetables. Mixed cropping is another form of multiple cropping that is common in CHAL, in which two or more crops are grown together at the same time in the same land.

Cover cropping is found in the uplands of Dhading, Gorkha and Tanahu Districts, where closely growing crops are planted mainly for protecting soil between regular crops. These cover crops are beans, cow peas, peas, rahar etc., depending on actual needs of the farmers. Improved grasses such as *Mott Napier* are also grown as cover crops along terrace bunds.

The major cereal crops grown in the districts of CHAL are paddy, maize, and wheat, with millet being grown in the midhills and Inner Terai (Chitwan), while maize, wheat, barley, and buckwheat are major crops in the high mountains (Manage, Rasuwa and Mustang). The main improved varieties of early rice grown in lowland areas are *Hardinath* 1 and 2, *Chaite* 2, 4 and 6, *Laxmi,* IR 24 etc. The main season rice grown in the hills and lowland areas are *Radha* 4, 7, 11 and 12, *Makawanpur* 1, *Sabitri*, *Khumal* 5, 6, 7, 8 and 9, *Palung* 2 and *Pokhreli Jethobudho*. Some local varieties of rice known locally as *Batissara, Lami, Goal Dhan, Dalle or Apjhutte, Jhinuwa and Kanak Jira* appear to be threatened and *Anga, Marsi, Mansara* may be almost extinct (Annex 7.1). This is attributed to high productivity of the improved rice varieties. These threatened and endemic rice species or varieties should be preserved in Lumle and other agriculture research centers.

The major improved varieties of maize and wheat grown in CHAL are *Rampur* composite, *Arun* 2, *Manakamana* 1, 2, 4, 5 and 6, *Poshilo Makai*-1, *Kakani Pahenlo*, *Khumal Pahenlo, Achyut*, *Annapurna* 4, *Aditya*, RR 21, *Lerma Rojo* 64, BL 022, *Bhirkuti*, and NL 30. Similarly, improved varieties of barley (*Solu Uwa*, *HBL 56* etc.), and finger millet (*Dall* 1, *Okhle* 1 etc.) are also grown in the landscape. Ground nut (*Jayanti, Jyoti, Janak, B 4, Rajharshi* etc.), cotton (*Tamcot SP 37*), sugarcane (*Jiptur* 1,2,3 and 4), rape seed (*Preeti*, *Unnati* and *Pragati*), ginger, turmeric, cardamom and coffee (in Gulmi, Argakachi, Tanahu, Gorkha and Dhading Districts) are grown as cash crops. The major pulse crops grown are *Musuro*, black gram (*Kalu*), soyabean (*Puja, Tarkari Bhatamas* 1, *Lumle* 1, *Hardee* and *Cobb*), *Arahar*, *Mung*, *Rajma*, cowpea (*Surya*, *Prakash* and *Akash*), four season beans, *Gahat*, peas and grams.

The production of major crops such as rice, maize and wheat is relatively low in CHAL as compared to the national average. Farmers consulted during the course of this study have reported 2.5, 2.1 and 2.0 metric tons per hectare production of rice, maize and wheat, respectively, which is about 16, eight and 12 percent lower than the average national production of these crops. This reduction in productivity is attributed to bad weather, uncertain monsoon rains, climate change and variability, inadequate irrigation facilities, less utilization of available farmlands, less accessibility of farmers to markets (in the high mountains), scarcity of a young and energetic labour force, under utilization of available technology, soil fertility loss and frequent occurrence of livestock related epidemic diseases.

Due to the climatic variation, different types of fruits can be grown in CHAL. In river basins and plain areas of Makawanpur, Chitwan and Nawalparasi districts, tropical fruits such as mango, litchi, banana, papaya, pineapple, jackfruit, and guava are grown. Sub-tropical fruits such as citrus (especially orange) have been grown commercially in Palpa, Syangja, Kaski, Tanahu, Lamjung, Gorkha, and Dhading districts. Peach, plum, persimmon, and pear are being grown for subsistence in Baglung, Myagdi, Manang, Mustang, and Gorkha Districts. There is good scope for growing these fruits on a commercial scale, such as apples which are grown commercially in Mustang district.

Vegetables and spices are other important crops grown in the landscape. Cauliflower, cabbage, okra, eggplant, pumpkin, mustard, radish, and carrot are the most common vegetable crops. Potato is ranked second in terms of area and production. There is also an increasing trend in commercial farming of seasonal and off-season vegetables. Ginger, turmeric, onion and garlic are some important cash crops. Vegetables near the city areas are grown commercially. This work should be strengthened to improve the livelihoods of FUG members and members of other groups supported by the Hariyo Ban Program.

Major vegetables and their varieties produced in this region are as follows:

- **Winter Vegetables:** Cauliflower (Kathmandu local, Dolpa snow ball and *Sarlahi Dipali*), cabbage (Copenhagen Market), onion (Red Kriole), rayo (*Khumal Rato Pat, Tangkhuwa Rayo, Marpha Chaudapat, Krishna* etc.)), radish (Chalis Dinae, White Neck, Mino Early etc.), carrot (Nantis Forte), simi/beans (*Khumal Tane, Jhange Simi, Sarlahi Tane* etc.), tomato (Roma, *NBL 1,* Pusa Ruby etc.), potato (*Khumal Laxmi, IYP 8, Khumal Seto 1 and 2, Janak Dev, Kufri Sinduri, Disiree,* etc.), peas (New Line, *Sarlahi Arkel*, and *Sikkime* etc.), and mushroom etc.

- **Summer vegetables:** Tomato, cucumber (*Kushle*), asparagus, pumpkin*, jukini,* bitter gourd (Green *Karela*), snakegourd/chichindo, beans, ramtoria/okra (*Parbati*), chillies (*Jwala*), spongguard/*ghiraula* (*Kantipure*), egg plant (*Nurki*), and mushroom etc.

7.2 Farming Systems

Almost all the farmers are subsistence farmers, which means they cultivate cereal crops along with other commodities such as vegetables and cash fruits crops such as orange, banana and apple (Walker et al. 1995; Miller and Nair 2006). Additionally, they keep very nominal numbers of livestock for home consumption and for extra income. In the river basins, hills and other areas where land is relatively fertile, the main farming system is cereal based, whereas livestock farming is an alternative occupation in most of highlanders' farming systems (Nair, 1993; Neupane et al., 2002).

Farming communities in CHAL have developed an integrated farming system to fulfill their household needs by combining trees, crops, and livestock in their farming practices based on traditional knowledge. Forests and trees were found an integral part of subsistence farming in almost all studied communities. This adds diversity to the farming system and contributes to rural household economies. Lately, the positive benefits of such a system to the household and to the environment have been increasingly recognized, e.g. fodder trees and carbon sequestration. The existing farming system has improved food and nutritional needs and mitigates environmental degradation by combining trees and crops in spatial or temporal arrangements. In addition this system has provided supportive and complimentary benefits to specific social and environmental contexts across CHAL.

In the hills of CHAL, most tree species grow on the edges of farm boundaries along with upland crops and on the walls of gullies and barren

lands locally called *kharbari,* where some kinds of thatch grasses grow naturally. In some cases, fodder trees were planted on terrace edges and risers in close spacing by maintaining a one to two meter tree height. This helps, especially in the hills where heavy reliance is placed on tree resources, to sustain the farming system and generate environmental benefits (e.g. reducing soil erosion) from the same piece of land.

7.3 Livestock Management Practices

Livestock is an integral part of the farming system in CHAL. The main livestock are cattle, buffalos, goats, sheep and pigs. With the improvement of pastureland biomass production in terms of quantity and quality, livestock might be a means for a reliable enterprise in the high lands in the future. In the existing situation, poultry is one of the roads to commercialization among farmers. The average livestock holding by household in the studied communities was found to be 4.1, which is relatively lower than the national average (CBS, 2011). The result shows that the goat and sheep population is higher (10 goats/ sheep per household) in Mustang and Rasuwa Districts compared to other study districts. This result highlights the importance of goats and sheep in household level income and employment opportunities. The total population of livestock by type is presented in Table 7.1.

Trees are an important component of the farming system. Farmers interviewed during this study reported that private trees provide about 20 percent of the total animal feed. Grasses and agriculture residues are other major sources of fodder. Women are mostly involved in the collection of grass fodder, which puts extra burden on them, sometimes at risk to life. The fact that two women in Bandre CFUG in Syangja reportedly died while collecting fodder from a steep slope section of the community forest exemplifies the situation. This shows that fodder and forage development and correct management is important to reduce the work load and physical danger to women.

Table 7.1: Livestock population in Chitwan-Annapurna Landscape

S. N.	Livestock	Improved Breeds	Local Breeds
1	Cattle	51,540	268,696
2	Buffalo	16,301	370,557
3	Goat	152,595	501,232
4	Sheep	385	13,480
5	Swine	20,679	44,169
6	Poultry	498,662	311,808

(Source:District profile, 2010)

The livestock herding system is governed by factors such as cropping system, availability and proximity of forest resources, animal species and their productive stage, labor availability and per household livestock population. Livestock rearing in a particular village depends on the overall farming system adopted. Farming systems of the CHAL areas are determined by rainfall and irrigation systems, type of farm land, presence of trees and forage species on farm land, temperature, and other interrelated factors. In general, there are three types of livestock management systems in CHAL, which are discussed below:

(a) Transhumance system: This system is where animal herds (mostly yak, sheep and goats, and in some cases buffaloes and cattle) are herded from one place to another place throughout the year, and is common in the high mountain areas of Lamjung, Gorkha, Manang, Dhading, and Gorkha Districts. This system utilizes fodder and forage resources available in alpine pastures during the summer or monsoon season and crop stubble (wheat and barley straw, maize stalk etc.) on fallow, farm lands during the winter months. During the upward and downward migration of animals, the undergrowth in the forest is the major source of feeds for livestock.

(b) Sedentary system: Ruminant livestock such as cattle, buffalos, goat and sheep are grazed daily in forests, range lands or community grazing lands, returning to cattle shed or paddocks every evening. Scrublands and community grazing areas around the village are the main grazing areas during the summer. The sedentary livestock population consists of working oxen, cows, dry buffaloes, goats and sheep. This system is dominant in midhills and Siwaliks.

(c) *Stall feeding:* This system is found in those areas where fodder, forage or grasses and crop residues are abundantly available. Mostly high value animals such as milking cows and buffaloes, goats, and exotic or crossbreed animals are kept under this system. This system is common in the foothills and mountain valleys, where intensive cropping systems are practiced. Stall feeding will have added advantage of producing bio-gas.

7.4 Opportunities and Challenges for Livestock Development

CHAL is dominated by local livestock breeds, except in poultry. Jersey and Holisten cows, *Murras* buffalo and Jamunapari, *Barbari,* Bayer-African breeds and *Betal* are common improved varieties of livestock. The major challenges in livestock development include declining local (*Parkote* and *Limi* buffalo and *Khari* goat) breeds, low productivity of local cows, inadequate green fodder and forage production in winter and early summer, and degradation of high altitude pastures (Mustang and Lamjung) due to over grazing. Community Forestry has been a hurdle in some high mountain areas because of restrictions imposed by CFUGs on grazing and movement of animals. Wildlife predation is a major problem in areas adjacent to protected areas, and lack of marketing facilities for livestock products is an issue in remote areas.

Despite the above constraints, local people have the opportunity to promote fodder and forage in community and private lands, and roadsides, landslides and gullies. The government's priority to promote agriculture and livestock related business in the high mountain districts (HIMALI project) has encouraged local people to apply sustainable use and management to their livestock products and resources. Local people are interested in raising livestock to increase employment opportunities through community resource management. Establishment of fodder and forage resource centers for the promotion of a livestock farming system, soil conservation and water source protection using improved fodder and forage species are other opportunities. Soil fertility improvement through the promotion of legume fodder and forage species and the development of fodder and forage entrepreneurship would have added benefits for local people. Moreover, there is a great scope for promotion of fodder and forage in barren farmlands that will improve biodiversity conservation.

7.5 Agro-biodiversity

Agricultural biodiversity is an important part of Nepalese tradition and has an important role in the livelihoods of the local community and country's food security. Lost agriculture biodiversity results in the agriculture sector becoming more vulnerable to the effects of climate change. An attempt was made to assess the agro-biodiversity condition in CHAL through discussion with experienced farmers and staff of the District Agriculture Development Offices. The findings are presented in Table 7.2.

Major threats to agriculture biodiversity and natural challenges such as extreme weather events due to climate change; increasing use of improved varieties; poor response of local varieties to the use of fertilizers and irrigation compared with improved varieties; limited knowledge of farmers about the importance of biodiversity, and lack of support to conserve agriculture biodiversity and to promote organic farming.

Table 7.2: Situation of agro-biodiversity in CHAL

River Basin[3]	Local Varieties Assumed to be Extinct (E) and Threatened (T)		
	Rice	Maize	Others
Trishuli	Anga (E), Mansara (E), Rato lekali (T), Ghaiya (T)	Sathiya (E), Rato, Seto, Korche (T) and Murali makai (T)	Local cucumber (T), Potato local red (T)
Seti	Pahele, Jarneli (T), Juhari kalo, Kalo patle, Angha (E), Baliyali (E), Marsi, Mansara (E) Batissara, Lami, Goal Dhan, Dalle or Apjhutte, Jhinuwa and Kanak Jira(T), Jhinuwa (T), Malinza and Malasip (E), Mansuli (T)	Sathiya (E), Khutle (T), Bhalu and Manakamana 1, 2, Rato and seto local (T)	Rato Bhatta (E), Local cucumber (T) and Local red tomato (T)
Kali "A"	Silani, Khuita, Reshali, Bharkhune, Kalodhan (T), Jarneli (T), Juhari, Koili, Kalodhan, Thulo Gauriya, Gudura, Angha (E)	Seto and pahelo (T), Kande makai (E), marpha local(T)	Apple Kusu local (E), Nepale Bhatta (E, Buckwheat- Tite and Gulio, Nacked barley- Kalo barley (E)
Kali "B"	Mansara, Marsi, Ruduwa and Setogola (E), Anga, mansuli (E)	Sathiya, Seto Makai (T),	Kalo soyabean (E), Gahat, Rajma and Soyabean (T)
Marsyandhi	Aga, Marsi, Mansara (E) Batissara, Lami, Goal Dhan, Dalle or Apjhutte, Jhinuwa and Kanak Jira (T), Dalle or Apjhutte, Jhinuwa (T)	Sathiya (E)	Local cucumber (T)

(*Source: Present study, all the names are local*)

3 Trisuli = Rasuwa, Nuwakot and Dhading, Seti = Chitwan, Makawanpur, Nawalparansi, Tanhu and Kaski, Kali 'A' = Baglung, Parbat, Mustang and Myagdi, Marsyandi = Manang, Lamjung and Gorkha and Kali 'B' = Syanja, Palpa, Gulmi and Argakhanchi

Some local maize varieties such as *Sathiya, Khutle, Bhalu, Seto*, *Rato* and, *Kande* are near to extinction, while some others such as *Marpha* local and *Korche* are threatened in the study areas. Similarly, *Kusu* local apple, *Tite* and *Gulaio* (buckwheat), and *Kalo* barley of Mustang District are extinct. Black soyabean from Syangja, red soyabean from Kaski have also been lost (Annex 7.1).

7.6 Seeds and Other Inputs - Supply Situation

Seeds

Almost all farmers consulted during the study have reported use of improved varieties and hybrids in both irrigated and *bari* lands. Local species of major agriculture crops, therefore, have been found to be threatened and on the verge of extinction. In some cases, farmers purchase improved seeds from the local market, but the majority store seeds of major crops themselves. Farmers involved in commercial vegetable farming have reported that they buy vegetable seeds from the market, because they get more money selling fresh vegetable than producing seeds.

Manure and chemical fertilizers

Almost all farmers consulted during the study reported the use of both organic manure and chemical fertilizers in both paddy and *bari* lands, which on average is 4kg Di-ammonium phosphate and 2kg urea, and about 250kgs of farm yard manure or compost manure per 500 square meters (1 *ropani*). In addition to this, some vegetable producing farmers also used 1kg of murite of potash per ropani. However, the production and productivity of cultivated land has been reduced due to the lack of organic matter in the soil. A decrease in the livestock population has caused a decrease in farmyard manure. Inappropriate application of nitrogen fertilizers has made the soil acidic in many places. The Hariyo Ban Program should promote the use compost manure. Bio-char is another fertilizer (an "engineered" charcoal), which is useful not only in improving agriculture production but also for climate change mitigation. Bio-char also increases the water holding capacity of soil, reduces nutrient leaching, and reverses soil acidification.

Insecticides and pesticides

Use of insecticides and pesticides was found variable across the landscape. The use of insecticides, pesticides and fungicides is higher in Dhading compared to the other CHAL districts. The main reason behind the high use of insecticides and pesticides is seasonal and off-season vegetable production. The main pesticides used are Malathion dust, Indosulphan, Fenvelerate, Mancozeb, Began bait, Carbendazim, Dithene M-45 etc. Palpa is another district where pesticides and insecticides are used in relatively higher amount. These insecticides and pesticides are one of the main sources of soil and water pollution. In some areas (e.g. Dovan, Palpa), local farmers are now more aware of the harmful effects of insecticides and pesticides and have started adopting integrated pest management techniques using organic pesticides such as wood ash, cattle urine, and liquid prepared from soap, and locally available plants (e.g. *Artemisia vulgaris*).

7.7 Issues in Agriculture and Livestock Management

Replacement of traditional cereal-based farming systems by more intensive vegetable-based systems and the high application of chemical fertilizers instead of farm yard manure has resulted in a decrease in the fertility of many soils in the midhills in recent years. Sustaining fertility of these soils is essential for the prosperity of local farmers but there are concerns that the breakdown of the traditional linkages between forest, livestock, and cropping systems is adversely affecting fertility.

Landlessness, heavy dependence on chemical fertilizers and inadequate fodder supply are the issues in the Siwaliks, which are directly affecting forest degradation and negatively influencing local biodiversity conservation. Agriculture productivity has been declining across all the ecological regions, while soil erosion and landslides are a common problem in the hilly part of the Siwaliks, midhills and high mountains. Spreading citrus greening disease is one of the major problems in some midhills districts (e.g. Lamjung, Kaski and Myagdi). Degradation of high altitude pastures and disappearance of indigenous apple varieties are a serious problem in the high mountains, especially in Mustang District. Inadequate irrigation, credit and marketing facilities have been the critical issues in the midhills and high mountains.

Watershed Condition and Management

8

International Water Management Institute (IWMI) (2012) identified and prioritized watersheds in the middle and high mountains of Nepal that are significantly vulnerable to climate change and came up with a vulnerability map as well as various other assessments for a total of 135 watersheds covering a total area of 81,484.21 km^2. Out of these, 31 lie in the Gandaki River Basin.

The coverage areas of these watersheds range from a maximum of 2,960 km^2 to a minimum of 46.38 km^2 with an average coverage area of 603.59 km^2. These watersheds were evaluated and ranked using indices viz. Combined Multiple Sensitivity Index (CSI), Combined Ecological Risk (CER), Combined/Multiple Risk Exposure (CMRE), Combined/Multiple Adaptation Capability Index (CMAC) and Combined/Multiple Vulnerability Index (CMVI). The indicators used and the list of ranked watersheds based on these indicators are presented in Annex 8.1 and Annex 8.2, respectively.

8.1 Classification of Watersheds

Shrestha and Ginneken (1983) ranked the districts in Nepal with respect to watershed condition by assigning a ranking to each watershed's condition; the poorer the watershed, the higher the ranking value. Mustang District has the highest value with very poor watershed conditions and Rasuwa, with lowest value, has good watersheds. Overall, three districts are in very poor condition; two poor; six marginal; six in fairly good condition, and two districts have a ranking of good watershed condition (Annex 8.3).

Fleming (1978) classified 36 catchments in the Western Development Region, out of which 33 lie in the Gandaki River Basin. They were classified according to potential erosion hazard based on precipitation and geological stability and existing land use problems based on forest cover, grazing pressure and gullies/landslides. Seven catchments are identified as 'high priority' areas for conservation, rehabilitation and management programs, 14 as having 'moderate priority' and 12 as 'low priority' (Annex 8.4).

In most of the districts sub-watersheds have been prioritized following the Guidelines and Methodology for Sub-Watershed Prioritisation in Watershed Management Planning (1997). The prioritization is based on 60 percent weightage given to erosion potential according to land use and land systems, and 40 percent weightage to population pressure in each sub-watershed. Critical sub-watersheds as prioritized by respective district soil and water conservation officers following Shrestha et al. (1997) are presented in Annex 8.5.

Consultations and interviews with district soil and water conservation officers and other key informants by telephone, and in cluster/group meetings, and secondary information was used to identify as "critical" 43 sub-watersheds and nine micro-watersheds. The basis for this identification was the presence of land degradation due to landslides; gullies; stream bank cutting; shifting cultivation; inhabitants of ethnic groups and poor people; potential for ecotourism, etc. A brief description of programs and projects and perceived critical sub-watersheds and micro-watersheds in each district is presented in Annex 8.6.

Out of these perceived critical sub-watersheds/ micro-watersheds, 38 were delineated on the district maps, digitized and then overlayed on the vulnerable map of the International Water Management Institute (IWMI) (2012). According to IWMI, the Upper East Seti Watershed is highly sensitive as it also falls within the district of high population density, followed by Andhikhola, also with high

sensitivity. Based on the CER the Upper East Seti was ranked as 1 (high) followed by the Lower Trishuli. According to the CMRE, the Upper Kali Gandaki was in the highest rank, followed by the East Rapti. Based on CMAC, the Upper East Seti Watershed has a high adaptive capability followed by the Modi Khola. Based on CMVI sensitivity analysis, the Upper East Seti Watershed is highly sensitive to climate change. Therefore, the watershed is at higher risk for various hazardous conditions such as landslides/floods, more frequent droughts, food insecurity and more frequent intensive rainstorms. The identified critical sub-watersheds and micro-watersheds are assessed considering a Combined/Multiple Sensitivity Index (based on six parameters) and Combined/Multiple Risk Exposure Index (based on 14 parameters) of the vulnerability mapping (IWMI, 2012) for each district in the Gandaki Basin, which is presented in descending order of vulnerability in Table 8.1. (See Annex 8.7 for further details)

Table 8.1: Critical sub-watersheds/micro-watersheds in CHAL

S. N.	Critical Sub/Micro Watershed	Area (km²)	District	Watershed
1	Sardikhola	52.29	Kaski	Upper East Seti
2	Bhumdi-Marsekhola	N/A	,,	
3	Lower Jyadulkhola	29.93	Gorkha	Budhi Gandaki
4	Chapakot	42.37	Syangja	Lower Kali Gandaki
5	Tualsibhanjyang	20.0	,,	
6	Upper Purbakhola	46.12	Palpa	
7	Ramdikhola	61.13	,,	
8	Debusakhola	41.27	Nawalparasi	
9	Puwa-Majuwa	19.6	Lamjung	Marsyangdi
10	Khudi	N/A	,,	
11	Chepe	N/A	Lamjung/Gorkha	
12	Letekhola	37.02	Mustang	Upper Kali Gandaki
13	Pongkyukhola	36.86	,,	
14	Syangkhola	35.91	,,	
15	Ruksekhola	48.75	Myagdi	
16	Lugdikhola	N/A	Parbat	
17	Lastikhola	34.65	,,	
18	Darmekhola	N/A	Nuwakot	Tandikhola
19	Agarakhola	36.8	Dhading	Maheshkhola
20	Malekhukhola	37.79	Dhading	Middle Trishuli
21	Theulekhola A	34.21	Baglung	Middle Kali Gandaki
22	Theulekhola B	30.25	,,	
23	Kalikhola	7.7	Gulmi	
24	Ullikhola	26.93	,,	
25	Bhadrikhola	N/A	Arghakhanchi	Ridikhola
26	Gachchekhola	15.69	,,	
27	Buldikhola	N/A	Tanahun	Lower East Seti
28	Chhabdikhola	N/A	,,	
29	Samrikhola	N/A	Nuwakot	Upper Trishuli
30	Ghattekhola MW	N/A	Rasuwa	
31	Andhikhola MW	N/A	,,	
32	Sirdikhola	26.62	Gorkha	Daraundi
33	Pangthalikhola	30.0	Makawanpur	Gorandhi
34	Jirkhekhola	21.0	,,	
35	Marang	100.8	Myagdi	Myagdi
36	Kalikhola MW	9.92	Chitwan	Trishuli-Marsyangdi
37	Lotharkhola	NA	Chitwan	
38	Kerunge (Gondhri)	101.52	Nawalparasi	

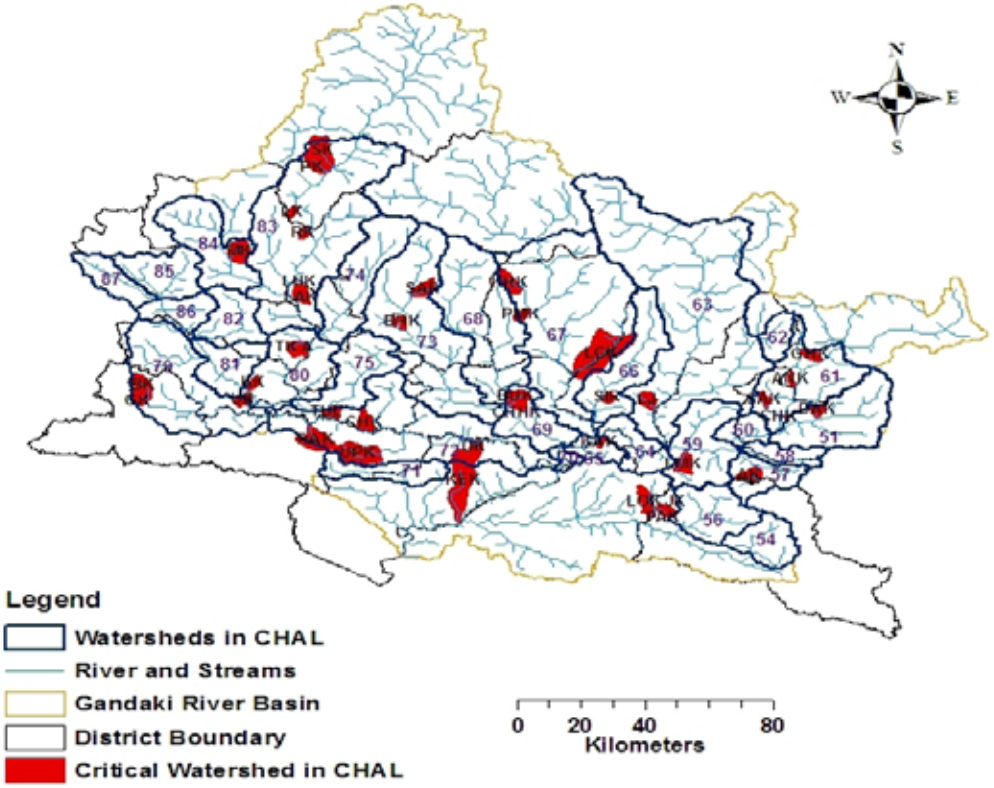
(Source: Present study and literature review of IWMI, 2012)

8.2 Watershed Management Programs

The Department of Soil Conservation and Watershed Management (DSCWM) has been implementing different soil conservation and watershed management programs and activities in CHAL through 17 District Soil Conservation Offices (DISCO). The emphasis of the programs is on people's participation. It has been envisaged that all activities related to soil conservation and watershed management programs should aim for sustainability by developing community initiatives and self-reliance mechanisms. This policy provides for the formulation of user groups to mobilize people to carry out all soil conservation and watershed management activities and to implement them through the local user groups. The level of participation varies depending upon the nature and scale of work. Generally, programs in the districts are implemented with 50 percent of the budget allocation for activities on watershed management approach in selected sub-watersheds and the rest for activities in other VDCs on a needs based approach in coordination with the District Development Committee (DDC).

District soil conservation programs are implemented through the government's internal financial resources. In addition, donor supported programs and projects are implemented in some districts (Annex 8.8). The DSCWM has given emphasis to the basin approach for the management of conservation in the Gandaki, Karnali and Koshi Basins, and, accordingly, proposed sub-basin and watershed management offices in the Gandaki Basin area (Annex 8.9). The basin approach will address the interlinkage between upstream and downstream, particularly as conservation in upstream areas can drastically change the characteristics of floods and sediment movement and ensure the long-term protection of river banks downstream. The linkages between the highland and lowland, upstream and downstream should be the core principle of watershed management and therefore, a larger landscape-level upstream and downstream dialogical relation needs to be in place through watershed management policies and programs (Pandit et al., 2007).

Figure 8.1: Critical sub-watersheds/micro-watersheds in CHAL



(Source: Present study; Data source: Department of Survey)

9 Hydrology and Water Management

There are many rivers, streams, ponds and lakes in the Gandaki Basin. The basin's physical setting between the Tibetan plateau and the Gangetic plain along the southern slope of the Himalayas contributes to a rich water regime. For about eight months, most of the rivers/streams derive water from snow melt and groundwater discharge. In the four months of the rainy season, all the rivers/streams turn violently swollen with flood water laden with sediment. High flows are related to monsoon precipitation. On average, more than 75 percent of the total annual precipitation is confined to the summer monsoon period. Winter precipitation is probably less than 25 percent for the country as a whole. Base flow and snow melt also must affect the seasonal distribution of runoff. The maximum monthly rainfall and the maximum monthly runoff normally occur during the months of July and August respectively, thus showing a time lag. High flows are maintained throughout September and October.

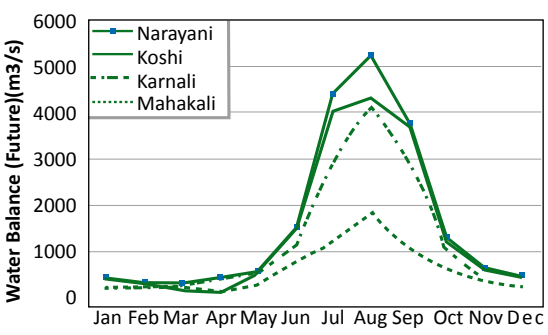
9.1 The Gandaki River

The Gandaki River (also known as Narayani) has a total catchment area of 34,960km^2 and close to 90 percent of the catchment lies in Nepalese territory. The average runoff of the Gandaki at Narayangadh is around 1,600 m^3/sec (equivalent to around 50 BCM per annum) (WECS 2002). It has an estimated ice reserve of 191.39km^3 (Mool et al., 2001). The Gandaki comprises of the Trishuli, Budhi Gandaki, Marsyangdi, Seti Gandaki, and the Kali Gandaki River. Among these, some parts of Kali Gandaki and Burhi Gandaki and major parts of the Trishuli lie in the Tibet Autonomous Region and flow down through the Himalayan range to Nepal. The water balance in the river basins if future potential in each basin were to be irrigated is presented in Figure 9.1. Out of the major basins in Nepal, the Gandaki/Narayani Basin has more surplus. The surface water availability in the basin is 29 percent for the population of 19 percent (2001 data) of the country (WECS, 2011).

The glacier contribution to the total stream flow of the basin in which they are situated varies widely, from approximately 30 percent in the Budhi Gandaki Basin to seven percent in the Kaligandaki, 16 percent in Marsyangdi, and 12 percent in Trishuli. Run-off is concentrated in the monsoon season. Snowmelt contribution to total run-off is mainly from March to July. The Gandaki has an even higher estimated runoff as compared to the Karnali, which has larger drainage area and longer river channel. Specific runoff has been found to be highest for Marshyangdi (1,737 mm) and the lowest (1,182 mm) for the Budhi Gandaki River (Table 9.1).

The average monthly high and low, average yearly and maximum and minimum instantaneous extreme flows measured at different stream/

Figure 9.1: Water balance in major river basins in Nepal



(*Source: WECS, 2011*)

Table 9.1: Specific runoff and streamflow in glacierized catchments in the Gandaki Basin

River	Specific runoff (mm)	Streamflow m³/sec	Avg. Altitude m.
Kaligandaki	1,270	267	4,200
Budhi Gandaki	1,182	160	5,400
Trishuli	1,382	173	5,200
Marshyangdi	1,737	212	4,200

(*Source: Alford et al,. 2010*)

river locations in CHAL over different periods are presented in Annex 9.1. Among the rivers/streams in the Gandaki Basin, an average monthly high discharge of 1,460 m³/s was observed in the Kali Gandaki at Ansigh-Andhi Ghat in the month of August whereas the average monthly low discharge of 1.38 m³/s was seen in the Lothar Khola at Lothar in March. Except at both stations of the Andhi Khola, which had high average monthly dischargesin July, all other streams/rivers showed a high average monthly discharge in August.

The majority of streams/rivers showed an average monthly low discharge in March, with some exceptions which can be seen in Annex 9.1. Among the streams/rivers, the maximum instantaneous discharge of 5,400m³/s was recorded in August 1974 on the Narayani at Narayanghat and the minimum instantaneous discharge of 0.12m³/s was recorded in Phalankhukhola at Betrawati in May of 1979.

9.2 Major Tributaries of the Gandaki River

9.2.1 Kali Gandaki

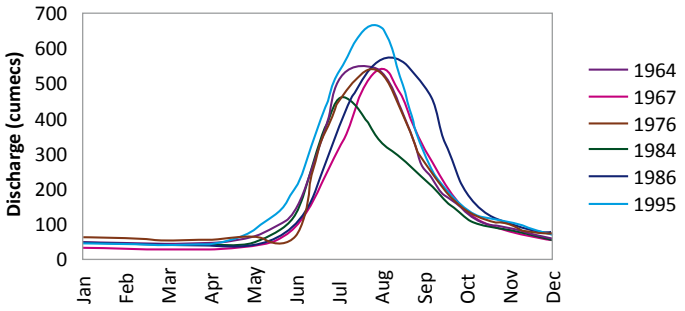
The Kali Gandaki River originates in Nepal near the Tibetan Plateau, flows southward through the Mustang Basin, crosses the Himalayas in a gorge, and descends to the lowlands of Nepal. The total length in Nepalese territory is about 300km. The Kali Valley is the deepest gorge, around 5,486m. Its watershed area at the damsite of the Kaligandaki A Hydropower Station is 4,618km² (ADB, 1996). The river exhibited very high fluctuations in flow in between 1964-1995 (WECS, 2010; Figure 9.2).

The data of the monthly average flow of the Kali Gandaki River shows that an increase in flow gradually starts from June to August and then decreases, also gradually, with the minimum flow in March and April. Additionally, the analysis of available data on the annual average flow shows a decrease of 19.82 m³/s per year (Bajracharya et al., 2011).

9.2.2 Seti

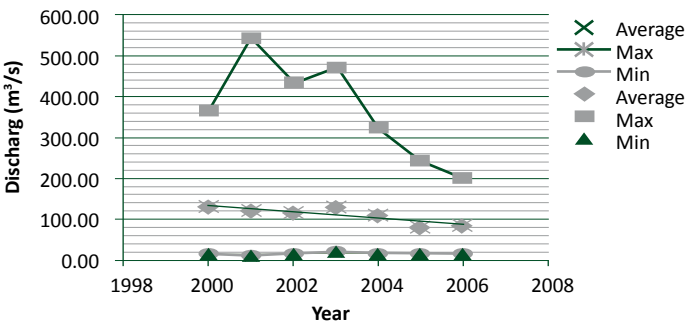
The Seti River is glacial in origin and comes from the Annapurna Range. This is the most important river in Kaski District and flows through the heart of Pokhara city where it cuts the ground deep and disappears almost underground for some distance. Its drainage area is 600km² and its length is 112.7km. It joins the Trishuli River at Gaighat. The average minimum flow was 13m³/s in April 2001 and the maximum flow was 543m³/s in August 2001. The annual average flow of the Seti River has been found to be decreasing by 7.9 m³/s annually at Damauli (Figure 9.3).

Figure 9.2: Shifting hydrograph in the Kali Gandaki River



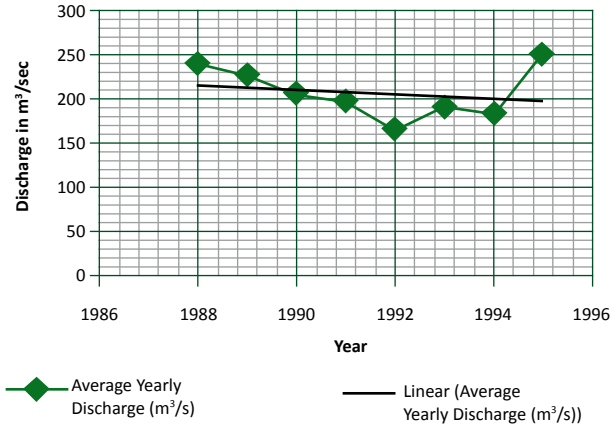
(*Source: WECS, 2010)*

Figure 9.3: Annual average discharge of the Seti River at Damauli Station



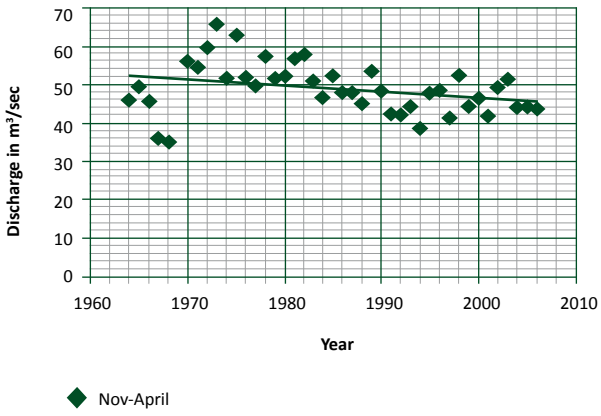
(*Source: Bajracharya et al., 2011)*

Figure 9.4: Annual average discharge of the Marsyangdi River at Bimalnagar Station



(Source: Bajracharya et. al., 2011)

Figure 9.5: Average annual discharge of the Budhi Gandaki River at Arughat Station during the dry season



(Source: Bajracharya et. al. ,2011)

9.2.3 Marsyangdi

The Marsyangdi originates from the south eastern flank of Muktinath Himal where it is called Jargung Khola. The river rises on the northern slopes of the Annapurna Himal, flows east through an arid valley around Manang, and then swings south to join the Trisuli River at Mugling. It meets the Naur Khola flowing from Mustang and the Peri Himal. Its total length is 145 km. Analyzing the monthly mean of the Marshyangdhi River, the flow has been found to be slightly increased by 0.3149, but the dry season flow (November to April) has remarkably decreased by 0.338. The flow is lowest during February and March, after which it gradually increases and becomes highest during July and August (Figure 9.4; Bajracharya et al., 2011).

9.2.4 Budhi Gandaki

Budhi Gandaki originates from the Tibetan Plateau and flows south-west and then south-east as Siringi Khola. The river drains the eastern slopes of Manaslu and the Ganesh Himal before flowing south through a steep-sided valley to join the Trisuli River near Mugling. Its total length is 145km. Its principle tributary is Ankhu Khola which drains from the western flank of Ganesh Himal. Analyzing the monthly mean of the Budi Gandaki River at Arughat, the flow has increased by 0.5076, but the dry season flow (November to April) shows that the flow has decreased by 0.1627 (Figure 9.5; Bajracharya et al., 2011)

9.2.5 Trishuli

The Trishuli comes from the Tibetan Plateau and crosses Nepal at Rasuwa Pass. It meets Chilime Khola and Langtang near Syabrubesi and Mailung Khola. The total length of this river in Nepal, before it joins Kaligandaki at Devghat, is 130km. Its watershed area in Nepal is 1,856 km^2. The annual average flow of the Trishuli river is found to increase by 2.7366 m^3/s per year (Figure 9.6). However, during the dry season (November-April) it decreased by 0.2206 m^3/year. Overall, the dry season flow decreased at a very slow rate, whereas the wet season flow either increased at higher rate or decreased at a slow rate. This reflects that the glacier contribution in the dry season is becoming less over time while the rain contribution during the wet season is not uniform (Bajracharya et al., 2011).

9.2.6 East Rapti

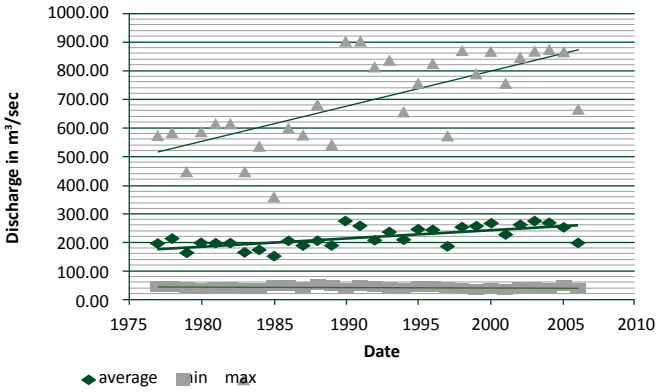
The river originates from the midhills in Makwanpur District at Chisapani Garhi and flows south to Hetauda and then takes a westerly course through a fertile valley of Makawanpur and Chitwan Districts before joining the Narayani River. The river has a catchment area of about 311 km^2 and runs for around 122km.

The average annual discharge of the river measured at Bhandara in Chitwan is 61m^3/s. According to the last complete data from DHM measured in this river at Rajaiya, the minimum daily discharge was 3.08 m^3/s and the maximum 141 m^3/s (Figure 9.7; Jha, 2005).

9.3 Snow and Glaciers

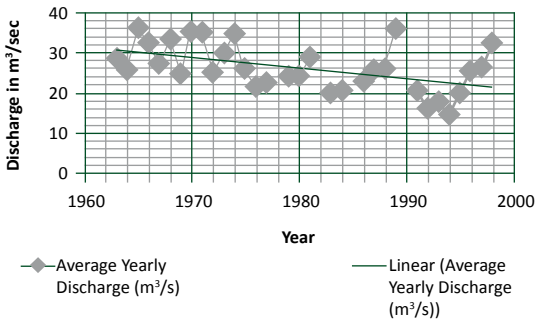
Gandaki is the biggest of Nepal's four river basins in terms of total glacier area coverage. There are 1,025 glaciers listed in this basin with an area of 2,030.15km^2 and an ice reserve of 191.39km^3. The

Figure 9.6: Annual average discharge (Trishuli, Betrabati Station) with minimum and maximum flow



(Source: Bajracharya et al., 2011)

Figure 9.7: Annual average discharge of the Rapti River at Rajaiya Station



(Source: Jha, 2005)

Kali Gandaki has the highest number of glaciers (399), while Marsyangdi has the highest glacier area coverage of 614.21km² (Table 9.2).

According to Mool et al. (2001), there are 74 glaciers in the Trishuli River Sub-basin. There is only one ice cap and 19 ice apron glaciers in the sub-basin. The mountain glaciers are greater in number, but the valley glaciers cover 66 percent of the area with 81 percent of the ice reserve (Mool et al. 2001). The Budhi Gandaki consists of 180 glaciers. Out of them, 17 glaciers are valley glaciers, which are nine percent of the total number of glaciers, but the area occupied by them is more or less equal to the area of the rest of the glaciers in the sub-basin. The valley glaciers have around 60 percent of the ice reserves of this sub-basin.

There are 311 glaciers in the Marsyangdi Sub-basin. Among them, 21 valley glaciers, which amount to only about seven percent of the total, cover around 41 percent of the area with an ice reserve of above 50 percent of the sub-basin. The Seti Sub-basin comprises the lowest number of glaciers, with 61 and covers an area of about 164km². It has an ice reserve of about 16 km³. There are only six valley glaciers and the rest are mountain glaciers and other small forms of mountain glaciers. There are 399 glaciers in the Kali Gandaki Sub-basin. The valley glaciers in this sub-basin comprise only 12 percent in terms of number, but the area occupied by them is 41 percent of the area covered by all the glaciers in the sub-basin. The ice reserve of the valley glaciers in the sub-basin is about 47 percent.

9.4 Lakes

9.4.1 Glacial lakes

These are lakes of glacial origin, mostly above 4,000m altitude. The cluster of lakes that lie in central Himalaya viz. Gosainkunda, Bhairavkund and Surajkund are Ramsar sites and important religious lakes.

Table 9.2 Distribution of glaciers in the Gandaki Basin

Sub-basin	Number of Glaciers	Area (km²)	Mean Area per Glacier (km²)	Ice Reserve (km³)
Trisuli	74	246.65	3.33	27.47
Budhi Gandaki	180	442.14	2.45	40.40
Marsyangdi	311	614.31	1.97	54.99
Seti	61	164.48	4.34	16.88
Kali Gandaki	399	562.67	1.41	51.65
Total	1,025	2030.25	2.25	191.39

(Source: Mool et al., 2001)

Table 9.3: Distribution of glacier lakes in the Gandaki Basin

Sub-basin Name	Number of Lakes	Area (km²)	Mean area per Lake (km²)
Trisuli	117	2.03	0.02
Budi Gandaki	37	0.64	0.01
Marsyangdi	78	6.28	0.08
Seti	10	0.26	0.03
Kali Gandaki	96	3.29	0.03
Total	338	12.50	0.17

(Source: Mool et al., 2001)

There are 338 lakes in the Gandaki Basin with an area of 12.28km². The average lake area ranges from 0.01 to 0.08 km² (Mool et al., 2001) Among the sub-basins, Trishuli has the highest number of lakes (117), whereas the largest area (6.28km²) is covered by the Marsyangdi Sub-basin (Mool et al., 2001). The distribution of glacier lakes in the Gandaki Basin is presented in Table 9.3.

Ives et al. (2010) made a comparison of number and areas occupied by glacial lakes between 2001 and 2009 and reported the highest reduction in number (-72.92%) to be in the Kali Gandaki Basin and lowest (-40.00%) in Seti whereas area occupied increased by 10.78 percent in Budhi Gandaki and decreased by -56.54 percent in Seti Sub-basin (Table 9.4).

Potentially dangerous glacial lakes

The moraine-dammed lake (Gbu_gl 9) is identified as potentially dangerous in Budhi Gandaki. Out of the two moraine-dammed lakes, the Gmar_gl 70 (Thulagi) is the only one identified as a potentially dangerous lake in Marsyangdi. All the identified potentially dangerous lakes belong to the category of moraine-dammed lakes in the Kali Gandaki, and they are Gka_gl 38, Gka_gl 41, Gka_gl 42, and Gka_gl 67. These lakes either fall in Category 1 as potentially dangerous glacial lakes without a record of past GLOF events or Category 3 as potentially dangerous glacial lakes identified in the inventory but posing no danger at present based on GLOF events in the past. They are: Category 1: Gbu_gl 9, Gmar_gl 70 (Thulagi), Gka_gl 38, and Gka_gl 67. Category 3: Gka_gl 41 and Gka_gl 42. Out of these, Gbu_gl 9 (Q) unnamed located at 28° 35.79' 84° 38.09' (3,5902300.082), Gmar_gl 70 (R) Thulagi located at 28° 29.69' 84° 29.01' (3,8254200.223), Gka_gl 38 (S) unnamed 29° 2.76' 83° 40.52' (5,4196000.149) and Gka_gl 67 (T) unnamed 29° 12.79' 83° 41.79' (5,452 3,610 1.013) are recommended for further investigation and field survey (Mool et al., 2001)

9.4.2: Other lakes

(a)*Tectonic lakes*: Tectonic lakes in the midlands are now drained out. A semi-lake condition was prevalent in the Pokhara Valley.

(b) Ox-bow lakes: Numerous ox-bow lakes are found in the Terai plain particularly in the central and western Terai region. These are formed due to shifting of rivers. Beeshazar Lake in Chitwan is an extensive, typical oxbow lake system situated between the Mahabharat Mountain Range to the north and the Siwalik range to the south.

In addition to these natural lakes, numerous man-made ponds and reservoirs are located especially in the Terai and valleys. Some of the important lakes, *dahas, kundas* in the districts of the Gandaki Basin are: *Suryakund*, *Sagarkund*, and *Baldehital* in Nuwakot; *Gosainkund*, *Bhairavkund*, *Surajkund Saraswoti Kund, Parbatikund*, *Ganeshkund*, and *Jaleswor Kund* in Rasuwa; *Kalchhuman* (1.5km long), *Narad*, *Kund*, *Dudhpokhari*, *Bhulbhulekhar*, *Birendra Chhosong*, *Pushkar Tirtha*, *Ranipokhari*, and *Manepani* in Gorkha District; *Dudhpokhari*, *Mamepokhari*, *Ilampokhari*, and *Barhapokhari* in Lamjung District, and *Fewa*, *Begnas*, *Rupa, Khaste, Dipang, Gunde, Neurani, Maidi,* and *Nandi* Lakes and *Shanti Kund* in Kaski District.

Table 9.4: Comparison of number and area occupied by glacial lakes between 2001 and 2009

	Glacial lakes 2001		Glacial lakes 2009		Comparison 2001/2009	
	Number	Area (km²)	Number	Area (km²)	Number %	Area (%)
Trishuli	117	2.03	50	1.68	-57.26	-17.44
Budhi Gandaki	37	0.64	12	0.71	-67.57	10.78
Marsyangdi	78	6.28	22	5.16	-71.79	-17.90
Seti	10	0.26	6	0.11	-40.00	-56.54
Kali Gandaki	96	3.29	26	1.88	-72.92	-42.86
Total	338	12.50	116	9.53	-65.68	-23.73

(*Source: Ives et al., 2010*)

Similarly, *Damodar Kund*, *Dhumba Tal*, *Titi Tal*, and *Sekong Tal* in Mustang District; *Gajako dah (Damek), Rudratal, Bobang,* and *Nildah (Bhakunde*) in Baglung District; *Thadadah, Senglengdah, Gahachaurdah, and Paneradah* in Arghakhanchi District; *Satyabati Tal in Ward 1 of* Koldanda VDC, Suke, and Nandan, Sitakund in Palpa; Andhaandhi Dah and Chhangchhangdi in Syangja District; *Tilicho* Lake in Khangsar, *Gangapurna* Lake in Manang, *Mringchho* Lake in Pisang, and Ngyamcho Lake in *Nache* village, *Ponkar* and *Himlung* Lake in Bhimthang, *Kecho* Lake in Manang District; and a a cluster of lakes north of Daunne, Nawalparsi District are other important lakes. Important lakes in Chitwan include: *Satrahazar Tal*, *Bishazar Tal, Sattaishazar Tal, Atthaishazar Tal, Mundatal, Devital, Lamital, Tamorghaila Tal, Kasaratal, Nandbahuju Tal, Anjuratal, Manjuratal, Gaduwatal, Anjanatal, Parshuram Kund, and Baikuntha Kund* (NTNC, 2008; DDC Chitwan, 2065).

9.5 Water Quality

In the Gandaki Basin, available water, both ground and surface, is used to meet the demand for domestic, industrial and agricultural use. Rivers/ streams have been tapped to generate hydropower for the country. Lakes, reservoirs and rivers are used for recreation and have been attractions for tourists. Though there are streamflow monitoring stations at 27 locations, there is no monitoring of water quality on a systematic and regular basis. Demand for water is rapidly increasing for the uses mentioned above. Non-point source of pollution from agricultural fields, and point source of pollution - discharge of untreated sewage into rivers and lakes, and dumping of industrial wastes are increasing. Groundwater is also at risk from contamination from mostly pathogenic bacteria, pesticides, nitrate and industrial effluents. The main source of pathogenic bacteria is sewage. Morphological disturbance through water abstraction for irrigation, industrial and domestic pollution, toxic contamination, and hydropower generation are some of the challenges seen in Nepalese water bodies (Sharma et al., 2005).

9.5.1 Water quality of lakes

Major lakes in the Pokhara Valley are well studied compared to other regions. Table 9.5 shows comparisons among three lakes (Fewa, Begnas, and Rupa) in the Pokhara Valley and Gosainkunda Lake which is a high altitude lake in Rasuwa District.

Table 9.5: Water quality in Fewa, Begnas, Rupa and Gosainkunda lakes

Parameters	Fewa	Begnas	Rupa	Gosainkunda
BOD (mg/l)	2.00	2.00	2.68	NA
$N\text{-}NO_3$ (mg/l)	0.12	0.10	0.10	0.20
Total Nitrogen (mg/l)	260.00	233.60	176.40	210.00
$P\text{-}PO_4$ (mg/l)	30.00	18.70	23.30	3.00
Total Phosphorus (mg/l)	45.00	43.50	59.60	6.80
Chlorophyll (mg/l)	8.00	5.50	6.50	1.20
E.coli (100 ml)	8.00	28.90	393.30	NA

(*Source: CBS, 2008*)

Analysis of limnological conditions in Fewa, Begnas and Rupa lakes indicated very high concentrations of Calcium cations (66.3% in Fewa and 43% in Begnas and Rupa), and bicarbonate anions (Sharma et al., 2005). Acharya et al. (2011) found the pH to be increasing in Fewa Lake because of point sources and also sewage and solid waste discharge, as well as residual chemicals from agricultural fields. Dissolved Oxygen (DO) was decreasing with 5.1-5.6 mg/l, with higher concentration in human influenced sites. As total nitrogen was higher than total phosphorus, the lake water was of mesotrophic character. Total suspended solids were in the normal range of 2-3 mg/l in rainy season and 4-11 mg/l in winter season. *Phirke Khola* and *Sedi Khola* were the main point source of nutrient input into the lake.

Sthapit and Balla (1998) reported an average annual sedimentation rate of 180,00 m^3 i.e. 15 m^3 per ha in Fewa lake from 1990 to 1998 and if this rate continued, 80 percent of Fewa Lake's storage capacity would be silted up in the next 190 years making the lake virtually useless. As it is, the silt trap area of Fewa Lake will be completely filled up in 24-33 years, reducing the lake area by 16 percent. According to Shrestha (2011), Rupa Lake has achieved hyper-eutrophic conditions due to heavy siltation from the catchment areas and organic load from decaying aquatic weeds in the lake. Fewa Lake's ecosystem is threatened by sedimentation, eutrophication and encroachment which represent a case of disturbed lake in dire need of management. Lake water quality has been deteriorating due to the inflow of large quantities of nutrients and sedimentation, sewerage discharges from households and hotels situated on the periphery and surface runoff, both from urban and agricultural areas and algal bloom as a result of destruction of ecotone or buffer zone area

resulting in anoxic condition (Pokharel, 2009; Lamichhane, 2000; Oli, 1997 as cited in Acharya et al., 2011).

In the case of high altitude lakes in the Gandaki Basin, Sharma et al. (2005) studied the trophic status and water quality in Lake Tilicho of Central Nepal. It is one of the largest glacier-fed lakes with slightly turbid water color and strong chemical stratification. This study revealed a low total phosphorus (1–6mg/l) and total nitrogen (0.16 to 0.25mg/l) in the water. According to Raut et al. (2012), the major cation concentrations were found in the order of Ca^{++} (3.47 mg/l) >Mg^{++} (1.30 mg/l) >Na^{+} (0.45 mg/l) >K^{+} (0.28 mg/l) and dominated by calcium, the anion concentrations in the order of Cl^{-} (20.50mg/l) > HCO_3^{-}(20.50mg/l) > SO_4^{-}(3.94mg/l), electrical conductivity of 11.66 µS/cm, DO of 8.55mg/l and pH of 7.00 in Gosainkunda Lake. Gosainkunda Lake can still be considered to be of oligotrophic status having low nutrient concentration, neutral pH and the presence of negligible amount of trace elements in the lake water. However, the concentration of nutrients, major cations and anions were found to follow an increasing trend as compared to previous studies. These indicate that the lake has become exposed to increasing anthropogenic impact, which might be due to discharge of wastewater directly to the lake. Devital, Lamital and Tamortal were investigated in Royal Chitwan National Park and classified as oligotrophic (Sharma et al., 2005).

9.5.2 Water quality in rivers and streams

The rivers/streams in the Gandaki Basin have been studied for their water quality. CBS, 2008a provided information on the water quality of the Seti and East Rapti during the dry season, as given in Table 9.6. Parameters like pH, TDS and DO were higher in the Seti than in the East Rapti, whereas biochemical oxygen demand (BOD) was less in Seti.

Evans et al. (2005) report that central Nepal rivers (Myagdi Khola, Kali Gandaki, Modi Khola, Seti Khola, and Langtang Khola) have temperatures of 8 to 19°C and pH values of 7.9 to 8.9. Carbonate dissolution dominates the cation budget with Ca^{2+} and Mg^{2+} comprising 75 to 95 percent of the cationic charge, and Na^{+} and K^{+} making up equal portions of the remaining cation budget. Bicarbonate is the dominant anion and the rivers generally have low Cl^{-}. TDS for the rivers averages around 150mg/l and is higher in samples downstream of spring locations. The rivers are near or above saturation with respect to calcite. The chemistry of the Trishuli differs somewhat from the other major streams, with a larger contribution to the cationic charge from Na^{+} and K^{+}. Sharma et al. (2005) analyzed water samples from nine locations and found the pH, nitrogen, total phosphorus and BOD within the permissible level, except BOD in the fish farm. The water quality of the Trishuli River has been reported as good in terms of its physico-chemical properties. However, they reported the Marsyangdi River had an exponential decrease in the water temperature with the decrease in elevation. Water was slightly alkaline, with pH values ranging from 7.4 to 8.0, and DO almost over the saturation limit.

Jha (2005) studied the change in water quality due to disturbances in six rivers and streams in the Gandaki Basin (Annex 9.2). He found that the agricultural disturbance exerted significant impacts on the river which had a potential to degrade the water quality and integrity. Urbanization had the least impact, however, the dam on the river was found to be an important threat to the river integrity, particularly, in reference to the upstream sites. The impact of industry was found to be the most serious among all the disturbances.

Table 9.6: Water quality of Seti and East Rapti rivers during dry season, 1998

Location of River	pH	TDS (mg/l)	DO (mg/l)	BOD (mg/l)
Seti at Ramghat	8.2	222	9.3	2.0
East Rapti at Sauraha	7.8	213	8.7	2.5
WHO Guideline	6.5-8.5	100	>5.0	3.0

(Source: CBS, 2008a)

Infrastructure 10

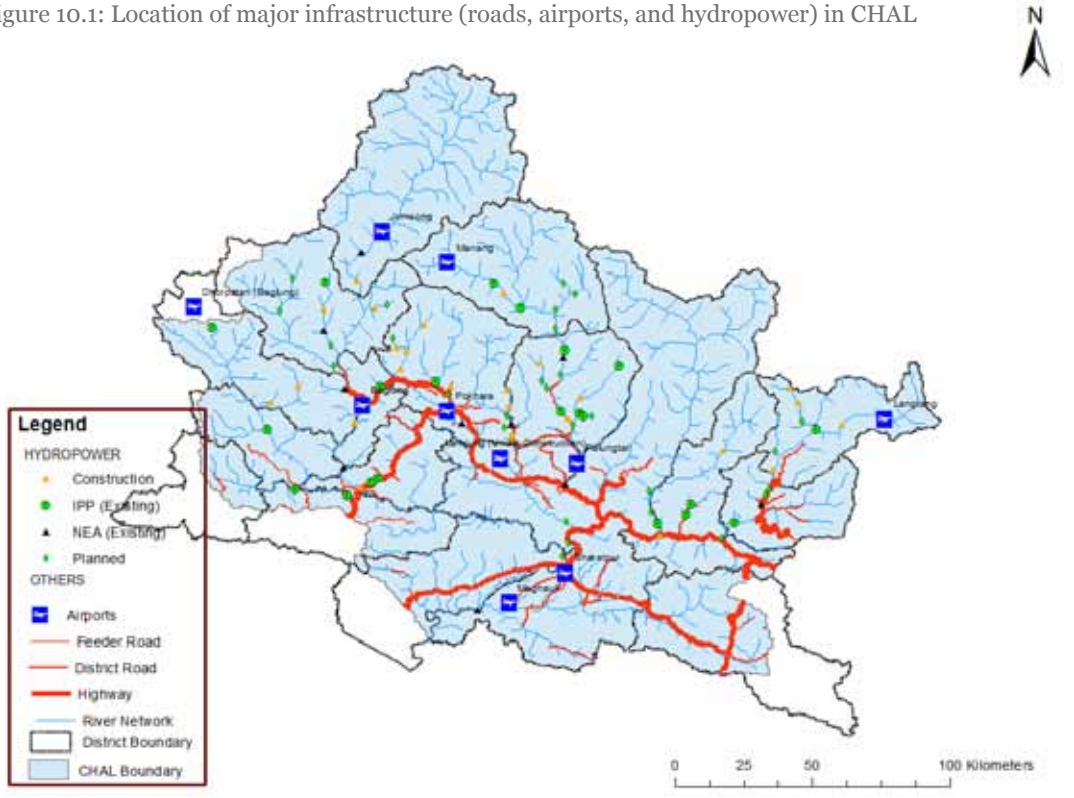
The Nineth Five Year Plan (2002 to 2007) of Nepal generally strove to increase output and employment opportunities by developing infrastructure to attain economic stability. As the development of infrastructure is taken as the backbone of overall development of a country, from the very beginning this sector has been receiving high priority in Nepal.

The following sections describe the major infrastructures in the landscape that are directly related to the promotion of industry, commerce, and international trade and tourism. The location of major roads, and airports and hydropower plans is shown in Figure 10.1.

10.1 Roads

Nepal's road network and quality are among the poorest in South Asia. By the end of fiscal year 2008-09, the total length of motorable road in the country reached 19,447 km, of which 6,245 km is black-topped, 4,336 km graveled, and 8,866 km is earthen (DoR, 2010). A total of 1,313 bridges have been constructed and 71 out of 75 district headquarters have been connected by roads. About 25,000 km of additional rural road tracks have been opened, and 4,100 suspension bridges are in the country.

Figure 10.1: Location of major infrastructure (roads, airports, and hydropower) in CHAL



(Source: DoR, 2010; CAAN, 2010; and NEA, 2011)

In CHAL, 18 of the total 19 district headquarters (except Manang) are connected by road. Overall, some 60 percent of the road network and most rural roads are inoperable during the rainy season. Improving these roads to an all-weather standard and implementing a system of regular maintenance is essential for economic growth and social welfare. A detailed account of the strategic road network in the landscape is presented in Annex 10.1, and link roads in Annex 10.2.

Construction of rural roads without planning and environmental safeguards is a major problem in the landscape; causing soil erosion, failure of slopes, losses of agricultural land and ultimately major landslide problems. Even existing highways have been damaged at several locations due to the opening of new rural roads. The slurry and gravel on the Prithivi Highway between Nagdhunga and Mugling; the landslide prone Nayapul (Sahasra Dhara) on the Pokhara-Baglung road; and the landslide prone Majghfant stretch on the Maldhunga-Beni Road are some examples of damage due to unmanaged rural road construction activities.

Sedimentation caused by such constructions and improper land use have caused severe sedimentation problem in Fewa and Begnas Lakes in the Pokhara Valley. The following are some of the immediate and long-term impacts of unplanned construction of rural roads.

Immediate Impacts of Rural Road Construction

- Upstream settlements are suffering from landslide and erosion and downstream settlements are suffering from floods and river bank cutting.
- River bed levels are rising in the Siwaliks due to soil, gravel and stone from rural roads near rivers.
- Damage on other infrastructure such as irrigation schemes, water supply schemes, reservoir sedimentation etc. due to poor planning and lack of coordination among the relevant line agencies.
- Rural road construction is triggering deforestation.
- Negative effects on aquatic fauna due to increased sedimentation and turbidity

Long-Term Impact of Rural Road Construction

- Water sources are depleting.
- Water recharge process is decreasing.
- Decrease in land productivity.
- Environmental degradation within watersheds.

Working Component/Mitigating Measures

- Proper survey and design of rural roads to achieve less impact on forest, water sources, water bodies, and settlement and agricultural land having less erosions.
- While estimating the budget for road construction, a certain fraction of the budget should be allocated for drainage and conservation activities such as bio engineering (structural as well as non structural measures).
- Ministry of Local Development, in close coordination with the DDC and concerned line agencies, should work on strategic documents for rural road construction focusing on the green road concept.

Table 10.1: Airports in CHAL

S. No.	Airport Name	Surface	Elevation (m)	District	Status
1	Bharatpur	Paved	207	Chitwan	In operation
2	Meghauli	Grass	152	Chitwan	Chartered Flight
3	Langtang	Grass	3,658	Rasuwa	Chartered flight
4	Pokhara	Paved	809	Kaski	In operation
5	Palungtar, Gorkha	Grass	445	Gorkha	Not in operation
6	Manang	Grass	3,381	Manang	In operation (seasonal)
7	Jomsom	Paved	2,736	Mustang	In operation
8	Belewa, Baglung	Grass	990	Baglung	Not in operation
9	Lamjung (Sitaleswanra)	Grass	1,650	Lamjung	Under Construction
10	Dhorpatan, Baglung	Grass	2,728	Baglung	Chartered Flight
11	Gulmi			Gulmi	Under Construction

(Source: CAAN, 2010)

10.2 Airports and Airstrips

Currently, Nepal has 55 airports, including one international, five regional (Nepalgunj, Biratnagar, Bhairahawa, Pokhara, and Dhangadhi), 43 other domestic airports and five airports under construction (Kalikot, Kamalbazar, Masinechaur, Sitaleshola, and Simichaur). Of these, 34 airports are operating at present (CAAN, 2010). Considering the increasing population and increasing number of air service providers, CAAN has plans to increase the number of international as well as domestic airports. In CHAL, four airports are in operation, two under construction, two not in operation and three in operation for chartered flights only (Table 10.1). Among these Manang airport is seasonal, being closed from beginning of July to end of September.

10.3 Hydropower, Dams and Electric Transmission Lines

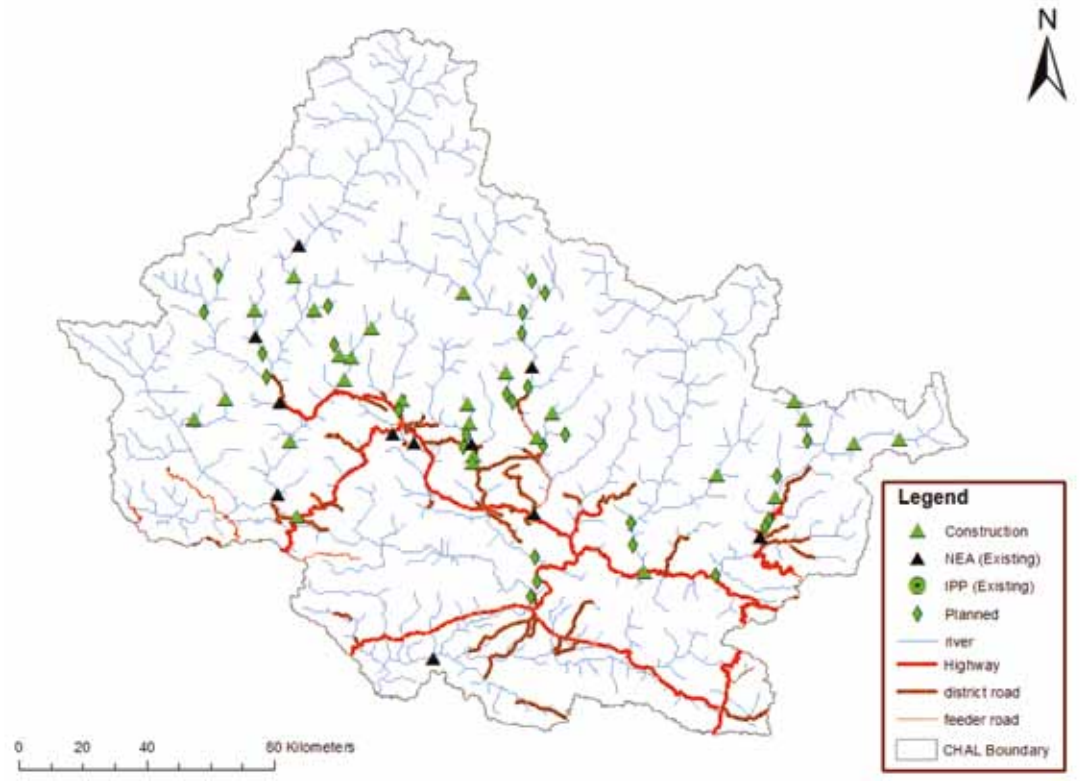
Nepal has huge hydropower potential. In fact, the perennial nature of Nepali rivers and the steep gradient of the country's topography provide ideal conditions for the development of large hydroelectric projects. The present situation is that Nepal has developed only approximately 638 megawatt (MW) of hydropower, with only 56 percent of people having access to electricity through hydropower, thermal electricity and alternative energy. Most of the power plants in Nepal are run-of-the-river type with energy in excess of the in-country demand during the monsoon season and a deficit of 400 MW in supply in the dry season.

While, on one hand, the increased establishment of hydropower plants is a step towards meeting the energy deficits, on the other hand, a cascade of hydropower dams and stations on some rivers is a matter of concern from the biodiversity conservation point of view. One such example can be seen on the Madi River, where one plant is currently in operation, another one is under construction and a third one is planned to be constructed in the near future. This can have severe negative impacts on aquatic biodiversity and livelihoods of some local communities (such as fishermen).

All existing and proposed hydropower plants are either run-of-the river types or peaking run-of-the river type. Upper Trishuli (128 MW) and Budi Gandaki (600MW) are the only storage projects which are in the construction phase and planned to be constructed by the Nepal Electricity Authority (NEA). At present, Kali Gandaki A (144 MW) is largest the hydropower project in operation. Annex 10.3 provides details of the major hydropower stations that are in existence, under construction and planned. Among the sub-basins, Kali Gandaki has the highest electricity

Existing Hydropower at Seti River (near Pokhara City)

Figure 10.2: Existing, under construction and planned hydropower dams in CHAL



(Source: NEA, 2011)

generation capacity. Currently, the river generates 154.14 MW. A 373.6 MW generation plant is under construction and another 935.8 MW is planned to be built in the near future. East Rapti has the lowest capacity, which is currently producing only 15 MW at Deughat (Figure 10.2; Table 10.2).

The fundamental objective of constructing dams is to obstruct flowing water for the benefit of human communities and regulation of water supplies to urban areas. However, the construction of dams also affects society and the environment. The construction of dams poses substantial and persistent effects on the ecology of aquatic habitats; by transforming the flowing water into stagnant water, and through the storage of water in reservoirs leading to changes in hydrological parameters such as levels of dissolved oxygen. The alteration in river hydrology impacts the ecological balance of the habitat causing changes in species composition and the number of fish. In addition to changes in river hydrology, changes in river paths associated with reservoir storage blocks migration routes of fish.

Table 10.2: Electricity generation capacity (Megawatt) within major sub-basins of the Gandaki River

S. N.	Sub Basin	Existing	Under Construction	Planned	Total
1	Kali Gandaki	154.14	373.6	935.8	1463.54
2	Narayani	15	0	0	15
3	Budhi Gandaki	0	9.2	656	665.2
4	Marsyangdi	139	216.5	561	916.5
5	Rapti	0	0	0	0
6	Seti	19.95	64.8	246	330.75
7	Trishuli	45.65	279.2	398.1	722.95

(Source:NEA, 2011)

The most controversial consequence of constructing large dams is the displacement of people; as the scale of the dam increases, the scope, duration and intensity of its impact is amplified significantly. The storage of water in reservoirs causes inundation of thousands of hectares of river line lands. In addition to the economic and social pressures of managing displaced people, the water storage in dams and the resulting higher evaporation rates increase the risks of adding salts to farming areas, thus making them unfit for irrigation due to increased salinity.

In addition, if a dam breaks, people and property downstream may be considerably endangered. Such an incident may cause an outbreak of waterborne diseases such as schistosomiasi and diarrhea throughout the local population.

The immediate and long term impacts are summarized below.

Immediate Impacts of Hydropower/Dam Construction

- Local employment generation.
- Increased local accessibility due to construction of access roads.
- Negative impacts on local flora and fauna (especially aquatic life).
- Creation of propensity for soil erosion, floods and sedimentation.
- Possible displacement of local people due to construction of large dams

Long-term Impacts of Hydropower/Dam Construction

- Project activities causes a chemical change in air/water/soil quality.
- Difference in local hydrology (for example increase in cloudy days in the vicinity of Marsyangdi hydropower headwork site, i.e. pondage area).
- Decrease in crop production.
- Forest areas may be more vulnerable in the vicinity due to access road construction.
- Tourism activities may be increased due to accessibility.
- Income generation activities may be increased.

Mitigation Measures/Working Components

- Project activities which may affect the bio-physical component of the project area should be carefully analyzed and measures adopted to mitigate the impacts as much as possible, through design, construction and implementation measures.
- The site may be habitat for keystone flora or faunal species and may also contain economic plants, endangered, rare, endemic and threatened species. Measures to protect such species and their habitats from any adverse impacts should be included in the development activity package. It may

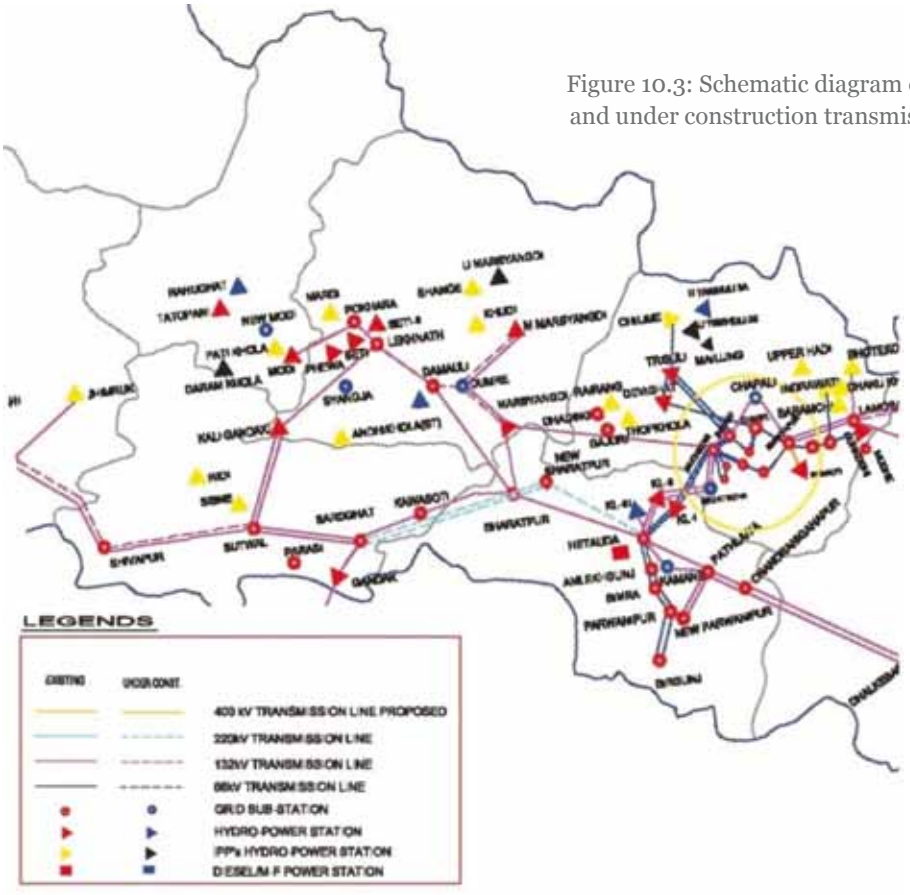


Figure 10.3: Schematic diagram of existing and under construction transmission lines in CHAL

(Source: NEA, 2011)

also constitute a primary component of biodiversity, which should be protected and conserved from the damage likely to take place in the implementation of project activities.

- Any activity, which can affect the biogeo-chemical cycle within an ecosystem, should be carefully analyzed and efforts should be made to minimize impacts through the implementation of appropriate measures.
- When planning hydroelectric dams, environmental impact assessment (EIA) should be done properly to assess negative impacts. If impacts are acceptable and the projects go ahead, mitigation measures should be are adequately incorporated during design, construction and implementation, and monitoring should be done during all phases.

With regard to transmission lines, deforestation and forest degradation are major environmental problem associated with them, which demands for proper planning to minimize the negative impacts on forest and biodiversity. The major existing, under construction and planned transmission line are presented in schematic diagram (Figure 10.3).

10.4 Irrigation Facilities

CHAL currently has 37 major irrigation canals (in 12 districts), with a total irrigation capacity of 26,801 ha in summer, and 11,719 ha in winter. An additional 791 recorded farmer-managed irrigation schemes are providing irrigation services to 40,683 ha in summer; 14,227 ha in winter, and 3,456 ha in spring (Annex 10.4 and 10.5).

There is, reportedly, a plan to divert water from the Kali Gandaki River to the Tinau River through a 30 km long tunnel to irrigate about 100,000 ha of agriculture land in Kapilvastu, Rupendehi and Nawalparasi Districts. Moreover, Kali Gandaki water has also been proposed to be diverted to Nawalparasi through a five km long tunnel to irrigate about 12,000 ha of land in Nawalparasi District. Water from the Trishuli is also planned to be diverted to Chitwan through a 30 km long tunnel to irrigate 40,000 ha land in Chitwan District. All these projects, if implemented, can pose substantial threats to the natural ecosystems and biodiversity of the regions.

11 Energy

Nepal's electricity generation is dominated by hydropower, though in the entire scenario of energy use in the country, electricity is a tiny fraction. The bulk of the energy supply comes from fuelwood, agricultural waste, animal dung and imported fossil fuel. Nepal's energy resources are presently classified into three categories namely the traditional, commercial and alternative. Traditional energy resources include fuel wood from forests and tree resources, agricultural residues and animal dung in the dry form.

11.1 Sources

Traditional energy resources can, of course, be termed as biomass energy resources since it covers bio materials. Energy resources coming under commercial or business practices are grouped into commercial energy resources that particularly include coal, grid electricity and petroleum products. Biogas, solar power, wind and micro level hydropower are categorized into the alternative energy resources in Nepal. Such resources are considered as supplement to conventional energy resources. Fuel wood extraction may not be the only cause of deforestation but deforestation is definitely causing a fuel wood crisis. With the fuel wood crisis, the consumption of agricultural residues for energy purposes has also increased resulting in falling production due to less uses of agricultural residues as a fertilizer/organic matter, encroachment of marginal land for farming also causing lower productivity, exposure to the risks of soil erosion and further degradation in crop productivity and biomass supply in the CHAL area. In CHAL, people are mainly using traditional energy sources in rural areas and in the urban areas commercial energy sources such as liquefied petroleum gas (LPG) are being used.

11.2 Demand

Total energy consumption in the year 2008/09 was about 9.3 million tons of oil equivalent, (401 million GJ) out of which 87 percent was derived from traditional resources, 12 percent from commercial sources and less than one percent from alternative sources (WECS, 2010).

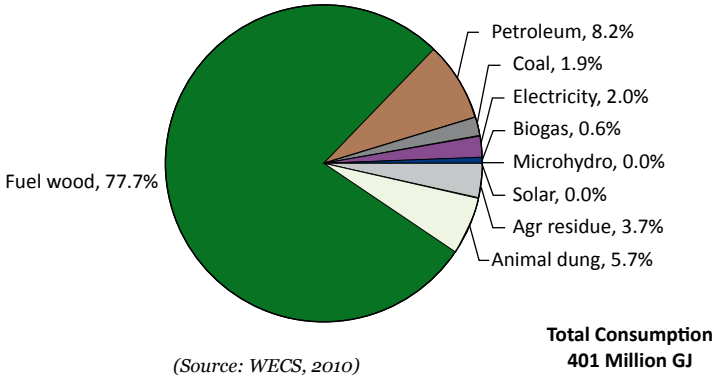
Bio-energy implies that energy derived from organic biomass of recent origin is available in different forms (solid, liquid or gas), from forestry, agriculture and other sectors. Woodfuel consist of woody biomass, i.e. stems, branches, twigs, etc., as well as sawdust, charcoal and other residues from logging and wood processing activities. The primary sources of woodfuel are both forest and non-forest lands.

In CHAL, use of different biomass for energy is dependent primarily upon availability of the preferred material. For example, firewood is commonly used in locations near forests. Other woodfuels are common in areas where agroforestry and private forestry practices exist. In other areas, agriculture residue and cowdung form the major source of household energy. People in urban and semi-urban areas commonly use LPG, electricity and kerosene. Municipal solid waste and forest and agro-industry wastes could be developed as an important source of energy. ADB/International Centre for Integrated Mountain Development (ICIMOD/MOEST/UNEP, 2007) reported that the 58 municipalities in the country generate over 1,350 tons of solid waste every day.

11.3 Supply and Demand Analysis

The total amount of energy consumed in Nepal in 2008-2009 was around 401 million GJ, which is

Figure 11.1: Energy consumption, 000 GJ in Nepal by various fuel types (2008-2009)



(Source: WECS, 2010)

increasing annually by an average rate of about 2.4 percent. This overall increase is actually higher than the increase in commercial fuel consumption (1.6%), which indicates a rapid increase in household energy demands. Within the commercial energy system, electricity consumption is growing at an annual rate of about 10 percent, and coal consumption by about 0.5 percent. Fuelwood is the largest energy resource providing about 77 percent of the total energy demand in the year 2008/09. Other sources of biomass energy are agricultural residues and animal dung which contribute about four percent and six percent, respectively. The share of petroleum fuels in the total energy system is about eight percent. Other sources of commercial energy are coal and electricity both of which contribute about four percent (Table 11.1; Figure 11.1; WECS, 2010). The sources of different energy and percent contributions are presented in Annex 11.1.

Biogas is one of the rapidly growing alternative energy in the country. The estimated total technical potential of biogas plants is about 1.9 million plants of which more than 200,000 plants of varying capacities (4, 6, 8, 10, 15 and 20m3) have been installed as of December 2008 (BSP, 2010). Solar energy consumption is increasing by more than 200 percent annually. Petroleum products consumption grew by about 0.7 percent between 2000/01 to 2008/09. Consumption of kerosene, furnace oil and light diesel is decreasing, whereas LPG is increasing by more than 25 percent annually (WECS, 2010).

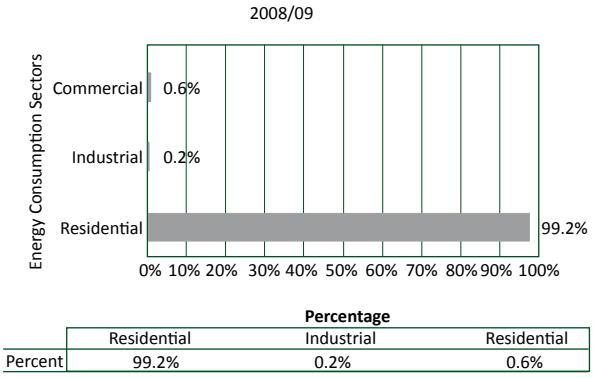
The total consumption of fuelwood in 2008/09 was about 311 million GJ which is about 77 percent of the total energy demand of the country. Average annual growth in demand of fuelwood is around 2.5 percent, which is higher than the population growth of the country. More than 99 percent of the total fuelwood is consumed in the residential sector (WECS, 2010). Other fuelwood consuming sectors are industrial and commercial. These sectors use fuelwood especially for heating, boiling and mixing with coal.

Table 11.1: Trends in energy consumption, 000 GJ in Nepal by various fuel types

Category	Fueltype	2001/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
Traditional	Agr residue	12732.1	13025.7	13326.6	13634.9	13963.5	14006.6	14370.9	14359.5	14684.7
	Animal dung	19491.8	19901.1	20319.0	20745.7	21181.4	21626.2	22080.3	22544.0	23017.4
	Fuelwood	258635.6	269157.7	274960.2	280888.3	286960.0	292460.4	298325.4	304721.2	311167.3
Traditional Total		290859.4	302084.6	308605.8	315269.0	322104.9	328093.2	334776.6	341624.7	348869.5
Commercial	ATF	2283.4	1716.3	1911.2	2316.4	2417.1	2327.0	2306.9	2493.5	2493.4
	Coal	7446.3	6481.0	5721.3	7292.4	6459.3	10364.0	6158.4	8243.0	7751.5
	Electricity	4612.1	5065.8	5433.5	59.74.5	6673.2	6969.9	7658.4	8100.8	8137.2
	Fuel oil	588.1	577.8	553.6	421.4	-27.7	1.2	52.8	27.2	0.0
	Gasoline	1984.1	2118.9	2259.1	2276.1	2533.6	2712.3	3413.0	3377.2	4158.4
	HSDiesel	12367.5	10856.8	11378.0	11368.7	11910.6	11163.9	11632.6	11481.6	17693.1
	Kerosene	11472.0	14017.8	12641.0	11270.6	8658.6	8217.9	7174.0	5628.1	2541.4
	LDiesel	133.7	94.4	23.9	23.1	3.4	11.4	7.0	12.0	14.8
	LPG	1974.6	2400.8	2761.3	3256.8	3820.7	3988.7	4607.0	4768.3	5702.6
	Other Petroleum	482.1	522.2	588.3	662.7	746.7	841.2	947.7	124.6	409.9
Commercial Total		43343.9	43851.9	43271.3	44862.7	43195.4	46597.3	43957.8	44256.4	48902.3
Renewable	Biogas	1179.2	1350.1	1526.5	1650.3	1847.5	2027.2	2222.1	2384.2	2593.1
	Microhydro	38.1	41.7	47.2	52.8	56.9	65.1	90.1	112.4	136.0
	Solar	0.3	0.9	1.7	2.2	2.7	2.9	3.1	4.1	5.6
Renewable Total		1217.5	1392.8	1557.5	1705.3	19.07	2095.2	2315.4	2501.0	2734.6
Grand Total		335420.9	347329.3	353452.5	361837.0	367207.4	376785.8	381049.9	388382.1	400506.4

(*Source: WECS, 2010)*

Figure 11.2: Fuelwood consumption by sector



	Residential	Industrial	Residential
Percent	99.2%	0.2%	0.6%

(Source: WECS, 2010)

Residential sector energy consumption depends upon the population growth rates as well as the economic situation of households. In the residential sector, energy is used mainly for cooking, heating, animal feed preparation, lighting etc. In CHAL, fuelwood consumption is reportedly decreasing due to the migration of rural people to urban areas and increasing use of LPG.

11.4 Alternative Energy

The consumption of solid biomass (traditional) forms of energy has a negative effect on the quality of life since it takes much time to collect wood and causes adverse effects on health. Besides, the use of these traditional energy sources is neither sustainable nor desirable from environmental considerations. Therefore, there is a need to replace or supplement those energy supply systems by modern forms of renewable energy.

The available sources of renewable energy development in Nepal are water, sun, wind, biomass, hot springs and so on. These renewable energy sources are un-interruptible and infinitely available. These energy sources are environmentally friendly as they have very little or no emissions of green house gases (GHG). However, storage of these energy sources is challenging and hence needs to be addressed properly with recently developed technologies.

The possible renewable energy technologies which can generate power by exploiting locally available energy resources within CHAL are: pico-hydro and micro-hydro power; biomass related biogas; bio-briquettes; gasifier; liquid bio-fuel; solar photovoltaic, and solar thermal and wind powered plants. Micro-hydro, biogas, improved cooking stove, solar photovoltaic (PV) home systems, and solar water heaters are becoming popular and are at varying stages of commercialization.

Gasification is a process that converts organic or fossil based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas (from synthesis gas or synthetic gas) or producer gas and is itself a fuel. The power derived from gasification of biomass and combustion of the resultant gas is considered to be a source of renewable energy; the gasification of fossil fuel derived materials such as plastic is not considered to be renewable energy.

A study by DANGRID, a Danish consulting firm in 1992 reported that there is potential to generate 200 MW of electrical power with an annual energy production of 500 GWh from the wind resources along the 12km valley between Kagbeni and Chusang in Mustang District. This is about 33 percent of the present electricity production of Nepal.

With a national average of sunshine hours of 6.8 per day and solar insolation intensity of about 4.7 kWh/m2/day, there is a huge potential for solar thermal devices such as solar water heaters, solar dryers, and solar cookers. Presently solar water heaters have been fully commercialized and till 2009 more than 185,000 had been installed in the country. Solar dryers and solar cookers are still in the phase of dissemination and commercialization. In the Muktinath area, the use of solar thermal devices for cooking purposes is increasing every year. Every house has at least one thermal device for their cooking purpose.

12 Demography, Education, Livelihoods and Governance

12.1 Population

The total population of CHAL in 2011 was 4.5 million. The population grew by an average annual rate of 0.41 percent during 2001-2011; this growth rate is much lower than the national average of 1.4 percent. In most of the districts, the population growth rate during the period remained negative. Seti River Basin districts (Makawanpur, Chitwan, Tanhu, Kaski and Nawalparasi) had a higher population growth as compared to the other districts (Table 12.1; Annex 12.1).

The findings indicate a decreasing trend in the rate of population growth. The population and its changing consumption behaviour has increased pressure on land and other natural resources. Productivity must be increased to address the growing demand and maintain the ecological balance. Inequality in access to land and other natural resources has compelled poor families to look for alternatives to agriculture for their livelihoods.

12.2 Ethnicity and Caste

CHAL has a very heterogenous social composition based on ethnicity, caste, and culture. *Brahmin, Chettri* and *Newar* are high in terms of human resource development followed by ethnic groups such as *Gurung, Magar, Tamang, Gharti. Damai, Kami, Sarki* and *Gandharba* are the major *Dalit* communities in the landscape, who are in the lower strata in terms of human resource development and well-being ranking. In the 15 communities studied, Brahmin, Chhetri and Newar represent 45 percent; indigenous group 39 percent, and *Dalit* 14 percent. This is more or less consistent with the national figure. *Dalits* are the most disadvantaged group, both socially and economically. The Hariyo Ban Project should promote their involvement in biodiversity conservation through promotion of green enterprises (NTFPs and agroforestry etc.).

Table 12.1: Population, literacy and population growth rates in CHAL

River Basin	Male		Female		Total population (2011)	Avg. HH size (2011)	Avg annual Population growth rate (%; 2001-2011)
	No.	Literacy rate (%)	No.	Literacy rate (%)			
Trisuli	313,774	55	345,035	41	658,809	4.41	-0.19
Seti	942,936	76	1,042,140	58	1,985,076	4.33	1.64
Kali "A"	243,351	71	301,264	54	544,615	4.09	-0.21
Kali "B"	387313	73	497,897	53	885,210	4.17	-0.53
Marsyangdi	201,710	67	243,309	48	445,019	4.07	-0.63
Total	2,089,084	68	2,429,645	51	4,518,729	4.21	0.41

(Source: CBS, 2011)

12.3 Education

Nepal's education system consists of three levels: primary (Grades 1-5), lower secondary (Grades 6-8) and secondary (Grades 9-10). Early Childhood Development (ECD), also known as preschool education, has appeared as a recent practice mostly concentrated in urban and suburban areas of the country (DoA, 2011). A higher secondary level (10+2) has been added in order to make the school system more or less comparable with regional and international systems. The first level of education (primary education) is officially free of charge in government owned schools.

Significant progress has been made in school enrollment in the past decade. From 2003 to 2010, net primary enrollment (Grades 1-5) rose from 83.5 percent to 93.7 percent. During the same period net secondary enrollment (Grades 9-10) increased from 29.5 percent to 63.2 percent. The CHAL area has gained better literacy rates (60%) compared to the national average (53%).

Although there is improvement in education, particularly at primary level, there are wide Gender Disparity Enrolment (GDE) rates at secondary and higher levels of education. The GDE has reached 0.98 in primary level (Flash Report I, 2006) from 0.87 in 2004. The GDE of primary level enrolment of *Dalits* and *Janajatis* (ethnic groups) is high with 0.93 and 0.97 respectively. However, the GDE of children with disabilities is lower than that of other groups (MoEST, May 2008). The Government of Nepal (GoN) has attempted to bring all girls and boys from disadvantaged and marginalized populations into mainstream education by providing free tuition, free textbooks and scholarships. The GoN, launched a National Literacy Campaign in 2008 with the goal of achieving literacy for all in the country within two years. Although the campaign has raised awareness in communities about the importance of literacy, there still remains a long way to go to achieve literacy for all. Despite these programs, there is still disparity in literacy rates between male and female members in CHAL area (Table 12.1).

The enrolment of women in higher education (university) in Nepal is also very low but increasing year by year. Women's enrolment percentage in 2003 as approximately 22.15 percent where, in contrast, the male enrolment percentage was 77.85 percent as cited in the Population Monograph of Nepal 2003, Annual Report of Tribhuvan University. This difference also demonstrates the attitude of Nepalese society towards education of women. Until women are provided equal higher education opportunities, women never can fully compete with men. Currently men play a dominant role everywhere including biodiversity and natural resource management due to their higher education and public exposure.

12.3.1 Barriers to girls' and women's education

Some of the important barriers include: (i) social and cultural barriers, (ii) economic barriers, (iii) psychological barriers, (iv) institutional barriers, (v) barriers caused by family circumstances, and (vi) geographic barriers. Although there is improvement in the literacy rate at primary level, the educational status of girls and women is still lower than men, Kali B and the Marsyandi River Basin areas have lower educational status for females than other river basins under CHAL. As a result they have very limited employment or livelihood opportunities in their adulthood.

12.3.2 Non-formal and adult education

Non-formal education in Nepal began in 1951 when activities for literacy enhancement began as part of the national development. These efforts were regularized in the First Five Year Plan (1956-1961) with the increasing foreign aid through international organizations and subsequent mushrooming of the non-governmental organizations. The non-formal education movement picked up momentum in the mid 1990s and by 2008, a total of 242 organizations were recorded at Social Welfare Council as working in this sector. Among them there were 12 INGOs and 230 NGOs.

The main purpose of establishing non-formal education was to reach those who were unable to attend regular schooling because of their age, family problems, poverty, geographical distance; gender based discriminatory practices, lack of trained or qualified teachers etc. Similarly government organizations and I/NGOs started adult education for women and disadvantaged groups for the same reasons. During the study it was highlighted that some communities are operating adult education classes in their communities with the help of NGOs/INGOs and Care Nepal is one of them. Although women were far behind at the higher decision making level,

some of those who are literate and have more public exposure (Lamjung, Nuwakot, Makawanpur, Kaski, Mustang) were quite vocal and confident to share gender discriminatory practices during the discussion. The quality of literacy, non-formal and adult education/programs and their links with income generation and lifelong-learning can help the empowerment of women and other marginalized groups.

12.3.3 Community Learning Centers

Within Nepal, the concept of Community Learning Center (CLC) has its origin in the Seti Education for Rural Development (SERD) Project, an adult literacy and development program which was initiated by UNESCO and United Nations Children's Fund (UNICEF) during the 1980s. Under the SERD project about 154 village reading centers were established across the country to provide community-based post literacy and continuing education training programs. The village reading center concept was later refined to a 'community learning center' following the introduction and implementation of the basic and primary education project BPEP-II, 1999-2004 and the established the National Committee on CLC. Following extensive consultations, the National Committee on CLC, an inter-agency board comprising of the National Resource Centre for Non-formal Education (NRC-NFE) and UNESCO established Non-formal Education Centers to spearhead the CLC program in Nepal.

NFEC has established more than 800 CLCs across the country with financial and technical support from UNESCO through the Asia-Pacific Programme of Education for All (APPEAL) and other donor organizations. Likewise the Government of Nepal has also pledged to establish 205 CLCs as part of its Tenth Five Year Plan (2002-2007) in each VDC/municipality.

The CLC program in Nepal also targeted out-of-school children, youth and adults from marginalized rural and urban communities. Besides non-formal and adult education, the CLC program provides people knowledge and skills on social mobilization, vocational training for livelihood opportunities, health services information, leadership training, human rights awareness, democratic governance and environmental management/conservation. During discussions the participants talked about having literacy class such as adult education but none of them talked about the CLCs program.

12.4 Health

Nepal's health sector policies and plans aim to help the general public gain access to quality health services. There has been considerable improvement in mortality rates of infants, children and mothers in recent years (National Planning Commission (NPC), 2010). Eighty nine percent of households have an improved source of drinking water (MoHP *et al.*, 2011). Various health organizations have provided free maternity service under mother protection programs. Health services provided by health posts, sub-health posts and district hospitals are free to marginal and excluded communities in the CHAL area. However, despite these services, there has not been the expected improvement in remote areas of all the districts, particularly in the remote villages of Manang, Rasuwa and Mustang Districts. The health condition of excluded communities and people below the poverty line have also not improved as expected. Community consultations indicated the constraining factors to be lack of human resources in remote villages, centralized programs, inadequacy of necessary equipment and medicines, and weak supervision.

Safe drinking water and sanitation is an important component of human survival, however, At present, 89 percent of people have access to improved sources of drinking water (MoHP *et al.*, 2011), and about 43 percent have access to sanitation services (NPC, 2010). The condition of the drinking water in the studied CFUGs is good. More than 70 percent of total households sampled in the hilly areas have access to piped water systems. In other areas wells, tube wells, natural springs, rivers and rivulets are used for drinking water.

Various institutions are involved in the implementation of drinking water supplies in the Chitwan-Annapurna Landscape areas. UNICEF, the District Drinking Water Division Office, VDCs and DDCs have made large contributions to the supply of safe drinking water. Community Forest User Groups (CFUG's) funds are also used for clean drinking water supplies. However, according to the CFUG members involved in this study, water pipes, taps and tube well are not properly maintained.

More than 80 percent of the total households in the studied CFUGs have latrines. Some households have also linked latrines with biogas production. However, the most common disease, sometimes becoming an epidemic, in the CHAL area is diarrhea. There are other problems in the

landscape such as lack of proper drainage that creates an enabling environment for mosquitoes to breed, and the use of firewood and lack of chimney in kitchens causing indoor air pollution, and use of pesticides that affect health. There is dramatic improvement in the maternity health and child health in the studied communities compared with 10-15 years ago. Nearly half the women make three to four antenatal care visits during pregnancy.

12.5 Employment

Currently, remittance contributes over 20 percent of the national Gross Domestic Product (GDP). Currently, in Nepal, 2.5 million people of working age are unemployed and labor participation stands at 83.4 percent. Of the total population, 30 percent is either un-employed or under employed (NPC, 2010). The percentage of employed people is higher in CHAL (45%) than the national average of 30 percent (Table 12.2; Annex 12.2).

The relatively higher employment rate in CHAL as compared to the national average could be because of access of rural people to various ecotourism centers within the landscape. The large volume of working age people indicates a labour availability that can be a good asset for agricultural, industrial or tourism growth.

Analysis of the data from the community consultations revealed that there is variation in employed male and female members of the household in CHAL (Table 12.2). The variation is even more in the study communities, where male employment (31%) is almost four times higher than female employment (8%). *Dalit* and socially marginalized people's employment is six percent of the total working age populalation in the whole CHAL area. (Annex 12.3).

12.6 Migration

Migration has been one of the major phenomena in the rural hills of Nepal for over 200 years (Poudel et al., 2012). Hill people historically migrated to North East Indian states and Burma or joined the Indian Army and British Army. Since the 1950s, three new destinations emerged for hill people – the Terai, major urban centers (Kathmandu, Pokhara) and other countries (India, Gulf countries, Malaysia etc.). Small farmers (>1 ha land holding) take the most advantage of migration opportunities as they can make the initial investment including temporary living costs, travel costs and have better access to information and social network. While migration to the Terai reached its peak during the 1980s, migration to cities reached its climax during the armed-conflict period (1996-2006). CBS (2011) shows that in urban areas migration is lower (14.62%) than rural area migration (42.30%). The number of absentee people shows the volume of migration from different areas of the CHAL (Annex 12.4).

'Out' migration has taken place from almost all communities except Nuwakot and Palpa. While, 'in' migration' had been found more in the plains and urban areas. This is the reason why there is high population growth rates in these areas (Table 12.1). Most of these migrants are from remote middle and high mountains, and are settled as *Sukumbasi*, which had been seen as a serious problem in forest protection and management.

Table 12.2: Employed population and percentage

River Basin	Male		Female		Total	
	Number	%	Female	%	Number	%
Trishuli	163,214	52	150,198	44	313412	47
Seti	514,662	55	395,846	38	910508	43
Kali "A"	107,499	44	128,931	43	236430	43
Kali "B"	227,048	58	276,846	56	503894	54
Marsyandhi	39,574	20	46,532	19	86106	18
Total	1,051,997	50	998,353	41	2050350	45

(Source: CBS 2011, District Profiles, compiled from Annex 12.2)

Migration of different types has different impacts on the development of the CHAL area. Migration to the Terai has increased the population there, and migration has induced labor shortage, which resulted either in fallow land or abandonment of lands by better off households. This has implications for the conservation of agri-biodiversity, as some of the species (e.g. red soyabean, *Kande* maize) cultivated in these lands have disappeared or are threatened. Some fallow lands have been invaded by invasive species such as *Eupatorium adenophorum* and *Ipomoea* species in the midhills and Inner Terai, respectively, thereby reducing the opportunities for economic return.

12.7 Land Tenure

Landholding size has been gradually decreasing due to division of parental land (and property) among offsprings in Nepal, and also in the CHAL area. Review of data at national level from three periods showed that average agricultural land per capita has decreased from 0.89 ha in 1996 to 0.7 ha in 2003 and 0.6 in 2010. The landless and near landless with land holding less than 0.5 ha comprise half of the rural population (1.6 million families) and command only 15 percent of the land (CBS, 2001). In the studied communities within CHAL, nine percent of sampled households were found landless (Annex 12.5).

Landlessness is highest in Chitwan followed by Nawalparasi, Gorkha and Makawanpur. In general, in a community of 36 households, three households are landless. With the exception of Chitwan, Lamjung and Syanjya, other communities stated that their lands were not registered. This problem is most severe in Makawanpur District.

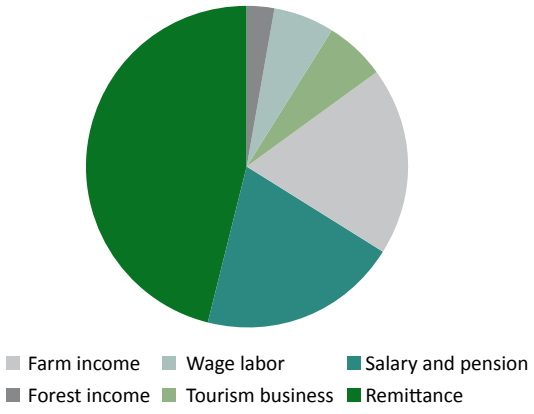
The issues of landlessness and land registration are serious in Chepang communities of Makawanpur, Chitwan and Dhading Districts. They are shifting cultivators who have been growing agriculture crops in shifting cultivation areas in government forests for the last 50-60 years. In Manahari area of Makawanpur District, some 1,200 families have not received land ownership certificates for their land. In addition, some cultivated uplands of high mountains and midhills are abandoned due to the migration of farmers from remote villages to roadside towns or markets. Landless people living in Panchakanya of Chitwan, Simpani Devkot of Makawanpur, and Ghiukhola of Nawalparasi (Annex 12.4) are migrants, and have settled there as Sukumbasi. Moreover, community and forest land encroachment is also a serious problem in some of the communities. For example, in Palming village of Mustang District about 15ha of government land had been encroached by local people. Similarly, 750 households in Ratna Nagar Tandi, Chitwan, have been settled as Sukumbasi and have encroached community lands. In Ramche village of Rasuwa about 5ha of community land has been encroached by community members, and about 2ha of land encroached in Bidur, Nuwakot.

12.8 Livelihood and Livelihood Options – Income and Expenditure

The major sources of livelihoods for people in CHAL are agriculture; livestock; forests and other community resources; business; wage laborering, and remittances. While planning livelihood improvement programs, it is very important for small holders and their supporting agencies to make clear the nature of the available resource and vulnerability of the small land holders in order to provide a basis for planning appropriate action. They should also be included in the program design.

During the community consultations, income and expenditure of at least 10 key informants (women, *Dalit*, young men and ethnic males) per community were examined to analyze the livelihood situation of people living in the CHAL area. In the community consultation, male and female participation was almost equal. Out of 15 communities consulted, family members of key

Figure 12.1: Share of household income in selected rural communities within CHAL



(Source:Present study)

informants of seven communities had gone to foreign countries and their income was higher than that from other categories. Out migration has a negative impact on green enterprise development and management in the Chitwan-Annapurna Landscape. It appears that a typical rural household in the CHAL area derives almost half (46%) of its livelihood from remittance, 20 percent from salaries/pensions and 19 percent from farm income (Figure 12.1). Tourism income contributed to livelihoods mainly in Gorkha, Mustang, Kaski and Tanahu Districts.

Major expenditures include rice and food; pulses; livestock products; clothing; education; health and others such as kerosene; fuel; religious events; house maintenance; tobacco; transport; cooking utensils and newspapers. Expenditure patterns show that household level expenditure was higher in Palming (Mustang) and Satpatre (Palpa), and was very low in Bankali (Lamjung). The key informants of Lamjung District were mostly from Dalit families, and their household expenditure was very low. This result shows that the living standard of *Dalits* in the Chitwan-Annapurna Landscape is very low compared with other ethnic groups.

12.9 Poverty and Underlying Causes

Rural poverty is high in Nepal, mainly due to low return from agriculture and lack of opportunities in a rural, off-farm economy. While Nepal remains a predominantly agricultural country with around 78.5 percent of the workforce (female 89.6%) engaged in agriculture, the sector's contribution to the GDP has been steadily declining and stands at 33 percent (ADB, 2011). Similarly, the rural per capita GDP of USD public private partership 1,162 is only about half the urban per capita GDP that stood at USD PPP 2,224 in 2001 (UNDP, 2009). It is explained by the fact that Nepal reduced poverty by 11 percentage points between 1996 and 2004 (from 42 to 31 percent) and six percentage points between 2005 and 2009, which has now reached approximately 25.4 percent (CBS, 2011).

Low agricultural productivity, among others, has resulted in widespread food insecurity and poverty. Some 30 of the country's 75 districts are reported to be food insecure in absolute terms. Since the rural non-farm economy has remained historically miniscule, incomes from short and long term migrations, mainly to India, has traditionally constituted an important component of the rural household economies. In recent years there has been an immense mass departure of labor force to more lucrative destinations mainly Gulf countries, and the remittances have had dramatic impact on the country's balance of payment as well as on the alleviation of poverty. The World Bank, using USD 1.25 per capita per day as the international poverty line income, has pegged Nepal's poverty ratio at 33.9 percent, although Nepal's own latest estimate is only 25.16 percent. With an average per capita income of USD 490 (2011), Nepal ranks as the 17th poorest country in the world. The poverty and food security issues have similar phenomena in CHAL area.

12.10 Food Security and Vulnerability Issues

The right to food has been declared as the right of every human being. Despite this, people in Nepal are struggling for food supply rights. The Ministry of Agriculture and Cooperative (MoAC) has published data on the lack of food in Nepal. Of the 75 districts, 30 fall into the category of food deficit. This is attributed to long droughts and dryness, and lack of irrigation facility and labor. According to a report of the UN World Food Organization (2009), around 3.5 million people in Nepal are food insecure. The food self-sufficiency of the study communities was analyzed, and it was found that almost one-fourth (24%) of the total population produced food sufficient for one year (Table 11.3). Almost one-third fell into the category of being food sufficient for up to up to six months. (Table 12.3). However, the MoHP *et al.*, 2011 have indicated different results where 49 percent of households were food secure and have access to round the year food. The reason for this difference could be because of our sample population was taken mostly from remote hills and mountains, except in Chitwan and Nawalparansi.

To overcome the problem of food insecurity, diversification of farm income and employment opportunities needs to be generated through natural resource and off-farm based micro-enterprise development initiatives.

Many rural households and communities are poor and economically insecure, and small land holders. Some of them are socially excluded and vulnerable. Generally, they don't receive adequate support services from anywhere, especially from local bodies, line agencies, NGOs or the private sector. As a result, they are very vulnerable to

Table 12.3: Food Sufficiency Level in Studied Communities

Name of Village and District	Total HHs	Up to 3 Months (%) (Ultra poor)	Up to 6 Months (%) (Poor)	Up to 9 Months (%) (Medium)	One year and Above (%) (Rich)
1. Bhadaure, Kaski	45	11	29	16	44
2. Dahapani, Baglung	50	16	30	24	30
3. Babiyachour, Myagdi	50	26	28	20	26
4. Pamling, Mustang	36	11	28	25	36
5. Jumdanda Jhapri, Tanhu	25	20	32	32	16
6. Simpani, Makawanpur	33	24	24	21	30
7. Panchakanya, Chitwan	25	20	16	16	48
8. Bankali, Lamjung	30	17	47	20	17
9. Rajdevi, Gorkha	24	46	21	21	13
10. Kalikasthan, Dhading	30	23	17	23	37
11. Ramche, Rasuwa	56	23	20	36	21
12. Bidur-3, Nuwakot	80	10	15	50	25
13. Bandre, Synjya	103	24	39	29	8
14. Satpatre, Palpa	82	12	37	22	29
15. Ghiukhola, Nawalparansi	94	34	32	19	15
Total		21	29	26	24

(Source: Present study)

various kinds of tragedies and natural disasters, such as the death or illness of a family member or livestock, crop failure, landslides and storms, and other kinds of shocks. Once a tragedy happens, it is often almost impossible for the local people to recover their livelihood and food security, and they become still more vulnerable. Vulnerable communities and groups will ultimately resort to natural resources for their livelihoods.

12.11 Issues

(a) Increased migration due to reduction of rural non-farm employment: Many rural youths are unemployed or under employed. Of the available total work force, only 45 percent have got jobs in the CHAL area. Women's employment, is only nine percent, while *Dalit* and socially marginalized people's employment is six percent of the total working age population in the whole CHAL area. The vast majority of rural youth is forced to either migrated to outside or resorted to illegal activities (such as illegal extraction of forest resources) which has a negative impact on biodiversity conservation and ecosystem services.

(b) Low return and high cost of agriculture: Another cause of poverty is the gradually decreasing agricultural productivity. At the same time, the cost of inputs has gone up. Farmers have spent increasingly larger shares of their farm income to buy inputs. Availability and accessibility of quality inputs has become a serious concern, leading to critical impacts on agriculture production. Consequently, agriculture has increasingly become less rewarding, explaining the degradation of the rural landscape (Paudel, et al., 2012).

(c) Fallow land and absentee ownership: Large areas of marginal lands in rural areas have not received adequate inputs. There is severe labor scarcity in rural areas mainly due to migration. Absentee landlords have also resulted in decreased investment in land. Because of absentee landlords, a large part of the land is left fallow that could have been managed for productive purposes. The productivity of these lands can be substantially increased through promotion of high value agroforestry products. This will not only support sustained livelihood but also promote improved biodiversity and reduce disasters (e.g. flood, landslides, drying up of springs).

(d) Low productivity of lands: The population growth, decreasing access to land, environmental degradation and neglected rural economy have resulted in low productivity of land based activities. Growing infrastructure and markets have brought new dynamics into the rural economy – increased demand for cash. Migration has the key strategy to meet the increased demand for cash. Because of this more areas are accessible to illegal extraction of timber and other products.

12.12 Community Based Governance

Good governance is essential to achieve the goal of social well-being for community members in which all members should be equally represented, and participation in decision-making should be genuine. This means that the needs and desires of those who had no voice in the past now need to be listened to. Also essential is transparency. Another key principle is that whatever mechanism is adopted to share benefits must be equitable and agreed upon by consensus. Good governance of the studied groups were analyzed in terms of degree of participation, decision making process, knowledge and transparency, accountability, leadership quality, trust and solidarity, linkage and coordination and organization strength. The representation of women, and *Dalits* in executive committees of CFUGs and other groups is presented in Annex 12.6, which shows that the participation of women in the studied committees of CFUGs and other groups was 40.5 percent, and *Dalit's* about 16.3 percent.

Annex 12.7 shows that the Satpatre CFUG of Palpa, Ghiukhola CFUG of Nawalparasi and Simpani Devkot CFUG of Makawanpur were more inclusive compared with other committees because there was representation of all ethnic groups. Similarly, a degree of participation, planning, implementation, etc. and the level of transparency trust and solidarity is vital to the overall success of the group, as can be seen in Annex 12.7. CFUGs such as Satpatre of Dovan VDC, Palpa; Simpani Devkot CFUG of Makawanpur and Dahapani CFUG of Baglung were strong groups in terms of good governance, which was attributed to institutional support from the Terai Arc Land (TAL)/WWF, Livelihoods and Forestry Programme (LFP) and Bio-Diversity Sector Project for Siwalik and Terai (BISEPST) project.

There are several offices at district headquarter and local level that can provide support to Hariyo Ban supported communities and groups. These stakeholders can play an important role in institutional strengthening and organizational development of farmers and forest user groups. These can also provide support to implement various livelihood improvement activities related to community based natural resource management, infrastructure development, human resource development, social capital strengthening and income generation etc. During community consultation meeting and regional workshops, some NGOs and civil societies were identified (Annex 12.8). These institutions offer potential support to local initiatives in collaboration with Hariyo Ban Project.

The policy and working process of supporting institutions will have great influence on the good governance practice of CFUGs and other groups, which means strengthening human capital can increase the knowledge and skills of CFUG members and other groups on good governance principles and practices. Therefore, the Hariyo Ban Program should also give attention on strengthening the capacity of group members on good governance principles and practices.

13 Economic Development: Opportunities and Options

13.1 Tourism

13.1.1 Status and trends

The mountains of Nepal are a popular tourism destination. This sector has been enriched by the presence of 23.23 percent of Nepal's land within protected areas. Like Nepal, CHAL is renowned for its rural mountain destinations. In fact, tourism has contributed more than six percent of total household income in CHAL. CHAL has the advantage of both mountain and Terai lowlands extending from Chitwan National Park (with wildlife viewing) to Langtang and Annapurna Conservation Areas. Thousands of tourists visit the CHAL area, particularly Chitwan and Langtang National Parks, the two Conservation Areas of Annapurna and Manaslu, the two religious temples of *Muktinath* and *Gosaikunda* and the 108 hot water springs, also at Muktinath. Bandipur village of Tanhu, Nuwkot Darbar, Gaun Sahar of Lamjung and Chamme village of Manang are other important mountain tourist destinations.

The tourism sector has been anticipated to contribute to the economic development of the country. Nepal envisaged encouraging community tourism development programs for achieving a balanced and inclusive development by supporting poverty reduction objectives in rural areas of the country. On-going programs and projects related to tourism have focused on making air transport safe, easily accessible, reliable and well managed in order to help develop and extend the tourism industry through increased numbers of both national visitors and international travelers. In addition, Nepal's objective is to generate more employment opportunities for the rural poor.

Despite this, the tourism industry is facing problems and challenges due to lack of proper identification and promotion of nation-wide dispersed heritage sites and places. NPC (2010) revealed some issues and challenges such as the national flag having limited planes, there being only one international airport, and physical facilities including road networks not being a government priority. Despite these problems, the private sector is willing to collaborate with the tourism sector to further develop tourism in the country.

The problems and challenges faced by the country are similar in the CHAL area. As indicated earlier, several historical sites fall into CHAL. Similarly, various religious places and temples in CHAL attract visiting Hindu pilgrims and tourists alike. Beautiful lakes and caves have also added value, as has the rich geographic settings and biodiversity. Strengthening CHAL as an eco-tourism destination in coordinated efforts with the local people, will generate money and employment opportunities.

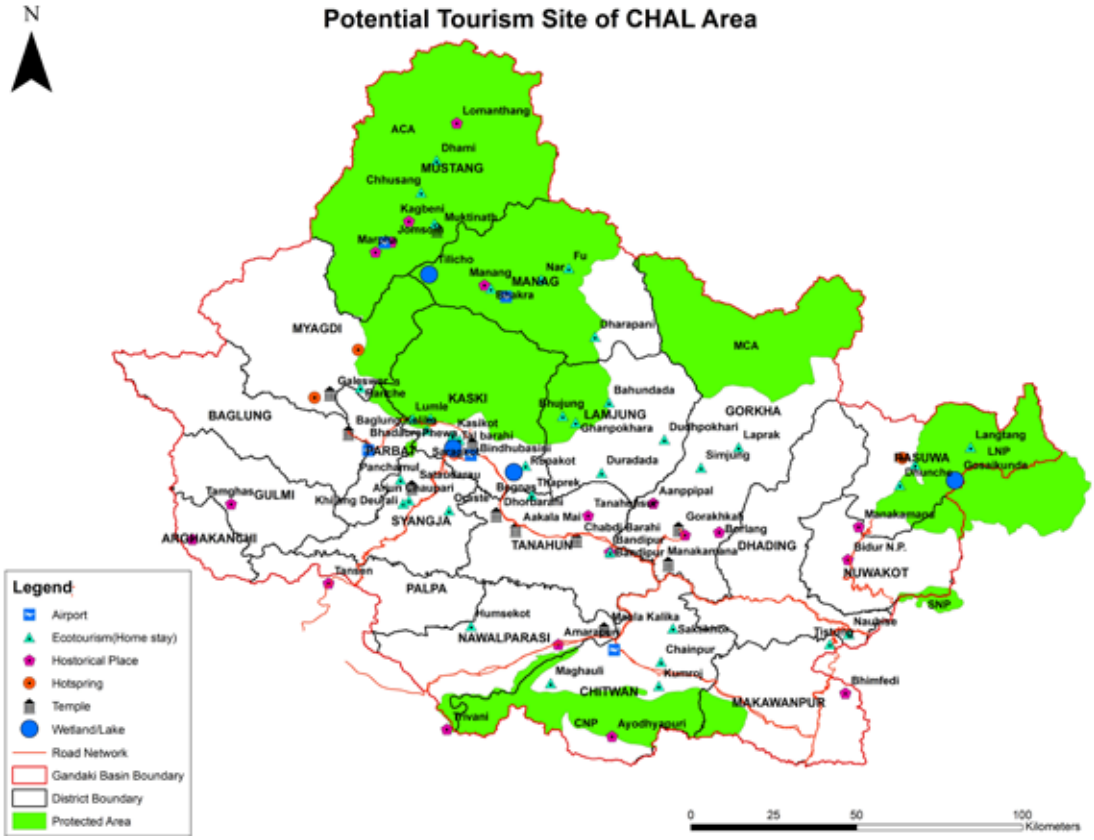
13.1.2 Facilities

In CHAL, there are various tourist attraction centers, which are connected by road networks, and three domestic airports (Bharatpur, Pokhara and Jomsom) that are in good condition.

When travelling by road visitors have three main trekking options that are accessible by road. One being the Jomsom Trek where a gravel road connects to Muktinath. Bad roads and syndicate bus owners make travel by bus difficult in this area. However, on the route to Muktinath there are many lodges and home stays with good facilities.

Relatively, Besishar and Gosaikunda treks are better than the Jomsom trek in terms of access to road networks. Of the three, the Gosainkunda trek is more arduous. There is chance of road blockages due to land slide and erosion.

Figure 13.1: Potential tourism sites in CHAL



(Source: Present study)

Photo by Ambika Gautam

Bhadaure village located at the base of Panchase forest in Kaski is a potential site for community-based tourism

Tatopani (hot water springs) in Singa VDC, Myagdi is a popular tourist destination

Hotels and lodges on all three trekking routes are often managed by a single family, who may employ locals. However, large scale hotels sometimes hire cooks from outside during peak season. No government hotels are available on trekking routes or near important historical or religious places in the CHAL area. Other facilities such as camping grounds, cooking huts, sign posts and teashops exist on some routes across the Great Himalayan Trail that traverse CHAL, but they are of poor quality.

13.1.3 Existing and potential sites

The major existing and potential tourism sites of the CHAL area have been presented in Annex 13.1. Kaski District has 10 existing tourism sites, of which four are potentials for further development. Baglung District has also 10 sites, of which three have potential. Potential sites have been selected based on four criteria - income to local communities, oriented to employment, no negative impact on the environment and the fact this program is a government priority (Figure 13.1; Annex 13.1).

13.1.4 Tourism products

There are many tourism products in the CHAL area. Kaski is known for potatoes, woolen bags and *lokta* paper. Similarly, Baglung produces *agar batti*, bags and *timur* powder, while Myagdi District is famous for gauria rice. Gulmi District has organic coffee and kafal (*myrica esculanta*) fruit, and Mustang District is known for its *bhote jira* (*carum carvi*), apple chips, apple brandy and *jimphu* (*alliums pp*). Tourism product of all districts is presented in Annex 13.2.

13.1.5 Issues

(a)Policies: Despite so many tourist destinations, Nepal lacks a tourist-friendly legal infrastructures and policies. Private sector institutions are unable to provide services as per license and permission given to them. There is no strong policy to control existing road blocks, strikes, forcefully shutting down of businesses and other disruptions. Nepal lacks policy that identifies dispersed heritage sites and places. Some protected areas are not very welcoming and therefore the government should devise enabling community based tourism policies.

(b) Capacity: The tourism sector lacks proper management and operational capacity. The hotel association and home stay groups are not well organized. Very few hotels and home stay owners are trained in hotel management. As reflected earlier, physical infrastructures (roads, trails, buildings etc.) have not been properly developed

and expanded. A mechanism for development of appropriate infrastructure facilities needs to be developed.

(c) Benefit sharing (GSI perspective): Rural tourism and home stay services have not been realized to yield benefits to the poor and women as most benefits have been diverted to village elite who have been involved in such business in the past. The poor and marginalized groups lack both skills and funds to start tourism businesses. The poor are employed as porters or guides in some cases, but the remuneration for guides and porters is very low. In hotels and restaurants some young women are working but the perception of local people towards them is not positive. Therefore, equitable tourism promotion is essential to promote community tourism in the CHAL area.

13.2 Green Enterprises

13.2.1 Existing green enterprises

Industrial development is the main basis of economic development of a nation. The Chitwan-Annapurna Landscape (CHAL) is underdeveloped from the industrial point of view. There are no big industries so far in the area and micro-enterprises are the major dominating industries in the area. There are four types of micro-enterprises in this landscape, namely, forestry, agriculture, livestock and off-farm based enterprises.

Some of the major forest based micro-enterprise are, *allo* processing at Salija, Kang, Pathichour and Deurali VDCs of Parbat District; bamboo basket production, handmade paper in Naglibang VDC, Baglung District; handmade paper and sea buckthorn juice in Naghi VDC, Myagdi District; *Sisno* powder making in Banskharka VDC Baglung and Benibazar, Myagdi District; Agarbatti (incense stick) making in Bihu VDC of Baglung District; timur production and sale in Sigpaughar VDC, Myagdi District, and seabuck thorn juice making in Lete VDC, Mustang. In Dhading, bio-briquettes and NTFP collection and sale are the major forestry based enterprises. Similarly, furniture making takes place in all districts of the CHAL area.

Agriculture based enterprises are fresh vegetable production and marketing along the Trithivi Highway and other roadsides; and in other areas, pickle making; fruit production and sale; orange seedling production; orange production and sale; ginger processing; honey production; dried apples etc. Similarly, fresh vegetable production is found in many of the CHAL areas, for example. green pea and strawberry production is found as an enterprise in Nuwakot and high hills potatoes in Rasuwa. Shiva Sakti Maize Seed Production Group, Pokharithok VDC, Palpa and Anamol Seed Production Group, Chitwan have produced seeds of Manakamana 3 and Poshilo maize as a foundation seed.

Livestock based enterprises includes milk collection and sale (23 milk collection cooperatives are found in Tanahu); cheese making in Sigpaughar VDC of Myagdi District; goat keeping, and poultry. In Palpa District, livestock pocket areas included Madan Pokhara (cows and poultry), Khani Chap (buffalos), Ghirubas (goats), Dovan (poultry) and Pipal Danda (pigs). Similarly, Digam and Jaisithok (cows and buffalos), Ruru, Birbas and Thanapati (goats), Tamghas, Neta and Birbas (poultry) and Birbas, Tamghas and Santipur (pigs) are also pocket areas of Gulmi District. Fish farming is practiced in CHAL and recently, 50 ponds have been constructed in Lamjung (Dhamili Kuwa, Chepay Khola, Sundar Bazar, Kirinche and Bhorletar) District to promote fish farming as a micro-enterprise. Fish farming is also practiced in Makawanpur, Chitwan and Nawalparasi Districts.

Off-farm enterprises includes candle making; bakery item production; noodles production; mobile telephone repair; radio and TV maintence centers; tailoring; shoe making; metal work; beauty-parlour operation; hair cutting, and hotel and tea shop operation. These enterprises have been found across the Chitwan-Annapurna Landscape. In addition nettle fiber production is a micro-enterprise in Darbang VDC, Myagdi District.

13.2.2 Potential micro-enterprises

Potential forest based enterprises include herbal soap production using Chiuri ghee; nigalo/ bamboo based handicraft production; allo processing; Nepali paper making; furniture making; asparagus production; sisno powder making; amala and lapsi candy making; herbal tea production; broom grass kucho making; sal leaf plate production; seabuck thorn juice making; chiraito cultivation; timur production and use of babiyo grass. Agriculture based enterprises are seasonal and off-season vegetable production; off-season vegetable seedling production;, citrus fruit production; establishment of fruit nurseries; banana farming; apple farming; fruit harvesting

and post harvesting support; ginger processing; turmeric power making, and foundation seed production. Similarly, livestock based enterprises includes dairy based enterprises (milk collection centers); goat farming; sheep improvement; wool based enterprise development; poultry farming; swine farming; bee keeping; fish farming, and the establishment of forage resource sites.

Finally, off-farm enterprises include those mentioned above in section 13.2.1 and could include the development of local resource people in providing user-paid, demand-driven services to CFUGs and other groups.

13.2.3 Issues and recommendations in developing green enterprises

- Access of women and *Dalits* to credit for establishing green enterprises is very low and therefore the Hariyo Ban project should utilize existing CFUGs and ensure community saving funds are effectively utilized.
- *Dalits*, poor and women are not getting enough support to establish and operate micro-enterprises. The Hariyo Ban Project can provide matching grants for pro-poor enterprise development.
- Landless and poor farmers have not realized the full benefits of agroforestry on abandoned private lands. This could be a priority activity for the project in order to absorb out-going rural youth in their villages.
- Forestry, agriculture, livestock and off-farm based micro-enterprises should be developed and promoted in villages of the CHAL areas to meet the needs of local demand.

13.3 Mineral Resources

13.3.1 Metallic and non-metallic minerals

There are potentialities for exploring and extracting some metallic and non-metallic mineral resources in CHAL. Metallic mineral deposits include copper (in 21 locations), gold (in 25 locations), iron (26 locations), and silver (8 locations), and non metallic mineral resources such as magnesite (Figure 13.2; Annex 13.3).

13.3.2 Stone, gravel and sand

The density of population in core city areas is increasing day by day because of the decade long conflict and migration from rural to urban areas in search of better services, facility and security.

Figure 13.2: Identified potential mineral resources within CHAL

(Source: Department of Mines and Geology, 2012)

Table 13.1: Geothermal springs in CHAL

District	Location	Latitude (Degree)	Longitude (Degree)
Myagdi	Mayagadi	28.369	83.509
Myagdi	Kali Gandaki	28.497	83.658
Myagdi	Sekeharke	28.457	83.626
Kaski	Seti Khola	28.419	83.995
Kaski	Naya Gaon	28.360	83.962
Kaski	Chitepani 1	28.290	83.954
Lamjung	Marchyangdi	28.150	84.373
Kaski	Chitepani 2	28.226	80.072

(Source: Present study)

Physical facilities such as houses, bridges, roads, telecommunications, water supplies etc. had to be developed. In the process of this infrastructure development, river mining, stone mining and quarries for construction materials has also developed. Mining leads to environmental degradation, hence conservation of these resources is necessary.

Excessive extraction of sand and gravel from river beds is a major problem in the Trishuli, Seti and East Rapti Rivers. There are many crusher industries on the river stretches causing river degradation. Due to the river mining in the downstream reaches of the East Rapti and Lothar Khola, river meandering is rapidly causing damage to the fertility of agricultural land. Aquatic life and the quality of water are degrading due to river mining activities.

There have been some efforts from the government to control or reverse the trend of the Siwaliks degradation. The problem has been reflected in the Three Year Interim Plan, the current 12th Plan (Three Years National Approach Plan), President Churia Conservation Program and other national and sectoral plans. To keep the river healthy and conserve aquatic life, the extent of mining should be identified and regular and effective monitoring should be done. Effective implementation of EIA legislation could be another measure to adopt. The possibility of keeping excavator machines off river beds and using local labor instead need to be explored.

13.3.3 Geo-thermal springs

There are eight natural sulphurated hotsprings in CHAL, including three in Myagdi, four in Kaski, and one in Lamjung District (Table 13.1). Most of these exist in the river valleys. The hotsprings have two main values, namely medical, and tourism, and thus attract huge numbers of visitors, both from within Nepal as well as overseas.

13.3.4 Potential for oil and gas

Records at the Department of Geology and Mining show that the only source of natural gas in the landscape exists at Muktinath, Mustang District. Currently, the continuous flame is serving as a religious site.

13.3.5 Issues related to the development of mineral resources

The three stages of mineral development, namely exploration, mining and processing, can cause different types of environmental damage, which include ecological disturbance, destruction of natural flora and fauna, pollution of air, land and water, instability of soil and rock masses, landscape degradation and radiation hazards. Since much of the damage is inevitable, precautionary and remedial measures need to developed and put in place to minimize the negative effects of mineral exploration. While the government should provide regulatory legislation with appropriate sanctions, the mineral-producing companies should carry out mandatory precautions, remedies or compensation for damage done.

14 Gender and Social Inclusion

14.1 Gender Specific Dimensions

Traditional gender roles in Asia are determined by historical, religious, ideological, ethnic, economic and cultural factors (Bhattarai, 2006; UNICEF, 2006; Acharya, 2001; Moser, 1993). Like any other South Asian country, in Nepal, men are expected to work outside the house, earn a living and support the family economically, whereas women are busy looking after family members and working on the farm. Women generally have less access and control over valuable resources and the vital importance of women's roles in economic spheres in Nepal is not recognized enough.

In Nepal, women comprise about 24 percent of executive committee positions within Community Forest Users Groups (CFUGs) but are still struggling to rise to decision-making positions in the community forestry sphere (Kanel and Kandel, 2006). One strategy toward balancing gender distribution has been to form women-led CFUGs (so far about five percent of community forest is controlled by only women) but women led CFUGs are generally provided with relatively small and marginal land as community forests. These CFUGs have access to forests only half the size per household as those forests under the control of mixed gender CFUGs (0.34 ha for women-only CFUGs, compared with 0.73 ha for mixed CFUGs). Women only CFUGs are well managed as compared to male or mixed CFUGs (Luintel and Timsina, 2008; Kanel and Kandel, 2006). Another initiative for seemingly balancing gender has been to include the names of women in the CFUG member list instead of the earlier practice of including only the male household head's name. Among the five key posts within the committee it is compulsory to give one key post to women. Although these initiatives have improved women's participation in community forestry, their overall management and decision making role still remain poor. This scenario was also found in CHAL.

The socio-cultural factors, gender discriminatory practices, traditional gender roles (in many cases) and less exposure are the major influencing factors for the poor management of CFUGs (Pandey, 2011; Luintel and Timsina, 2008; Kanel and Kandel, 2006). Community forestry and collaborative forestry management are very much affected by gender and marginalized group discrimination, even if today on paper they appear to be more equitable. (USAID, 2007; UNICEF, 2006).

14.2 Access to and Control over Natural Resources

Women are the primary source of labor in small and medium farms and in large farms their labor contribution is more or less equal to that of men. More than 80 percent of women in Nepal engage in agricultural, contributing in all stages of agricultural production. They perform agricultural work, producing food for their families and other goods that are sold in national and international markets (Pandey, 2011; Bhattarai, 2006; UNICEF, 2006; Upadhyay, B., 2005). Traditionally women have been active participants in both agricultural and forestry components and they have developed a deep affinity towards natural resources. However, women rarely have control over these resources as they do not have a legal title to the land they till. Without a title they are not viewed as farmers but continue to be perceived as homemakers by the government and public at large. This perception is ingrained in every aspect of the sociopolitical and economic outlook towards women. At the heart of it is the issue of unequal rights of women to land (Pandey, 2011; Upadhyay, B., 2005; WEDO, 2003).

Women in Nepal have the most unequal right to land in South Asia as only 10.8 percent of women own land in their names (Action Aid, 2010). Without secure land tenure, women are further excluded from decision-making about natural resource management. As a result, they have less control over valuable natural resources although they are the primary users of these resources to improve livelihood of family and protect the natural resources.

More than 20 years of evidence shows bias against women and girl children in the allocation of resources within households in Nepal. The majority of families, especially from semi and rural areas still do not provide sons and daughters equal access even to basic necessities such as food, education, health care, employment opportunity and socialization. It is unrealistic to rely on voluntary contributions and altruism of the family to allocate a woman adequate land or any land at all, the most valuable resource in the family and community (UNICEF 2006; Uprety, 2006; Upadhyay 2005; Acharya, 2001). Land given to a daughter is viewed by the natal family as a loss with virtually no reciprocal benefits (UNICEF, 2006). There is still a gender, class and caste-based division of labor and distribution of property and power keeping in Nepal (UNICEF, 2006; Bhattari, 2006; Acharya, 2001). Central to this view are concepts of ownership of, access to, and the right to use natural resources in combination with the effects of social discrimination.

The findings from this study revealed that people are engaged in farming related enterprises including animal husbandry which are highly dependent on the availability and quality of natural resources such as land, forests, seeds and water. They depend on the availability of fuel, fodder, grass, biogas, water, medicinal plants, building materials etc. to meet the livelihood of family members. During discussions it was learnt that many women are quite knowledgeable both about the environment and about the natural resource base and its uses. For instance, women were more interested in wild/seasonal vegetables (both for family use and earning cash), fodders, fuel woods, biogas, medical plants (though not all women or men were aware of use of the medical plants), whereas men were more interested in timbers and expensive NTFP to earn cash. Although research has shown that agricultural productivity increases significantly when women farmers have access to the land and technology, the government and institutional policies often fail to recognize the importance of women's access to land and natural resources (Action Aid, 2010; WEDO, 2003).

The findings from this study also demonstrated that women have played important and sometimes critical roles to manage and protect natural resources was used. It was reported that women are actively involved cleaning/removing damaged logs/trees, planting new ones, and guarding the community forest turn by turn. Yet, women's control of these resources is far from guaranteed. None of the women or other marginalized groups could sell valuable resources on their own and there was no transparency. Likewise, women were hardly involved in how benefits/income from natural resources were used. For example, women or other marginalized groups are often not invited to meetings on resource use because men and the elite class talk on their behalf. Although there are legislative arrangements for all sections of society to access and participate in the management of natural resources, this hardly ever is manifested into practice (Pandey, 2011; Bhattari 2006; Uprety, 2006; Thapa, 2005). In addition, lower levels of literacy/education, low self-confidence and less public exposure further restrict their participation.

One example would be NTFPs, a valuable natural resource of high economic value. The government of Nepal has identified 399 types of plants listed as NTFP and among them 72 plants species are regarded as having higher commercial value. Identification of many NTFPs is often difficult and not well documented in the community forest (Dutta, 2007), and not all respondents were familiar with their value or uses.

14.3 Participation of Women and other Marginalized Groups in Natural Resource Management

In the initial stages of community forest practice in Nepal, women's and other minority groups' participation was ignored. This resulted in poor natural resource management with benefits going to elites and not to marginalized groups (Pandey, 2011; Dhakal and Masuda, 2008; Kanel and Kadel, 2006). Realizing this, gradually policies were changed and priority was given to the participation of women and other marginalized groups.

A number of studies have shown that participation of women and other marginalized groups has increased in various programs of I/NGOs and GOs, particularly the former, but their level of involvement and benefit sharing remains questionable to many researchers (Pandey, 2011; Luintel and Timsina, 2008; Kanel and Kadel, 2006; Uprety, 2006; WEDO, 2003). Similar findings were seen during this study where there is a high level of participation of women and minority groups in different programs.

Reportedly, women's participation in activities relating to natural resources is increasing gradually because they have seen the benefits and been empowered through I/NGO programs. In recent times women are more actively involved in protecting the community forests from deforestation and poaching. Nevertheless, participation in programs related to natural resource management was still found to be missing. It was also unclear if people, in particular women and other marginalized groups, are involved from the initial stage of problem identification and continue into the subsequent stages of planning, implementing and management of programs, etc.

Although the government has recognized the importance of women's participation in every development program, the wider participation of women and other marginalized groups in decision-making and benefit sharing through legal provision has not translated into reality. Based on secondary information and findings it can be said that participation of women and other minority groups is still low in most development programs including community forestry though an increased trend is seen. Participation of persons with disabilities was not seen during the study and none of the respondents were aware if there were persons with disabilities in their program. This might be due to the absence of legal framework for participation in the past, and the fact influential persons would receive benefits in the name of participation as representation of women, persons with disabilities underprivileged castes and ethnic groups (Pandey, 2011; DFID & WB, 2006; WEDO, 2003). In addition, restricted mobility and absence of access can also be a hampering factor in the participation of persons with disabilities in natural resource management. Hariyo Ban should design the program to give meaningful participation to women and other minority groups regardless of their sex, disability, ethnicity and socio-economic status.

14.4 Participation in Decision Making in Natural Resource Management

Decision-making is a crucial element in any participatory resource management process. It is expected that if the majority of people are involved in the decision-making process, they take ownership and accountability of resource management. Participation is affected not only by those who make and implement the decisions but also by how decisions are made (Pandey, 2011; Bhattarai, 2006; Kanel and Kadel, 2006; UNICEF, 2006; Uprety, 2006; Thapa, 2005). However, participation in the implementation of activities does not necessarily ensure effective participation in decision-making because effective participation requires effectively recognizing people's views and taking these into account (Pandey, 2011; Action Aid, 2010; Chhatre and Agrawal 2008; DFID and WB, 2006; Upadhyay, 2005; WEDO, 2003). Effective participation in decision-making would enable women and other disadvantaged groups to influence the formulation of rules and regulations in their interest; however, that does not necessarily guarantee that they enjoy access to the incentives derived from the natural resources.

In Nepal, participation levels of women and other marginalized groups have increased in recent years but their decision making level is still, in reality, very low (Pandey, 2011; Dhakal and Musuda, 2008; Kanel and Kadel 2006; Upadhyay 2005; WEDO, 2003). The findings of this study were, in general, similar to the national level studies. The government policy of having at least one woman in a key post in any development program was not found to be practiced in CHAL. The involvement of women as executive committee members and their control in both decision making and implementation phases was found inadequate. It was also learnt that men and elite classes are often in the majority in meetings and they hardly appreciate the ideas raised by women or other marginalized groups (strongly reported in Dhading and Nuwakot). Males who are not in the executive committee are making decisions and women are obliged to provide the signature. Exclusion of women and other marginalized groups from the decision making process and from equal benefit sharing is one of the major challenges of natural resources/ community forest (Action Aid, 2010; Ojha et al., 2009; Thapa, 2005; WEDO, 2003).

Most women members of CFUG executive committees in the study communities of Tanahu and Rasuwa Districts were not aware of the CFUG programs. For example, in Bandipur, many CFUGs were planting asparagus but women were not aware about its nutritional and commercial value. The evidence indicates that there is a need for basic capacity building training, including terms of their roles. Guidelines should be developed in simple forms so people with minimum literacy can understand them.

Until and unless women can play a vital role in every decision-making process in all stages of natural resource management, their participation cannot be said to be really meaningful. Nevertheless, women and other minority groups are trying to be involved for the good management of natural resources as well as for the betterment of their family and for their own personal development.

Some studies have found that wealthier households not only control natural resource management decisions, but also make access to forest products disproportionate. As a result rich and male members have gained comparatively more benefits from natural resources than women and other marginalized groups (Pandey, 2011; Kanel and Kadel 2006; Thapa, 2005).

Although some men said that most of the decisions are made with active participation of all members at the meeting this information was contradicted by some women who participated in the interview who stated participation for most women is only a headcount. In practice it is not so easy to secure women, disadvantaged groups and poor people's participation at a decision making level because of social, cultural, economic, gender and other beliefs. The Hariyo Ban Program should focus on finding ways to involve women and other marginalized groups at both decision making level and in the share of benefits.

14.5 Livelihood Improvement from Natural Resources

Forests have historically held a central place in local livelihood practices and national politics in Nepal because of their importance in rural livelihoods and state revenues. As more than 70 percent of Nepal's population depends on agriculture, forestry and fisheries for their livelihood, community management of forests has been a critically important intervention (Pandey, 2011; Action Aid, 2010; Ojha et al., 2009; Dhakal and Masuda, 2008; Chhatre and Agrawal, 2008; USAID, 2007; UNICEF, 2006). There are several initiatives, traditional and more recent, to enable local people to be involved in natural resources, where they can take ownership of community forest and improve their livelihood through natural resources such as fuelwood, grass, timber, and traditional medicines.

Community forestry has enabled households to diversify their livelihood strategies to a greater extent than was possible before, including undertaking forest-based income-generating activities (ibid). On the other hand, some critiques argued that community forest has not improved livelihoods of women, the poor or marginalized groups. Because there is insufficient quantitative evidence of an improvement in the income component of livelihoods, particularly for the poorest households and women, divergent viewpoints exist over long-term natural resource management goals (Kanel and Kadel 2006; Thapa, 2005; Upadhyay, 2005).

Most community forests are opened once a year for the collection of wood and other available resources, which supports their livelihood directly and indirectly. During interactions, it was learnt that some people sell dead/damaged wood from the community forest for their mere survival (reported in Chitwan and Dhading) as they do not have land for farming and other alternative sources of income to meet their day to day needs. Some respondents have also formed their own saving and credit groups where they are able to save or use credit. Some have taken credit to open small shops in their vicinity, whereas others take credit for goat farming or cultivating seasonal vegetables. This is important because women and the poorest community members do not own land in their names. Having an alternative livelihood option and earning income of their own has helped in reducing social discrimination and increased their financial status.

During group discussions in four sites, it was highlighted that the poorest communities are more interested in daily labor rather than putting their energy in the community forest/natural resources and other community development as there is no immediate benefits, to meet their daily livelihood. For example internally displaced people (IDPs) (approximately 800 people according to

interviews) from Panchakanya in Chitwan District do not often participate in community programs operated by GoN or I/NGOs because they do not see immediate benefits, particularly as they can earn more than Rs 1,000 from a day's labor. It is also difficult to persuade them to protect the forests, perhaps because they feel less ownership.

Based on discussions, it was found that to some extent, community forestry has brought income generation, biodiversity conservation and social unity. Nevertheless, there is no clear evidence that there has been an increase in household level income of those from disadvantaged groups. Some respondents were of the opinion there is no equal distribution of benefit sharing from natural resources which could help their livelihood. In fact a few of them were disappointed and dropped out of the CFUGs as reported in Chitwan, Dhading and Nuwakot Districts. The researcher also got the impression that not all women or disadvantaged groups are aware of NTFPs and their usefulness.

Although there was no clear evidence about increased income at individual or household level from natural resources for the most disadvantaged groups, other changes were heard such as improved physical infrastructure (roads, taps, tube wells irrigation canals and latrines have been built in some sites), community halls have also been built, and community forests have been protected from deforestation. Skills development/capacity building for user groups has also increased mobility and social networking and other forms of social capital. Keeping this issue in mind, the Hariyo Ban Program can explore in detail in what ways natural resources could attract and help to improve livelihood opportunities for the most marginalized groups based on the local context.

Climate Change: Status, Impacts and Adaptations

15

15.1 Weather Stations, their Locations and Data Use

CHAL currently has 77 weather stations established by the Department of Hydrology and Meteorology, which are distributed in all physiographic zones. Relatively higher numbers of stations exist in the midhills as compared to other zones. Out of 77, long term (1979-2010) analysis of temperature and precipitation trends of seven stations are given in the table below.

15.2 Climate Change (Observed and Projected) and Climate Variability

15.2.1 Temperature

In Nepal, the average annual temperature increased by an average rate of 0.06 °C per year during 1975-2006. This rate is higher than the global rate of increase, which is estimated to be 0.02 °C per year. The year 2006 was reportedly the warmest year on record. The rate of increase has been found higher in the Himalayan region

Table 15.1: Location of selected meteorological stations in CHAL

S.N.	Station	Latitude (Degree/ Minutes)	Longitude (Degree/ Minutes)	Altitude (m)
1	Chame, Manang	28° 33'	84° 14'	2,680
2	Jomsom, Mustang	28° 47'	83° 47'	2,744
3	Walling, Syanja	27° 59'	83° 46'	750
4	Lumle, Kaski	28° 18'	83° 48'	1,740
5	Dhunibeshi, Dhading	27° 43'	85° 11'	1,085
6	Hetauda, Makawanpur	27° 25'	85° 03'	474
7	Rampur, Chitwan	27° 37'	84° 25'	225

(Source: adapted from DHM, 2010)

Table 15.2: Analysis of long-term (1979- 2010) temperature data in different regions of CHAL

Region	Mean annual Temperature (C°)	Mean Maximum Temperature(C°)	Mean Minimum Temperature(C°)	Mean Annual Trend (°C/Yr)
Trans-Himalayan/High Mountains				
Jomsom, Mustang	11.6	17.6	5.5	0.034
Chame, Manang	11	17	5	0.021
Midhills				
Lumle, Kaski	16.1	20.1	12	0.039
Walling, Syanja	21	27.2	14.7	0.037
Dhunibeshi, Dhading	21.3	21.3	16	0.037
Siwaliks				
Rampur, Chitwan and Hetauda, Makabanpur	30.1	23.6	17.2	0.036

(Source: adapted from DHM, 2010)

as compared to the other regions (Shrestha et al., 2012). The Global Circulation Model projection shows 11-28 percent increase in the frequency of hot days, and 18-28 percent increase in hot nights (Practical Action, 2009).

An analysis of 30 years (1979-2010) of meteorological data for the seven selected locations within CHAL shows a progressive increase in maximum temperatures in all regions during that period. The exact rate of increase in temperature, however, varies from place to place, from 0.039 °C in Lumle, Kaski, to 0.021 °C in Chame, Manang (Table 15.2; Annex 15.1).

The findings are in tune with Shrestha et al. (1999) who found an estimated increase in mean annual temperature by 0.06°C during 1977 to 1994, and the National Adaptation Plan of Action's (NAPA's) (2010) projection of possible increase in temperature by 1.2°C by 2030, 1.7°C by 2050, and 3.0°C by 2100 in Nepal. Field level consultations with focus groups and key informants at different locations covering all physiographic zones (e.g. Lete, and Marpha, Mustang, Rashuwa, Pokhara, Beni, Tansen, Lamjung, Bidur, Kawasoti, Dumkibas) also confirmed a general increase in temperature during the last five to six years. In some locations, however, local people reported unprecedented cold even in the month of May (such as in Babiochur, Myagdi, and Lete and Marpha, Mustang). The findings lead to the conclusion that the temperature in the landscape has been steadily increasing, but the rate of increase is variable across different regions.

15.2.2 Precipitation

The annual precipitation varies substantially across the landscape. Analysis of long-term (1979-2010) precipitation data indicated that Lumle, Kaski received the highest average total annual rainfall (5,496.3 mm) and Jomsom, Mustang received the lowest average total annual rainfall (269.6 mm) during the period. These two locations represent the highest and the lowest rainfall areas in the region. Analysis of data from different stations showed no clear trend in average annual precipitation (Table 15.3, Annex 15.2).

Local level focus group and key informant interviews indicated that more than 80 percent of the communities have experienced an increase in water stress due to decreased rainfall and delay (by 15 to 20 days) in monsoon arrival. Erratic rainfall, high intensity rainfall, and uneven distribution of rainfall were other common observation of local people. For example, local people in Parbat and Baglung Districts cited the year 2006 when the monsoon rains started only at the end of July. According to a key informant, winter fog has become common in the district headquarters of Parbat in recent years, which was not the case in the past. The timing and intensity of hailstones has also been reportedly changing over the years. Unprecedented hailstones in Pangarang VDC of Parbat (a pocket area for vegetable seed production) last year reportedly caused heavy damage to vegetable seed crops.

One interesting observation in Jomsom was that the traditional mud and stone roofs are

Table 15.3: Analysis of long-term (1979-2010) rainfall (mm) data in different regions of CHAL

Region	Mean Annual Rainfall (mm)	Maximum Rainfall (mm)	Minimum Rainfall(mm)	Annual Trend (mm/ Yr)
Trans-Himalayan/ High Mountains				
Jomsom, Mustang	269.6	432.1 (1995)	83.3 (1984)	1.5
Chama, Manang	9,75.9	1,682.6 (2007)	482.3 (2009)	-2.2
Midhills				
Lumla, Kaski	5,496.8	6,561.4 (1995)	4,162.4 (2006)	15.9
Walling, Syanja	1,930	2, 716 (2000)	920.9 (2005)	-19.32
Dhunibeshi, Dhading	1,585.2	3,025.2 (1999)	1,022.7 (1989)	7.61
Siwaliks				
Rampu, Chitwan	2,047	2,742.6 (2007)	1,732 (2005)	14.8
Hetauda, Makabanpur	2,446.8	3,323.1	1846.2	13.2

(Source: adapted from DHM, 2010)

Table 15.4: Examples of extreme events in CHAL in recent decades

Year and Date	Rainfall (mm) in a 24 Hour Period	District and VDC
27 August 1990	438	Hetauda, Makawanpur
6 September 1993	398	Dumkibas, Nawalparasi
19 -20 July 1993	540	Tistung, Makawanpur
23-24 July 2011	118mm rainfall in 48 hours (normal average total annual rainfall is170 mm)	Lomanthang, Mustang

***(Source:** MOHA, 2009 and Dixit, 2010)*

progressively being replaced by corrugated zinc sheets. The reason behind was said to be increasing amount and intensity of rainfall in recent years. The unprecedented intense rainfall that continued for 48 hours in Lomanthang (rain shadow area) on July 23-24, 2011 was highlighted by a national newspaper. Similarly, extreme climatic events have been reported in other locations (Table 15.4). Local people in Panchase of Kaski District, on the other hand, reported a decreasing trend in the quantity and duration of snowfall in recent years.

The finding that there is high variability in precipitation in the landscape is supported by some past studies, which find significant inter-annual variability on annual and decadal time scales and climatic models and predict an increase in monsoon precipitation because of green house gas induced warming (e.g. Shrestha et al., 2000; MoE 2010b/NAPA, 2010b). The regional circulation model projects both rise and fall in the mean annual precipitation with no clear trends and a similar trend has been recorded for the Gandaki Basin. Precipitation data analyzed projected an increase in mean annual rainfall in Nepal (-14 to 59 mm per month) (UNDP, 2007) but that its intensity, frequency, duration, amount and distribution will be highly variable and unpredictable.

A modeling exercise conducted in 2009 by a team of Nepali, American, British, Pakistani and Bangladeshi experts (NCVST, 2009) using the emissions scenarios in the Inter-governmental Panel for Climate Change (IPCC's special report (2007) found that the temperature will indeed increase in the midhills and that this region is likely to grow more arid in the non-monsoon seasons. The report also suggested that precipitation is likely to be more uncertain and that storm intensity will increase (NCVST, 2009). The overall average trend for Nepal indicates that the annual average precipitation over Nepal is decreasing at the rate of 9.8 mm/decade (MoPE, 2004). The analysis of past precipitation records revealed a decreasing trend in the number of rainy days. Conversely, the days with more intense precipitation were increasing, i.e. more precipitation occurred in fewer days. This changing precipitation pattern indicated that the drought period was becoming longer; however, there was no definite trend in the annual precipitation amount (WECS, 2011).

Through precipitation data analysis and local consultation, it was found that there is high variability and unpredictable precipitation in the region, varying from location to location (Annex 15.2). Furthermore, it is reported that monsoons were delayed and there was an increase in weather-related disasters such as floods and landslides. A scarcity of water resources and an increase in periods of drought, particularly in the Siwalik region is predicted for the future.

A case of extreme rainfall variability (source: Adapted from *Kantipur Daily*, July 26, 2011)

Normal life in the Lomanthang area was greatly affected due to the unexpected extreme event of intense rainfall lasting more than 48 hours. Generally, Upper Mustang receives < 200 mm rainfall annually. The normal pattern of rainfall in this area is dizzle for few minutes to an hour. According to Indra Bahadur Bista, Chairman of Lomathang Conservation Area Management Committee, the unprecedented rain badly damaged the mud and stone-roofs that are common in the area. All 171 households that live in Lomangthang VDC were affected. One woman in Chuang VDC 5 died after her house collapsed due to the rainfall.

15.3 Impacts of Climate Change

15.3.1 Impacts on forests and biodiversity

Climate change and biodiversity are closely interconnected, not only does climate change affect biodiversity, but changes in biodiversity and ecosystem functioning can also affect changes in climate. Climate change is likely to become one of the most significant drivers of biodiversity loss as well as forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits (Gisladottir and Stocking, 2005).

The impacts of climate change on forests and biodiversity in CHAL are not well known. The information that exists relates to peoples' perceptions, which makes it difficult to ascertain whether the perceived impacts are indeed caused by climate change or some other factors.

Representatives of different line agencies and local key informants consulted in different ecological regions indicated loss of terrestrial and aquatic biodiversity, tree line shift, and degradation of grasslands in the high mountain region due to climate change. Occurrence of new tree species was reported from some areas (e.g. *Schima castanopsis* in Dahapani-Bieu VDC, Baglung). Increased encroachment of high altitude pastures by thorny bushes was reported in Mustang. A substantial decrease in the number of *Quercus semicarpifolia* trees was reported from Panchase Protected Forest. Changed timing of phenological events of some tree species (e.g. rhododendron, *Prunus* sp.) was another common observation among local people.

The habitat of *Rhododendron* sp. has reportedly expanded to higher altitudes in Gorkha District (LFP, 2009). According to Yonzan (2010), fir *(Abies* sp.*)* has moved up 23 m on the south slopes and 17 m on north slopes in the last ten years. In Rasuwa District, local communities have observed changes in local vegetation patterns and a reduction in production and supply of NTFPs (SAGUN, 2009). Similar observations were made in parts of Mustang and Manang Districts (Dahal, 2006). Sagun (2009) further reported occurrence of rhododendron, juniper and lokta in higher altitudes than they normally occur.

In the midhills and Siwaliks, increased drought periods resulting in increased intensity and frequency of forest fires was reported. Drying up of small streams and ponds, decreased ground water table, increased events of flashfloods and sedimentation downstream were other general observations. Increased level of siltation was also reported in Beeshazari Tal, Panchakanya, Lami Ghol in Chitwan, and Banunna Ghol and Khudia Tal in Nawalparasi Districts.

Increased invasion by alien plant species and increased insects and pests attack on *Dalbegia sissoo* and other trees, might have links to climate change. Some important forest and grassland ecosystems, including Chitwan National Park, are increasingly threatened by invasion and rapid expansion of *Mikenia mikrantha* and *Lantana camara*. According to a study (Yonzon, 2010), forests in the Siwaliks region are increasingly being lost due to increased droughts.

Decreased precipitation and snowfall in the trans-Himalayan region has resulted in decreased production of grass in pastures, which has substantial negative effects on the nomad community, whose livelihood depends on cattle and sheep farming (MoE 2010b; Tiwari, et al., 2010). A similar situation has been reported in the high mountain pastures (namely, Murkha and Sainduku *Kharka*) of Gorkha District (LFP, 2009).

Forests and biodiversity in the Siwaliks (see Annex 15.3 for the VDCs located in the Siwalik Hills) are more vulnerable to the impacts of climate change than those in the midhills. Degradation or modification of Chitwan grasslands due to climate change and human activities can have a negative impact on important wildlife such as tiger and rhino. There is a need for a detailed study on the impacts of climate change on diverse ecosystems and species found in the landscape.

15.3.2 Impact on agriculture and livestock

The agricultural sector is highly dependent on weather, particularly on precipitation in this region. The majority of the farmers in this region have rainfed farms which are directly affected by climatic variability. Nearly 21 percent of the crop area is irrigated in Nepal (Pant, 2009). Small changes in the climate can induce large changes in agricultural risk in the mountains. Extreme weather conditions such as flood, drought, frost, hailstone and heat and cold waves are direct hazards to agriculture production.

Local consultations at district and community level also expressed that delayed and short monsoons as well as long periods of drought and decreased winter rainfall means increasing uncertainty on the impact on agriculture production, both summer crops (maize, paddy) and winter crops (wheat, legume and mustard). Furthermore, local communities of the mid mountain (Palpa, Syanja, Baglung, Magdi, Dhading, Nuwakot) and the Siwalik region (Nawalparasi, Papla Dovan, Chitwan, Makabanpur) reported that shorter monsoons have an effect on rice plantation and harvesting. The community in Dumkibas (Nawalparsi) reported that every alternate year there was a trend of drought during the winter. Rain fed crops like wheat, oil (rape mustard), winter vegetables and maize have been severely affected due to low rainfall in the winter and pre-monsoon. It is observed that this year also saw long dry periods which affected the maize crops and delay paddy plantation in some districts such as Palpa, Gulmi, Dhading, Nawalparasi and Chitwan. Furthermore, Areas of Tanahu such as Bandipur, and Lamjung, such as Udipur, reported an increasing trend of citrus greening and dieback disease affecting orange crops, possibly due to increased temperature.

In the case of the high mountains, farmers in Lete, Mustang reported that unpredictable and un-timely precipitation in recent years resulted in damaged crops and low soil temperature for maize seed germination in the month of May. Reports from the Agriculture Sub-center in Lete Mustang (2012) found that local farmers are now cultivating potatoes on about 200ha of their farm land, replacing barley, oat, wheat and maize. Climate change impact has also some positive impacts, such as opportunities to cultivate fruit and vegetables in the higher mountains. Local consultation with Magdi DADO reported that ecoline shift in Magdi District might be due to increased temperature. In general orange production is found at 1,200 to 1,600m but at present orange production can be found at 1,700m. Similarly, in the Mustang District apple production is improving at higher altitude areas compared to the past.

Different research reports support the fact that that subsistence farmers, non-irrigated lands and crops already at their maximum temperature tolerance are the most vulnerable to climate change (IPCC, 2007). A study carried out by the MoPE (2004) showed that temperature rise had a negative effect on maize, which gave decreased yield. Over the last decade (1990-2000), particularly in Nepal and the Indo-Gangetic plains of India, immediately south of the mountain region, there has been a significant reduction in the yield of winter crops such as wheat, mustard and pulses due to low rainfall. Compared to the average of the preceding 10 years, yield reduction in 1997/98 ranged from 11 to 38 percent due to variability of precipitation (MoPE, 2004). Higher temperatures, increased evapo-transpiration and decreased winter precipitation may bring about more droughts in Nepal (Alam and Regmi, 2004). Considering the influence of rapid population growth, climatic variability and urbanization, the risk of hunger is projected to remain very high.

With regards to livestock, midhill farmers reported that Anthrex and foot rot in cattle has increased in recent years. This has not been confirmed as to be a result of climate change, nor has the that fact dogs have been observed to breed twice a year rather than once as in the past, and which is the norm in Nepal. There is a need for a detailed study on the impact of climate change on agriculture and livestock in each region.

The overall agriculture production system is still traditional, unmanaged and too slow to adopt new technology in this region. Increased evapo-transpiration and water stress may also mean that crops will require more water through irrigation. Degrading soil and water resources will place enormous strain on achieving food security for growing populations. Local consultation reported that more than 50 percent of households have food insecurity and any negative impact of climate change on agriculture will further threaten food security in the local communities in this region. It is found that upland-rainfed farms particularly in the Siwalik and midhills region of the Narayani Basin, will be more vulnerable due to water stress for crop production and food insecurity in future.

15.3.3 Impact on water resources

Climate change impacts include too little water in some places, too much water in others, and degraded water quality. Some locations will be subject to both these conditions during different times of the year. Changes in water quality and quantity at the basin level affects all connected components such as energy production and use, human health, agriculture, and ecosystems services.

Field consultation and literature review revealed that water resources have decreased in natural springs and stream flows in all districts and all physiographic regions of the Narayani Basin. However, it is very difficult to analysis the cause of the impact on water resources: is it climate change or anthropogenic activities such as haphazard construction of rural road, deforestation and forest degradation or use of excess resources through urbanization.

The majority of respondents expressed that the incidents of drought have been increasing and link it with the decrease in water resources seen in all visited areas over the past few years. Trans-Himalayan (Mustang) and high mountain (Rashua, Magdi) communities reported that there used to be good snowfall at high altitude, up to 2 to 2.5 feet. But, in the last five or six years, snowfall is only negligible. In some areas, communities have relocated due to lack of water. Furthermore, local people from the high mountains (Magdi, Mustang, Rashuwa) have also noticed spectacular changes in their surroundings in the last couple of decades; hillsides that once used to be covered in snow throughout the year are now bare and dry. Similar observations were reported by local people, confirming findings from recent scientific studies, particularly about shrinking snow cover and retreating glaciers (ICIMOD, 2009).

Glaciers, ice, and snow cover 17 percent of the Greater Himalayan region and are receding more rapidly than the world average (Dyurgerov and Meier 2005; IPCC, 2007). The rate of retreat has increased in recent years (Liu et al., 2006; Zemp et al., 2008). The Landsat imageries clearly show there has been a decline in snow and ice coverage during the last twenty-five years. Between 1975 and 2000, there was a decrease of nearly 40 percent (29,208.3ha) in the snow and ice covered areas in the Himalayan region (WECS, 2011). If this trend continues, there will be severe impact on the hydrological regime in this region.

Local communities from the mid mountains (Palpa, Baglung, Parbat, Nuwakot) and Siwalik (Nawalparasi and Makabanpur) region reported that there has been a significant decrease in water in the stream flow during the dry season which was not noticed in the past. The trend in the annual discharges of the Koshi, Gandaki and the Karnali Basins indicate that the discharges in these major basins are decreasing annually (MoPE, 2004). The study from Sagun (2009) also found similar observations: in the midhills region of Dhading District reportedly natural springs, wells and water sources have dried up over the past seven or eight years due to decreased amount of recharge. Communities from Deupuje CFUG, Dhading, reported that 11 of their natural wells had dried up in the last few years. Similarly, streams in Ramche area, Rashua District were completely dry during the dry season, but they triggered flash floods during the rainy season. In Gatlang of Rasuwa District, eight to ten water sources existed in the last decade, but now only two or three sources remain. Additionally, important lakes such as Fewa and Rupa Lake in Kaski District are in continuous siltation and have decreased in size due to human activities. It was observed that there were more than nine rural road constructed upstream of the Fewa Lake (potential corridor for CHAL-Panchase Forest). The climatic variability such as high and intense rainfall in this area (Lumla, Kaski) and haphazard construction of rural roads in the Fewa watershed will result in more siltation and a decrease in the lake area.

Impact on water resources was found to be very high which ultimately affects all sectors such as agriculture production, forestry biodiversity, drinking water supply, and hydropower, as well as increasing water induced disasters. Anthropogenic activities as well as climatic uncertainties in this region showed there will be more water stress in all sectors in the future during both winter and summer and flooding, landslides and river bank erosion in the rainy season. Therefore, water management is a major challenge and potential opportunity in this region.

15.3.4 Impacts on infrastructure

The inter-annual variability and flash floods in the river possibly affect infrastructure. Construction of haphazard rural roads, particularity in the midhills and Siwalik regions and climatic variability result in vulnerability of infrastructure. In 1993 heavy rainfall (540mm rainfall in 24 hours) in Makawanpur, Dhading and Chitwan Districts severely damaged Kulakhani Hydropower Station, Prithivi Highway and three bridges in Dhading District and many houses, land and human life in the Chitwan area was lost (Dixit, 2010).

Furthermore, dense and unsafely built urban settlements along the course of rivers and flood plain areas, (for example, along the Rapti river of Makbanpur, Chitwan) old flood plains, or terraces and at the base of slopes or old landslide areas are

vulnerable to flood and landslides. Additionally, scattered settlement near river banks and haphazard urbanization in the foothills along stream banks in the Siwalik area (Nawalparasi, Chitwan, Makawanpur Districts) are also prone to climate induce disaster. It is suggested that local leaders and local planners should be aware about the impact of haphazard infrastructure construction in the environment and possible resulting disasters. A detailed study on the impact of climate change on the infrastructure on this area needs to be carried out.

15.3.5 Impact on public health

Climate sensitive diseases such as malaria, kalaazar, typhoid, diarrhea etc. are now frequently reported (MoE 2010b). Local consultation in the midhills (Palpa, Syanja, Dhading), Siwalik and Inner Terai (Nawalparasi and Chitwan) also reported that food and water borne disease such as diarrhea and typhoid has increased in recent years. Furthermore, they have reported that the mosquito population has significantly increased even in the midhills in the winter season. Mosquitoes were also noticed in Jomsom in recent years. This could be due to either an increase in temperature or due to improved transportation in the area. Further study is needed on mosquito adaptation in the mountains. It is indicated that a decrease in the availability of drinking water in the some part of midhills (Palpa, Baglung) and Siwalik region (Nawalparasi and Chitwan) may increased water born disease. No information is available related to public health and climate change in this region.

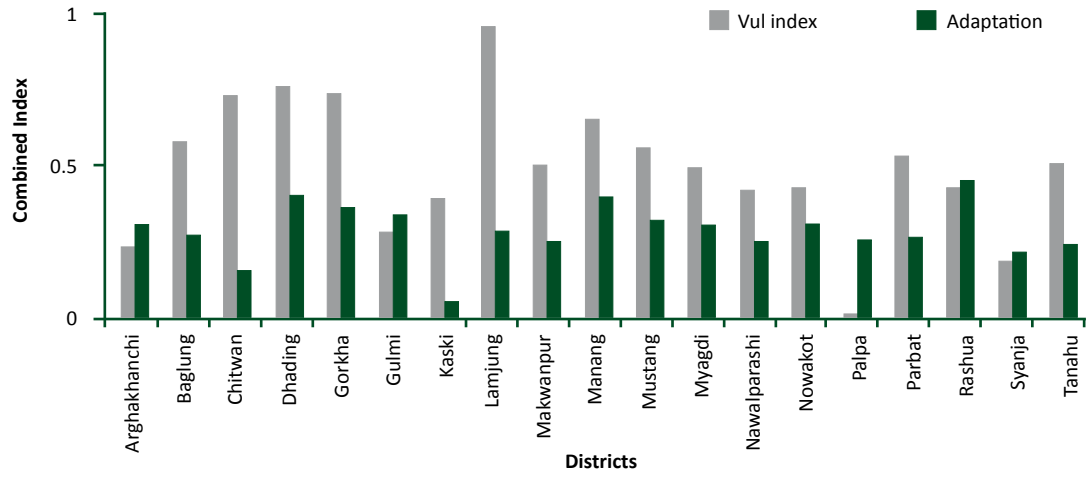
15.4 Human and Ecosystem Vulnerability to Climate Variability and Climate Change

CHAL is characterized by a rugged topography with high relief, complex geological features, concentrated rainfall, and a dense population. Many parts of this region are vulnerable to natural hazards. Furthermore, anthropogenic activities such as haphazard rural road construction, urbanization, deforestation and forest degradation particularly in the Siwaliks and Inner Terai regions have resulted in accelerated vulnerability. Analysis from the climate change vulnerability mapping (MoE, 2010a) for the 19 districts of the Narayani Basin have found a very a high vulnerability index in Lamjung and Dhading District. Furthermore, Makawanpur, Lamjung, Baglung, and Parbat District have reported very high risks of landslides (Figure 15.1).

Dhading District is ranked very high in relation to being drought prone and Lamjung, Gorkha has a moderate ranking. Similarly, Manang and Mustang are ranked with a very high GLOF potential, while Chitwan and Nawalparasi fall under the flood risk zone in the Narayani Basin. However, floods have also been reported in recent years in the mountains, for example the Seti River flood near Pokhara and the Kaligandaki River flood/river cutting prone area in Chhusang VDC of Upper Mustang.

The analysis of local consultations and field observations found that even although land

Figure 15.1: Climate change vulnerability and adaptation capacity of CHAL districts



(Vul Index= Vulnerability Index), Higher the index value, higher the vulnerability i.e 1 = Very High, 0.5= High, 0.3= Moderate, 0.2= Low and 0.1= very low. In the case of the Adaptation index, the lower the index value, the higher the adaptation capacity i.e= <0.05 =Very High, 0.05=High, 0.178= Moderate, 0.35= Low, 0.57=Very low.

(Source: Ministry of Environment (MoE), 2010a)

slide risk was ranked lower in Nawalparsi and Chitwan District, the Siwalik region of these districts observed more land slide prone areas due to construction of rural roads and steep land cultivation. It is found that vulnerability is location specific and needs to be studied and mapped in detail.

It is recognized that poorer nations will suffer the worst from climate change, either because of geographical reasons, and/or because they will have less resources to cope with a problem (IPCC, 2007). Poorer rural communities and women are among the most vulnerable to climate change, partly because in many rural areas they make up the larger share of the agricultural work force and partly because they tend to have access to fewer income-earning opportunities. Drought and erratic rainfall force women to work harder to secure food, water and energy for their homes. Most respondents reported that climate change might exacerbate existing water shortages, and as women are largely responsible for water collection, they will be more affected by changes to water sources.

In most of CHAL, there is an increasing trend of male migration for employment opportunities, creating pressure on women. With climate change and its consequences increasing the unpredictability of crop production, women's workload will increase. However, income from remittances was found to be a major source of income to cope with shocks and vulnerabilities. It is reported that more than 50 percent of income from remittance is utilized for food consumption. Consultations with women's groups in the mid hills and Siwaliks found that financial empowerment through income generating activities such as cash crop farming, poultry or goat farming, is the best options to reduce climatic vulnerability for poor women.

Local consultations in the Siwalik region (Manahari, Makawanpur) reported Chepang communities along the Manahari and Lothar watershed area were highly vulnerable due to land degradation, landslides and food insecurity. More than 90 percent of Chepang households were reported food insecure in these areas. Climate change with unpredictable rainfall will make them more vulnerable. Furthermore, wetlands, including ponds, streams, temporary canals and rivers, are livelihood resources for ethnic *Majhi* and *Bote* communities in the Inner Terai. Fishing communities who depend on these wetlands complain about the drying of these resources, as well as the decreasing fish numbers. This has posed serious challenges in sustaining the livelihoods of these poor ethnic communities. A detailed study should be carried out to examine livelihood options.

15.5 Community and Ecosystem Based Adaptation Capacity

An ecosystem based adaptation approach is the potential option to minimize the vulnerability of climate change in the upstream and downstream communities of the Narayani Basin. Inter-linkages between many risks in upstream and downstream communities and their activities multiply the destructive effects and therefore demand integrated solutions, inbuilt into the ecological, social, political and economic regimes of the Narayani Basin. Community based forest management in the mountain region is the one of the successful natural resource management and rural livelihood improved programs in Nepal. More than 16,000 CFUGs and their network from local level to national level can play an effective role in climate change mitigation and adaptation programs in Nepal. Community forestry acts in a dual role in climate change ie mitigation on greenhouse gas emission, and adaptation through sustainable forest management.

Community based natural management is an important dimension of natural resources management in CHAL. In the high mountain region, the Annapurna Conservation Area Project has formed community level Natural Resource Conservation and Management Committees as a local level institution. In the midhills region, Community Forest User Groups (CFUG) have been formed in all districts, at community level through the District Forest Office. In the Churia/ Siwalik region Leasehold Forest User Groups and Community Forest User Groups have been formed to manage local level forest resource management. The President of the Churia Conservation Program has recently implemented an ecosystem based conservation program. Similarly, in the Inner Terai, Buffer Zone Community Forest Management, and CFUGS are the community level institutions for managing natural resources.

Besides these forest based natural resource management institutions, there are other

community based institutions, also formed through the District Soil Conservation Office and District Agriculture Development Office, working on natural resource management, agriculture production and climate change adaptation practices. These CFUGs not only protect and manage forests on community land but also promote climate change adaptation practices such as rehabilitation of community land, soil conservation and watershed management. They are also involved in promoting multipurpose tree plantation, non-timber forest product (NTFP) management and perennial grass plantation (*Amliso, Napier*) in the farm land and communal land as an income diversification. These institutions can play a key role in climate change adaptation and mitigation through community based natural resource management at ecosystem and community level. However, there is not any mechanism for ecosystem based adaptation practices, and as a result, the institutional capacities of these institutions are very weak in regards to implementing climate change adaptation programs. In this context, ecosystem based adaptation has emerged as a potential approach to address climatic threats and build the resilience of both the communities and the ecosystem to adapt to the adverse impacts of climate change. Thus, these local institutions should be strengthening to enable the implementation of climate change adaptation programs.

15.6 Adaptation Practices and Opportunities

Climate change is a crosscutting issue and its impact is more on rural farmers, particularly upland farmers, and rural women who are more dependent on natural resource for their livelihood. The negative impact of climate change to the rural communities opens the door for opportunities to implement an integrated conservation and development program and related activities. For example, water management is great opportunity to minimize water induced disaster and increased crop yield, decrease runoff and landslides and improve livelihood of the rural communities.

Different adaptation practices were found in different areas of CHAL. In the high mountain regions adaptation measures were very limited. Analysis from the climate change vulnerability mapping (MoE, 2010a) for the 19 districts of the Narayani Basin have found high to low adaptation capacity. Kaski and Chitwan Districts are of high adaptation capacity and Rashua, Dhading, Mustang and Manang were lower in adaptation capacity. It is found that adaptation capacity varies even within districts due to fragility of the land and the capabilities of marginalized communities. Therefore, climate change adaptation programs should be location specific.

It is reported that degradation of the grass land and low grass production has lead to a reduction in livestock numbers as well as the grazing system. Some respondents reported that they were thinking to change occupation to, for example, the hotel business, or migration for employment. Furthermore, in the mountains and Siwalik region, local people have been managing community forests and leasehold forests, which may increase the resilience of the community by fulfilling the demand of forest products and minimizing shifting cultivation by indigenous communities (Magar/Chepang) in the Siwalik region. They have adopted Sloping Agricultural Land Technology (SALT) as an agroforestry (Horto-Silviculture, Silvo-pastural) practice on their steep land and minimized soil erosion.

In areas with market accessibility, many farmers were growing vegetables instead of cereal crops as a livelihood diversification. Optimum utilization of marginal lands by planting fodder trees, fruit trees, and other grasses was also observed. Local farmers reported that they have changed the sowing and planting time as well as adopting early ripening and drought tolerant varieties on their farm land. Some upstream farmers have started rainwater harvesting and conservation ponds and have utilized excess drinking water for vegetable production. Local farmers in all districts expressed that drought is the major problem and if irrigation facilities are available, major climate change impact will be minimized.

The impact of climate change is an emerging issue and different government and non-government institutions have initiated climate change adaptation programs and practices. The National Adaptation Program of Action to Climate Change, (NAPA) Nepal, highlighted the adaptation practices and adaptation framework from national to local level (MoE, 2010b). Additionally, the Local Adaptation Program of Action to Climate Change has implemented, as a pilot program in some selected districts; an initiation of local adaptation practices at local level. Recently, the Government of Nepal approved the Climate

Change Policy Nepal 2011. This policy has focused on the interdisciplinary approach and 80 percent of funds are to be allocated to the local level. However, local institutions currently do not have the capacity to institutionalize any adaptation programs. Some district level offices such as the District Forest Office, District Soil Conservation Office and District Agriculture Development Office have now initiated some climate change adaptation activities such as construction of conservation ponds or water harvesting ponds for irrigation; water source protection; agroforestry practices in leasehold forestry programs; small irrigation programs; plastic tunnels for vegetable production; early ripening crop varieties, and training on climate change adaptation and mitigation. Similarly, in some districts community level and VDC level five year local adaptation plans have been prepared with the help of the Livelihood Forestry Project (Rupantran) and CARE Nepal (Baglung, Nawalparashi). Moreover, community based institutions have been formed at village level such as mothers' groups, Community Forest User Groups, Buffer Zone User Groups, Community Managed Cooperatives, and Vegetable Farmer's Group for different activities such as natural resource management, awareness raising, and income generating activities through saving and credit programs and cooperatives. Pokharel and Byrne (2009) expressed that strong community based institutions will have the potential to develop climate change mitigation and adaptation activities that are in line with the rights and interests of forest users.

Adaptation capacity and practices were observed to vary from location to location and community to community, even at household level. Climate change adaptation is complex by nature and there are many challenges for implementation at local level, for example the coordination among line agencies. It is suggested that an integrated approach focusing on water management technology through enhanced capacity and institutionalization at the local level be carried out. Furthermore, potential benefit from reducing emissions from deforestation and forest degradation and sustainable forest management (REDD+) in the community based forest management is another opportunity for climate change mitigation and adaptation in this region. See Section 17 for further details.

Disasters/Hazards 16

The CHAL region is geologically active; instabilities due to tectonic activity and ongoing erosion are apparent everywhere. These factors, combined with the peculiar meteorological conditions where both the rainfall and river flow vary tremendously in both time and space, make the landscape vulnerable to water-induced disasters such as floods, landslides, slope failures, river bed variation (resulting in subsequent shifting and degradation) and debris flow. In addition to these natural processes, development activities and increasing population have caused further vulnerability and destabilization of land resources. This includes human activities such as deforestation, cultivation of marginal land, haphazard construction of rural road building in the Siwalik and mountains and the encroachment of flood plains. Water-induced disasters, thus, have been occurring more frequently in recent times.

16.1 Major Hazards

Landslides, riverbank erosion, floods and droughts are the common climate induced disasters in this region (Table 16.1). Geographically, disasters such as landslides dominant in the mountains, Siwaliks and steep slopes. In the foothills and flood plains of the river valleys, floods often deposit coarse sediment over the adjoining flood plains, damaging standing crops and converting the land into an infertile land mass.

River banks in such areas are subjected to severe bank erosion and loss of soil, which in turn provides more sediment for the river to deposit downstream. Additionally, unpredictable rainfall and larger numbers of drought periods, with haphazard construction of rural road in the mountain and Siwalik regions have resulted in increased drought areas, a decrease in water flow in the streams, dried natural springs, and more flash floods in the foothills and Inner Terai region.

Table 16.1: Major climate-induced risks and hazards in different regions

Hazards	Regions			
	High Mountains/ Trans-Himalaya	Mid hills	Siwaliks (Hills)	Siwaliks (Lowlands)
Riverbank erosion	√	√	√	√
Landslide	√	√	√	
Flood/ sedimentation		√	√	√
Drought	√	√	√	√
Drying of springs	√	√	√	
Hailstone	√	√		

(*Source: Present study, 2012*)

Floods, landslides and droughts are likely to become more common and more intense as regional and seasonal precipitation patterns change, and rainfall becomes more concentrated into heavy events (with longer, hotter dry periods in between). In general, floods and landslides during the monsoon are a natural phenomenon in Nepal.

It is reported that Nepal is highly prone to different types of disasters and every year more than 100 people are killed, with property loss of more than 288 million rupees from natural disasters, mainly flood and landslides (CBS, 2008a). Dixit, (2006)

Case study: Seti River Landslide
The formation of temporary lakes due to landslide damming is a common phenomenon in the high mountain areas where there are very narrow river channels and steep mountain slopes. Recently (May 5, 2012) landslides upstream dammed the Seti River for a few hours. The eventual breaking of the dam resulted in a high flashflood downstream, which caused the death or disappearance of at least 72 people. Property, including homes, businesses, crops, livestock, and valuable infrastructure was also lost. These types of events will occur in other river systems in the future as well. Therefore, there should be regular monitoring and the installation of an early warning system.

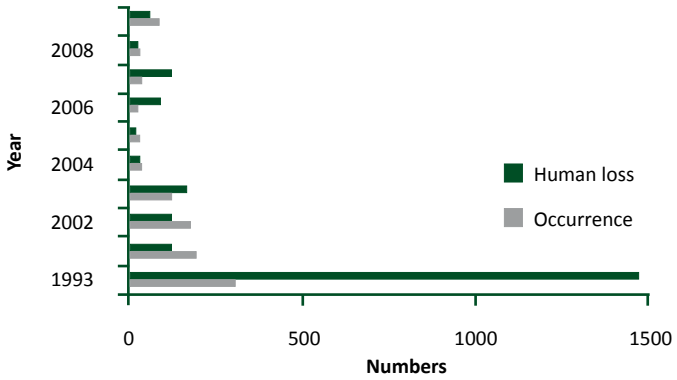
further reported that the midhills were the most susceptible to landslides. Furthermore, crop damage through unpredictable hailstones is also found in some areas. Communities of Lamjung District reported that in 2012 crops, vegetables and fruit were severely damaged by hailstones.

16.2 Available Data on Disaster and Hazard Incidence

Data collected from the MoHA (2009) showed that landslides with flooding were the major climate-induced disasters in CHAL (Figure 16.1, Annex 16. 1). The 1993 rainfalls in the area of Chitwan, Dhading, and Makawanpur Districts were the most disastrous, which caused heavy loss of life and property. The rainfalls reportedly took 1,460 human lives and more than 73,000 households were damaged within 24 hours rainfall (Dixit, 2010).

Over the last 20 years, 131 human lives were lost and 1,990 households were damaged by landslides and floods, and related disasters. And this is increasing. Drought is another major problem in the region. Winter rainfall in 2008-2009 was only about 50 percent of the normal, which caused a drastic decrease in the production of winter crops. Other years with severe drought (for Chitwan, Gulmi, Syanja, Parbat and Nawalparasi Districts) included: 1993, 1994, 2005, 2006, and 2012. In Parbat, the year 2006 saw no winter rain at all (pers. comm. with DAO). Overall, the impact of drought, landslides and floods were much more severe in the Siwalik Hills as compared to other regions. This is the region where high numbers of poor and marginalized communities live. Moreover, the region is an important biological corridor linking the lowland protected areas with the high mountain block forests. Integrated watershed management and livelihood enhancement programs are necessary to solve or minimize these socio-economic and environmental problems.

Figure 16.1: Occurrence and human loss through major disasters (landslides and floods) in CHAL



(Source: Adapted from MoE, 2010)

16.3 Scale of Vulnerability from Climate Induced Disasters

Limited data and local consultations showed that the scale of vulnerability from climate induced disasters has increased in recent years. The increasingly long drought periods have affected rainfed farmers and rural women. The scale of landslides and drought has increased due to climatic variability and anthropogenic activities such as rural road construction in mountains and forest degradation in the Siwaliks (Annex 16.2).

There are indications that the poor and women are being affected more by climate-induced disasters than other sections of the society. For example, loss or decrease of nearby sources of drinking water adds extra burden on rural women. Field observations and consultations showed that farmers in the Siwalik region (Palpa, Nawalparasi, Chitwan, and Makawanpur Districts), were more vulnerable as compared to the other regions and the Inner Terai.

16.4 Early Warning Systems

Early warning systems have been recently introduced in Chitwan and Nawalparasi. (DDC Chitwan, 2011). In those districts, each VDC has prepared a hazard management plan and has identified hazard potential areas and assigned an early warning system. They have given high priorities for women and poor communities to minimize the impact of climate induced disasters. In other districts no early warning system has been introduced but district level Disaster Relief Committees, the Red Cross and different NGOs have provided awareness and training programs for disaster management and early warning systems at community level. It is evident that lack of an early warning system in the mountain region resulted in the death of more than 40 people in the recent Seti River flood (5 May, 2012) in the upper Pokhara Valley. It is suggested that an early warning system should be developed in other parts of CHAL, particularly Kaski, Myagdi, Manang, Rashuwa, Lamjung and Makawanpur Districts.

PES and REDD: Past Efforts and Scope

17

17.1 National Efforts

A number of REDD and PES related initiatives have been taken at the national level with a country-wide relevance. The 2011 National Climate Change Policy specifically targets, among others, the formulation of a national carbon trade strategy, forest conservation, and public awareness.

Approval of the country's REDD Readiness Preparation Proposal, identification of REDD+ and PES as a major component in NAPA, strong political support, and formation of REDD Working Group involving donors and NGOs are the other major efforts taking place at national level towards implementing REDD+ and PES. These, along with legal involvement of local communities in forest conservation through the widely implemented community forestry program, have created a favorable condition towards launching REDD+ projects in the field. A few projects implemented recently as pilots have provided useful insights and ideas of challenges, which can help improve design and implementation of such projects in the near future. The REDD Forestry and Climate Change Cell housed within the Ministry of Forests and Soil Conservation is responsible for REDD+ piloting and implementation in the country.

17.2 Past Experience: Examples

17.2.1 PES in Kulekhani

PES was first implemented in Kulekhani Hydropower site in Makawanpur District, with the main objective of reducing siltation to the reservoir through effective conservation of forest and soil in its catchment area. The mechanism was set up under the policy provision of the Local Self Governance Act and Local Self Governance Regulations (1999), which have provisions for the central government to provide 12 percent of its total electricity royalty to the DDC housing the hydroelectricity project (Adhikari, 2009). In Kulekhani, 20 percent of the total revenue received by the DDC goes to the Environmental Management Special Fund as compensation to upstream communities. The eight VDCs in the catchment jointly select priority projects and implement them through local user committees. The local communities are expected to improve, or at least maintain, the current level of forest conditions and soil erosion. Projects should also support the livelihoods of local communities (Upadhyaya, S.K., 2005; Adhikari, 2009).

The performance of the Kulekhsni PES scheme is, however, limited due mainly to the deficiencies in the design of institutions, and weak monitoring and enforcement. Lack of legal provision guaranteeing the rights of upstream communities, and claims on the Environmental Management Special Fund by people outside the Kulekhani Watershed were other problems. As a result, the DDC has failed to provide rewards to upstream groups recently (Khatri, 2009).

17.2.2 Norwegian Agency for Development Cooperation (NORAD)-funded REDD+ pilot project

This four-year (2009-2013) project is being implemented by ICIMOD with FECOFUN and the Asian Network of Sustainable Agriculture and Bio-resources (ANSAB), in community forests of two watersheds namely, the Kayarkhola Watershed in Chitwan District and Ludikhola Watershed in Gorkha District, as well as a watershed in Dolakha District (outside CHAL). The project has prepared a sub-national level REDD Strategy and measurement, reporting and verification (MRV) system by using a combination of remote sensing analysis and field measurements by CFUGs. The project has also established a payment criteria and distributed seed money to local CFUGs (Rana, 2010).

17.2.3 PES scheme in Rupa Lake, Kaski

Under the scheme, the local Rupa Lake Rehabilitation and Fisheries Cooperative compensates upstream CFUGs for their efforts to conserve forest and soil in the Rupa Lake catchment, which enhances fish stocks and improves the lake's water quality. The compensation is tied up with an effective local benefit-sharing mechanism. Inadequate awareness among the upland communities of the environmental impacts of their farming and forestry practices is the major issue in this scheme (Regmi et al., 2009).

17.2.4 Other initiatives

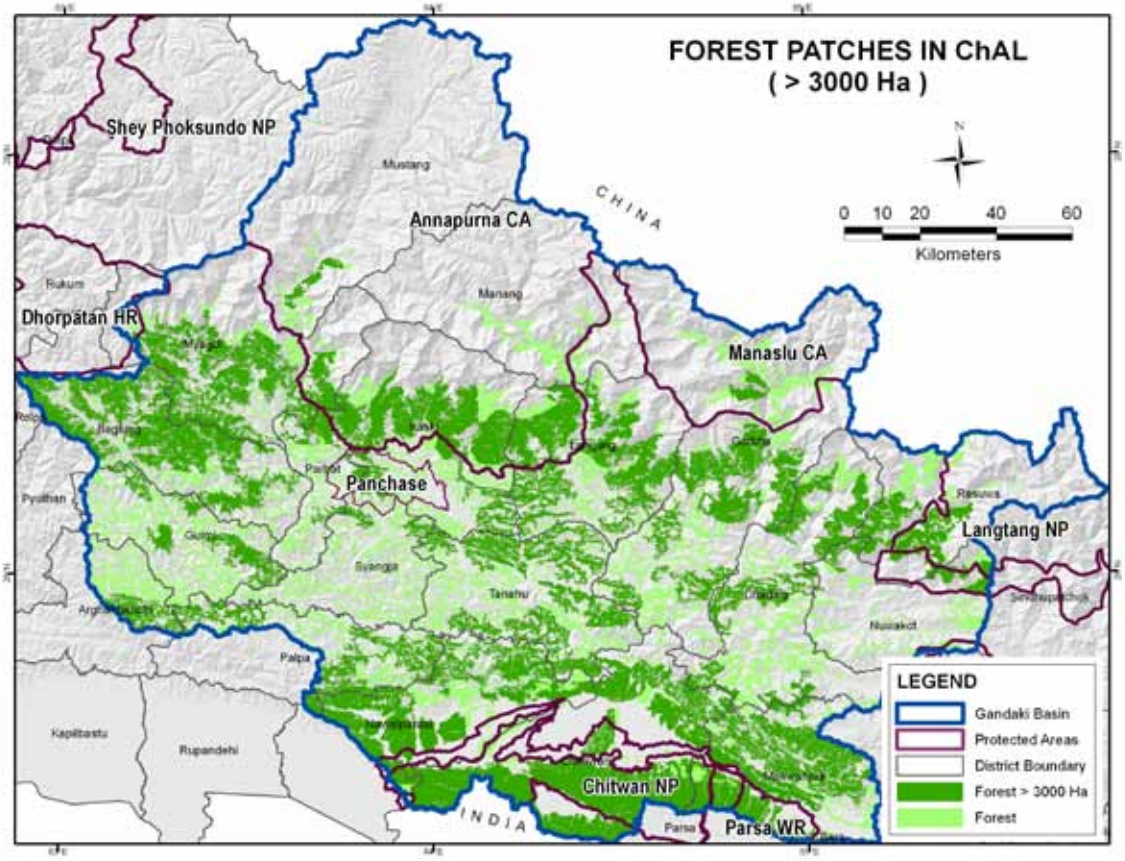
A project on "assessment of the role of community forests in CO2 sequestration, biodiversity and land use change" was initiated by the Nepal Development Research Institute in ten districts, including Palpa, Syangja, Kaski, and Lamjung. Achievements and current status of this initiative is unknown.

17.3 Scope and Potential Areas for Implementing REDD and PES in CHAL

Past studies have indicated high potential to implement REDD projects in Nepal (e.g. Karki et al., 2009; Gurung et al., 2010). There is also a growing interest and support from donors. The fact that Nepal has recently been selected for the World Bank's Forest Carbon Facilities Program to develop national REDD programs can be taken as evidence of donors' interests.

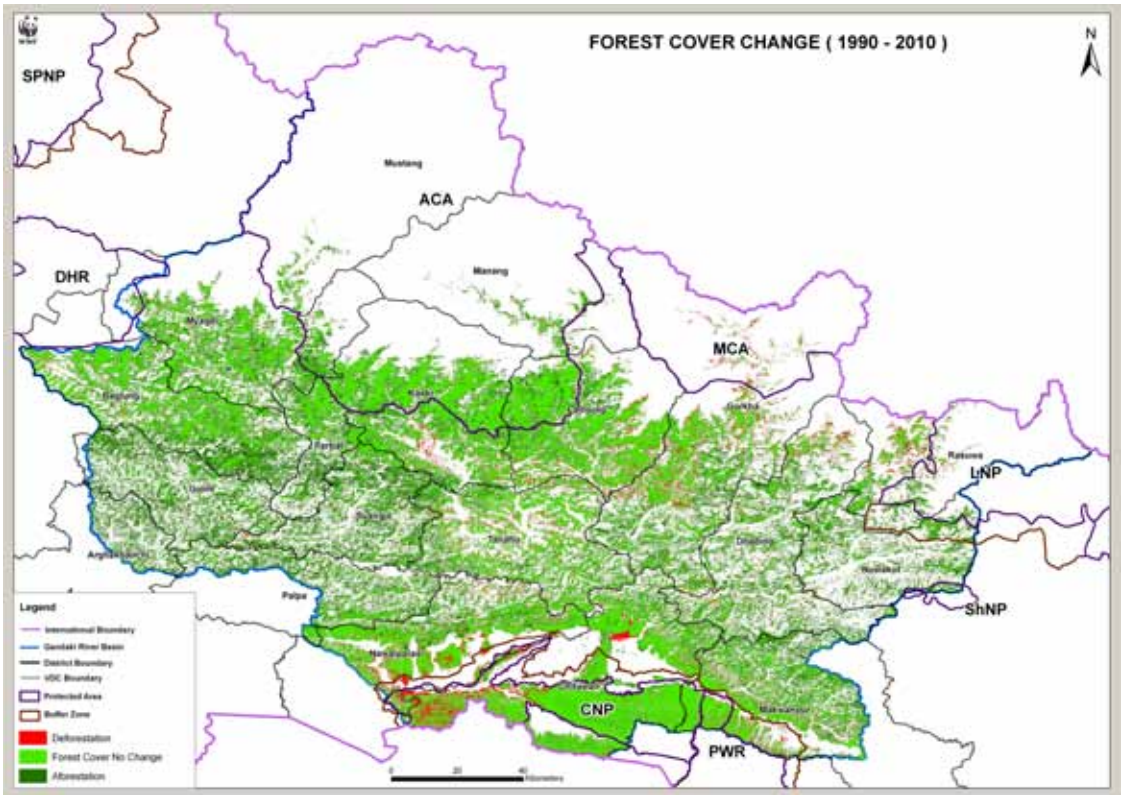
Quick assessments of scope for implementing REDD and REDD+ schemes in CHAL indicates three possible ways to implement such schemes. These include: (i) improving forest management though the application of scientific principles and techniques that enhance carbon sequestration and retain higher amounts of carbon in forest biomass, (ii) controlling deforestation and forest degradation through enhanced enforcement of

Figure 17.1: Location of block (>3,000ha) forests in CHAL



(Source: Present study)

Figure 17.2: Location of sites where forest loss and gain took place during 1990-2010



(Source: Present study)

law, and expansion of community based forest management where feasible, and (iii) increasing forest cover and quality through afforestation and reforestation.

The first type of project (improving forest management) can be started in areas where sufficiently large block forests exist; local institutional arrangements are favorable (e.g. well-functioning community forestry system), and there is no major dispute related to land or forest tenure. Accessibility to the area should be another consideration as frequent visits by relevant experts and other outsiders are expected, at least during the initial phases.

The existing block forests in the districts of Baglung, Myagdi, Kaski, Lamjung, Gorkha and Chitwan (Figure 17.1) could be some of the candidate sites for possible implementation of REDD+ projects near future. A thorough investigation of the sites is necessary before site-specific REDD+ implementation plan can be prepared and implemented.

The other two types of projects (controlling deforestation and forest degradation and increasing forest cover and quality) can be implemented in the Siwalik region (both the hills and lowlands) where deforestation and forest degradation due to encroachment and excessive extraction of forest products is high (Figure 17.2). PES could be feasible near urban and semi urban areas.

17.4 Issues in Implementation of REDD and REDD+ and Possible Way Forward

One of the challenges in implementing REDD+ relates to developing a viable strategy for setting reference levels for carbon credits and establishing a suitable benefit sharing mechanism that is agreeable to stakeholders at the national, district and local levels. Ensuring the rights of the local Forest User Groups (CFUGS), who are managing and utilizing the forest resources, and involving the private sector are other important needs and challenges for long-term sustainability of REDD+

schemes. A nested approach that accommodates all major interests and needs could be the best approach in the given situation.

For any REDD+ project to be successful, local community participation from planning stage to implementation stage is important. However, getting effective participation of local communities, most of which are poor, could be difficult as they use most of their time in searching for opportunities to meet their daily subsistence needs. Incorporating a mechanism that provides tangible livelihood benefits to local communities might solve this problem.

Some other limitations for implementing REDD and REDD+ in CHAL (and Nepal) include the following:

(a) The difficult and cumbersome process in accessing international financial mechanisms that requires measuring carbon and showing both additionality and permanence of the carbon stock is a major challenge for CFUGs and government agencies.
(b) Nepal may not be a priority country for REDD so considering only carbon credits may not be a beneficial strategy for Nepal.
(c) REDD is not directly linked to biodiversity, which could be a matter of particular concern for the Hariyo Ban Program.

In this context, some experts consulted during this study opined that PES schemes, which provide livelihood benefits and protect and enhance the ability of ecosystems to provide services (such as carbon sequestration, clean water, provision of NTFPs etc.) could be a better alternative for Nepal (instead of limiting to REDD and REDD+). This means, the focus should be on sustainable forest management rather than an exclusive focus on carbon. This argument is also based on the perception that the carbon prices alone may be insufficient to justify protection of forests in a situation like Nepal.

18 Conclusions

This Rapid Assessment provides a broad overview of the general environment of the Chitwan-Annapurna Landscape, including hydrology, watersheds and ecosystems; impacts, vulnerability and adaptations of the people and ecosystems to climate change, and potential for payments for environmental services. It takes into account changes in land use/land cover, forest governance arrangements, current planned infrastructure projects, options and opportunities for economic development and livelihood enhancement including green enterprises and tourism, and the status of gender and social inclusion in the management of natural resources.

Working closely with the Hariyo Ban Program team and conducting consultations with national, district and community level stakeholders, and undertaking research and analysis of secondary data, this Assessment forms the foundation of the on-going work by the Hariyo Ban Program over the coming years (2011-2016).

Throughout the research, attention was paid to the three cross-cutting themes of this Program: livelihoods, governance, and gender and social inclusion.

From the findings of the Rapid Assessment, the key areas for focus are pro-poor community-led actions, with a large livelihood component for sustainability, sustainability of land and water use, and green energy.

Recommendations put forward by the research team can be found in Section 19 of this Assessment.

19 Recommendations

19.1 Further Research

1. Investigate, more thoroughly, impacts of climate change on different components of the landscape, including forest ecosystems, species, water resources, hydropower generating systems, and local people (particularly upland farmers and rural women). The existing information is inadequate to fully understand the impacts on different resources and sectors and formulating mitigation and adaptation strategies. Currently it is unsure as to whether impacts have been variable across different physiographic zones, elevations and aspects.

2. Further investigation of the complex hydrological systems in the landscape is required for better understanding, planning and sustainable management of water resources and minimizing damage from water-induced disasters (such as from GLOF).

3. Analyze and map, more accurately, land use and land cover changes using high resolution satellite images, so that there is credible baseline information for planning and possible future comparisons. Having a more accurate picture of land use and land cover is particularly required for establishing a baseline scenario for implementing REDD and REDD+. This can be done in collaboration with the FRA project. The information included in this report, which is based on analysis of Landsat images, can give only a rough idea of land use and land cover in the landscape.

4. A thorough research on the current status of CHAL-specific biodiversity (including agro-biodiversity), over time changes, and strategic measures required to enhance it is recommended. This is particularly important in the context of perceived substantial decrease in diversity of cereal crops and livestock species or varieties in recent years.

5. Further investigation on status and biological diversity of main wetlands located in different physiographic zones is required to better understand their conservation and livelihoods significance so that appropriate strategies and plans for their conservation can be prepared and implemented.

6. There is a need for participatory research on different aspects of agroforestry to: (i) develop methods of increasing the productivity of traditional agroforestry systems while maintaining biodiversity benefits, (ii) determine the effectiveness of different types of agroforestry systems as biological corridors, (iii) identify indigenous tree species suitable for shading cash crops (such as coffee and tea), and (iv) to develop indicators and effective monitoring systems to assess the ecological services fulfilled by agroforestry systems in different physiographic zones.

7. Carry out research on controlling and possible utilization of invasive alien plant species and implement the findings.

8. Sex-disaggregated data is required to better analyze, measure and monitor the impacts of natural resources management and climate change on women and men. Equally important is the capacity enhancement and empowerment of women and other disadvantaged social groups to enable them to take decision-making positions at different levels of natural resources management, and implementing innovative income generating activities.

19.2 Design, Implemention and Promotion of Approaches

19.2.1 Community led action

1. Design and implement an integrated landscape management strategy that focuses on local, community-led actions to solve resource management, biodiversity conservation, and climate change challenges. This, among others, requires raising awareness of poverty-environment linkages, integration of pro-poor sustainable natural resources management into the budgetary process at the central level, and a more programmatic and integrated approach in local level development planning.

2. Place local livelihoods at the center of community based forestry and biodiversity conservation efforts. Some specific measures include: (i) promotion of mixed forests of indigenous plant species in community forests with due consideration to NTFPs and biodiversity, (ii) promotion of NTFP based micro enterprises, (iii) support to establish multi-purpose private nurseries (including forest trees, NTFPs, horticulture species), and (iv) support to CFUGs in the revision of community forest operational plans to make them more livelihood and conservation oriented, and support to implement the revised plans. This approach would also promote gender equality and broader social equity in forest management.

3. Promote active management of community forests for balancing conservation and optimal use. This demands for developing or revising community forest management plans to balance protection with active forest management, which could be a strategic solution to ensure meeting the major part of the requirement for fuel wood and other basic products from the community forests, and avoiding pressure shifts to government-managed forests. Any such revision needs to be based on the principles of specific ecosystem management approaches to increase positive impact on conservation outcomes and help meet biodiversity and climate change objectives along with community needs.

4. The leasehold forestry program has been successful in restoring degraded lands and improving local livelihoods in some areas. Replicate and expand the successful leasehold forestry model in other parts of the Siwaliks and traditional shifting cultivation areas.

5. Identify and support the traditional cropping and animal husbandry systems. This is for better conservation of agro-biodiversity, enhancing food security, and reducing vulnerabilities and strengthening adaptation capacities of small farmers to the possible effects of climate change.

6. Extend support for economic empowerment of women and marginalized communities through identification and implementation of innovative income generating activities (such as forest and agriculture based green enterprises, eco-tourism, and off-farm small enterprises). Capacity enhancement should be an integral component of such initiatives.

7. Promote eco-friendly tourism, with particular focus on community-based ecotourism.

19.2.2 Green energy

1. Promote non-conventional energy sources, such as biogas, solar energy, and small hydropower, where feasible. This can help reduce dependency of households on forests for meeting their energy needs, control forest degradation, and mitigate effects of climate change.

2. Promote more efficient forest products utilization technologies such as bio-briquette, improved stoves, particle board, and improved harvest, storage and processing of NTFPs.

19.2.3 Climate change adaptation and REDD

1. Formulate and implement village, district, and landscape level climate change adaptation strategies and plans with clear set of activities and institutional responsibilities.

2. REDD and REDD+ offer opportunities for immediate financial benefits from halting deforestation and sustainable forest management. Review different aspects of the NORAD-funded REDD+ pilot project implemented by ICIMOD with ANSAB and FECOFUN in Chitwan, Gorkha and Dolakha Districts and consider replicating it in feasible sites within CHAL. This would, among others, require building capacity of forestry staff and CFUGs for REDD MRV systems. PES schemes, which provide livelihood benefits and protect and enhance the ability of ecosystems to provide services (such as carbon sequestration, clean water, provision of NTFPs etc.) could be an alternative option to REDD+ in some areas, particularly near urban centers. Encourage participation of private sector in PES schemes.

19.3 Sustainable Management

19.3.1 Landuse

1. Introduce and promote scientific management of forests to maximize the benefits of the forestry sector to the full potential. This can be started at pilot scale in a few selected sites in each physiographic zone. The focus should be effective and improved silvicultual operations for improving site specific productivity and enhancing local livelihoods. Scientific management will not only ensure sustainability but also will lead to legal production of essential forest products which are currently being supplied illegally, and help meet the ever increasing demands. Moreover, sustainable forest management can also help forest managers to reduce the risk of damage and possible losses from changing climatic conditions and also to undertake effective mitigation actions.

2. Identify and promote appropriate land use (e.g. agroforestry, private forestry in marginal lands) and land management systems (e.g. SALT). This is required to: (i) control further degradation of watersheds; (ii) conserve or enhance productivity of agricultural lands thereby enhancing food security and income of rural households (iii) improve biodiversity conservation, and (iv) reduce pressure on forests.

3. Improve and expand participatory soil and water conservation initiatives, with emphasis on bio-engineering and based on principles and approaches of integrated watershed management. The critical sub-watersheds and micro-watersheds should get priority treatment.

4. Strengthen agricultural extension services with focus on: (i) promotion of appropriate land use and land management practices; (ii) optimal use of chemical fertilizers; (iii) promotion of agro-based small green enterprises (such as organic vegetable farming), and (iv) commercial production of fruits, vegetable, livestock, and dairy products.

19.3.2 National level actions

1. Enhance the law enforcement capacity of Department of Forests and Department of National Parks and Wildlife Department through: (i) review and necessary revision of organizational structure; (ii) provision of necessary budget and human resource to district forest offices and warden offices; (iii) formulation and implementation of transparent performance monitoring, evaluation and reward and punishment system, and (iv) investigating and implementing safeguards against political interference.

2. Support implementation of national land use policy, and promote participatory land evaluation, land use planning at the local level.

3. Formulate and implement inter-agency coordination mechanisms to mitigate negative environmental impacts of infrastructure development projects (e.g. rural roads, dams) and enhance cooperation for effective enforcement of forestry and environmental legislation.

References

Acharya, K., Tiwari, K. R., Sharma, S., Upadhyaya, C.P., Timilsina, Y.P. and Jha, R., 2011. Monsoon and Post-monsoon Evaluation of Water Quality of Fewa Lake in Pokhara. *Himalayan Scientific Journal* 4:33-41.

Acharya, M., 2001. Women and the Economy: Gender and Democracy in Nepal. Central Department of Home Science, Women's Studies Programme Kathmandu, Nepal.

Action Aid, 2010. Women's Rights and Access to Land: The Last Stretch of Road to Eradicate Hunger. Action Aid Nepal.

ADB, 1996. Summary Environmental Impact Assessment for the Kaligandaki 'A' Hydroelectric Project in Nepal. Asian Development Bank (ADB). Accessed at: http://www2.adb.org/Documents/Environment/NEP/26362/26362-NEP-SEIA.pdf

ADB (2010). Overview of Gender Equality and Social Inclusion in Nepal. Asian Development Bank (ADB).

ADB, 2011. Assessment Report. Technical Assistance for the Preparation of the Agricultural Development Strategy, Asian Development Bank (ADB).

Adhikari, B., 2009. Market-Based Approaches to Environmental Management: A Review of Lessons from Payment for Ecosystem Services in Asia. Working Paper No. 134, Asian Development Bank Institute, Tokyo.

Agrawal, S., Raksakulthai V., Aalst M., Larsen P., Smith J. and Reynolds J., 2003. Development and Climate Change in Nepal: Focus on water resources and hydropower. Organization for Economic Cooperation and Development, Paris, pp. 64.

Alam, M. and Regmi, B. R., 2004. Adverse impacts of climate change on Development of Nepal: Integrating Adaptation into Policies and Activities. IIED, BCAS and the Ring Alliance. CLACC Working Paper No. 3. Nepal.

Alford, D. and Armstrong, R., 2010. The Role of Glaciers in Stream Flow from the Nepal Himalaya, *The Cryosphere Discuss*., 4, 469–494, doi: 10.5194/tcd-4-469-2010.

Bajracharya, S. R., Mool, P. K., and Shrestha, B. R., 2007. Impact of Climate Change on Himalayan Glaciers and Glacial Lakes: Case Studies on GLOF and Associated Hazards in Nepal and Bhutan. ICIMOD, pp. 3-119.

Bajracharya, T. R., S. Acharya and B. B. Ale, 2011. Changing Climatic Parameters and its Possible Impacts in Hydropower Generation in Nepal (A case study on the Gandaki River Basin). *Journal of the Institute of Engineering* 8 (1): 160–173

Balla, M. K., Awasthi, K. D., Shrestha, P. K. and Sherchan, D. P., 2003. Land Use Changes in Two Sub-watersheds in Chitwan and Tanahun Districts, West Nepal. *Nepal J. of Sc. and Technology* 5:49-56.

Baral, H. S. and Inskipp, C., 2005. Important Bird Areas in Nepal: Key Sites for Conservation. Bird Conservation Nepal and Birdlife International, Kathmandu and Cambridge.

Bhattarai, N. D., Chaudhary, R. C., Magar, G. and Kumal, G., 2011. Annual Progress Report 2011 (Palpa Hub Office). Technical Assistance for Leasehold Forestry and Livestock Program.

Bhattarai, S., 2006. *Gender*. National Book Center, Kathmandu.

Bhattrai, S., Chaudhary, R., and Taylor, R., 2006. Ethnomedicinal Plants Used by the People of Manang District, Central Nepal; *Journal of Ethnobiology and Ethnomedicine*, 2:41

Biodiversity Profiles Project, 1995 (series of publications). Department of National Parks and Wildlife Conservation, Government of Nepal and Government of the Netherlands.

BSP, 2010. Management Information System of Biogas. The Nepal Biogas Support Programme (BSP), Ministry of Environment, Science and Technology, Kathmandu.

CAAN, 2010. Civil Aviation Report 2009-2010. Civil Aviation Authority of Nepal (CAAN), Kathmandu.

Carson, B., 1992. The Land, the Farmer, and the Future. A Soil Fertility Management Strategy for Nepal. ICIMOD, Occasional Paper No.21. ICIMOD, Kathmandu, Nepal

CBS, 2001. National Census 2001. Central Bureau of Statistics, Government of Nepal, Kathmandu.

CBS, 2008a. Environment Statistics of Nepal. National Planning Commission Secretariat, Central Bureau of Statistics (CBS), Kathmandu.

CBS, 2008b. Figures in Nepal, Statistical Year Book of Nepal Central Bureau of Statistics (CBS), Kathmandu, Nepal.

CBS, 2011. Nepal Living Standards Survey. Statistical Report, Volume 1. Central Bureau of Statistics, Government of Nepal, Kathmandu.

Chhatre, A. and Agrawal, A., 2008.Forest Commons and Local Enforcement,Proceeding of the National Academy of Sciences of USA, 105(36): 13286–13291.

Dahal, N., 2005. Perceptions of Climate Change in the Himalayas. Teimpo Bulletin. Accessed at: http://www.cru.uea.ac.uk/tiempo/newswatch/feature050910.htm

Dahal, R. K., 2006. Geology for Technical Students, Bhrikuti Academic Publications, Kathmandu, Nepal

DDC Chitwan, 2008. Introduction to Chitwan District. District Development Committee (DDC), Chitwan. Accessed at: http://www.ddcchitwan.gov.np/sites/default/files/ddc-brousher-2065.pdf.

Development Vision, 2005. Final Report on Impact Evaluation of Hills Leasehold Forestry andForage Development Project (GCP/NEP/049 NET). Development Vision Nepal (P.) Ltd. Naya Baneshwor, Kathmandu.

DFID and World Bank, 2006. Unequal Citizens: Gender, Caste and Ethnic Exclusion in Nepal, World Bank and DFID Nepal, Kathmandu.

Dhakal, M. and Masuda, M., 2009. Role of Participatory Forest Management in Rural Livelihood Improvement: A Case of Nawalparasi District, Nepal. Available online at: http://www.forestrynepal.org/user/152/posts (Accessed 15 June 2012).

DHM, 2010. Longterm Rainfall and Temperature Data Analysis, Department of Hydrology and Meteorology (DHM), Ministry of Environment, Kathmandu.

Dinerstein, E. and Price, L., 1991. Demography and Habitat use by Greater One-Horned Rhinoceros in Nepal. J. Wildl. Man. 55:401-411.

Dixit, A., 2006. Floods in South Asia, Water Nepal, 12(1-2), Nepal Water Conservation Foundation, Kathmandu.

Dixit, A. 2010. Climate Change in Nepal (Nepali version): Science. Experiences and Proposed. ISCT-Nepal, Kathmandu.

DNPWC, 2001. Royal Chitwan National Park and Buffer Zone Management Plan (2001-2005). Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu.

DNPWC, 2012. List of Buffer Zone Community Forests (unpublished office record in Nepali). Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu.

DoA, 2011, Annual Progress Report on Agriculture Production in Nepal. Department of Agriculture (DoA), Harihar Bhanwan, Lalitpur, Nepal.

Dobremez, J.F., 1970. Biogéographie du Centre Népal. *Bull. Ass. Géographes, France*, 379-380:79-90.

Dobremez, J. F., 1976. *Le Nepal Ecologie et Biogeographie* (Nepal Ecology and Biography). Centre Nationale de la Recherche Centifique, Paris, France.

DoF, 2011. Forest Management Plan for Panchase Protected Forest (in Nepali). Department of Forests (DoF), Kathmandu, Nepal.

DoF, 2012a. *CFUG Database Record Available in MIS* (unpublished). Department of Forest (DoF), Babarmahal, Kathmandu, Nepal.

DoF, 2012b. Leasehold Forestry Program: District Level Group Status (unpublished). Department of Forest (DoF), Babarmahal, Kathmandu, Nepal.

DoF, 2012c. Summary of Forest Encroachment until 2068-2069 BS (2011-2012). Department of Forests (DoF), Babarmahal, Kathmandu (unpublished office record in Nepali).

DoI, 2007. Development of Database for Irrigation Development in Nepal, Government of Nepal, Department of Irrigation (DoI), Kathmandu.

DoMG, 2012. MINERALS Resources of Nepal (unpublished data available on request). Government of Nepal, Department of Mines and Geology, Kathmandu.

DoR, 2010. Statistics of Strategic Road Networks (SSRN 2009/10). Government of Nepal, Department of Roads (DoR), Kathmandu.

DSCWM, 2011. Annual Report 2066/67. Ministry of Forest and Soil Conservation, Department of Soil and Watershed Conservation (DSCWM), Babarmahal, Kathmandu.

Dutta, I. C., 2007. Non-Timber Forest Products of Nepal: Identification, Classification, Ethnic Users and Cultivation, Hillside Press P. (Ltd.), Kathmandu.

Dyurgerov, M. D., and Meier, M. F., 2005. Glaciers and changing earth system: a 2004 snapshot. Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado.

Evans, M. J., Derry, L. A. and Lanord, C. F., 2004. Geothermal Fluxes of Alkalinity in the Narayani River System of Central Nepal. Geochemistry Geophysics Geosystems, 5(8): 1-21.

FAO, 1998. Asia's Women in Agriculture, Environment and Rural Production, Sustainable Development Department, FAO, UN, Bangkok, Thailand.

Fleming, W.M., 1978. Classification of Catchments in the Western Development Region of Nepal: Erosion Hazard and Land Management Problems. IWM/WP/10, Ministry of Forest, Department of Soil and Water Conservation, Kathmandu.

Gairhe, J. J., 2003. Soil Productivity and Fertility Status in Different Regions of the Chitwan Valley. M.Sc. Thesis. Tribhuvan University-Institute of Agriculture and Animal Science. Rampur, Nepal.

Gautam, A. P., Webb, E. L. and Shivakoti, G. P. 2002. Local Participants' Perception About Socio-economic and Environmental Impacts of Community Forestry in the Mid Hills of Nepal. *Asia-Pacific Journal of Rural Development* 12(2): 60-81.

Gee, E. P., 1959. Report on a Survey of the Rhinoceros Area of Nepal. Oryx 5:53-85.

Gisladottir, G. and Stocking, M., 2005. Land degradation control and its global environmental benefits. Land Degradation. Develop. 16: 99–112.

GoN/New ERA and ICF, 2012. Nepal Demographic Health Survey, Population Division, Ministry of Health and Population and USAID, Kathmandu.

GoN/UNDP-GEF, 2007. Conservation and Sustainable Use of Wetlands in Nepal Project (NEP/05/G01) Project Document (unpublished). Government of Nepal (GON) and United Nations Development Programme-Global Environment Facility (UNDP-GEF), Kathmandu.

Gurung, J. D., 1999. Women, Children and Well Being in the Mountains of the Hindu Kush Himalayan Region. *International Journal of Forestry and Forest Industries* 50 (1).

Gurung, J., Giri, K., Setyowati, A. B., and Lebow, E., 2010. Gender & REDD+: An Asia Regional Analysis**.** USAID. Accessed at http://www.rightsandresources.org/documents/files/doc_2307.pdf.

Heinen, J. T., and Mehta J. N., 2000. Emerging Issues in Legal and Procedural Aspects of Buffer Zone Management with Case Studies from Nepal. Journal of Environment and Development 9:45–67.

HMGN, 1999. Buffer Zone Management Guidelines. His Majesty's Government of Nepal (HMGN), Ministry of Forests and Soil Conservation and Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

ICIMOD/MOEST/UNEP, 2007. Kathmandu Valley Environmental Outlook. International Centre for Integrated Mountain Development (ICIMOD)/Ministry of Environment, Science and Technology (MOEST)/United Nations Environment Programme (UNEP), Kathmandu.

ICIMOD, 2007. Disaster Preparedness for Natural Hazards: Current Status in Nepal International Centre for Integrated Mountain Development (ICIMOD), Kathmandu.

ICIMOD, 2009. Potential for Carbon Finance in the Land Use Sector of the Hindu Kush-Himalayan Region Region. ICIMOD, Kathmandu.

IFAD, 2004. Breaking New Ground: Leasehold Forestry in Nepal. International Fund for Agricultural Development (IFAD), Rome, Italy. Available online: http://www.ifad.org/[accessed 25 October 2007].

IPCC, 2007. Climate Change 2007: The Physical Science Basis (summary for policymakers). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.), Cambridge University Press, Cambridge, 1-18.

IUCN, 1996. An Inventory of Nepal's Wetlands. IUCN-Nepal, Kathmandu.

IUCN, 2006. Securing a Safe Future for Rhinoceros in Nepal. IUCN Nepal Country Office. Accessed at: http://www.iucnnepal.org/pdf/Rhino_conservation.pdf [accessed 02 Feb. 2008].

Ives, J.D. and Messerli, B., 1989. The Himalayan Dilemma, Rutledge, London.

Ives, J. D., Shrestha, R. B. and Mool, P. K., 2010. Formation of Glacial Lakes in the Hindu Kush-Himalayas and GLOF Risk Assessment. International Centre for Integrated Mountain Development, Kathmandu.

IWMI, 2012. Climate Change and Vulnerability Mapping in Watersheds in Middle and High Mountains of Nepal. International Water Management Institute (IWMI), Kathmandu, Nepal, For Department of Soil Conservation and Watershed Management (DSCWM), Government of Nepal. (Draft report)

Jha, B. R., 2005. Fish Ecological Studies and its Application in Assessing Ecological Integrity of Rivers in Nepal. Ph. D. Thesis, Department of Biological Sciences and Environmental Science, School of Science, Kathmandu University, Dhulikhel, Nepal.

Jha, P. K., Thapa, R. B. and Shrestha, J. B., 2005. Conservation and Management of Pollinators for Sustainable Agriculture through an Ecosystem Approach. Report submitted to Food and agriculture Organization of the United Nations, Kathmandu.

Kanel, K.R. and Kandel, B.R., 2006. Achievements and Challenges of Community Forest. Hamro Ban, pp, 128, Government of Nepal, Ministry of Forests and Soil Conservation, Kathmandu.

Karkee, M., 2008. Nepal Economic Growth Assessment Agriculture. USAID Nepal.

Karki, K. B. and Dahal B. M., 2009. Current Status and Future Directives for Digital Soil Mapping in Nepal. Soil Research Report, National Agriculture Research Council, Kathmandu.

Karki M., Dangi, R., and Karki, B., 2009. Nepal's Experience in REDD with Community Forestry. Accessed at www.goes.msu.edu/apn_arcp_2009.../Karki_Nepal_REDD_ICIMOD.pdf.

Khatri, D.B., 2009. Payments for Ecosystem Services in Kulekhani Watershed of Nepal: An Institutional Annalysis of Mechanisms for Sharing Hydroelectricity revenue. Accessed at: http://www.forestaction.org/app/webroot/js/tinymce/editor/plugins/filemanager/files/3.%20IASC%20paper%20Khatri.pdf (accessed on 10 July 2012].

Laurie, W. A., 1978. The Ecology and Behaviour of the Greater One-Horned Rhinoceros. A dissertation submitted to the University of Cambridge for the degree of Doctor of Philosophy.

Le Fort, P. 1975. Himalaya: The collided range. Present knowledge of the continental arc. *American Journal of Sciences* 275: 1-44.

LFP, 2009. Impact of Climate Change on Forest and Livelihoods: Issues and Options for Nepal. Livelihood and Forestry Programme (LFP), Kathmandu, Nepal.

Liu, S. Y., Ding, Y. J., Li, J., Shangguan, D. H. and Zhang, Y., 2006. Glaciers in response to recent climate warming in Western China. Quaternary Sciences 26:762–771.

LRMP, 1986. Land Resources Mapping Project (LRMP), Soil and Geology Report. Kenting Earth Science Canada and Department of Topography. HMG/Nepal. Kathmandu.

Luintel, H. and Timsina, N., 2008. Is Forestry Decentralization Effective in Empowering Women's Agency? Forest Action, Kathmandu, Nepal.

Maskey, T. M., Bajimaya, S., Dhamala, B. R., Joshi, B. K. L. and Budhathoki, P., 1999. Park People Programme: 1999 the year in review.. Department of National Parks and Wildlife Conservation Parks People Programme and United Nations Development Program, Kathmandu, Nepal.

Matthew, J., Evans, L., Derry, A. and France-Lanord, C., 2004. Geothermal Fluxes of Alkalinity in the Narayani River System of Central Nepal. Geochemistry Geophysics Geosystems, 5 (8): 1-21.

Miller, R.P. and Nair, P. K. R., 2006. Indigenous Agroforestry Systems in Amazonia: From Prehistory to Today. Agroforestry Systems 66 (2):151-164.

Mittermeier, R.A., Giles, P. R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C. G., Lamoreaux, J. and Da Fonseca, G.A.B. (eds.). 2004. Hotspots Revisited. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Mexico City: CEMEX/Agrupacion Sierra Madre.

MoAC, 2011. Statistical Information on Nepalese Agriculture 2010/2011. Ministry of Agriculture and Co-operatives (MoAC), Agri-Business Promotion and Statistics Division, Government of Nepal, Kathmandu.

MoE, 2010a. Climate Change Vulnerability Mapping for Nepal. Ministry of Environment (MoE), Kathmandu, Nepal.

MoE, 2010b. National Adaptation Program of Action to Climate Change, Ministry of Environment (MoE), Kathmandu.

MoE, 2011. Status of Climate Change in Nepal, Ministry of Environment (MoE), Kathmandu, Nepal.

MoEST, 2004. Nepal National Action Program on Land Degradation and Desertification in the Context of UNCCD. Ministry of Environment, Science and Technology (MoEST), Government of Nepal, Kathmandu.

MoEST, 2008. Nepal Thematic Assessment Report: Land Degradation. Nepal Capacity Self Assessment for Global Environment Management. Ministry of Environment, Science and Technology (MoEST), Government of Nepal.

MoHA, 2009. Nepal Disaster Report 2009. Ministry of Home Affairs (MoHA), Government of Nepal, Kathmandu.

MoHP, New ERA, and ICF International Inc. 2012. Nepal Demographic and Health Survey 2011. Ministry of Health and Population (MoHP), New ERA, Kathmandu, Nepal and ICF International, Calverton, Maryland.

MoLE, 2012. Women Migrant Worker Empowerment Project. Ministry of Labor and Employment (MoLE), Government of Nepal, Kathmandu. Accessed at: http://www.moltm.gov.np/en/WMW-Empowerment-Project/57/[accessed on 23rd May 2012].

Mool, P. K., Bajracharya, S. R. and Joshi, S. P., 2001. Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods: Monitoring and Early Warning Systems in the Hindu Kush-Himalayan Region,

Nepal. International Centre for Integrated Mountain Development Mountain Environment and Natural Resources' Information Systems, Kathmandu.
MoPE, 2004. Initial National Communication to the Conference of Parties of the United Nations Framework Convention on Climate Change. Ministry of Population and Environment (MOPE), Kathmandu.
Moser, C., 1993. Gender Planning and Development: Theory, Practice and Training. Routledge, London.
Myers, N., Mittermeier, R. A., Mittermeier, C. G. Da Fonseca, G.A.B. and Kent, J., 2000. Biodiversity Hotspots for Conservation Priorities. Nature 403(24): 853-858.
Nair, P. K. R., 1993. State-of-the-art of Agroforestry Research and Education. Agroforestry Systems 23 (2-3):95-119.
NBS, 2002. Nepal Biodiversity Strategy (NBS). His Majesty's Government of Nepal, Ministry of Forests and Soil Conservation, Kathmandu.
NCVST, 2009. Vulnerability Through the Eye of Vulnerable: Climate Change Included Uncertainties and Nepal's Development Predicaments. Institute for Social and Environmental Transition (ISET), Boulder, Colorado, for Nepal Climate Vulnerability Study Team (NCVST), Kathmandu.
NEA, 2008. Nepal Electricity Authority (NEA), Annual Report 2008, Kathmandu Nepal.
NEA, 2011. Annual Report 2011. Nepal Electricity Authority (NEA), Kathmandu.
Neupane, R.P., Sharma, K.R. and Thapa, G.B., 2002. Adoption of Agroforestry in the Hills of Nepal: A Logistic Regression Analysis. Agricultural Systems 72 (3):177-196
NPC, 2010. Three Year Plan Approach Paper (2010/11-2013/14). Government of Nepal, National Planning Comission (NPC), Singha Durbar, Kathmandu.
NTNC, 2008. Sustainable Development Plan of Manang (2008-2013); National Trust for Nature Conservation (NTNC), Kathmandu.
Ojha, H. Persha, L. and Chhatre, A., 2009. Community Forestry in Nepal: A Policy Innovation for Local Livelihood. International Food Policy Research Institute, Washington DC.
Pandey, R., 2011. Women in Forest Management: A Case Study of Dharapani Women Community Forest Bharatpokhari VDC, Kaski, Nepal.
Pandit, B. H. and Thapa, G. B., 2003. A Tragedy of Non-timber Forest Resources in the Mountain Commons of Nepal, Environment Conservation, 30 (3) 283-292.
Pandit, B. H. and Thapa, G. B., 2004. Poverty and Resource Degradation in the Mountains of Nepal. *Society and Natural Resources, 17:1-16*.
Pandit, B. H., Wagley, M. P., Neupane R. P. and Adhikary, B. R., 2007. Watershed management and livelihoods: lessons from Nepal. *Journal of Forest and Livelihood* 6(2): 67-75.
Pant, K. P., 2009. Effects of Agriculture on Climate Change: A Cross Country Study of Factors Affecting Carbon Emission. *The Journal of Agriculture and Environment* 10: 72-88.
Paudel, N. S., Bastakoti, B.B.P, Karki, R. and Bista, R. 2012. Drivers and Dynamics of Agrarian Transformation in Hills of Nepal. Paper presented in a workshop on Enhancing livelihoods and food security from agroforestry and community forestry systems in Nepal. ACIAR, IUCN and Forest Action, Kathmanu.
Pilbeam, C. J., Tripathi, B. P., Sherchan, D. P., Gregory, P. J. and Gaunt, J., 2000. Nitrogen Balances for Households in the Mid Hills of Nepal. Agriculture, Ecosystems & Environment 79:61-72.
Pokharel, B. K. and Byrne, S., 2009. Climate Change Mitigation and Adaptation Strategies in Nepal's Forest Sector: How can Rural Communities Benefit? NSCFP Discussion Paper no 7. Nepal Swiss Community Forest Project, Kathmandu.
Practical Action, 2009. Temporal and Spatial Variability of Climate Change Over Nepal (1976-2005). Practical Action, Kathmandu.
Rana, E., 2010. NORAD's Climate & Forest Initiative. Presentation at WOCAN workshop on Gender in Climate Change and REDD+, held at Hotel Himalaya, Kathmandu on 13 August 2010.
Raut, N., Sitaula, B. K, and Bajracharya R. M., 2010. Agriculture Intensification: Linking with Livelihood Improvement and Environmental Degradation in Mid Hills of Nepal. The Journal of Agriculture and Environment, 11:83-94.
Raut, R., Gurung, S., Sharma, S. and Bajracharya, R.M., 2012. Water Quality and Littoral Diatom Assemblages in High Altitude Himalayan Lake Gosainkunda of Central Nepal. School of Science, Kathmandu University, Dhulikhel (Draft).
Regmi, B. R., Kafle, G., Adhikari, A., Subedi, A., Suwal, R., and Paudel, I., 2009. Towards an Innovative Approach to Integrated Wetland Management in Rupa Lake Area of Nepal. Journal of Geography and Regional Planning, 2(4): 80-85 (available online at http://www.academicjournals.org/JGRP).

Regmi, B. R., Thapa.L., Suwal, R., Khadka, S., and Tamang, B.B., 2009: Agro-biodiversity management: Key strategies to promote community based adaptation. Journal of Forest and Livelihood. Special Issues on Climate Change. Forest Action, Nepal.

SAGUN, 2009. Climate Change Impacts on Livelihoods of Poor and Vulnerable Communities and Biodiversity. A Case Study in Banke, Bardia, Dhading and Rasuwa Districts of Nepal. Strengthened Actions for Governance in Utilization of Natural Resources (SAGUN) Project, Care Nepal, Kathmandu.

Sharma, C. K., 1977. River Systems of Nepal. Sangeeta Sharma, Bishalnagar, Kathmandu.

Sharma, C. K., 1981. Ground Water Resources of Nepal. Sangeeta Sharma, Bishalnagar, Kathmandu.

Sharma, K. P., 2004. 'Existing Treaties Agreements and Arrangements in Flood Data Sharing'. In Nepal National Consultation on the Establishment of a Regional Flood Information System in the Hindu Kush-Himalayan (HKH) Region, March 16-17, 2004. ICIMOD, Kathmandu.

Sharma, S., Bajracharya, R. M., Sitaula B. K. and Mertz, J., 2005. Water Quality in the Central Himalaya. Current Science 89 (5): 774-786.

Sharma, T., Upreti, B. N. and Vashi, N. M., 1980. Kali Gandaki Gravel Deposit of Central Nepal: their Neotectonic Significance. *Tectonophysics*, 62:127-139.

Shrestha A. B., Wake C.P., Mayewski P.A. and Dibb, J. E., 1999. Maximum Temperature Trends in the Himalaya and its Vicinity: An Analysis Based on Temperature Records from Nepal for the Period 1971–94. *Journal of Climate,* 12(9): 2775-2786.

Shrestha A. B., Wake C.P., Dibb J.E. and Mayewski P.A., 2000. Precipitation Fluctuations in the Nepal Himalaya and its Vicinity and Relationship with Some Large Scale Climatological Parameters. *International Journal of Climatology*, 20(3): 317–327.

Shrestha, B.D. and Van Ginneken, P., 1983. Watershed Condition of the Districts of Nepal. HMGN, Department of Soil Conservation and Watershed Management, Watershed Management and Conservation Education Project, Kathmandu.

Shrestha, B.D., Bogati, R. and Kharel, B. 1997. Guidelines and Methodology for Sub-Watershed Prioritisation in Watershed Management Planning, DSCWM, Kathmandu.

Shrestha, K.L., 2005. Global Change Impact Assessment for Himalayan Mountain Regions for Environmental Management and Sustainable Development, Global Environmental Research 9 (1): 69-81.

Shrestha, M. S., Artan, G. A., Bajracharya, S. R., Gautam, D. K. and Tokar, S. A., 2011. Bias-adjusted Satellite-based Rainfall Estimates for Predicting Floods: Narayani Basin J Flood Risk Management, 4: 360–373.

Shrestha, U., 2011. Community Participation in Wetland Conservation in Nepal. The Journal of Agriculture and Environment 12: 140-147.

Shrestha U. B, Gautam S. and Bawa K. S., 2012. Widespread Climate Change in the Himalayas and Associated Changes in Local Ecosystems. PLoS ONE 7(5): e36741. doi:10.1371/journal.pone.0036741.

Singh, S., 2010. Water Induced Disasters of the Year 2010. Disaster Review, July 2011. Department of Water-Induced Disaster Prevention, Government of Nepal, Kathmandu.

Spillett, J. J. and Tamang, K. M., 1966. Wildlife Conservation in Nepal. J. Bombay Nat. Hist. Soc. 63:557-571.

Stainton, J.D.A., 1972. Forests of Nepal. John Murray, London.

Sthapit, B., Shrestha, P. and Upadhyay, M. (eds.), 2006. On-farm Management of Agricultural Biodiversity in Nepal: Good Practices. NARC/Li-BIRD/IPGRI/IDRC.

Sthapit, K.M. and Balla, M. K., 1998. Sedimentation Monitoring of Fewa lake. Institute of Forestry and ITTO Project, Pokhara.

Stocklin, J. and Bhattarai, K. D., 1977. Geology of Kathmandu Area and Central Mahabharat Range, Nepal Himalaya, Department of Mines and Geology (HMG/UNDP), Technical Report, (unpublished). Kathmandu.

Thapa, M., 2005. Natural Resource Management from Gender Perspectives. Presented at "When Women Gain, So Does the World". The Eighth International Women's Policy Research Conference (June 19-21, 2005), Washington DC.

Thapa, Y. B., 2011. Summary presentation of protected forests management plans (unpublished presentation in Nepali).

Tiwari, K. R., Awasthi, K. D., Balla, M. K. and Sitaula, B. K., 2010. Local people's perception on climate change, its impact and adaptation practices in Himalaya to Terai regions of Nepal. Himalayan Journal of Development and Democracy, 5:56-63. Nepal Study Center, University of Mexico, USA.

Tiwari, K. R., Sitaula, B. K., Børresen, T., and Bajracharya, R. M., 2006. An assessment of soil quality in Pokhare Khola watershed of the Midhills in Nepal. Journal of Food Agriculture & Environment, 4:276-283.

UNDP, 2007. Climate Change Country Profile of Nepal. United Nations Development Programme (UNDP), Kathmandu. Available online at: http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Nepal/Nepal.hires.report.pdf (accessed on 21 June 2012).

UNDP, 2009. Human Development Report of Nepal. United Nations Development Program (UNDP), Nepal Country Office, Kathmandu.

UNESCO, 2006. Building UNESCO National Education Support Strategy (UNESS) Nepal (2008-2013). An Inventory of Non-Formal Education in Nepal, Gender Responsive Non-Formal Education in Nepal: A Case Study, UNESCO Nepal, Kathmandu.

UNICEF, 2006. Situation of Children and Women in Nepal. United Nations Children's Education Fund (UNICEF) Nepal Office, Kathmandu, Nepal.

Upadhyay, B., 2005. Women and natural resource management: Illustrations from India and Nepal, Natural Resources Forum, 29(3): 224-232.

Upadhyaya, S.K., 2005. Payments for Ecosystem Services: Sharing Hydropower Benefits with Upland Communities. RUPES Kulekhani Working Paper no. 1, Winrock International, Kathmandu.

Upreti, B. N., Sharma, T. and Merh, S. S., 1980. Structural Geology of Kusma-Sirkang Section of Kali Gandaki Valley and its Bearing on the Tectonic Framework of Nepal Himalaya. Tectonophysics, 62:155-164.

Uprety, D., 2006. Community Forestry, Rural Livelihoods and Conflict: A Case Study of CFUGs in Nepal. Ph.D. thesis, BOKU, Austria.

USAID, 2007. Gender and Social Inclusion Assessment, USAID Nepal, Kathmandu. Walker, D. H, Sinclair, F. L and Thapa, B., 1995. Incorporation of Indigenous Knowledge and Perspectives in Agroforestry Development. Part 1: Review of Methods and their Application. Agroforestry Systems 30 (1-2):235-248.

Walker, D.H., Sinclair, F.L. and Thapa, B., 1995. Incorporation of indigenous knowledge and perspectives in agroforestry development. Part 1: review of methods and their application. Agroforestry Systems 30 (1-2):235-248.

WECS, 2002. National Water Plan – Nepal. Water and Energy Commission Secretariat (WECS), Kathmandu.

WECS, 2010. Energy Sector Synopsis Report. Government of Nepal, Water and Energy Commission Secretariat (WECS), Kathmandu.

WECS, 2011. Water Resources of Nepal in the Context of Climate Change. Water and Energy Commission Secretariat (WECS), Kathmandu.

WEDO (2003).Common Ground- Women's Access to Natural Resources and the United Nations Millennium Development Goals. Women's Environment and Development Organization (WEDO).

WFP, 2009. Report on Food Security in Nepal, the UN-World Food Programme (WFP), Pulchowk, Lalitpur, Nepal.

Willan, R. S. M., 1965. Rhinos Increase in Nepal. *Oryx,* 8:159-160.

WMP (1997). District-wise Watershed System. Watershed Management Project (WMP), Department of Soil Conservation, Kathmandu.

WRFD, 2011. Forest Encroachment Study Monitoring Report (Nawalparasi, Rupandehi and Kapilvastu) (in Nepali). Western Regional Forest Directorate (WRFD), Pokhara, Nepal.

WWF, 2000. Biodiversity Assessment and Conservation Planning: Chitwan-Annapurna Linkage. WWF Nepal Program, Kathmandu.

WWF, 2009. Displays and documents for tourism in key tourist and pilgrim sites: Trails in Gosaikunda. Environment Education Project, WWF Nepal, Kathmandu.

Yagi, H., Maruo, Y., Saiju, K. and Nakamura, S., 1990. 'The September 1988 Large Landslide in the Vicinity of MCT, Darbang, Nepal'. *Journal of the Japan Geologic Society,* 26 (4): 44-49.

Yonzon, P., 1994. Count Rhino '94. Department of National Parks and Wildlife Conservation, Kathmandu (unpublished report).

Yonzon, P. (ed.), 2010. Nepal Himalaya Notes 2010, Headlines Himalaya, Kathmandu.

Zemp, M., Roer, I., Kaab, A., Hoelzle, M., Paul, F. and Haeberli, W., 2008. Global glacial changes: facts and figures. World Glacier Monitoring Service, Zurich, Switzerland.

Annexes

Annex 2.1: List of Agencies and Individuals Consulted in Kathmandu

S. N.	Agencies/Individuals
1	Ministry of Forests and Soil Conservation – Mr. Ram Lamsal, Chief- Foreign Aid Coordination Division; Mr. Resham Dangi, Chief- REDD Cell
2	Ministry of Environment - Mr. Batu Krishna Upreti
3	Department of Hydrology and Meteorology - Mr. Rajendra Shrestha
4	Department of Plant Resources, Director General Dr. Annapurna Das, and Mr. Suraj Ketan Dhungana
5	Department of National Parks and Wildlife Conservation - Director General Mr. Krishna Prasad Acharya, Dr. Maheswar Dhakal, Mr. Kamal Jung Kunwar; Mr. Barna B. Thapa, Mr. Jhamak Karki, Chief Warden CNP, Mr. Yub Raj Regmi, Chief Warden Suklaphanta WLR, Mr. Bed Dhakal, Chief Warden, Langtang National Park, Mr. Gopal Bhattarai, Chief Warden Shivapuri Nagarjun National Park
6	Department of Forests- Director General Mr. Braj Kishor Yadav, Mr. Shyam Sharma (community forestry divison), DDG Mr. Gaurisankar Timila (planning division), DDG Yam B. Thapa and Hem Raj Bista (National Forest Division), Binod (?)
7	Leasehold Forestry Program and TA Project- Coordinator Mr. Bala Ram Adhikari, CTA Mr. Govinda Kafle, Mr. Ghuran Thakur, Mr. Praksh Chandra Tara, Mr. Balaram Kandel
8	Department of Forest Research and Survey- Director General Mr. S.M. Shrestha, Mr. Prakash Mathema, Mr. Ramesh Shakya, and Mr. Deepak Kharal
9	FRA- Mr. Tumo Katimaki, Mr. Pem Kandel, Mr. Anish Joshi
10	Department of Soil Conservation and Watershed Managemet- DG Mr. Bharat Pundasaini, Dr. J. Joshi, Dilip Kumar Sardoula, Senior Divisional Engineering Geologist, Mr. Deewakar Paudel District Soil Conservation Officer, Myagdi
11	Wetland Conservation Project – Dr. Top Bahadur Khatri
12	Ministry of Agriculture and Cooperatives - Dr. Deepak M Pokheral, Environment and Gender Division
13	Nepal Tourism Board - Mr. Suvash Lohani
14	Nepal Electricity Authority - Mr. Shiva Ram KC
15	Department of Irrigation, Jawlakhel - Tika Baral, Engineer
16	Department of Roads - Dhruba Jha, Engineer
17	Water-induced Disaster Prevention Department- Mr. Sundar Sharma
18	Water and Energy Commission Secretariat - ?
19	Ministry of Home – Head, Disaster Management Unit (Under Secretary)
20	NARC - Dr. Ram Babu Paneru
21	Nepal Electricity Development Board, Ministry of Energy
22	International Centre for Integrated Mountain Development –Dr. Bhaskar Karky (REDD), Dr. Laxman Joshi (PES)
23	National Trust for Nature Conservation – Mr. Juddha Gurung, Mr. Ganga Jung Thapa, and Mr. Deepak Singh, Mr. Nara B. Amgain, ACA
24	FECOFUN- Ms. Apsara Chapagain, Mr. Krishna Bahadur Khadka, Mr. Brikha Bahadur Shahi
25	Multi Stakeholder Forestry Program- Mr. Peter Neil, and Mr. Ramu Subedi
26	ANSAB- Dr. Bhishma Subedi
27	Community Self Reliance Center – Mr. Jagat Basent, Mr. Jagat Deuja
28	Yaatra – Youth organization working on NRM and environment conservation: Ms. Deepti Khakurel, Founder President, Ms. Anjana Luitel, President
29	Federation of Water and Sanitation Users in Nepal – Mr. Rajendra Aryal, National President
30	Women Organizing for Change in Agriculture and NRM (WOCAN), Ms. Kanchan Gurung
31	Himalayan Nature - Dr. Hem Sagar Baral
32	Birds Conservation Nepal, Dr. Hem Gurung, CEO
33	Department of National Parks and Wildlife Conservation, former Director General, Mr. Shyam Bajimaya
34	Department of National Parks and Wildlife Conservation, former Director General, Mr. Biswa Nath Upreti
35	Mr. Shiva Raj Bhatta
36	Rupantaran Nepal - Mr. Shanker Paudel
37	SDE-DOED/Hydropower Investment and Development Company - Sanjeev Baral
38	SDE, DoI/IWRMP - Basudhev Lohanee
39	SDE- CAAN, Babarmahal - Pradeep Adhikari

Annex 2.2 District and Community Level Consultations and Field Visit Program

River Basins	District-level Consultations			Community-level Consultations and Field Visits	
	Districts	Venue/ Date/Time	Participation	Communities	Dates*
Kali A	Mustang, Myagdi, Baglung, and Parbat	Beni Bazar/ May 07/ 09-16:30 hrs	DFOs, DSCO, ACA, FECOFUN District Chapters, DDC, WDO, DLO, DAO, DIO, and Hariyo Ban field team, REDP, MEDEP, Rupantaran, WatSan Federartion, Roads, NEA	(1) Bieu (Baglung) (2) Tatopani (Myagdi) (3) Lete (Mustang) (4) Marpha (Mustang)	May 06-10 (Team A)
Kali B	Gulmi, Palpa, Arghakhachi, Nawalparasi and Syanja	Palpa/ June 04/ 09-16:30 hrs	DFOs, DSCO, Protection Forest, FECOFUN District Chapters, DDC, WDO, DLO, DAO, DIO, and Hariyo Ban field team, Roads, NEA, Manager Madane Protection Forest Program Tamghas	(1) Putlibazar (Syanja) (2) Dovan (Palpa) (3) Dumkibas (Nawalparasi) (4) Hupsekot (Nawalparasi)	June 03-08 (Team A)
Seti	Kaski, Tanahu, Chitwan, and Makawanpur	Pokhara/ May 03/ 09-16:30 hrs	DFOs, DSCO, PAs (CNP, PWR), Protection Forest, FECOFUN District Chapters, DDC, WDO, DLO, DAO, RD Forest (West and Central), Collaborative FM Coordinator, Collaborative FM Chitwan and Nawalparasi District Chapters, IOF, Narayani Basin Office, DIO, LiBIRD, and Hariyo Ban field team, Roads, NEA, JICA watershed project	(1) Vadaure (Kaski) -A (2) Bandipur (Tanahu) - B (3) Ratnanagar (Chitwan) - B (4) Manahari (Makwanpur) - B	May 01-05** (Team A and Team B)
Marsyandi	Manang, Lamjung and Gorkha	Beshisahar/ May 07/ 09-16:30 hrs	DFOs, DSCO, PA (MCA), FECOFUN District Chapters, DDC, WDO, DLO, DAO, DIO, and Hariyo Ban field team, Roads, NEA	(1) Palungtar (Gorkha) (2) Udipur (Lamjung)	May 06-10 (Team B)
Trishuli	Rasuwa, Nuwakot and Dhading	Trishuli/ June 04/ 09-16:30 hrs	DFOs, DSCO, PAs (LNP, ShNP), FECOFUN District Chapters, DDC, WDO, DLO, DAO, DIO, and Hariyo Ban field team, Roads, NEA	(1) Galchhi (Dhading) (2) Bidur (Nuwakot) (3) Kalikasthan (Rasuwa)	June 03-06 (Team B)

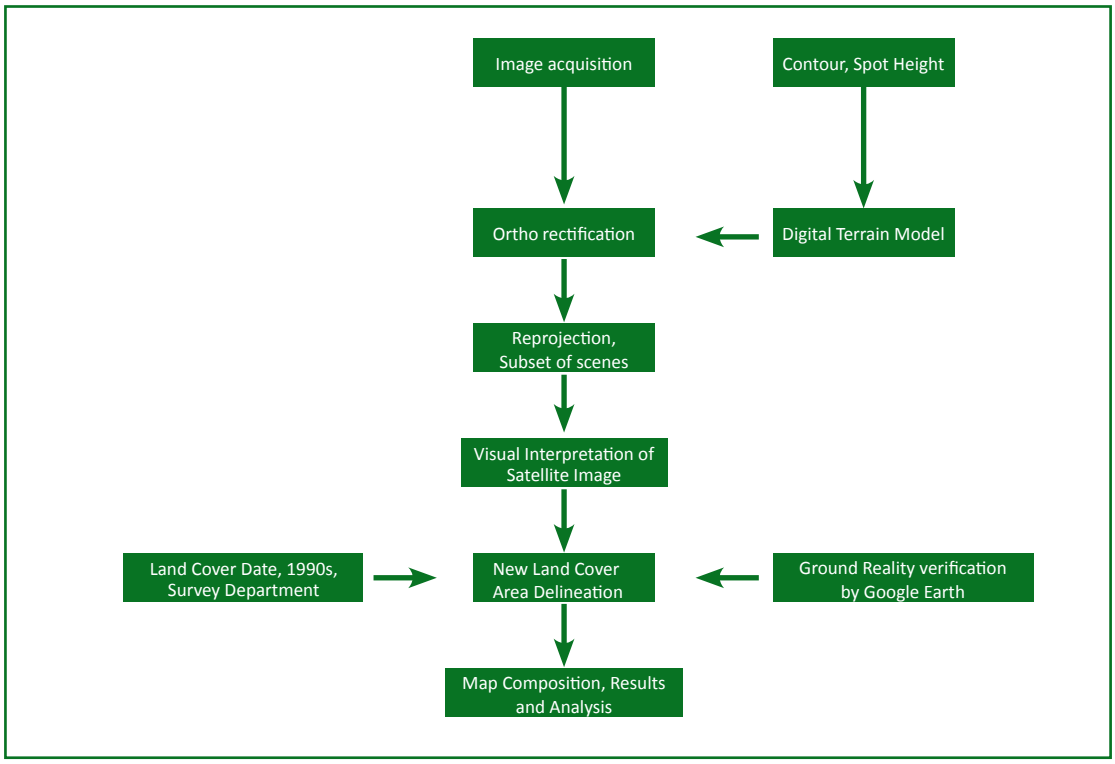
** Including time for travel*
*** The Assessment Team split into two groups (Team A and Team B) after the Pokhara meeting*

Annex 2.3: Satellite Images Used in Land Use/Land Cover Classification

Year	Satellite type and sensor	Path	Row	Date
2010	Landsat 5 TM	141	40	7-Nov-09
		141	41	7-Nov-09
		142	40	3-Dec-10
		142	41	5-Feb-11
		143	40	7-Dec-09
2000	Landsat 7 ETM+	141	40	22-Nov-00
		141	41	27-Dec-01
		142	40	13-Dec-99
		142	41	13-Dec-1999***
		143	40	25-Dec-01
1990	Landsat 5	141	40	12-Oct-88
		141	41	31-Oct-89
		142	40	10-Nov-90
		142	41	7-Nov-89
		143	40	17-Nov-90

**** This scene with cloud cover area was masked by the scene of 2 February 2002*

Annex 2.4: A Simplified Procedure Used in Land Use Mapping



Annex 3.1: Climate and Water Resources in CHAL Districts

S.N.	District	Av. Daily Temp. (°C)		Av. Annual Rainfall (mm)	Climate	Av. Elevation (m)	Water Bodies* (ha/%)	Snow* (ha/%)	Ponds (No)***	Water surface area (ha)***	Major Rivers/ Streams**	River Basin
1.	Nuwakot	26.6	16.3	1431.0	Sub-tropical, mid-temperate	518-4876	405 0.34%	1352 1.14%	52	5.0	Phalankhu, Likhu, Samari, Salankhu, Sindhure, Tadi, Trishuli, Suryamati, Kolpu, Chhatre	Trishuli
2.	Rasuwa	22.6	11.5	994.3	Sub-tropical, temperate\ alpine	905-7408	54 0.04%	25138 16.64%	27	0.50	Chilime, Langtang, Melung,Trishuli, Ghaatte, Bhotekoshi	Trishuli
3.	Dhading	26.7	16.6	2121.2	Sub-tropical, warm-temperate, Cool temperate, alpine	488-7409	745 0.39%	6382 3.38%	30	4.00	Budhigandaki, Trishuli, Shyar, Ankhu, Mahesh, Kolfu, Malekhu, Belkhu, Charaundi,	Trishuli
4.	Makwanpur	30.3	16.6	2288.9	Sub-tropical, temperate cool temperate	305-2743	817 0.34%	-	115	33.00	Rapti, Samari, Bhainse, Manahari, (Bakaiya), (Bagmati), (Kulekhani)	East Rapti
5.	Chitwan			1512.3	Tropical, sub-tropical	244-1945	2465 1.11%	-	535	137	Lothar, Manahari, Narayani, Rapti, Khageri	East Rapti

6.	Gorkha	25.0	14.0	1491.5	Sub-tropical, temperate, cool temperate, alpine	488-8156	497 0.14%	119141 33.08%	100	9.00	Budhigandaki, Chepe, Daraundi, Marshyangdi, Trishuli, Shyarkhola	Daraundi
7.	Lamjung	25.9	15.0	2225.5	Sub-tropical, temperate, cool temperate, alpine, tundra	793-8155	607 0.37%	15162 9.15%	50	2.00	Marshyangdi, Madi, Khudi, Chepe, Dardi, Paundi, Chhar, Midim, Risti, Naundi, Kisedi, Ngadi	Marshyangdi
8.	Tanahun	25.8	15.0	2057.8	Sub-tropical, mid-temperate, cool temperate	1220-2134	1004 0.65%	49 0.03%	132	11.00	Marshyangdi, Seti, Madi, Kaligandaki, Chundi, Kalestee, Risti, Naundi, Faundi, Sange, Myagde	Seti-Madi
9.	Syangja	26.2	14.3	1462.2	Sub-tropical, temperate	366-2515	707 0.61%	74 0.06%	70	8.00	Kaligandaki, Andhi, Bhat, Suraundi, Fusra, Jyagdi, Dushain, Darau	Andhi Khola
10.	Kaski	26.01	15.9	3880.3	Sub-tropical, temperate, alpine, tundra	450-7939	1803 0.89%	47308 23.44%	140	23.00	Modi, Seti, Madi, Mardi, Kali, Bijayapur, Kotre, Sardi, Kahun, Harpan	Seti-Madi
11.	Manang	16.6	6.4	499.4	Temperate,cool temperate, alpine	1880-8156	378 0.17%	165154 72.53%	0	0.00	Dudh, Marshyangdi, Nar	Marshyangdi
12.	Mustang	17.7	5.5	1321.7	Sub-tropical, cool-temperate, alpine	1372-8167	272 0.08%	229295 63.82%	0	0.00	Kaligandaki, Lete, Sete, Marpha, Charang, Syang, Yara, Thini, Narsing, Samrang	Upper Kaligandaki
13.	Myagdi	26.2	14.13	1448.2	Sub-tropical, mid-temperate, cool temperate	915-8167	330 0.14%	70444 30.62%	18	0.40	Kaligandaki-Raghuganga, Kag, Ghar, Boksi, Bhirinti, Rupse, Beg, Myagdi- Gurja, Marang, Dar, Ritung, Dang, Arje	Upper Kaligandaki
14.	Parbat	26.2	14.3	1950.0	Mid-temperate, cool temperate, alpine, tundra	762-8091	141 0.28%	7 0.01%	16	2.00	Kaligandaki, Modi, Mardi, Malyangdi, Bachchha, Sedi, Pati, Lungdi, Rati, Lamaya, Chirdi, Lasti, Jahare	Andhi Khola
15.	Baglung	26.6	19.1	1060.9	Sub-tropical, mid-tmperate, cool temperate, alpine	1000-7244	391 0.22%	1738 0.97%	16	1.50	Kaligandaki, Uttarganga, Theule, Dhor, Taman, Nisi, Bhuji, Bhim, Daram, Gaundi, Kathe, Hugdi	Badighat
16.	Gulmi	23.3	14.8	1516.6	Sub-tropical, mid-temperate, cool temperate	610-3050	364 0.31%	80 0.07%	15	3.00	Badighat, Kaligandaki, Chaldi, Nisti, Hugdi, Ridi, Dram, Panaha, Ulli, Kharjyang,	Badighat
17.	Palpa	23.3	14.8	1903.2	Tropical, sub-tropical, temperate	152-1936	538 0.38%	42 0.03%	40	4.40	Kaligandaki, Binayee, (Tinau), Ridhi, Kurong, Barangdi, Purba, Nimdi	Tinau
18.	Nawalparasi	28.9	20.5	1588.4	Tropical, sub-tropical, mid-temperate	91-1936	3260 1.47%	25 0.01%	985	252.00	Narayani, Arung, Kiran, (Jharjhai), (Dhanewa), (Satbarte), Turikha, Khajharadi, Girwari	Tinau
19.	Arghakhanchi			849.5	Tropical, sub-tropical, temperate	305-2515	302 0.26%	-	12	3.00	Ridi, (Banganga), Mathura, (Rapti), (Sita), (Bangsiri), Chauwaha, Durga	Banganga

Note: Rivers/streams in parentheses fall outside CHAL
** CBS (2008)*
*** Modified with information from annual reports of different district soil conservation offices*
****ABPSD (2011)*

Annex 3.2: Tributaries of Gandaki River System

River System	Tributaries	Sub-tributaries
I. Kaligandaki	1. Myangdi khola	
	2. Modi khola	
	3. Barigad khola	(a) Chalti khola; (b) Nisti khola; (c) Ghanruk khola
	4. Riri khola	(a) Sardeva khola; (b) Riri khola; (c) Mathura khola; (d) Kharni khola; (e) Kordi khola (8 km); (f) Hardi khola (6.4 km); (g) Chal khola (4.8 km); (h) Gobli khola (19.3 km); (i) Harip khola (19.3 km); (j) Kharjang khola (8 km); (k) Kendra khola (9.7 km)
	5. Andhi khola	(a) Mardhi khola; (b) Armadi khola (8 km)
	6. Jyagdi khola (12.9 km)	(a) Lungdi khola (4.8 km); (b) Gaira khola (6.4 km); (c) Jyagdi khola (11.3 km)
	7. Nistinadi (16 km)	(a) Kuhar khola (6.4 km); (b) Kehar khola (9.7 km); (c) Purba khola (19.3 km)
	8. Turundi khola	
	9. Keladi khola (6.4 km)	
	10. Maiti khola (9.7 km)	
	11. Kuru khola (11.3km)	
II. Trishuli	1. Lende khola (Tibet border)	
	2. Bhurlung khola (Tibet border to some extent)	
	3. Chilime khola (35.4 km)	Bridang khola
	4. Langtang khola (66 km)	
	5. Trishuli khola (19.3 km)	Gosaikund khola
	6. Mailung khola (19.3 km)	(a) Lungdi khola (4.8 km); (b) Gaira khola (6.4 km); (c) Jyagdi khola (11.3 km)
	7. Tadi khola (25.7 km)	(a) Lokhu khola (3.2 km); (b) Sindhure khola (14.5 km); (c) Chhare khola (9.7 km); (d) Darme khola (12.9 km); (e) Betini khola (4.8 km); (f) Amari khola (6.4 km)
	8. Phalangu khola (11.3 km)	
	9. Silanku khola	
	10. Gerkhu khola (11.3 km)	
	11. Betrawati khola	
	12. Samri khola (17.7 km)	
	13. Chainpur khola (14.5 km)	
	14. Bhanraur khola (30.6 km)	
	15. Khani khola (6.4 km)	
	16. Kalphu khola (45.1 km)	(a) Panchase khola (9.7 km); (b) Chauthe khola (8 km)
	17. Mahesh khola (19.3 km)	Khasate khola ((8 km)
III. Budhigandaki	1. Budhigandaki (90.1 km)	(a) Tam or Mawang khola (12.9 km); (b) Sringi khola (12.9 km); (c) Chhuling khola (25.7 km); (d) Shiar khola (19.3 km); (e) Bhalu khola (16.1 km); (f) Yaru khola (19.3 km); (g) Dobhan khola (16.1 km); (h) Namrung khola (16.1 km); (i) Samno khola (16.1 km); (j) Machcha khola (35.4 km); (k) Rochet khola (12.9 km); (l) Dundar khla (8 km); (m) Mangbang khola (12.9 km); (n) Arkhet khola (8 km); (o) Manu khola (16.1 km); (p) Kaste khola (9.7 km); (q) Istul khola (27.4 km); (r) Borlang khola (6.4 km)
	2. Ankhu khola (22.5 km)	(a) Manjeet khola (12.9 km); (b) Aul khola (12.9 km); (c) Kintang khola (6.4 km); (d) Baguwa khola (8 km); (e) Lapang khola (4.8 km)

IV. Seti	1. Suranti khola	
	2. Lidi khola	
	3. Batase khola (6.4 km)	
	4. Bijayapur khola(8 km)	
	5. Phusre khola	
	6. Khudi khola (16.1 km)	(a) Ampu khola; (b) Tal khola (6.4 km); (c) Thar khola (6.4 km)
	7. Saraudi khola (14.5 km)	
	8. Kyangdi khola (16.1 km)	
	9. Syangdi khola (12.9 km)	(a) Jamdi khola (6.4 km); (b) Medhi khola (11.3 km)
	10. Madi River	(a) Midam khola (16.1 km); (b) Madi khola; (c) Kalesti khola (12.9 km); (d) Mudkyum khola (14.5 km); (e) Chhar khola (17.7 km); (f) Rudi khola (20.9 km); (g) Bhujang khola (9.7 km); (h) Kaun khola (4.8 km); (i) Balam khola (3.2 km); (j) Sardi khola (8 km); (k) Mibje khola (8 km); (l) Pisti khola (4.8 km); (m) Virohi khola (8 km); (n) Khalte khola (3.2 km); (o) Risti khola (3.2km)
	11. Chundi khola (19.3 km)	
	12. Kali khola	
	13. Marse khola	
V. Marsyangdi	1. Marsyangdi Khola (53.1 km)	(a) Miyardi khola (27.4 km); (b) Galdu khola (9.6 km); (c) Chharchhare khola (16.1 km); (d) Randi khola (8 km); (e) Nyadi khola (22.5 km); (f) Khudi khola (32.2 km); (g) Bhachok khola (12.9 km)
	3. Daraondi (53.1 km)	(a) Hununu khola (6.4 km); (b) Chhicha khola (6.4 km); (c) Sambhu khola (6.4 km); (d) Radlung khola (6.4 km); (e) Mahabir khola (4.8 km); (f) Andhare khola (8 km); (g) Jhala khola (9.7 km); (h) Sandi khola (8 km); (i) Hundi khola (14.5 km); (j) Landi khola (6.4 km); (k) Lundi khola (6.4 km); (l) Jarang khola (6.4 km); (m) Khare khola (8 km); (n) Masel khola; (o) Dumshri khola (4.8 km); (p) Kahre khola (8 km); (q) Bhusundi khola (8 km); (r) Beni khola (9.7 km)
	3. Chepe khola (40.2 km)	(a) Chyadi khola (6.4 km); (b) Landi khola (9.6 km); (c) Andheri khola (9.6 km); (d) Kovala khola (6.4 km); (e) Sandi khola (4.8 km); (f) Chihli khola (6.4 km); (g) Khar khola (6.4 km)
	4. Dordi khola (24.1 km)	(a) Chhangdi khola (6.4 km); (b) Chepe khola (9.6 km); (c) Dordi khola (12.9 km); (d) Kishanti khola (8 km)
	5. Musi khola	
	6. Khudi khola (32.2 km)	(a) Sinder khola (11.3 km); (b) Kichemiche khola (9.6 km)
	7. Phul khola	
	8. Dudh khola	
	9. Paundi khola (19.3km)	
VI. Rapti	1. Manohari	
	2. Lothar khola	
	3. Reu khola	

(Source: Adapted from Sharma, 1977)

Annex 4.1: List of recorded Lakes and Ghols in Chitwan National Park and its Buffer Zone

S.No.	Name	Inside the National Park (NP) or Buffer Zone (BZ)?	Specific Location
1	Gaidakhasa Ghol	NP	East of Gaidakhasa
2	Temple Tiger Ghol	NP	In front of Temple Tiger Hotel
3	Jamuna Ghol	NP	Bandarjhula Island
4	Mardi Ghol	NP	Bandharjhula Island
5	Lamichaur Ghol Complex	BZ	Lamichaur
6	Devi Tal	NP	South of Khoriyamuhan
7	Lamo Tal	NP	East of Khoriyamuhan
8	Munda Tal	NP	South-east of Baghmara
9	Singe Tal	NP	South of Baghmara
10	Nanda Bhauju Tal	NP	North-west of Bhimle
11	Suksuke Tal	NP	South of Bhimle
12	Budhi Rapti Ghol	NP	East of Bhimle
13	Thotari Tal	NP	West of Bankatta
14	Kamal Tal	NP	East of Sukhibhar
15	Sera Tal	NP	West of Dhruba
16	Thapaliya Tal	NP	South-west of Kasara
17	Niure Ghol	NP	Kasara
18	Tamor Tal	NP	South of Kasara
19	Lami Tal	NP	West of Ghatgai
20	Simara Ghol	NP	Near Botesimara
21	Sapnawoti Ghol	NP	East of Bankatta
22	Laguna Tal	NP	West of Jarneli
23	Gaur Machan Ghol	NP	Near Gaur Machan
24	Dumariya Ghol	NP	North-west of Dumariya
25	Majur Tal	NP	West of Charahara khola
26	Nandan Tal	NP	South of Bhawanipur
27	Jayamangala Ghol	NP	Padampur west
28	Marchauli Ghol	NP	Padampur
29	Garud/Patna Tal	NP	Padampur
30	Python Tal	NP	West of Bhimpur
31	Chaparchuli Ghol	NP	Near Chaparchulli Post
32	Ghol	NP	Near CJL
33	Liglige Ghol	NP	West of Sunachuri
34	Beeshazari Tal Complex	BZ	Barandabhar
35	Chepang Tal	BZ	Tikauli
36	Tikauli Tal	BZ	Tikauli
37	Bob Tal	BZ	Barandabhar
38	Icharni Ghol Complex	NP	Icharni
39	Kumrose Tal	BZ	Kumrose BCF
40	Musahar Tal	BZ	Baghmara BCF
41	Kuchkuche Ghol	BZ	Kuchkuche BCF
42	Kumal Tal	BZ	Milijuli BCF
43	Belsahar Tal	BZ	Belsahar BCF
44	Sitamai Tal	BZ	Near Sitamai Ghat

(Source: Based on communication with Chitwan NP)

Annex 6.1: Protected Areas in CHAL and Their Conservation Significance

S.N.	Name	Area (000 ha)		Physiographic Representation	Conservation Significance
		Total	In CHAL		
1	Chitwan NP	93.2	81.2	Siwaliks	World Heritage site; second largest home to endangered one-horned rhino (Rhinoceros unicornis); habitat for tiger (Panthera tigris), and gharial (Gavialis gangeticus), vulnerable smooth-coated otter (Lutra perpiscillata), sloth bear (Melaurus ursinus), marsh crocodile (Crocodylus palustris), lesser adjutant stork (Leptoptilos javanicus), giant pied hornbill, ferruginous duck (Aythya nyroca)
2	Langtang NP	171.0	100.3	High Mountains, High Himal	Home to a considerable number of IUCN Red listed endangered and vulnerable species including red panda (Ailurus fulgens) and Assamese monkey
3	Shivapuri-Nagarjun NP	14.4	7.9	Middle Mountains	Habitat for several species of birds and endemic plants.
4	Parsa WR	49.9	5.4	Siwaliks	An extension of the Chitwan National Park; representative Chure landscape. Home to tiger, elephant (Elephas maximus), gaur, and wild dog
5	Dhorpatan HR	132.5	762.9	High Mountains	Famous for blue sheep; harbors several species of endemic plants
6	Annapurna CA	762.9	164.0	High Mountains, High Himal	A model for integrating conservation with local development; comprises trans-Himalayan as well as mountain ecosystems including the highest and lowest rainfall areas in Nepal; home to snow leopard, musk deer, brown bear, grey wolf, wild ass, and several species of pheasants and endemic plants
7	Manaslu CA	166.3	2.6	High Himal	Habitat for several important animal species including grey wolf, musk deer, snow leopard, blue sheep, Himalayan black beer, and Himalayan thar.
	Total	1,340.3	1,124.3		

NP = National Park; WR = Wildlife Reserve; HR = Hunting Reserve; CA = Conservation Area
(Source: http://www.dnpwc.gov.np/protected-areas.html)

Annex 6.2: Registered Private Forests in CHAL Districts (1984-2008)

S. No.	District	Private Forest		
		Number	Area (ha)	Number of Trees
1	Chitwan	201	142.6	303,510
2	Nawalparasi	90	40.3	38,454
3	Makwanpur	181	105.2	197,712
4	Arghakhanchi	3	4.5	6,490
5	Tanahu	12	7.2	15,907
6	Palpa	50	61.6	5,351
7	Gulmi	1	0.2	504
8	Baglung	1	0.8	1,234
9	Parbat	11	8.4	9,388
10	Syangja	15	10.6	39,269
11	Lamjung	29	8.7	4,311
12	Dhading	13	9.3	36,025
13	Nuwakot	7	21.6	31,162
14	Myagdi	5	1.4	-
15	Gorkha	14	26.4	31,144
16	Rasuwa	21	12.5	-
Total		**654**	**461.3**	**720,461**

(Source: Department of Forests 2012, Unpublished)

Annex 7.1: Situation of Agricultural Biodiversity in the Chitwan-Annapurna Landscape

Village	District	Varieties Extinct (E), Varieties threatened (T); Local Names		
		Rice	Maize	Others
Bhadaure	Kaski	Pahele, Jarneli (T), Juhari kalo, Kalo patle, Angha (E), Baliyali (E)	Khutle, Bhalu and Manakamana-1, 2	Rato Bhatta (E)
Dahapani	Baglung	Silani, Khuita, Reshali, Bharkhune, Kalodhan (T)	Seto and pahelo	Nepale Bhatta (E)
Babiyachour	Myagdi	Jarneli (T), Juhari, Koili, Kalodhan, Thulo Gauriya, Gudura, Angha (E)		
Pamling	Mustang	NA	Kande makai (E), marpha local (T)	Apple, Kusu local (E), Buckwheat- Tite and Gulio, Nacked barley- Kalo barley (E)
Jumdanda Jhapri	Tanahu	Aga, Marsi, Mansara (E) Batissara, Lami, Goal Dhan, Dalle or Apjhutte, Jhinuwa and Kanak Jira(T)	Sathiya (E)	NA
Simpani Devkot	Makwanpur	Aga, Marsi, Mansara (E), Jhinuwa (T)	Sathiya (E)	NA
Panchakanya	Chitwan	Malinza and Malasip (E)	Sathiya (E)	NA
Bankali	Lamjung	Aga, Marsi, Mansara (E) Batissara, Lami, Goal Dhan, Dalle or Apjhutte, Jhinuwa and Kanak Jira(T)	Sathiya (E)	Local cucumber (T)
Rajdevi	Gorkha	Aga, Mansara (E), Dalle or Apjhutte, Jhinuwa (T)	Sathiya (E)	Local cucumber (T)
Kalikasthan	Dhading	Aga, Mansara (E) and	Sathiya (E)	Local cucumber (T)
Ramche	Rasuwa	Rato lekali (T), Angha	Rato, Seto and Korche (T)	
Bidur 3	Nuwakot	Ghaiya (T)	Murali makai (T)	Potato- local Red (T)
Bandre	Syangja	Mansara, Marsi, Ruduwa and Setogola (E)	Sathiya, Seto Makai (T)	Kalo soyabean (E)
Satpatre	Palpa	Aga, mansuli (E)	Sathiya Makai (E)	Gahat, Rajma and Soyabean (T)
Ghiukhola	Nawalparasi	Mansuli (T)	Rato and seto local (T)	Local red tomato (T)

(Source: Field Survey, 2012)

Annex 8.1: Indicators Used to Develop Different Indices in Evaluating Watersheds

Combined/Multiple Sensitivity Index was developed by the aggregation of weighted standardized ecological and human sensitivity sub-indices of the watersheds.

Both human ecology and physical ecology index were aggregated to get combined ecological risk index after giving equal weightage for standardization.

Combined/multiple risk exposure index was constructed based on landslide/flood risk, drought and food risk, ecological risk and rainfall and temperature risk indices. Each of the indices was assigned weightage, standardized and aggregated to get the combined index. The combined index was then normalized to get values between the range 0-1.

To construct the Combined/Multiple Adaptation Capability Index, all three sub-indices were assigned weightage and combined assuming higher the socio-economic status (education, income/employment, health and sanitation, human development and empowerment,

gender empowerment etc.), infrastructure and technological development in the communities residing in a specific spatial location, higher will be the adaptive capability of that community. The combined weighted value was then aggregated and normalized.

Based on Comined/Multiple Vulnerability indices sensitivity analysis, the watersheds in the Gandaki Basin were evaluated for their sensitivity to climate change. The watershed is at higher risk for various hazardous conditions such as landslides/ flood, more frequent droughts, food insecurity and more frequent intensive rainstorms. As the ability of a community to respond and adjust to climate induced risks also affects the level of vulnerability, the study assessed the adaptive capacity of the communities by looking at socioeconomic indices, presence of infrastructure as well as existing technologies.

(Source: IWMI 2012)

Annex 8.2: Watersheds in Gandaki Basin Ranked by Different Indices

Sub-Basin	Watershed	Area (km²)	Included District	CSI Rank	CER Rank	CMRE Rank	CMAC Rank	CMVI Rank
Budhi Gandaki	Budhi Gandaki	2960.15	Dhading, Gorkha, Lamjung, Manang, Nuwakot, Rasuwa	15(H)	9(H)	44(M)	17(H)	34(M)
Kali Gandaki	Upper Kali Gandaki	2084.59	Baglung, Kaski, Manang, Mustang, Myagdi, Parbat	29(M)	25(M)	115(L)	6(H)	13(H)
East Seti	Upper East Seti	1470.65	Kaski, Manang, Parbat, Syangja, Tanahun	33(M)	1(VH)	16(H)	35(M)	2(VH)
Kali Gandaki	Lower Kali Gandaki	1547.58	Chitawan, Nawalparasi, Palpa, Syangja, Tanahun	45(M)	10(H)	79(L)	20(H)	7(H)
Trishuli	Kolpu Khola	170.28	Dhading, Kathmandu, Nuwakot	50(M)	20(H)	121(L)	76(L)	64(M)
Marshyangdi	Marsyangdi	2054.6	Chitawan, Gorkha, Kaski, Lamjung, Manang, Tanahun	56(M)	13(H)	92(L)	39(M)	12(H)
Kali Gandaki	Lower Badigad Khola (ID81)	339.03	Baglung, Gulmi, Pyuthan	58(M)	7(H)	85(L)	144(L)	33(M)
Trishuli	Middle Trishuli	557.96	Chitawan, Dhading, Makawanpur, Nuwakot	59(M)	17(H)	132(L)	94(L)	53(M)
Kali Gandaki	Middle Kali Gandaki	648.07	Baglung, Gulmi, Parbat, Syangja	60(M)	8(H)	108(L)	75(L)	16(H)
Kali Gandaki	Aandi Khola	479.63	Kaski, Parbat, Syangja	61(M)	4(H)	56(M)	59(M)	11(H)
Kali Gandaki	Ridi Khola	1075.69	Arghakhanchi, Baglung, Gulmi, Palpa, Syangja	68(L)	6(H)	81(L)	100(L)	15(H)
East Rapti	East Rapti	293.17	Makawanpur	71(L)	64(L)	105(L)	16(H)	24(M)
Trishuli	Mahesh Khola	278.95	Dhading, Kathmandu, Makawanpur, Nuwakot	72(L)	18(H)	57(M)	96(L)	31(M)
Kali Gandaki	Daram Khola	335.6	Baglung, Gulmi, Myagdi	77(L)	66(L)	109(L)	31(M)	25(M)
Trishuli	Bhyaure Khola	153.82	Dhading, Nuwakot	79(L)	30(M)	128(L)	126(L)	75(L)
Kali Gandaki	Lower Badigad Khola (ID86)	239.08	Baglung, Gulmi	82(L)	64(L)	111(L)	47(M)	32(M)
Trishuli	Lower Trishuli	281.66	Chitawan, Dhading, Gorkha, Tanahun	86(L)	58(M)	19(H)	105(L)	73(M)

Trishuli	Tadi Khola	664.04	Kathmandu, Nuwakot, Rasuwa, Sindhupalchok	88(L)	19(H)	114(L)	99(L)	19(M)
Trishuli	Trishuli-Marshyangdi	127.64	Chitawan, Dhading, Tanahun	89(L)	75(L)	124(L)	102(L)	86(L)
Trishuli	Upper Trishuli	707.22	Dhading, Nuwakot, Rasuwa	90(L)	50(M)	84(L)	104(L)	59(M)
Marshyangdi	Daraudi Khola	610.18	Gorkha, Lamjung, Tanahun	99(L)	35(M)	120(L)	129(L)	51(M)
Kali Gandaki	Myagdi Khola	614.94	Baglung, Myagdi	104(L)	108(L)	107(L)	55(M)	40(M)
East Rapti	Gorandhi Khola	425.84	Dhading, Makawanpur	105(L)	76(L)	75(L)	61(L)	21(M)
East Seti	Madi	1121.97	Kaski, Lamjung, Manang, Tanahun	106(L)	48(M)	77(L)	57(M)	10(H)
East Seti	Lower East Seti	354.45	Chitawan, Tanahun,	108(L)	51(M)	20(H)	108(L)	27(M)
Kali Gandaki	Taman Khola	373.98	Baglung, Myagdi	121(L)	111(L)	61(L)	66(L)	26(M)
Trishuli	Trishuli-Seti	59.24	Chitawan, Tanahun, Udayapur	122(L)	104(L)	82(L)	106(L)	44(M)
Kali Gandaki	Modi Khola	674.74	Kaski, Manang, Myagdi, Parbat	124(L)	43(M)	125(L)	91(L)	6(H)
Budhi Gandaki	Bhabil Khola	144.09	Dhading, Rasuwa	125(L)	134(L)	135(L)	120(L)	98(L)
Kali Gandaki	Nisi Khola	233.6	Baglung, Pyuthan, Rolpa, Rukum	130(L)	121(L)	46(M)	110(L)	28(M)
East Rapti	Arun Khola	270.86	Nawalparasi, Palpa	132(L)	116(L)	94(L)	123(L)	30(M)

(Source: IWMI 2012)
Note: High – (0.570-0.745), Moderate - (0.395-0.570), Low- (0.000-0.395)
Combined/Multiple Vulnerability Index - CMVI
Combined/Multiple Sensitivity Index - CSI
Combined Ecological Risk- CER
Combined/Multiple Risk Exposure - CMRE
Combined/Multiple Adaptation Capability Index - CMAC

Annex 8.3: Districts in the Gandaki Basin in Order of their Watershed Condition

S.No.	District	Value	Watershed Condition
1	Mustang	4824	Very poor
2	Syangja	4725	,,
3	Nuwakot	4646	,,
4	Gulmi	3477	Poor
5	Arghakhanchi	3476	,,
6	Parbat	2822	Marginal
7	Manang	2486	,,
8	Myagdi	2126	,,
9	Palpa	2032	,,
10	Dhading	1765	,,
11	Tanahun	1744	,,
12	Nawalparasi	1392	Fairly Good
13	Makawanpur	1370	,,
14	Kaski	982	,,
15	Gorkha	934	,,
16	Lamjunng	575	,,
17	Baglung	569	,,
18	Chitwan	261	Good
19	Rasuwa	194	,,

(Source: Shrestha and Ginneken, 1983)

Annex 8.4: Classification of Catchments in CHAL Based on Conservation, Rehabilitation and Management Priority

Catchments	Total value	Priority
Fewa Tal	21	High
Andhi	20	,,
Lower Kaligandaki	20	,,
Lower Modi	19	,,
Lower Mayandi	19	,,
Lower Chepe	19	,,
West Nisi	18	Moderate
Ridi	18	,,
Lower Narayani	18	,,
Lower Buri Gandaki	17	,,
Lower Marsyangdi	17	,,
Lower Madi	17	,,
Middle Seti	17	,,
Rapti	17	,,
Middle Kali Gandaki	16	,,
Upper Narayani	15	,,
Upper Chepe	14	,,
Lower Seti	14	,,
East Nisi	13.5	,,
Middle Buri Gandaki	13	,,
Upper Ganga	12	Low
Mustang	11.5	,,
Upper Daraundi	11	,,
Middle Marsyangdi	9	,,
Upper Madi	9	,,
Upper Seti	8	,,
Upper Kali Gandaki	8	,,
Upper Modi	7	,,
Upper Marsyangdi	6.5	,,
Shiar	6	,,
Upper Buri Gandaki	6	,,
Upper Mayandi	6	,,

(Source: Fleming 1978)

Annex 8.5: List of Sub-Watersheds Prioritized in Various Districts

Priority	SW	Area (km²)	VDCs	Programs
Rasuwa District (SWs not prioritized)				
1	Tallo Falankhu (Ghatte)	21.26	Lahare Pauwa, Dhaibung, Bhorle	WM plan prepared; Pgm from 053/54-059/60 by NepDWMP and From 061/62 by NARMSAP
2	Upper Falankhu	107.57	Bhorle, Saramthali, Yarsa	
3	Tallo Trishuli Ganga	61.26	Dhaibung, Ramche, Thulogaun, Danda gaun, Laharepauwa,	WM plan prepared; Pgm being implemented
4	Upper Trishuli Ganga	39.71	Dhunche, Ramche, Haku, Gatlang, Goljung, Shyafru	
5	Langtang	81.42	Shyafru, Bridchim, Langtang	
6	Mailung	81.11	Haku, Danda Gaun	
7	Chilime	110.88	Goljung, Chilime, Gatlang	Pgm from 060/61-064/65 implemented; WM plan prepared
8	Bhote Koshi	132.78	Thuman, Timure, Briddhim	
Dhading District				
1	Agara	36.8	Bhumesthan, Thakre, Tasarpu	WM plan being prepared
2	Salyantar Ankhu khola	45.35	Aginchok, Chainpur, Jyamrung, Salyantar	WM plan, Pgm being implemented
3	Kumpur	31.5	Kumpur, Kalleri	WM plan, Pgm implemented from 053/54 by NDWMP
4	Mahesh khola Upper	105.53	Chhatre deurali, Naubise, Thakre, Jeevanpur, Kewalpur	from 056/57-061/62 by NARMSAP, continued by GON
5	Dumreechaur	26.52	Kalleri, Kumpur, Goganpani	
6	Palenkhu	54.2		
7	Kolpu	35.75		
8	Geldu	38.1		
9	Chhapgaun	32.34		
10	Thopal	50.56	Kumpur, Muralibhanjyang, Nalang, Neelkantha, Sunaulabazar	
13	Malekhu	37.79	Benighat, Madevsthan, Gajuri	
31	Chyadu	36.54	Dhola, Chainpur, Maidi, Muralibhanjyang, Nalang	WM plan, Pgm implemented from 056/57- 061/062 by NARMSAP, continued by GON
Makawanpur District (Part of the List of Prioritized Sub-Watersheds)				
2	Upper Bhalu khola	28.20		
5	Lower Gorungdi khola	22.08		
6	Bhudrung	40.88		
8	Padampokhari gaon	43.38		
9	Lower Karra khola	44.00		
Gorkha District				
1	Jarangkhola	32.60	Takukot, Pandrung, Panchkhuwa, Deurali, Masel, Takumajh	Pgm from 066/67; GoN supported SCWM pgms
2	Sirdi	26.62	Gorkha muni, Phinam	WM plan prepared; Some pgms. started
3	Daraundi	43.47	Simjung, Barpak	
4	Tallo Ludikhola	30.87	Gorkha muni., Bakrang	
5	Upallo Ludikhola	33.86	Gorkha muni., Bakrang, Bungkot, Finam, Taklung, Ghairung	GoN conservation Pgm from 062/63-064/65
6	Bakrang Bhogteni	32.28	Manakamana, Bakrang	
7	Masel	12.92	Taple, Masel, Baguwa	GoN conservation Pgm from 050/51-056/57

8	Moudi	15.75	Tandrang, Arupokhari, Pandrung, Masel	GoN SCWM Pgm from 050/51-054/55
9	Uppallo Machhikhola	40.32	Laprak, Gumda	
10	Judhikhola	47.72	Deurali, Dhunwakot, Chyangli	
14	Tandrangkhola	45.36	Dhawa, Borlang, Tandang, Baguwa, Taple, Asrang	
20	Tallo Jyadulkhola	29.93	Borlang, Bungkot, Asrang	Critical SW
23	Bhushunde	28.35	Chhoprak, Kholand, Ampipal, Harmi	Pgm from 050/51-056/57; FAO supported Participatory Upland Conservation and Development Project
31	Stulkhola	51.66	Swanra, Aruarbang, Arupokhari, Aruchanaute, Panch khuwa, Deurali	GoN conervation Pgm from 057/58-061/62

Tanahun District				
1	Buldikhola			
2	Chhabdi		Byas muni, Ghansi kuwa, Keshabtar, Pokhari bhanjyang	WM plan prepared; Pgm from 048/49-052/53 by GoN; In 053/54 by GoN; From 054/55 by NARMSAP;
3	Chiti			WM plan prepared
4	Phundi			
5	Kyangdi			
6	Saldi			
7	Thar			
8	Risti			
9	Saraundi			
10	Kalesti			

Syangja District				
1	Faudikhola	18.90	Sirsekot, Pelakot, Thumpokhara	IWM program implemented
2	Malunga	24.26	Jagatradevi, Tulasibhanjyang, Malunga, Shrikrishna Gandaki	
3	Tindobate	16.85	Waling Muni., Tindobate	
4	Mirmi Andhidovan	25.36	Nibuwakharka, Shrikrishna Gandaki, Bighaarchal	
5	Mirdikhola	21.11	Waling Muni., Jagatbhanjyang, Kebrebhnajyang	
26	Upper Jyagdi (Barahkhola)	20.95	Rangbhang, Praste, Biruwa Archale	
28	Lubdhikhola	28.98	Arjun Chaupari, Dhapuk, Khilung Deurali, Swarek	CDFWCP from 060/61 with Japan KR2;

Mustang District				
1	Letekhola	37.02	Lete	Pgm implementatin
2	Pongkyukhola	36.86	Marpha	
3	Syang	35.91	Marpha, Jomsom	
4	Pandakhola	46.31	Jomsom, Muktinath	
5	Langpyoghynkhola	41.42	Jomsom, Marpha	
6	Nechang	48.03	Chhonhup	
7	Uppallo Jhong	63.16	Muktinath, Jhong	Pgm implementatin
8	Tallo Jhong	41.58	Muktinath, Jhong, Kagbeni	Pgm implementatin
9	Langekhola	31.34	Lete, Kobang	
10	Kaligandaki	38.59	Muktinath, Jomsom, Kagbeni	
13	Pangbukhola	54.81	Kunjo, Lete, Kobang, Tukuche	Pgm implementatin
15	Larjung	43.31	Kobang, Tukuche	Pgm implementatin
16	Thapakhola	71.82	Tukuche	Pgm implementatin
27	Lungpakhola	65.99	Tukuche, Gagbeni	Pgm implementatin

Myagdi District				
1	Lower Myagdi	26.59	Pulachaur, Singa, Babiyachaur, Kuhun, Arthunge	062/63 by GON and Japan KR 2 CDFWCP in Singa and Pulachaur VDCs for pasture management & Swiss government financed sustainable land management in Arthunge and Pulachaur VDCs
2	Arman	42.13	Baranja, Arman, Niskot	CDFWCP
3	Dukhu	34.18	Babiyachaur, Kuhun, Darbang	Some WM works
4	Arje	63.17	Singa, Ratnechaur, Jyamrukkot, Bhakimli,, Baranja	
5	Marang	100.8	Darbang, Marang, Kuinemangale, Bim, Malkabang, Takam, Mudi	
6	Ministri	73.87	Shikh, Narchyang	
7	Rukse	48.75	Dana, Narchyang	WM plan prepared
8	Ghar	98.21	Histan, Shikh	
9	Lulang	77.81	Muna, Mudi, Lulang	
10	Rahughat	93.56	Arthunge, Ghatan, Patlekhet, Piple, Dagnam, Jhin, Pakhapani	PWM and Local Governance Project in Patlekhet, Jhin, Pakhapani VDCs
18	Upper Myagdi	93.71	Kuinemangale, Malkabang, Mudi,	Under RCUP, pgm implemented in Upper Kaligandaki W from 037/38, 045/46 – 047/48 by GON, 048/49- 53/54 ADB, 054/55- 060/61 by NARMSAP

Parbat District				
1	Khahare Khola	24.89	Pang, Khurkot, Dulung, Shivalay	
2	Lastikhola	34.65	Banau, Dhairing, Nanglibang	Management plan; Pgm implemented
3	Malyangdi Khola	22.36	Karkineta, Khaulalankuri, Mudhikuwa, Shankarpokhari, Thapathana, Pipaltari, Thulipokhari, Katuwachaupari	Management plan; Pgm implemented
4	Sedikhola	43.88	Beulibas, Hosrabas, Lunkhudeurali, Pakhapani, Saraunkhola, Saligram, Taklak, Tribeni, Urampokhara	
5	Bahaki	30.87	Bachcha, Bihadi, Barrachaur, Bahaakithanti, Urampokhara, Ranipani	
8	Phantkhola	54.62 Largest	Banskharka, Lekphat, Mallaj	
13	Upper Modikhola	15.6	Chuwa, Durlung, Kyang, Bajung, Tilahar	
15	Patikhola	42.53	Kyang, Bajung, Deurali, Deupur	Management plan; Pgm implemented

Baglung District				
1	Lower Kanthekhola	42.37	Bhakunde, Tityang, Palakot, Baglung M., Bhimpokhara, Sigana	WM program
2	Theulekhola A	34.21	Rangkhani, Paiyunthanthap, Sarkuwa, Damek	,,
3	Theulekhola B	30.25	Dhullu, Jaidi, Arjewa, Binamare, Kusmisera, Sarkuwa	,,
4	Upper Kanthekhola A	40.95	Bhimpokhara, Dhamja, Tangram, Bihunkot	,,
5	Upper Kanthekhola B	34.97	Lekhani, Resh, Bihunkot, Sigana	,,
6	Malika	20.63	Malika and Baglung M	
18	Upper Badigadkhola	112.72	Burtibang, Rajkut, Bhingithe, Adhikarichaur, Devisthan	
38	Tarakhola	64.73	Tara	

Gulmi District				
1	Jogithumkhola	22.05	Tamghas, Arkhale	
2	Kharjyangkhola	44.26	Kharjyang, Hardineta, Birbas, Amararbathok, Darbar Devisthan, Gaundakot	WM programs implemented from 58/59 – 62/63
3	Dubichaur	39.06	Darbar Devichaur, Simichaur, Gaundakot, Dubichaur, Tamghas	
4	Ghatmata	16.38	Dubichaur, Balithum, Paralmi, Tamghas	
5	Digam	23.94	Ruru, Thanpati, Baletaksar, Digam	WM programs being implemented from 064/65

Palpa District				
4	Mid Nisdikhola	30.21	Galdha, Mityal, Jhirubas, Darchha	
13	Purbakhola	37.08	Jyamire, Bahadurpur, Jalpa, Archale, Siluwa	WM programs implemented in 065/066
15	Kurungkhola	41.39	Bandi Pokhara, Baughagumba, Deurali, Baugha Pokharathok, Khasyali, Argali, Khyaha	
16	Upper Purbakhola	46.12	Siluwa, Ringnerah, Birkot, Tahun, Humin, Jalpa, Devinagar	
17	Sardewakhola	57.3	Khasyauli, Kusum, Palungmainadi, Deurali, Khyaha, Chhahara, Somadi, Siddheswor, Mujhung	WM programs implemented in 066/067
18	Tamakhanikhola	18.78	Siluwa, Khaliban, Birkot, Rignerah	WM programs implemented in 066/067
29	Ramdikhola	61.13	Foksingkot, Chidipani, Nayaranmatales, Khanichhap, Chanpani, Darlamdanda, Yamgha	

Nawalparasi District				
1	Kerungekhola (Gondrikhola)	101.52	Dhaubadi, Shivamandir, Deurali, Kawasoti, Kumarbarti, Argyauli	
2	Debusakhola	41.27	Dandajhairitari, Bulingtar, Dhoubadi, Arkhala	
3	Bungdikhola	67.41	Rakuwa, Dedhagaun, Mithukaram, Naram	
4	Nirandikhola	68.83	Bharatipur, Mithukaram, Naram, Jaubari, Dhoubadi, Arkhala	
5	Arunkhola	76.55	Mainaghat, Rakachouli, Nayabelhari, Parsauni	

Arghakhanchi District				
1	Upper Khanchikhola	36.95		WM plans
2	Sangnekhola	36.67		WM plans; Program in certain wards; Not in CHAL
3	Gachchekhola	15.69		WM plans; Program in certain wards
4	Mathurakhola	13.18		WM plans; Program in certain wards
5	Wadakhola	2.14		,,
6	Jarrekhola	31.02		WM plans
7	Sisnekhola	19.62		WM plans; Program in certain wards; Not in CHAL

(Source: Shrestha et al. 1997)

Annex 8.6: Brief Descriptions of Programs and Projects and Perceived Critical Sub-Watersheds and Microwatersheds in Each District

1. Nuwakot

Different SCWM activities/programs have been implemented by NARMSAP in Gerkhu and Salankhu VDCs. Salankhukhola SW includes Manakamana, Fikuri, Kaule, Bhalche, Salme, Bungtang, Deurali and Tupche VDCs. Its area is 104.91 sq. km and encompasses 34 landslides. Gerkhukhola SW is 25.26 sq. km, extends 610-1,619 m amsl, and includes Gerkhu, Bageswori, and Bidur VDCs. SCWM programs/activities started in this SW from 053/054. Main SWs in Nuwakot district are given as follows:

Main Sub-Watersheds in Nuwakot District

SWs	Area sq. km	Max elev	Min elev	Length of streams
1. Phalakhukhola	150	4590 m	625 m	26.5 km
2. Salakhu khola	120	3580	640	18.5
3. Tadi khola	390	5150	560	43.5
4. Likhu khola	165	2730	560	27.5
5. Kalphu khola	185	2317	450	39

Though sub-watersheds are identified and areas in each sub-watershed lying under high, moderate and low erosion potential calculated, prioritization has not been completed. However, Darme, Gerkhu, Upper Salankhu and Ghyangphedi have been identified as prioritized SWs. As per DSCO, Mr. Khruschev Shrestha, critical SWs in the district are:

1. Samrikhola sub-watershed encompassing Samri, Kalyanpur, Deurali, Tupche, and Bidur municipality with inhabitants of mixed ethnic group. Its water management plan has been prepared.
2. Dorkhukhola sub-watershed in Narjamandap, Kharanitar, Lachyang, Urleni and Raluka VDCs with inhabitants of mixed ethnic group.
3. Darmekhola sub-watershed in Ganeshthan, Haldekalika, Bageswori, Narjamandap and Lachyang VDCs; majority of ethnic people.
4. Charkekhola SW in Rautbesi, Samundratar, Balkumari, Betini and Gaunkhrka VDCs; majority of ethnic Tamang.

In addition, micro-watersheds identified are:
1. Sermangkhola MW in Bungtang VDC and
2. Chamelikhola MW in Bidur municipality.

2. Rasuwa

Eight subwatersheds have been identified, however, they have not been prioritized. In addition to programs shown in this annex, , the FARM program has been implemented in Goljung and Shyafru VDCs.

As per Bishnu Bhandari, DSCO, Rasuwa (2012) critical watersheds are:

Number 4 Upper Trishuli Ganga sub-watershed because of hydro projects in the pipeline, three VDCs on each side of the sub-watershed. It includes Ghattekhola micro-watershed- 10 sq km in size which has 22 landslides - large and small, river bank cutting, 42 water sources, 150 ha barren land to be planted. It is inhabited by 199 households of Tamang ethnic community. As no development work haas been carried out in the area so far, people are very interested to participate in SCWM works. The MW lies in Haku VDC, Ward Nos. 2,3,4,5,6, and 7, and is about eight hours walking distance from Dhunche.

In Number 3 Tallo Trishuli Ganga sub-watershed, Andherikhola MW is a critical micro-watershed. It includes Thulogaun VDC, Ward nos. 1,2,6,7, and 8; it is inhabited by 125 households, the majority being Gurung, with some Brahmin/Chhetry households. It has problems due to several landslides, land degradation, slope land farming, water source, etc. It is located seven kilometers from Dhunche and is accessible by road.

3. Dhading

Critical sub-watersheds (as per DISCO, Mr. Krishna P Ghimire) are:

Number 1 Agarakhola sub-watershed which includes Bhumesthan, Thakre, and Tasarpu VDCs. Its water management plan is being prepared. Problems include more manual aggregate collection from streams, land degradation in Thakre. Being a south to north (north facing) SW, Tasarpu VDC is potential for ecotourism. The area extends to Daman in Makwanpur and may be important from corridor connectivity point of view. Number 13 Malekhukhola sub-watershed has problems of land degradation, aggregate collection more; no water management plan has been prepared.

4. Makawanpur

The Kulekhani project implemented programs/ activities from 035/36-057/58 under USAID, UNDP/FAO, FINNIDA and the EU in five phases. Rashtrapati Churia Conservation Program is being implemented since 067/68 in Churia region VDCs viz. Raigaun, Phaparbari, Dhinyal, Chhatiwan, Harnamadi, Hatiya, Churia Mai, Padampokhari, Handikhola and Manahari in this district. Shakti Khola sub-watershed is selected for upstream-downstream conservation (downstream by Bara district). DISCO-Makawanpur (NA) has prioritized 84 subwatersheds in the district and part of the list of SWs lying in Gandaki basin is given in Annex.

According to Mr. Badri Karki of Makawanpur, during the Pokhara cluster meeting, Chepangs live in six VDCs in Manohari, where land degradation is more in the sub-watersheds and sedimentation problems, and climate change impact on the Chepangs. Critical sub-watersheds, as based on discussions at Manahari with forest guardss, school teachers, the FUG secretary and FUG member of Baghbhairab and Polghari C Forest are as follows:

1.Jirkhekhola - Kankada and Devitar: much of the area (about 1,000ha) is affected by landslides near Kuttasing, Baran 8,9 and 3 Wards and Raxirang VDC in 2050 and 2059 BE. The area of the sub-watershed is about 2,100ha and is inhabited by 200-300 households (HHs) of marginalized people like Chepang, Biswokarma and Tamang, who practice shifting cultivation. It is located 3km from the highway, and has about 400ha forest.

2. Pangthalikhola sub-watershed, which is a tributary of Lotharkhola, includes Kankada 4, 5, Shilaghani, Silinge and Madaldamar. Its area is about 3,000ha of which 2,500 has been destroyed by flood and landslides and the forest area is only 200ha. About 200 HHs of marginalized people like Chepang, Biswokarma, and Tamang live in the area and depend on shifting cultivation.

5. Chitwan

There is no DISCO in Chitwan. Makawanpur DISCO has been given the responsibility of implementing programs on a needs basis in the district.

Kalikhola SW of 992.4 ha in Chandibhanjyang VDC can be considered a critical SW as it is inhabited mostly by the Chepang ethnic group. Agriculture and shifting cultivation are practiced on steep slopes (Balla et al., 2003). Lotharkhola subwatershed area (Korak, Piple VDCs) was destroyed by flood and landslide in 2050 and 2059. It is mostly inhabited by Chepangs.

6. Gorkha

Fifty four sub-watersheds are prioritized. RCUP implemented water management programs from 2036/37- 044/45 in Daraundi watershed (whole) of 800 sq km with 29 whole or partly covered VDCs.

According to Mr. Ramhari Pantha, DSCO Gorkha, Critical sub-watersheds are:

Chepekhola sub-watershed that forms the border between Gorkha and Lamjung (Ligligkot and Lamjungkot), will have visual impact and arouse competition between Gorkha and Lamjung DISCOs for better water management. Gorkha has a historical background of some significance.

Number 2 Sirdikhola sub-watershed includes Gorkha Municipality, 1-9 Wards. Problems include sedimentation, uncontrolled urbanization and road construction, and destruction of thousands of ropanis of land. Water management plans have been prepared, and some SCWM programs have been carried out. Number 20 Jyadulkhola sub-watershed encompasses Bungkot VDC 4 and 5 Wards and Asrang VDC. There are problems of sedimentation and no works have been done so far in this SW.

7. Lamjung

Water management programs implemented in Paundikhola SW (50 km2) area. Water management programs being implemented in Puwa-Majuwa SW (19.6 km2), situated at altitude of 667-1,912m, which includes whole or part of Besisahar, Gaunsahar, Chandisthan and Nalma VDCs. This sub-watershed is prioritized as number one. Water management programs are being implemented in Pistikhola SW (25 km2). No satisfactory work is being done due to no motivation and low participation by the community.. Also, it is located far from Besisahar.

Altogether 23 sub-watersheds have been prioritized in the district. Some errors are reported in the prioritization and therefore, need rectification in prioritization. According to Mr. Rajendra Bohora, Madhya Marshyangdi Project Sarokar Samiti, and Ramesh Subedi, Khudikhola, Nyadikhola (a total of

200 sq. km) are critical sub-watersheds because of construction of hydropower at Nyad, Degradation in sub-watersheds and contributing sediments to the Marshyangdi River due to cultivation of steep slopes of 70-80 percentage. According to Khem Gurung, Janajati Mahasangh, Chepe, Dordi, and Kishedi sub-watersheds form corridors and are problematic areas due to dryness and degradation.

8. Tanahun

In Chhabdikhola SW, WM program implemented from 048/49-052/53 by GoN with ADB loan; in 053/54 by GoN; from 054/55 by NARMSAP; Replication of CDFWCP program from 061/62 with Japan KR2 fund. WM plan prepared for Chhabdikhola, Chitikhola and Chundikhola SWs. A total of 42 SWs have been prioritized in the district (Annex).

9. Syangja

GoN and Care Nepal implemented the Upper Andhikhola Watershed Management Project from 1992-2002 in Bicharichautara, Chilaunebas, Bangsing Deurali, Bangephandke, Arukharka, Bhatkhola, Phedikhola, Setidobhan, Faparthum, Pauwaigaunde, Thuladihi, and Bahakot VDCs and Putalibazar municipality in Syangja and Arthar and Karkineta VDCs in Parbat District, encompassing 180 km2 . GoN implemented watershed management programs in Lubdhikhola sub-watershed from 055/56 in Sworek, Khilung Deurali and Dhapuk VDCs. Micro watershed conservation demonstration programs implemented in Daraun MW in 1995 in Daraun and Panchamul VDC, a tributary of Andhikhola, Chaudillachaur, Putalibazar in 060/61, Kukhurikhola MW in Fedikhola in 061/62 and Pokharichaur, Putalibazar in 061/62. CDFWCP implemented WM programs in Pelakot, Sisnekot, Thumpokhara, Jagat bhanjyang, Keware Bhanjyang, Glyankot, Biruwa Archale, Kichnas and Rangbhang VDCs. Integrated planned water management programs are implemented in Number 26 Upper Jyagdikhola (Barahkhola) sub-watershed consisting of Rangbhang and Biruwa Archale VDCs; and Number 1 Fuandikhola sub-watershed consisting of Sirsekot and Pelakot VDCs. Replication of CDFWCP programs from 060/61 with Japan KR2 fund. CDFWCP implanted programs from 068/69 in Khilung, Dhapuk and Sworek VDCs of Number 28 Lubdikhola SW.

According to DSCO, Mr. Shyam Sapkota, critical Subwatersheds (SWs) are:

1. Priority is Number 13 Chapakot sub-watershed, encompassing Kewarebhanjyang, Kuwakot, Chapakot, Ratnapur VDCs and 42.37 sq. km area.
2. Another priority is Number 8 Tulasibhanjyang sub-watershed encompassing Tulsibhanjyang, Pakwadi, Tindobate VDCs and 20 sq. km area. In both areas, land degradation and forest destruction are very high and steep lands are cultivated. A total of 38 SWs have been prioritized in the district.

10. Kaski

GoN, UNDP/FAO and FINNIDA started the Fewa Tal WC Project in 2031 and continued to 050/51 in Fewatal watershed. GoN and Care-Nepal started the Begnas Tal-Rupatal WC Project in 2042-052/53. JICA- CDFWCP continued water management programs from 051/52-055/56 in BTRT and VDCs not included in ACAP viz. Kristinachne Chaur, Deurali, Arba Bijay, Mauja, Puranchaur, and Chapakot VDCs. The second phase of the JICA- CDFWCP project started from 056/57-060/61 and extended to March 05 in Armala, Bhadaure Tamagi, Pumdi Bhumdi, Siddha, and Thumki VDCs. Replication of program from 060/61 with Japan KR2 fund in Bhalam VDC and from 061/62 in Dhikurpokhari VDC.

Critical sub-watersheds as mentioned in the Annual Progress Report 062/63 are given in Annex. Sthapit, K.M. and M. K. Balla (1998). Based on estimated soil loss and presence of landslides and sediment contribution directly to the lake, critical sub-watersheds/management plas of Fewa lake are:

- SW 1, unknown in Pumdi of Fewa watershed with slope 6-77 percent, average slope 30 percent directly draining to silt trap area of lake.
- SW 2, Bhumdikhola in Kaskikot of Fewa watershed with slope 11-72 percent, avg slope 27 percent.
- SW 3, Marsekhola in Kaskikot of Fewa watershed with slope 3-60 percent, avg slope 26 percent..
- SW 4, Budhimulkhola in Kaskikot of Fewa watershed with slope 2-43 percent, average slope 20 percent..
- DISCO, Kaski Annual report 062/63 mentioned critical areas in Madi River, Bijaypur Khola, Kalikhola, Seti, Mardi, Modi, Harpankhola, Fusrekhola and Suraundikhola watersheds. Out of these, on a sub-watershed basis, the critical sub-watersheds are given in the following table:-

S.No.	SWs	Area (km²)	VDCs
1	Sardikhola	52.29	Sardikhola, Puranchaur
2	Idikhola	60.48	Lumle, Lwang Ghalel, Rivan, Dhampus, Dhital
3	Harpankhola		Kaskikot, Dhikurpokhari, Sarangkot, Bhadauretamagi
4	Kalikhola		Armala, Bhalam

11. Manang

No DISCO exists in Manang District.

12. Mustang

RCUP project under the upper Kaligandaki Watersged Conservation Project implemented water management programs from 038/39-044/45, GoN continued watershed conservation programs from 045/46-47/48 from internal funding and with ADB loan from 048/49-051/52. WM programs are being implemented in Pangbukhola, Thapakhola, Larjungkhola, Letekhola, Rajkhola, Upallo Jhongkhola, and Tallo Jhongkhola and Lungpakhola SWs.

13. Myagdi

RCUP implemented watershed management programs in the Upper Kaligandaki Watershed from 037/38, GoN from 045/46 – 047/48, ADB from 048/49- 53/54, NARMSAP from 054/55-060/61 and GoN and Japan KR 2 CDFWCP from 062/63 in Lower Myagdi sub-watershed in Singa and Pulachaur VDCs for pasture management and the Swiss Government financed sustainable land management in Arthunge and Pulachaur VDCs.

As per DISCO Mr. Diwakar Paudel, critical sub-watersheds that need watershed management work are Number 5 Marang SW and Number 7 Rukse for which plan have been prepared. Mudi, Bim, Chikhola, Tatopani, Rum, Niskot, Arman, Baranja, Singa, Arthunge, Ghatan, Piple and Jhin VDS have landslides hazards. Altogether 20 sub-watersheds have been prioritized in Myagdi District (Annex).

14. Parbat

JICA/JOCV CDWFCP implemented water management programs from 051/52- 55/56 in Thulipokhari, Thapathana, Bhangara Sirubaari and Tribeni VDCs; 56/57 – 61/62 JICA second phase program in Pipaltari, Limithana, Thanmaula, Saraunkhola amd Beulibas VDCs; from 62/63 Japan KR 2 program in the same VDCs. From 63/64, watershed management programs are being implemented in addition to the above five VDCs, in Lastikhola, Patikhola, and Malyangdikhola sub-watershed encompassing six VDCs viz. Dhairing, Banau, Kyang, Deupur, Midhikuwa and Khaunlalankuri. Following the CDFWCP working approach and model, water management programs are implemented from 60/61 in Khaulalankuri and from 61/62 in Chuwa VDC selected as model replication VDCs. Management plans have been prepared for Lastikhola, Patikhola, and Malyangdikhola sub-watersheds.

Landslide prone areas are present in Deupur, Tilahar, Nanglibang, Bajung, Balakot, Hoshrangdi, Thanamaula, Barrachaur and Dhairing VDCs; stream bank cutting problems in Lugdikhola, Paiyun, Rati, Lasti, Malyangdi, Patikhola SWs. According to Ram Chandra (prior DISCO, Parbat) Saraikhola Subwatershed is critical because of problems of destruction of irrigation canal to irrigate productive lands. As per DISCO, Mr. Raju Sapkota, Lugdikhola sub-watershed is critical encompassing Mallaj, Lekhphant and Shalija VDCs degradation is high, damage due to haphazard road construction, potential from an eco-tourism point of view and developing as a demonstration sub-watersed as it also accessible. A total of 18 sub-watersheds have been prioritized in the district.

15. Baglung

GoN implemented water management programs in Kathekhola sub-watershed in 2050 and NARMSAP from 055/56 - 060/61. CDFWCP implemented water management programs from 061/62 in Number 2 priority Theulekhola sub-watershed in Rangkhani and Paiyunthanthap VDCs, and from 062/63 in Sarkuwa and Damek VDCs.

A total of 40 sub-watersheds have been prioritized in Baglung District (Annex). Sarkuwa, Arjewa and Rangkhani VDCs are landslide prone areas.

16. Gulmi

Sub-watershed management plans for Setikhola, Chhaldi Panah, Kali, Sotabagar, Ulli, Lower Chhaldi, Kharjyang and Hugdikholas have been prepared. Different programs have been implemented from 052/53 in Setikhola, Chhaldi Panah, Kali, Sotabagar, Ulli, Lower Chhaldi sub-watersheds. Water management

programs implemented from 58/59 – 62/63 in Kharjyangkhola sub-watershed with an area of 36.47 sq. km encompassing Kharjyang, Hardineta, Birbas, Gaundakot, Daungha, Darbardevisthan, and Amararbathok VDCs. Water management programs implemented from 63/64 in Chhaldikhola SW with an area of 109.33 sq. km in Marbhung, Chhapahile, Sirseni, Ghamir, Dohali, Arjai, Esmarjsthal, Bagla, Amarpur, Ghurkot Rajsthal, Darlamchaur, Hastichaur, and Bastu VDCs. Watershed management programs being implemented from 064/65 in Digamkhola Sub-watershed with an area of 23.30 sq. km in Ruru, Thanpati, Baletaksar, Digam VDCs. Thirty eight sub-watersheds have been prioritized.

17. Palpa

Swiss/GTZ implemented Tinau WC Project from 033/034 -044/045; GoN from 045/046 – 053/054; NARMSAP from 054/055 – 063/064; and GoN in priority watersheds from 064/065. Water management programs implemented in sub-watershed Number 13 Purbakhola in 065/066, and in sub-watershed Number 17 Sardewakhola (western part of the district) and sub-watershed number 18 Tamakhanikhola (eastern part) from 066/067.

According to DISCO, Mr. Gopal Ram Paudel, critical sub-watersheds are: 1. Number 16 SW Upper Purbakhola because of landslides including Sakheni landslide; Number 29 sub-watershed Ramdikhola because of steep slopes and on both sides of highway for developing as a demonstration sub-watershed and is inhabited by ethnic Magar community; 3. Number 15 SW Kurungkhola from eco-tourism point of view and Ranimahal is in this sub-watershed. Altogether 40 sub-watersheds have been prioritized part of the list of sub-watersheds in the Gandaki Basin..

18. Nawalparasi

Critical sub-watersheds as mentioned in meetings are located in Kawasoti, Shivamandir, Arkhala, Dhoubadi, Bulingtar, Dedhagaun, Rakuwa, Bhratipur, Narayani, Dumkibas, Parsauni, Kotghar, and Dandajhairitari VDCs as these have landslide affected areas. The five SWS prioritized in the district are presented in Annex .

19. Arghakhanchi

Water management plans made and programs implemented in certain wards in Shirlingkhola SW (not in CHAL), Mathura Khola SW, Wadakhola sub-watershed, Bangikhola sub-watershed, Ran Singhkhola sub-watershed (Not in CHAL) , Gachhekhola sub-watershed, Sisnekhola sub-watershed (Not in CHAL), and Jarrekhola sub-watershed. In addition WM plan prepared for Bhadrikhola sub-watershed.

According to DISCO Mr. Krishna Paudel, VDCs like Thada, Siddhara and Jukena (not in CHAL) and Simpani VDC (Ban Ganga SW) in Churia are critical. Sub-watersheds in the district are not prioritized or not available.

(Source: Present study)

Annex 8.7: Vulnerability of Sub-watersheds Based on Vulnerability Class of Watersheds by Various Indices

Sub-Watershed	Area (km²)	VDCs	District	Watershed	CMVI Class	CSI Class	CER Class	CMRE Class	CMAC Class	Remarks
Samrikhola	NA	Samri, Kalyanpur, Deurali, Tupche, and Bidur municipality	Nuwakot	Upper Trishuli (61)	L	M	L	L	M	Inhabitants of mixed ethnic group. WM plan has been prepared
Darmekhola	NA	Ganeshthan, Haldekalika, Bageswori, Narjamandap and Lachyang	Nuwakot	Tadikhola (51)	L	H	L	L	M	Majority of ethnic people
Ghattekhola MW	10	Haku	Rasuwa	Upper Trishuli (61)	L	M	L	L	M	22 landslides- large and small, river bank cutting, 42 water sources, 150 ha barren land
Andherikhola MW	NA	Thulogaun	Rasuwa	Upper Trishuli (61)	L	M	L	L	M	Several landslides, land degradation, slope land farming, water source, etc.
Agarakhola	36.8	Bhumesthan, Thakre, and Tasarpu	Dhading	Maheshkhola (57)	L	H	M	L	M	Aggregate collection from streams, land degradation, Tasarpu is potential for ecotourism; WM plan
Malekhukhola	37.79	Benighat, Madevsthan, Gajuri	Dhading	Middle Trishuli (59)	M	H	L	L	M	Land degradation, aggregate collection more; no WM plan
.Pangthalikhola	30	Kankada, Shilaghani, Silinge and Madaldamar	Makawanpur	Gorandhikhola (56)	L	L	L	L	M	Flood and landslide hazard; forest in small area only; 200 HHs of marginalized people like Chepang, BK and Tamang
Jirkhekhola	21	Kankada and Devitar	Makawanpur	Gorandhikhola (56)	L	L	L	L	M	Landslides; 200-300 HHs of Chepang, Biswokarma and Tamang; shifting cultivation
Lower Jyadulkhola	29.93	Borlang, Bungkot, Asrang	Gorkha	Budhigandaki (63)	H	H	M	H	M	Problems of sedimentation and no WM works
Puwa-Majuwa	19.6	Besisahar, Gaunsahar, Chandisthan and Nalma	Lamjung	Marsyangdi (67)	M	H	L	M	H	Prioritized as 1
Khudikhola	NA	NA	Lamjung	Marsyangdi (67)	M	H	L	M	H	Construction of hydropower; degradation contributing sediments to Marshyangdi river due to cultivation of steep slopes of 70-80%.
Buldikhola	NA	Byas M, Ghansi kuwa, Tanahunsur, Barbhanjyang	Tanahun	Lower East Seti (69)	L	M	L	M	H	Prioritized as 1
Chhabdi	NA	Byas M, Ghansi kuwa, Keshabtar, Pokhari bhanjyang	Tanahun	Lower East Seti (69)	L	M	L	M	H	Prioritized as 2
Chapakot	42.37	Kewarebhanjyang, Kuwakot, Chapakot, Ratnapur	Syangja	Lower Kaligandaki (72)	M	H	L	H	H	Priority # 13; land degradation and forest destruction are very high and steep lands are cultivated

Sub-Watershed	Area (km²)	VDCs	District	Watershed	CMVI Class	CSI Class	CER Class	CMRE Class	CMAC Class	Remarks
Tulasibhanjyang	20	Tulsibhanjyan, Pakwadi, Tindobate	Syangja	Lower Kaligandaki (72)	M	H	L	H	H	Priority # 8; land degradation and forest destruction are very high and steep lands are cultivated
Bhumdi-Marsekhola	NA	Kaskikot	Kaski	Upper East Seti (73)	M	VH	M	H	VH	Landslides and sediment contribution directly to the lake
Sardikhola	52.29	Sardikhola, Puranchaur	Kaski	Upper East Seti (73)	M	VH	M	H	VH	Land degradation; recent flood
Letekhola	37.02	Lete	Mustang	Upper Kaligandaki (83)	M	M	L	H	H	Priority # 1; WM program
Pongkyukhola	36.86	Marpha	Mustang	Upper Kaligandaki (83)	M	M	L	H	H	Priority # 2
Syang	35.91	Marpha, Jomsom	Mustang	Upper Kaligandaki (83)	M	M	L	H	H	Priority # 3
Rukse	48.75	Dana, Narchyang	Myagdi	Upper Kaligandaki (83)	M	M	L	H	H	WM plan; Priority # 7
Marang	100.8	Darbang, Marang, Kuinemangale, Bim, Malkabang, Takam, Mudi	Myagdi	Myagdikhola (84)	L	L	L	M	M	Priority # 5
Lugdikhola	NA	Mallaj, Lekhphant and Shalija	Parbat	Upper Kaligandaki (83)	M	M	L	H	H	Land degradation, damage due to road construction, eco-tourism and developing as a demonstration SW
Lastikhola	34.65	Banau, Dhairing, Nanglibang	Parbat	Upper Kaligandaki (83)	M	M	L	H	H	WM plan; Stream bank cutting; Priority # 2
Theulekhola A	34.21	Rangkhani, Paiyunthanthap, Sarkuwa, Damek	Baglung	Middle Kaligandaki (80)	M	H	L	L	H	Priority # 2
Theulekhola B	30.25	Dhullu, Jaidi, Arjewa, Binamare, Kusmisera, Sarkuwa	Baglung	Middle Kaligandaki (80)	M	H	L	L	H	Priority # 3
Kalikhola	7.7	Juhang, Junia	Gulmi	Middle Kaligandaki (80)	M	H	L	L	H	WM plan
Ullikhola	26.93	Baletaksar, Bamgha, Hunga, Digam, Pallikot	Gulmi	Middle Kaligandaki (80)	M	H	L	L	H	WM plan
Upper Purbakhola	46.12	Siluwa, Ringnehar, Birkot, Tahun, Humin, Jalpa, Devinagar	Palpa	Lower Kaligandaki (72)	M	H	L	H	H	Landslides including Sakheni landslide; Priority # 16

Sub-Watershed	Area (km²)	VDCs	District	Watershed	CMVI Class	CSI Class	CER Class	CMRE Class	CMAC Class	Remarks
Ramdikhola	61.13	Foksingkot, Chidipani, Nayaranmatales, Khanichhap, Chanpani, Yamgha Darlamdanda,	Palpa	Lower Kaligandaki (72)	M	H	L	H	H	Steep slopes on both sides of highway; demonstration SW; inhabited by ethnic Magar community; Priority # 29
Kerungekhola (Gondrikhola	101.52	Dhaubadi, Argyauli Shivamandir, Deurali, Kawasoti, Kumarbarti,	Nawalparasi	NA						Priority # 1
Debusakhola	41.27	Dandajhairita,Bulingtar, Dhoubadi, Arkhala	Nawalparasi	Lower Kaligandaki (72)	M	H	L	H	H	Priority # 2
Bhadrikhola	NA	Argha, Kimdanda, Nuwakot	Arghakhanchi	Ridikhola (79)	L	H	L	L	H	
Gachchekhola	15.69	Kimdanda, Dhikura, Nuwakot, Dihikitani	Arghakhanchi	Ridikhola (79)	L	H	L	L	H	
Kalikhola	9.92	Chandibhanjyang	Chitwan	Trishuli-Marsyangdi (65)	L	L	L	L	L	Mostly Chepangs; Agriculture and shifting cultivation in steep slope
Lotharkhola	NA	Korak, Piple	Chitwan	NA						Flood and landslide hazard
Chepekhola	NA		Gorkha	Marsyangdi (67)	M	H	L	M	H	Forms border between Gorkha and Lamjung; historical background
Sirdikhola	26.62	Gorkha M	Gorkha	Daraundi (66)	L	M	L	L	M	Sedimentation, uncontrolled urbanization and road construction, and destruction of thousands of ropani

Note: Number in parentheses indicates watershed ID
(Source: IWMI, 2012)

Annex 8.8: District-wise Watershed Management Programs in CHAL Districts

SN	District	Watershed Management Project	Community Development and Forest/ Watershed Conservation	District Soil Conservation	District Soil Conservation (Basin Approach)	Soil Conservation for Livelihood	Biodiversity Support Program in Shiwalik and Terai	Participatory WM and Local Governance	District Soil Conservation (Lapsi Special Program)
1	Kaski		√	√	√			√	
2	Syangja		√	√	√			√	
3	Palpa			√	√				
4	Tanahun	√	√	√	√			√	
5	Gorkha			√	√				
6	Gulmi	√		√	√				
7	Baglung		√	√	√			√	
8	Arghakhanchi			√	√				
9	Parbat	√	√	√				√	√
10	Myagdi	√	√	√	√			√	
11	Mustang			√	√				
12	Lamjung	√		√	√				
13	Nawalparasi			√		√			
14	Nuwakot			√	√				
15	Rasuwa			√	√				
16	Dhading			√	√				
17	Makawanpur	√		√	√		√		

(Source: DSCWM, 2011)

Annex 8.9: Proposed Sub-basins and Watershed Management Offices in CHAL

Sub-Basin	Districts Included	Watershed Management Office
Lower Narayani	Makawanpur, Chitwan, Nawalparasi, Palpa*	
Trishuli	Rasuwa, Nuwakot, Dhading, Gorkha*	Bidur
Daraundi-Marsyangdi	Manang, Lamjung, Gorkha, Tanahun*	Besisahar
Seti-Madi	Kaski, Tanahun,Lamjung*,Syangja*	Damauli
Upper Kaligandaki	Myagdi, Mustang	Beni
Middle Kaligandaki	Parbat, Baglung, Kaski*, Gulmi*	Kushma
Lower Madi-Ridi	Gulmi-Arghakhanchi, Palpa*	Tamghash
Lower Kaligandaki-Tinau	Syangja, Palpa, Tanahaun*, Nawalparasi*	Palpa

*Note: Districts with * are included in jurisdiction of district without **
(Source: DSCWM, 2011)

Annex 9.1: Discharge at Different Locations of Streams/Rivers in the Gandaki Basin

Station no.	Location	River	Discharge (m^3/s)			Extreme Discharges (m^3/s)	
			Avg Monthly/ High & Month	Avg Monthly/ Low & Month	Average Yearly	Max. Instantaneous	Min. Instantaneous
404.7	Mangla Ghat	Myagdi Khola	209 (August)	11.9 (March)	67.4	926; 15/07/1989	6.60; 11/01/1996
406.5	Nayapul near Jhapre Bagar	Modi Khola	195 (August)	9.11 (March)	51.6	2020; 12/08/2002	5.31; 16/03/1998
410	Seti Beni	Kali Gandaki	875 (August)	50.1 (February)	279	3280; 01/07/1975	28.6;11/04/1967
415	Dumrichaur Andhimuhan	Andhi Khola	100 (July)	2.97 (April)	29.9	1590; 17/06/1970	0.13; 11/05/1989
415.1	Borlangpul	Andhi Khola	54.4 (July)	1.65 (March)	14.7	991; 21/07/2002	17/03/2002
419.1	Ansigh-Andhi Ghat	Kali Gandaki	1430 (August)	83.8 (March)	429	6210; 07/07/1998	45.6; 15/02/2003
420	Kotagaon Shringe	Kali Gandaki	1460 (August)	83.2 (March)	443	8050; 06/09/1980	45.5;10/04/1984
428	Lahachok	Mardi Khola	60.0 (August)	2.78 (March)	17.5	273; 26/07/1994	06/05/1975
430	Phoolbari	Seti River	147 (August)	11.3 (March)	49.5	1180; 29/07/1974	14/03/1981
430.5	Damauli	Seti Gandaki	326 (August)	17.8 (March)	111	3860; 22/08/2001	9.16; 12/04/2001
438	Shisa Ghat	Madi River	225 (August)	15.0 (February)	75.0	2060; 12/06/1976	01/04/1993
439.3	Khudi Bazar	Khudi Khola	27.9 (August)	3.53 (February)	10.2	162; 02/08/1987	1.55; 07/03/1987
439.7	Bimal Nagar	Marsyangdi	656 (August)	43.8 (March)	210	2520; 24/06/2000	30.4; 01/04/2004
439.8	Gopling Ghat	Marsyangdi	607 (August)	40.7 (March)	211	3790; 05/08/1974	27.0; 09/04/1985
439.35	Bhakunde Besi	Marsyangdi	372 (August)	29.7 (Feb/March)	128	768; 02/08/2000	22.8; 25/03/2001
440	Garam Besi	Chepe Khola	75.9 (August)	4.47 (March)	24.6	977; 09/07/2003	1.37; 25/03/2001
445	Arughat	Burhi Gandaki	441 (August)	31.0 (February)	163	5210; 02/08/1968	20.2; 16/03/1967
446.8	Betrawati	Phalankhu K.	43.8 (August)	1.81 (March)	12.9	510; 10/09/1971	12/05/1979
447	Betrawati	Trishuli	668 (August)	44.4 (February)	218	2100; 04/08/1985	31.2; 01/04/2006
448	Tadipul Belkot	Tadi Khola	129 (August)	5.23 (March)	39.4	1330; NA/1995	0.38 1.01 22/03/2000
450	Narayan Ghat	Narayani	4670 (August)	279 (March)	1550	15400; 05/08/1974	146; 30/03/2006
460	Rajaiya	Rapti River	76.7 (August)	7.27 (April)	26.1	3260; 31/07/2004	2.18; 07/06/1994
465	Manahari	Manahari K.	74.2 (August)	4.64 (March)	19.7	1730; 21/07/1993	0.22; 11/04/2006
470	Lothar	Lothar Khola	30.2 (August)	1.38 (March)	8.90	1170; 22/07/1993	0.26; 08/04/2001
485	Chitrasari	Buri Rapti	53.7 (August)	2.72 (May)	15.7	400; 17/07/1970	1.00; 01/06/1972

(Source: Department of Hydrology and Meteorology, Various Years)

Annex 9.2: Change in Water Quality due to Disturbances

Location of River	Area of Watershed km²	Avg. Annual flow (m³/s)	Tempera-ture (°C)	pH	DO (ppm)	Conductivity (µS/cm)
Aandhikhola	195	14.5				
Upstream			14.7 to 25.4	8.0	10	51
Downstream			14.9 to 23.5	8.1	7.2	52.2
Arungkhola	215	12.3				
Upstream above distillery			17.4 to 28.5	8.6	8.67	72.5
Downstream of distillery			17 to 26	8.3	7.7	72.2
Karrakhola	96					
Upstream above HID			14 to 25.1	7.33	8.4	68
Downstream of HID			17.2 to 27.4	7.28	7.6	115
Narayani	34960	1576				
Upstream above Narayanghat			14 to 23.9	8.2	8.8	283
Downstream of Narayanghat			16.2 to 28.3	8.8	9.8	273
East Rapti	3110	61				
Upstream before Hetauda			17.8 to 24.1	8.3	8.2	174
Downstream at Bhandara			16.4 to 30	8.0	9.4	420
Seti	3000	52				
Upstream before Pokhara			12.8 to 21	8.5	9.5	54.2
Downstream at Phulbari			14.3 to 20.5	7.9	9.4	63.7

(Source: Jha, 2005)

Annex 10.1: Length (km) of Strategic Road Network (SRN) with Pavement Types in CHAL Districts

District	Type of Road				Road Category					Total SRN
	BT	GR	ER	Total	NH	FRN	FRO	MH	PR	
Nuwakot	94.71	21.00	25.00	140.71	0.00	106.51	34.20	0.00	0.00	140.71
Rasuwa	0.00	50.50	15.70	66.20	0.00	66.20	0.00	0.00	0.00	66.20
Dhading	114.88	20.00	30.20	165.08	94.38	70.70	0.00	0.00	0.00	165.08
Makwanpur	174.97	44.57	70.20	289.74	139.97	125.77	24.00	0.00	0.00	289.74
Arghakhachi	58.91	3.00	84.00	145.91	4.12	99.79	42.00	0.00	0.00	145.91
Chitawan	136.25	54.00	39.00	229.25	88.76	79.49	0.00	0.00	61.00	229.25
Gorkha	23.84	34.00	119.40	177.24	0.00	128.64	48.60	0.00	0.00	177.24
Lamjung	19.17	1.00	51.87	72.04	0.00	70.04	2.00	0.00	0.00	72.04
Tanahu	118.09	9.32	34.08	161.49	71.25	90.24	0.00	0.00	0.00	161.49
Syangja	97.94	10.00	57.00	164.94	78.94	86.00	0.00	0.00	0.00	164.94
Kaski	87.46	5.00	20.50	112.96	35.40	54.06	23.50	0.00	0.00	112.96
Manang	0.00	0.00	29.00	29.00	0.00	29.00	0.00	0.00	0.00	29.00
Mustang	0.00	0.00	59.00	59.00	0.00	59.00	0.00	0.00	0.00	59.00
Myagdi	0.00	10.00	21.00	31.00	0.00	31.00	0.00	0.00	0.00	31.00
Parbat	24.11	0.00	26.50	50.61	0.00	37.61	13.00	0.00	0.00	50.61
Baglung	6.34	5.79	89.00	101.13	0.00	12.13	0.00	89.00	0.00	101.13
Gulmi	44.54	0.00	79.00	123.54	0.00	114.54	9.00	0.00	0.00	123.54
Palpa	108.59	0.00	39.00	147.59	58.93	88.66	0.00	0.00	0.00	147.59
Nawalparasi	151.07	23.80	29.00	203.87	98.47	80.40	11.00	0.00	14.00	203.87

Note: BT=Black Topped, GR=Gravel Road, ER= Earthen Road, NH= National Highway, FRN= Feeder Roads Major (National), FRO=Feeder Roads Minor (Others), MH= Mid Hill Road, PR= Postal Road
(Source: http://www.for.gov.np/documents/list of important_SRN_and _status, pdf)

Annex 10.2: Link Road Network in CHAL

S.N	District Name	Link Name	Length	Pavement Status
1	Makwanpur	Hetauda-Sano Gadhi(Kanti Rajpath)	6	BT
2	Makwanpur	Hetauda-Sano Gadhi(Kanti Rajpath)	10	GR
3	Makwanpur	Sano Gadhi-Baguwa(Kanti Rajpath)	26	ER
4	Makwanpur	Sano Gadhi-Baguwa(Kanti Rajpath)	6	UC
5	Makwanpur	Sano Gadhi-Baguwa(Kanti Rajpath)	15	PL
6	Dhading	Dhading Besi-Aarughat	20	GR
7	Dhading	Dhading Besi-Aarughat	11	ER
8	Gorkha	Aarughat-Dharapani-Gorkha	0.4	GR
9	Gorkha	Aarughat-Dharapani-Gorkha	39.6	ER
10	Chitawan	Tandi, Ratnanagar (MRM)-Sauraha	5	BT
11	Chitawan	Tandi, Ratnanagar (MRM)-Sauraha	2	GR
12	Chitawan	Bharatpur-Meghauli Airport	16	BT
13	Chitawan	Bharatpur-Meghauli Airport	9	GR
14	Chitawan	Meghauli Airport-Dhruwa(PR)	8	PL
15	Chitawan	Anptari (H05)-Devghat	4	BT
16	Tanahu	Dumre (PRM)-Bandipur	8	BT
17	Tanahu	Damauli (PRM)-Jyamiretar	0.8	BT
18	Tanahu	Damauli (PRM)-Jyamiretar	14.25	GR
19	Tanahu	Damauli (PRM)-Jyamiretar	5	ER
20	Lamjung	Jyamiretar-Neupanebesi	5	ER
21	Lamjung	Neupanebesi-Bhorletar	7.7	ER
22	Kaski	Talchok (PRM)-Khudimuhan (Beganas Lake)	3.5	BT
23	Nawalparasi	Bhumahi (MRM)-Parasi	7	ER
24	Nawalparasi	Parasi-Amawa	8	GR
25	Syangja	Malunga (SRM)-Mirmi	19	BT
26	Syangja	Mirmi-Setibeni (Kaligandaki-Kushma)	1	GR
27	Syangja	Mirmi-Setibeni (Kaligandaki-Kushma)	13	PL
28	Parbat	Setibeni-Gupteswor(Kaligandaki-Kushma)	52	PL
29	Gulmi	Ridi-Rudrabeni-Wami Taksar	57	ER
30	Baglung	Burtibang-Barula Kharka(Dhorpatan)	38	PL
31	Makwanpur	Bastipur-Makri-Pashupatinagar(Hetauda Bypass)	15	PL
32	Makwanpur	Lothar (MRM)-Damrang	13	PL
33	Chitawan	Damrang-Chuniyadhara	13	PL
34	Dhading	Chuniyadhara-Malekhu	14	PL
35	Tanahu	Khairenitar (PRM)-Bhimad-Ghumarighat	8	ER
36	Tanahu	Khairenitar (PRM)-Bhimad-Ghumarighat	41	PL
37	Nawalparasi	Ghumarighat-Pangre-Nawalpur (Kawaswoti)	57	PL
38	Kaski	Gagangaunda (PRM)-Khudi (Access to PU)	1	GR
39	Kaski	Gagangaunda (PRM)-Khudi (Access to PU)	1	ER
40	Palpa	Aryabhanjyang-Amalang	4	GR
41	Palpa	Aryabhanjyang-Amalang	30	ER
42	Palpa	Aryabhanjyang-Amalang	5	UC
43	Palpa	Aryabhanjyang-Amalang	14	PL

S.N	District Name	Link Name	Length	Pavement Status
44	Nawalparasi	Amalang-Gaindakot	56	PL
45	Makwanpur	Chitlang Bhanjyang-Chandragadhi-Markhu	14	ER
46	Syangja	Putalikhet-Karkineta	20	ER
47	Syangja	Putalikhet-Karkineta	5.98	UC
48	Parbat	Putalikhet-Karkineta	0.02	UC
49	Parbat	Karkineta-Kusma(Majhbeni)	5	UC
50	Parbat	Karkineta-Kusma(Majhbeni)	16	PL
51	Syangja	Mirdi-Chitre Bhanjyang	2	GR
52	Syangja	Mirdi-Chitre Bhanjyang	17	ER
53	Syangja	Mirdi-Chitre Bhanjyang	5	UC
54	Syangja	Mirdi-Chitre Bhanjyang	17	PL
55	Tanahu	Chitre Bhanjyang-Bhimad	18	PL
56	Nawalparasi	Dumkibas (MRM) - Tribeni	10	ER
57	Nawalparasi	Dumkibas (MRM) - Tribeni	13	PL
58	Nuwakot	Damki-Phalante (Nuwakot Darbar Access Road)	6	BT
59	Nuwakot	Damki-Phalante (Nuwakot Darbar Access Road)	2	GR
60	Nuwakot	Kuwapani-Kakani-Kaulethana(F21)	4	BT
61	Nuwakot	Kuwapani-Kakani-Kaulethana(F21)	2.5	PL
62	Nuwakot	Dandagaun(KVRR)-Gurjebhanjyang	0.11	UC
63	Makwanpur	Pakhelchaur-Kulekhani	9	ER
64	Makwanpur	Bhimphedi-Kulekhani	12	GR
65	Parbat	Maldhunga-Beni	13	ER
66	Gulmi	Tamghas-Neta Gaun	9	ER
67	Arghakhanchi	Neta Gaun-Sandhikharka	42	ER
68	Arghakhanchi	Sandhikharka-Asurkot-Lamdanda	33	PL
69	Kaski	Beganastal-Ram Bajar	4	GR
70	Kaski	Beganastal-Ram Bajar	19.5	ER
71	Lamjung	Ram Bajar-Bhorletar	2	PL
72	Nawalparasi	Pratapur-Raninagar-Triveni	6	GR
73	Nawalparasi	Pratapur-Raninagar-Triveni	5	ER
74	Nawalparasi	Pratapur-Raninagar-Triveni	8	UC
75	Mustang	Jomsom-Muktinath	26	PL
76	Nuwakot	Tadi-Labdhu-Samundratar- Golphubhanjyang	8	GR
77	Nuwakot	Tadi-Labdhu-Samundratar- Golphubhanjyang	9.2	ER
78	Nuwakot	Tadi-Labdhu-Samundratar-Golphubhanjyang	3	UC
79	Nuwakot	Tadi-Labdhu-Samundratar-Golphubhanjyang	10	PL
80	Gorkha	11 Kilo(F035)-Chhepetar-Bhaluswara-Barpak	24.5	ER
81	Gorkha	11 Kilo(F035)-Chhepetar-Bhaluswara-Barpak	10	UC
82	Gorkha	11 Kilo(F035)-Chhepetar-Bhaluswara-Barpak	18.5	PL
83	Nawalparasi	Kathawa (IB)-Tribeni	19	PL
84	Baglung	Baglung-Wami Taksar-Burtibang (Midhill)	90	ER
85	Chitawan	Amuwapost(Thori)-Madi-Jagatpur-Bharatpur(MRM)(Postal)	12	BT
86	Chitawan	Amuwapost(Thori)-Madi-Jagatpur-Bharatpur(MRM)(Postal)	39	GR
87	Chitawan	Amuwapost(Thori)-Madi-Jagatpur-Bharatpur(MRM)(Postal)	10	ER
88	Chitawan	Amuwapost(Thori)-Madi-Jagatpur-Bharatpur(MRM)(Postal)	5	PL

S.N	District Name	Link Name	Length	Pavement Status
89	Nawalparasi	Narayanchok - Parasi (Postal)	12	GR
90	Nawalparasi	Narayanchok - Parasi (Postal)	2	ER
91	Lamjung/Manang	Besisahar - Chame Road (Manang 35 km)	65	GR
92	Manang	Chame Road	30	GR
93	Mustang	Ghasa - Jomsong	40	GR
94	Mustang	Jomsong - Kagbeni - Mustang	29	GR
95	Mustang	Koralla - Syangboche (Ghami)	45	GR

Note: BT: Blacktop, GR: Graveled Road, ER: Earthen Road, UC: Under Construction, PL: Planned Road
(Source: http://www.for.gov.np/documents/list of important_SRN_and _status, pdf)

Annex 10.3: Major Existing, Under Construction and Planned Hydropower Plants in CHAL

Existing: Non-NEA

S.No.	Code	Name	Capacity (MW)	River
1	58	Mardi Khola	3.1	Mardi
2	41	Pati Khola	0.96	Pati Khola
3	46	Andhi Khola	5.1	Andhi Khola
4	58	Thoppal Khola	1.65	Thoppal Khola
5	70	Chilime	20	Chilime
6	73	Ridi Khola	2.4	Ridi

Existing: NEA

S.No.	Code	Name	Capacity (MW)	River
1	1	Jomson	0.24	Mustang
2	26	Modi Khola	14.8	Modi
3	31	Seti	1.05	Seti
4	32	Fewa Pokhara	1	
5	44	Kali Gandaki A	144	Kali Gandaki
6	51	Gandak	15	Gandaki
7	52	Marshyangdi	69	Marshyangdi
8	62	Trisuli	24	Trisuali
9	78	Baglung	0.2	Baglung
10	81	Tinau	1.24	Tinau

Under Construction and Pre-Construction

S.N.	Code	Name	Capacity	River Name
1	2	Kali Gandaki Kowan	100	Kali Gandaki
2	7	Upper Marsyangdi 2	125	Marsyangdi
3	13	Upper Khudi Khola	19.5	Khudi Khola
4	16	Dordi Khola	22	Dordi Khola
5	22	Upper Marsyangdi 1	50	Marsyangdi
6	24	Madi 1	20	Madi
7	25	Madi 2	7	Madi
8	28	Upper Madi	19.2	Madi
9	29	Super Madi	7.1	Madi
10	34	Namrjun Madi	11.5	Mardi
11	36	Lower Modi 1	10	Modi

S.N.	Code	Name	Capacity	River Name
12	37	Lower Modi Khola	20	Modi
13	39	Upper Modi (A)	42	Modi
14	40	Upper Modi	14	Modi
15	42	Kali Gandaki Gorge	100	Kali Gandaki
16	45	Andhi Khola	9.4	Andhi Khola
17	56	Budhi Gandaki	600	Budhi Gandaki
18	60	Mathillo Aankhu Khola	9.2	Akhu Khola
19	61	Devighat Cascode	10.2	Trisuli
20	65	Upper Trisuli (Sto)	128	Trisuli
21	68	Upper Trisuli 3a	61	Trisuli
22	69	Upper Trisuli 3b	44	Trisuli
23	71	Sanjen	25	Sangen
24	72	Sanjen Upper	11	Sangen
25	75	Bhim Khola	7.2	Bhim
26	76	Dharam Khola	5	Dharam
27	82	Rahnghat	30	Rahnghat
29	86	Mistri Khola	42	Mistri

Planned

S.N.	Code	Name	Capacity	River Name
1	3	Bimdang Khola	6.85	Bimdang Khola
2	4	Upper Dudh Khola	9.65	Dudh Khola
3	5	Dudh Khola Small	10	Dudh Khola
4	9	Manang Marsyangdi	100	Mara
5	12	Marsyngdi-3	42	Marsyngdi
6	14	Rudi A	10	Khudi Khola
7	15	Marsyangdi Besi	50	Marsyngdi
8	20	Upper Nyadi	10	Nyadi
9	21	Upper Marsyangdi 1	100	Marsyngdi
10	27	Madi Ishanes Hwor (Sto)	86	Madiriver
11	30	Begnas Rupa Sto	9	Rupa Begnas
12	33	Madi-Bhorletor	9	Madi
13	38	Upper Modi	30	Modi
14	48	Upper Seti (Stroeg)	122	Seti
15	49	Seti-Trishuli	142	Trishuli
16	50	Kali Gandaki-2	660	Kali Gandaki
17	54	Budhi Gandaki Kha	43.4	Budhi Gandaki
18	55	Budhi Gandaki Ka	22.2	Budhi Gandaki
19	57	Trishuli-Nadi	20.1	Trishuli
20	63	Trishuli Galchhi	10	Trishuli
21	64	Bhote Koshi (Trishuli)	75	Trishuli
22	66	Upper Trishuli-1	75	Trishuli
23	70	Langtang Strage	218	Langtang
24	74	Badigad	7	Badigad
25	79	Beni Kali Gandaki	50	Kali Gandaki
26	80	Rahughat Magole	16.8	Rahughat
27	84	Nilgiri Khola	20	Nilgiri
28	85	Upper Myagai	20	Myagdi
29	87	Ghalaalemdi Khola	10	Ghalaalemdi

(Source: Nepal Electricity Authority 2012)

Annex 10.4: Existing Irrigation Projects in CHAL

S.N.	Name of Project	District	Irrigated Land (ha.)	
			Summer	Winter
1	Pithuwa	Chitwan	500	100
2	Chitwan	Chitwan	8300	2000
3	Gajui tar	Dhading	100	60
4	Kalleri tar	Dhading	200	0
5	Pipal tar	Dhading	30	30
6	Bat tar lift	Nuwakot	424	0
7	Gadkhar	Nuwakot	100	100
8	Labdhu-dhikuree-s	Nuwakot	180	100
9	Simara	Nuwakot	400	250
10	Buling tar	Nawalparasi	280	225
11	Ded gaon tar	Nawalparasi	150	50
12	West gandak	Nawalparasi	10300	6180
13	Aru tar	Gorkha	100	50
14	Bhimsen kulo	Gorkha	75	50
15	Chepe tar	Gorkha	60	5
16	Chorkate tar	Gorkha	60	20
17	Dhuwakot	Gorkha	44	44
18	Malla tar	Gorkha	50	30
19	Apchaur coffe	Gulmi	100	50
20	Argentichap	Gulmi	60	30
21	Begnas	Kaski	580	580
22	Bijayapur	Kaski	1000	300
23	Pokhara	Kaski	1030	300
24	Hyankga	Kaski	330	200
25	Fewa tal	Kaski	320	100
26	Sardu khola puran	Kaski	200	100
27	Bhorle tar	Lamjung	200	200
28	Hande tar	Lamjung	220	50
29	Ramgha tar	Lamjung	100	50
30	Kachalphant	Palpa	282	0
31	Gyandi	Parbat	60	30
32	Phalebas	Parbat	325	75
33	Kisan adhighat	Syangja	0	0
34	Atrauliputrar	Tanahu	450	300
35	Sajha tar	Tanahu	40	20
36	Sanghe patyani	Tanahu	100	50
37	Chhonup	Mustang	51	0

(Source: Department of Irrigation 2007 and unpublished data 2012)

Annex 10.5: Existing Farmer Managed Irrigation Schemes in CHAL

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
1	Burirapti-III	Chitwan	264	158	70
2	Khumjor1v	Chitwan	68	0	0
3	Meghalu	Chitwan	64	0	0
4	Pampha khola	Chitwan	70	0	0
5	Asruli tar	Dhading	6	0	0
6	Baguwa khola	Dhading	7	0	0
7	Baj khet	Dhading	5	0	0
8	Bar khola	Dhading	14	0	0
9	Beakhu khola	Dhading	25	0	0
10	Bhajrdip	Dhading	8	0	0
11	Bhalu khola	Dhading	6	0	0
12	Bhamangpida	Dhading	11	7	3
13	Chanaute phant	Dhading	11	0	0
14	Churamani	Dhading	6	3	1
15	Danagade	Dhading	7	44	2
16	Gadare khola	Dhading	11	0	0
17	Has tar	Dhading	7	4	2
18	Hugdi khola	Dhading	18	10	5
19	Khaireni khola	Dhading	7	0	0
20	Mahadev besi	Dhading	30	18	9
21	Malekhu khola	Dhading	14	0	0
22	Mane gaon	Dhading	35	21	10
23	Mul khola	Dhading	50	0	0
24	Pachase khola	Dhading	11	0	0
25	Sadi khola	Dhading	30	0	0
26	Saune khola	Dhading	10	6	3
27	Seti pakha	Dhading	4	0	0
28	Shankar khola	Dhading	7	4	2
29	Tharpu dhara	Dhading	8	0	0
30	Ahale khola	Dhading	13	0	0
31	Ahali gaon	Dhading	5	0	0
32	Anp tarinikaantha	Dhading	19	0	0
33	Bel tar,gajuri-4	Dhading	25	15	7
34	Bikhyakhrt	Dhading	13	7	3
35	Birkhe tar	Dhading	10	0	0
36	Cha khola	Dhading	30	0	0
37	Chakra khola	Dhading	24	0	0
38	Danda tale	Dhading	15	0	0
39	Dangdunge khola	Dhading	44	0	0
40	Dansingkharka	Dhading	20	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
41	Dhodeni khola	Dhading	15	0	0
42	Dhonehisokas-3	Dhading	13	0	0
43	Fedi khola	Dhading	6	0	0
44	Garang	Dhading	20	0	0
45	Garduwa khola	Dhading	8	0	0
46	Ghatte khola	Dhading	10	0	0
47	Ghumti khola	Dhading	15	0	0
48	Gumdi-3	Dhading	5	0	0
49	Jamu tarbelkhu	Dhading	90	0	0
50	Jogi tar	Dhading	20	0	0
51	Jorgahatte,pida	Dhading	12	7	3
52	Kadam khola	Dhading	18	0	0
53	Kali tar	Dhading	21	0	0
54	Karelithimka	Dhading	15	0	0
55	Karki danda	Dhading	16	0	0
56	Kartike tar	Dhading	14	0	0
57	Khar bari	Dhading	8	0	0
58	Kupa khola	Dhading	8	0	0
59	Maheshkhala-8	Dhading	10	0	0
60	Mahes tarkalleri - 3	Dhading	20	0	0
61	Mulkharka	Dhading	25	0	0
62	Odare khola	Dhading	15	0	0
63	Pakhure,pida	Dhading	12	7	3
64	Palakhu khola	Dhading	6	0	0
65	Panchakanya	Dhading	20	0	0
66	Rist tar	Dhading	25	0	0
67	Sanyasi tar	Dhading	26	15	7
68	Simlana khet	Dhading	10	0	0
69	Simle torkhari-7	Dhading	45	0	0
70	Thulo khola	Dhading	7	0	0
71	Thulo phant	Dhading	15	0	0
72	Wangrang	Dhading	10	0	0
73	Rajaiya	Makawanpur	25	0	0
74	Kamera khola	Nuwakot	5	3	1
75	Adhri khola	Nuwakot	70	0	0
76	Ahale khola	Nuwakot	25	0	0
77	Balkumari	Nuwakot	25	0	0
78	Birman tar	Nuwakot	25	0	0
79	Jhankri khola	Nuwakot	35	0	0
80	Karang khola	Nuwakot	30	0	0
81	Lachi khola	Nuwakot	55	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
82	Man dada	Nuwakot	35	0	0
83	Panchakanya	Nuwakot	70	0	0
84	Sano bhorle	Nuwakot	25	0	0
85	Thaprek	Nuwakot	10	0	0
86	Thulo chour	Nuwakot	26	0	0
87	Kartike khloa	Nuwakot	35	0	0
88	Chiuri khola	Nawalparasi	8	0	0
89	Dangrai khola	Nawalparasi	83	50	20
90	Amal tari	Nawalparasi	100	0	0
91	Amarasagangoli	Nawalparasi	34	0	0
92	Bara khola	Nawalparasi	137	0	0
93	Gaidakot	Nawalparasi	58	0	0
94	Gangarani	Nawalparasi	30	0	0
95	Jaysshree khola	Nawalparasi	30	18	9
96	Jhari khola	Nawalparasi	67	0	0
97	Ulti khola	Nawalparasi	68	0	0
98	Sar kuwa	Baglung	9	5	2
99	Bandre.mallika	Baglung	10	6	3
100	Takil khola	Baglung	23	0	0
101	Bhandarthowk	Gorkha	100	60	30
102	Jugdi tar	Gorkha	16	9	4
103	Satbise phant	Gorkha	14	0	0
104	Silling tar	Gorkha	5	3	1
105	Ulter tar	Gorkha	12	7	3
106	Gahire gaon	Gorkha	0	0	0
107	Ganakhu	Gorkha	40	24	10
108	Judi khola	Gorkha	17	0	0
109	Pandure	Gorkha	16	0	0
110	Simal tar bhorle	Gorkha	5	0	0
111	Tilaram khola	Gorkha	19	0	0
112	Anthauna kulo	Gulmi	9	0	0
113	Bharse khola jun	Gulmi	43	0	0
114	Jimdi khola	Gulmi	5	0	0
115	Sayamuri	Gulmi	10	0	0
116	Dumre kharka	Gulmi	13	0	0
117	Jumdi khola	Gulmi	24	0	0
118	Arukharka	Kaski	6	0	0
119	Dobila	Kaski	20	12	6
120	Tor khola	Kaski	10	6	3
121	Bisauna	Kaski	8	0	0
122	Dhabkuna	Kaski	12	7	3
123	Gyapumajuwai	Kaski	7	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
124	Mauja-3,kavre	Kaski	6	0	0
125	Mauja-7bisauna	Kaski	7	0	0
126	Dhodsing	Lamjung	15	0	0
127	Haniyajhar	Myagdi	13	0	0
128	Chis tari	Palpa	10	0	0
129	Karandhi khola	Palpa	14	0	0
130	Kukhuredhap	Palpa	26	0	0
131	Simtadi kulo	Palpa	4	2	1
132	Sisne khola	Palpa	6	0	0
133	Sisne khola dovan	Palpa	20	0	0
134	Bajung,beda khet	Parbat	16	10	5
135	Lungdi khola	Parbat	38	22	10
136	Majhuwa	Syangja	7	4	2
137	Ambotechhinnebas	Syangja	16	9	4
138	Khordi, chandibhanjyag	Syangja	9	5	2
139	Majuwa	Syangja	18	0	0
140	Thulakhel	Syangja	9	5	2
141	Siudenlanbu	Tanahu	15	9	4
142	Thuladhunge plant	Tanahu	5	3	1
143	Babge khola	Tanahu	9	0	0
144	Baraha khola	Tanahu	9	0	0
145	Barbanjyang	Tanahu	10	0	0
146	Marpha	Mustang	21	12	6
147	Satrasai kulo	Lamjung	60	0	0
148	Chisti	Baglung	50	50	25
149	Hari chaur	Baglung	65	65	30
150	Lekhani	Baglung	69	69	30
151	Masalgaun	Baglung	40	30	20
152	Amalchur	Myagdi	35	30	0
153	Ardjewa	Myagdi	20	20	0
154	Bhingithe	Myagdi	32	32	0
155	Bihu	Myagdi	10	10	5
156	Budhathok	Myagdi	20	20	15
157	Gwali chaur	Myagdi	45	45	0
158	Harapata	Myagdi	10	10	5
159	Hugdisir	Myagdi	9	9	0
160	Kudlepangra khola	Myagdi	15	15	10
161	Kuidangtank	Myagdi	11	11	0
162	Kusi gaon	Myagdi	8	6	0
163	Kusmisera	Myagdi	30	30	0
164	Narayanstha	Myagdi	20	16	0
165	Huluwa	Myagdi	17	17	10

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
166	Arman	Myagdi	47	47	30
167	Bagar phant	Myagdi	25	15	0
168	Bhedokhor	Myagdi	40	40	20
169	Pakhu	Myagdi	25	10	0
170	Poka phant	Myagdi	23	23	10
171	Babiyr chaur	Myagdi	25	25	0
172	Chhiswang	Myagdi	19	19	0
173	Kaskeri	Myagdi	23	23	0
174	Kawetetusare pani	Myagdi	40	40	0
175	Khar pani	Myagdi	14	14	0
176	Pipalbot	Myagdi	31	31	0
177	Ranbang	Myagdi	60	60	0
178	Ratne chaur kulo	Myagdi	25	25	10
179	Ratne chour kulo	Myagdi	25	25	10
180	Sera phat	Myagdi	15	15	0
181	Tato pani	Myagdi	28	28	0
182	Anya chaur	Parbat	10	10	0
183	Charkang	Parbat	40	40	20
184	Marangsing	Parbat	18	18	0
185	Ratochauka	Parbat	12	10	0
186	Bachha khola	Parbat	50	50	0
187	Bhurtula	Parbat	10	10	0
188	Danabagar	Parbat	10	10	5
189	Dhairing	Parbat	0	0	0
190	Jahare	Parbat	60	60	0
191	Karnaspangarang	Parbat	33	33	0
192	Khurkotpang	Parbat	100	100	60
193	Kurgha	Parbat	80	40	0
194	Lamapata	Parbat	30	20	0
195	Paral khola	Parbat	35	35	20
196	Pipal tari	Parbat	20	20	10
197	Seto phat	Parbat	20	20	0
198	Siudi kulo	Parbat	20	20	10
199	Sun tari	Parbat	8	4	0
200	Charang	Mustang	75	0	0
201	Chhairo	Mustang	16	0	0
202	Dhakmar	Mustang	70	0	0
203	Ghami	Mustang	80	0	0
204	Helku dhitap	Mustang	45	0	0
205	Lomanghthang	Mustang	70	0	0
206	Marang	Mustang	80	0	0
207	Phuwa	Mustang	20	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
208	Sauru phant	Mustang	18	0	0
209	Syang	Mustang	70	0	0
210	Thimini	Mustang	42	0	0
211	Tiri	Mustang	11	0	0
212	Bhandara	Chitwan	100	0	0
213	Kalyanpurmadi	Chitwan	50	0	0
214	Khairanijamaul	Chitwan	150	60	0
215	Patihaniparsa	Chitwan	400	150	0
216	Radi gaonjineli	Chitwan	200	0	0
217	Royagangshinaga	Chitwan	100	0	0
218	Sukranagar	Chitwan	100	0	0
219	Bhirkot	Dhading	20	0	0
220	Nam tar	Makawanpur	50	0	0
221	Hadi khola	Makawanpur	20	10	0
222	Nibuwa tar	Makawanpur	10	10	0
223	Raj gaon	Makawanpur	60	24	0
224	Sisneri	Makawanpur	20	8	0
225	Sisnerimul khola	Makawanpur	55	0	0
226	Belkot	Nuwakot	20	10	0
227	Chau taradihi	Nuwakot	55	0	0
228	Phagate bandh	Nuwakot	20	10	0
229	Samari	Nuwakot	20	10	0
230	Sukhari	Nuwakot	50	0	0
231	Bhutaha	Nawalparasi	30	0	0
232	Mukundapur	Nawalparasi	40	0	0
233	Pokharapalhi	Nawalparasi	230	0	0
234	Torketghat	Nawalparasi	5	0	0
235	Bas khola	Baglung	15	15	0
236	Chhusang	Baglung	15	10	0
237	Dhunge khola	Baglung	50	0	0
238	Malma	Baglung	35	0	0
239	Nishi	Baglung	50	0	0
240	Sar kuwa	Baglung	5	0	0
241	Tirke	Baglung	8	8	0
242	Yara	Baglung	10	10	0
243	Arbenithumkijethika	Gulmi	30	30	0
244	Chaldh khola	Gulmi	37	37	0
245	Rabenikhulo	Gulmi	56	0	0
246	Ghandruk	Kaski	50	0	0
247	Lahachokjogi chour	Kaski	8	4	0
248	Parche	Kaski	32	15	0
249	Rivan	Kaski	22	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
250	Shisuwa	Kaski	50	25	0
251	Upallolahockok	Kaski	45	25	0
252	Ditha village pancha	Lamjung	50	0	0
253	Jita	Lamjung	50	25	25
254	Parajuli besi	Lamjung	100	0	0
255	Adheri khola	Myagdi	25	10	0
256	Ashkare	Myagdi	60	0	0
257	Chhari khola far	Myagdi	40	10	0
258	Dhuku khola	Myagdi	25	5	0
259	Rakhubhagabati	Myagdi	11	0	0
260	Ratne chour	Myagdi	10	10	0
261	Satmule	Myagdi	65	40	5
262	Sisneri danubase	Myagdi	20	5	0
263	Sisneri gidumor	Myagdi	30	30	0
264	Turia	Myagdi	200	0	0
265	Chamrinandi	Palpa	400	0	0
266	Gejaheklang	Palpa	20	0	0
267	Salibanyakle tar	Palpa	10	0	0
268	Bharuwa khola	Parbat	45	45	0
269	Chaliselulo	Parbat	50	50	0
270	Durlung	Parbat	5	5	0
271	Ghorni khola	Parbat	2	2	0
272	Okhadi kulo	Parbat	65	30	0
273	Pati khola	Parbat	110	0	0
274	Pyudhar tar	Tanahu	51	50	0
275	Dabal	Manang	12	12	0
276	Dhunge khola	Manang	50	50	0
277	Nar	Manang	25	25	0
278	Chhusang	Mustang	25	25	0
279	Dhiirrigation	Mustang	28	28	0
280	Sopi	Mustang	20	20	0
281	Aitebagar kulo	Chitwan	50	38	38
282	Amiliyaghole kulo	Chitwan	0	0	0
283	Amirit kulo	Chitwan	75	56	56
284	Bachhyali kulo	Chitwan	262	262	0
285	Badgaur kulo	Chitwan	0	0	0
286	Bagarbelidiya kulo	Chitwan	0	0	0
287	Bahera kulo	Chitwan	0	0	0
288	Bairen kulo	Chitwan	0	0	0
289	Bakulahar kulo	Chitwan	0	0	0
290	Basyauli kulo	Chitwan	0	0	0
291	Beidiyabagar	Chitwan	15	15	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
292	Belidoha kulo	Chitwan	75	75	0
293	Beluwa kulo	Chitwan	0	0	0
294	Beluwa kulo	Chitwan	0	0	0
295	Bhutaha kulo	Chitwan	0	0	0
296	Budhi kulo	Chitwan	0	0	0
297	Budhirapti kulo	Chitwan	115	115	0
298	Cha tara kulo	Chitwan	0	0	0
299	Chhatiwan gaidachhap	Chitwan	94	45	30
300	Chipleti kulo	Chitwan	40	20	0
301	Churighol kulo	Chitwan	10	0	0
302	Daitya kulo	Chitwan	50	0	0
303	Debaouli kulo	Chitwan	0	0	0
304	Dharampur kulo	Chitwan	0	0	0
305	Dhudhkoshi kulo	Chitwan	0	0	0
306	Dhungre parsa kulo	Chitwan	0	0	0
307	Dorangi kulo	Chitwan	0	0	0
308	East bahari kulo	Chitwan	0	0	0
309	Gaida dhap kulo	Chitwan	0	0	0
310	Gauchar kulo	Chitwan	0	0	0
311	Godhap kulo	Chitwan	0	0	0
312	Hardi kulo	Chitwan	92	92	0
313	Hazipurbaheri kulo	Chitwan	0	0	0
314	Janakalyankha	Chitwan	118	118	0
315	Janakpur kulo	Chitwan	230	230	0
316	Jankalyanga kulo	Chitwan	50	50	0
317	Japkauli kulo	Chitwan	0	0	0
318	Jaruwa 1 kulo	Chitwan	30	15	15
319	Jaruwa 2 kulo	Chitwan	30	15	15
320	Jhubani kulo	Chitwan	176	176	0
321	Jhurjhue kulo	Chitwan	0	0	0
322	Jivanpur kulo	Chitwan	41	41	0
323	Jyamire kulo	Chitwan	0	0	0
324	Kankali kulo	Chitwan	338	0	0
325	Kapiya kulo	Chitwan	80	60	60
326	Kariya kulo	Chitwan	0	0	0
327	Kashi gaon kulo	Chitwan	92	45	30
328	Kathar&gothauli kulo	Chitwan	0	0	0
329	Kathar kulo	Chitwan	0	0	0
330	Kathar kulo	Chitwan	0	0	0
331	Kathar paini kulo	Chitwan	203	203	0
332	Kharkhuttekhulo	Chitwan	30	30	30
333	Kharkhuttelowerkul	Chitwan	47	47	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
334	Kharkhutteupper kulo	Chitwan	57	57	0
335	Kharthutte-1	Chitwan	0	0	0
336	Kyampa kulo	Chitwan	90	45	30
337	La baripateni kulo	Chitwan	30	0	0
338	Lamai kulo	Chitwan	80	50	0
339	Lauroghol kulo	Chitwan	75	40	30
340	Mahadev kulo	Chitwan	90	68	68
341	Mainaha kulo	Chitwan	0	0	0
342	Majhue kulo	Chitwan	131	98	98
343	Mangiyachuhadi	Chitwan	0	0	0
344	Mudavir kulo	Chitwan	145	145	0
345	Naubighe kulo	Chitwan	0	0	0
346	Oharmariberiya	Chitwan	348	348	0
347	Padariya kulo	Chitwan	139	139	0
348	Pampa kulo	Chitwan	80	40	30
349	Panisaradhap kulo	Chitwan	30	15	15
350	Parajuli kulo	Chitwan	5	5	0
351	Parsa kulo	Chitwan	48	30	0
352	Parsauni kulo	Chitwan	0	0	0
353	Phesernapheserni kulo	Chitwan	0	0	0
354	Piparabhd gaon	Chitwan	202	202	0
355	Pithuwa kulo	Chitwan	250	100	0
356	Pratappurbagar	Chitwan	0	0	0
357	Pratappur kulo	Chitwan	263	263	0
358	Puchh barimajoee kulo	Chitwan	0	0	0
359	Pur bari kulo	Chitwan	26	26	0
360	Purbsribagar kulo	Chitwan	0	0	0
361	Santana kulo	Chitwan	0	0	0
362	Sathibighe kulo	Chitwan	0	0	0
363	Saunpur kulo	Chitwan	0	0	0
364	Shantichowk kulo	Chitwan	0	0	0
365	Shudhi kulo	Chitwan	0	0	0
366	Shukha1 kulo	Chitwan	35	20	15
367	Shukha2 kulo	Chitwan	26	15	10
368	Sisabas kulo	Chitwan	107	107	0
369	Sisangadi kulo	Chitwan	21	21	0
370	Sisuwari kulo	Chitwan	0	0	0
371	Si tal pani kulo	Chitwan	30	15	10
372	Sukambashi kulo	Chitwan	0	0	0
373	Sukha khola kulo	Chitwan	0	0	0
374	Surtana kulo	Chitwan	185	139	139
375	Tadauli kulo	Chitwan	77	77	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
376	Thanbungkali kulo	Chitwan	236	200	100
377	Tugdudhkoshi kulo	Chitwan	20	10	10
378	Tulsipur kulo	Chitwan	0	0	0
379	Unantoledhuseni kulo	Chitwan	0	0	0
380	Westbahari kulo	Chitwan	0	0	0
381	Bad gaon	Chitwan	150	0	0
382	Birendra nagar	Chitwan	50	0	0
383	Dunge khola	Chitwan	50	0	0
384	Jagatpur	Chitwan	200	0	0
385	Junpur	Chitwan	100	0	0
386	Kahirani	Chitwan	200	0	0
387	Kapiya kumroj	Chitwan	200	0	0
388	Kathara(a)	Chitwan	400	0	0
389	Ladari	Chitwan	60	0	0
390	Majhui	Chitwan	150	0	0
391	Tanahi	Chitwan	150	0	0
392	Tabal besi	Dhading	0	0	0
393	Betini khola	Nuwakot	70	0	0
394	Bhanjyang bhurung	Nuwakot	70	0	0
395	Chhupang khola	Nuwakot	250	0	0
396	Chhyang khola	Nuwakot	200	0	0
397	Duichhange	Nuwakot	150	0	0
398	Gomati khola	Nuwakot	30	0	0
399	Majhuwa	Nuwakot	150	0	0
400	Phalakhu khola	Rasuwa	30	0	0
401	Misrauli bhaluwa	Nawalparasi	0	0	0
402	Ghudi khola	Baglung	60	0	0
403	Dhapa khola	Baglung	65	0	0
404	Lubhuwa khola	Baglung	20	0	0
405	Hile khola	Gulmi	44	0	0
406	Phaure khola	Myagdi	25	0	0
407	Nildaha	Myagdi	25	0	0
408	Thulo khola	Myagdi	125	0	0
409	Galcha phant	Palpa	12	0	0
410	Gijan chour panche	Palpa	4	0	0
411	Sera danda	Palpa	15	0	0
412	Baraute-syal	Parbat	20	0	0
413	Gade khola	Parbat	25	0	0
414	Khandula	Parbat	50	0	0
415	Siru bari	Parbat	25	0	0
416	Arthar dandakhark	Parbat	25	0	0
417	Chinne khola	Parbat	25	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
418	Dhairing lougdi	Parbat	25	0	0
419	Gahare khola	Parbat	25	0	0
420	Jharuwa	Parbat	20	0	0
421	Jhyaple khola	Parbat	8	0	0
422	Lasti khola	Parbat	45	0	0
423	Sundare khola	Parbat	25	0	0
424	Khahare khola	Parbat	50	0	0
425	Rayou	Parbat	50	0	0
426	Dovanlift	Lamjung	1	0	0
427	Swreeswara	Lamjung	4	0	0
428	Taksar head reg	Lamjung	40	0	0
429	Phirdi lift	Lamjung	50	0	0
430	Kared danda	Syangja	15	0	0
431	Baisjagar	Tanahu	10	0	0
432	Karki dada	Dhading	185	0	0
433	Andheri khola	Gorkha	50	0	0
434	Beni khola	Gorkha	50	0	0
435	Blang khola	Gorkha	13	0	0
436	Daraudi khola	Gorkha	10	0	0
437	Dhakde khola	Gorkha	115	0	0
438	Mulapeng khola	Gorkha	10	0	0
439	Raudi khola	Gorkha	20	0	0
440	Sirdi khola	Gorkha	50	0	0
441	Taudi khola	Gorkha	50	0	0
442	Bhidim khola	Lamjung	100	0	0
443	Bisedi khola	Lamjung	20	0	0
444	Dhad khola	Lamjung	65	0	0
445	Dhuwa khola	Lamjung	25	0	0
446	Jyamitre khola	Lamjung	60	0	0
447	Khahare khola	Lamjung	50	0	0
448	Khali marang	Lamjung	70	0	0
449	Paudi khola	Lamjung	15	0	0
450	Rople khola	Lamjung	35	0	0
451	Rumatako khola	Lamjung	40	0	0
452	Sisueri khola	Lamjung	15	0	0
453	Tardo khola	Lamjung	18	0	0
454	Andhi khola	Syangja	50	0	0
455	Batang khola	Syangja	27	0	0
456	Bodi khola	Syangja	30	0	0
457	Chhore khola	Syangja	40	0	0
458	Chiti khola	Syangja	100	0	0
459	Dolche khola	Syangja	50	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
460	Gudi khola	Syangja	25	0	0
461	Jare khola	Syangja	30	0	0
462	Jyagdi khola	Syangja	70	0	0
463	Kebare khola	Syangja	32	0	0
464	Labdi khola	Syangja	50	0	0
465	Mirdi khola	Syangja	25	0	0
466	Mulung khola	Syangja	30	0	0
467	Thulo tal	Syangja	20	0	0
468	Bande khola	Tanahu	50	0	0
469	Byandi khola	Tanahu	30	0	0
470	Chundi k (basantpur)	Tanahu	50	0	0
471	Chundi khola (chitti)	Tanahu	30	0	0
472	Daudi khola	Tanahu	30	0	0
473	Dhalesti khola	Tanahu	31	0	0
474	Kulang khola	Tanahu	30	0	0
475	Thasam kandi khola	Tanahu	30	0	0
476	Dangor khola	Nawalparasi	100	0	0
477	Dante	Nawalparasi	50	0	0
478	Dedgaun tar	Nawalparasi	225	0	0
479	Dumkibas	Nawalparasi	50	0	0
480	Jaluke ghumure	Nawalparasi	148	0	0
481	Mathar	Nawalparasi	12	0	0
482	Patawari	Nawalparasi	105	0	0
483	Ramueapur	Nawalparasi	98	0	0
484	Sukhaura	Nawalparasi	60	0	0
485	Bhutaha	Nawalparasi	50	0	0
486	Pusaha	Nawalparasi	600	0	0
487	Alhawal	Nawalparasi	200	0	0
488	Dhursari	Nawalparasi	30	0	0
489	Arun khola	Nawalparasi	200	80	0
490	Jayashree khola	Nawalparasi	258	100	50
491	Aaru tar	Gorkha	100	0	0
492	Anp tari	Gorkha	15	10	5
493	Aprik bhogteni	Gorkha	60	35	15
494	Banghari	Gorkha	4	4	0
495	Baspur tar	Gorkha	40	40	40
496	Bhimsen kulo	Gorkha	75	0	0
497	Birta khola	Gorkha	60	0	0
498	Buddhi kulo	Gorkha	165	0	0
499	Chhepe tar	Gorkha	60	0	0
500	Chorkate tar	Gorkha	130	130	0
501	Dhundure	Gorkha	50	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
502	Drabya shah kulo	Gorkha	25	5	0
503	Khar khola	Gorkha	50	45	0
504	Muge phant	Gorkha	15	15	5
505	Nimel phant	Gorkha	75	60	0
506	Pam khola	Gorkha	60	60	0
507	Pasupati tar	Gorkha	26	0	0
508	Pokhara tar	Gorkha	75	75	0
509	Rudum phalim	Gorkha	25	5	0
510	Kal tari	Gorkha	60	0	0
511	Thapa tar	Gorkha	44	0	0
512	Jau bari	Gorkha	30	30	15
513	Ramchedihi tar	Gorkha	65	40	20
514	Chhote tar	Gorkha	0	0	0
515	Arbeni	Gulmi	57	30	15
516	Chhaldi	Gulmi	30	0	0
517	Damai ghat	Gulmi	0	0	0
518	Jamune tari	Gulmi	15	15	0
519	Jherdi khola	Gulmi	50	30	0
520	Lasaha	Gulmi	22	0	0
521	Ninthara	Gulmi	7	25	0
522	Rupakot	Gulmi	60	6	0
523	Tardi khola	Gulmi	60	30	0
524	Turang	Gulmi	0	0	0
525	Misikot	Gulmi	25	0	0
526	Chilli damai	Gulmi	55	0	0
527	Dhumka phant	Gulmi	100	60	30
528	Besika chaur	Gulmi	26	0	0
529	Sota phant	Gulmi	35	18	10
530	Gan tari	Gulmi	25	10	0
531	Buwa phant	Gulmi	25	25	12
532	Bhaimal phant	Kaski	0	0	0
533	Chimro phant	Kaski	50	30	0
534	Dhi tal	Kaski	24	20	0
535	Idi khola	Kaski	65	60	0
536	Jhobang	Kaski	30	25	20
537	Jogi chaur	Kaski	140	70	0
538	Lumle	Kaski	37	37	0
539	Sandhi khet	Kaski	25	15	0
540	Tallo lahachok	Kaski	90	40	20
541	Tauniswara	Kaski	150	0	0
542	Aiselu chaur	Kaski	55	45	0
543	Gaduwa	Kaski	50	40	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
544	Kim besi	Kaski	40	30	20
545	Ghachok	Kaski	150	100	0
546	Bahra besi	Lamjung	15	10	0
547	Banjh khet	Lamjung	8	8	0
548	Barbote	Lamjung	35	35	0
549	Betini	Lamjung	45	0	0
550	Bhorle tar	Lamjung	220	0	0
551	Bhujung ramche	Lamjung	25	0	0
552	Bohara gaun	Lamjung	44	0	0
553	Dhand besi	Lamjung	15	10	5
554	Duman	Lamjung	75	30	20
555	Gairi gateri	Lamjung	0	0	0
556	Ghopte khola	Lamjung	40	0	0
557	Hande tar	Lamjung	250	0	0
558	Kyarano	Lamjung	25	10	5
559	Mashar ko kulo	Lamjung	18	15	2
560	Naubise (bhakunde r)	Lamjung	30	0	0
561	Painsi khola	Lamjung	50	25	10
562	Ramgha tar	Lamjung	220	0	0
563	Sail phedi	Lamjung	25	0	0
564	Shera phant	Lamjung	15	0	0
565	Siru pani	Lamjung	20	0	0
566	Thar chaur	Lamjung	35	0	0
567	Kamali khoria	Lamjung	49	49	20
568	Karapur tar	Lamjung	100	0	0
569	Kalyan majuwa	Lamjung	125	0	0
570	Churote	Lamjung	15	0	0
571	Bans tari	Palpa	10	10	0
572	Chherlung kulo	Palpa	106	50	25
573	Ghurchis phant	Palpa	40	40	0
574	Harijol khola	Palpa	30	30	0
575	Heklang chhangling	Palpa	35	30	0
576	Jhumsa khet	Palpa	35	0	0
577	Khursane	Palpa	8	8	0
578	Laghuwa phant	Palpa	20	20	0
579	Lamgtang khola	Palpa	13	13	0
580	Mahili kulo	Palpa	0	0	0
581	Majh ko kulo	Palpa	0	0	0
582	Sainju kulo	Palpa	30	25	0
583	Tamlok	Palpa	0	0	0
584	Waireghat	Palpa	0	0	0
585	Chewa phant	Palpa	25	20	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
586	Niki chaur	Palpa	30	30	0
587	Raj kulo jethi	Palpa	60	60	0
588	Chherlung (lower)	Palpa	50	0	0
589	Bejad	Palpa	50	0	0
590	Chheduwa kulo	Palpa	43	20	0
591	Ultey khola	Palpa	18	12	0
592	Andhi khalta	Syangja	30	30	5
593	Ashiv maghane	Syangja	22	5	1
594	Bada chaur	Syangja	20	20	5
595	Bagar khet	Syangja	25	18	5
596	Chaulane phant	Syangja	20	0	0
597	Chhahare banskot	Syangja	7	0	0
598	Chilaunebas	Syangja	50	0	0
599	Dhangling	Syangja	32	0	0
600	Dhanubase	Syangja	15	0	0
601	Dhapuk simal	Syangja	50	0	0
602	Firfire barahar	Syangja	40	0	0
603	Gaire bari	Syangja	11	11	0
604	Hilamarang	Syangja	40	35	6
605	Jayashara	Syangja	16	10	0
606	Jyagdi barabise	Syangja	40	40	15
607	Khalte khola	Syangja	10	0	0
608	Labsibot majuwa	Syangja	20	20	0
609	Lamange phant	Syangja	74	70	25
610	Naulo kulo	Syangja	25	25	0
611	Parewa	Syangja	18	18	8
612	Pauwa labsibot	Syangja	12	12	5
613	Pipal tari	Syangja	0	0	0
614	Shankhar phant	Syangja	60	0	0
615	Simal chaur	Syangja	37	0	0
616	Sthan chaur	Syangja	22	22	5
617	Tama pani keware	Syangja	37	18	0
618	Uttak phant	Syangja	30	30	5
619	Nibuwa kharka	Syangja	30	10	10
620	Bangsing	Syangja	120	100	25
621	Tikaja tallo phant	Syangja	28	28	14
622	Thuli besi	Syangja	245	0	0
623	Surandi	Syangja	45	30	0
624	Anp tari	Tanahu	40	20	5
625	Bachyangdi phant	Tanahu	26	26	0
626	Barah kulo	Tanahu	30	0	0
627	Buduwa	Tanahu	45	20	5

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
628	Durge tari	Tanahu	40	20	10
629	Gairi baguwa	Tanahu	54	25	6
630	Kalesti	Tanahu	36	15	5
631	Kandele kulo	Tanahu	19	5	0
632	Kander tari	Tanahu	25	0	0
633	Ka tari	Tanahu	40	20	5
634	Maryan ghat	Tanahu	40	40	0
635	Naya tar	Tanahu	90	30	0
636	Patle barahbishe	Tanahu	45	20	6
637	Payer phat	Tanahu	33	10	0
638	Phedi khola	Tanahu	35	20	5
639	Pipal tari	Tanahu	45	25	10
640	Pokharel phant	Tanahu	35	35	0
641	Sajha tar	Tanahu	60	0	0
642	Satra saya kyamin	Tanahu	35	20	15
643	Satra saya phant	Tanahu	60	0	0
644	Sera pachpanne	Tanahu	30	30	0
645	Sera khet	Tanahu	18	18	0
646	Shera phant	Tanahu	0	0	0
647	Sumal tari	Tanahu	20	20	0
648	Thulo tar	Tanahu	0	0	0
649	Sangrale phat	Tanahu	15	4	0
650	Gadhi jhauri	Tanahu	50	50	0
651	Buldi birta	Tanahu	18	18	0
652	Kafle amreni phant	Tanahu	34	34	0
653	Genzano	Manang	0	0	0
654	Jikre	Manang	25	25	15
655	Kyang	Manang	15	15	0
656	Tiliche	Manang	30	30	20
657	Maroth	Chitwan	300	270	130
658	Anjana tal	Chitwan	550	270	100
659	Ganga nagar	Chitwan	220	220	0
660	Gopal nagar	Chitwan	162	100	50
661	Jamakalyan	Chitwan	150	100	0
662	Maduvar	Chitwan	75	0	0
663	Patihani parsa	Chitwan	665	400	200
664	Sisabas	Chitwan	113	100	0
665	Upallorihu	Chitwan	100	100	50
666	Laguta parsa	Chitwan	102	61	24
667	Bahunsthan	Dhading	70	35	35
668	Bisal tar	Dhading	70	35	35
669	Richok tar	Dhading	0	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
670	Gomati	Dhading	48	48	48
671	Khaireni tar	Dhading	25	20	10
672	Kudule tar	Dhading	35	20	20
673	Majhitar kamputar	Dhading	31	15	15
674	Maji tar	Dhading	48	48	17
675	Ulti tar	Dhading	30	30	30
676	Parewa tar	Dhading	100	60	24
677	Chyauchyau	Makawanpur	99	50	25
678	Doobo	Makawanpur	50	25	12
679	Kalika tar	Makawanpur	80	40	20
680	Karmachuli	Makawanpur	90	40	0
681	Raptinawalpur11	Makawanpur	50	30	20
682	Dardara	Makawanpur	105	0	0
683	Ghattedamar	Makawanpur	65	30	0
684	Gurubirta	Makawanpur	107	65	50
685	Juina	Makawanpur	25	12	6
686	Jyamire	Makawanpur	125	60	0
687	Kalidamar	Makawanpur	32	16	0
688	Lamkhet	Makawanpur	60	25	0
689	Paldamar	Makawanpur	30	12	0
690	Pawasvollry	Makawanpur	85	40	0
691	Rapti nawalpur	Makawanpur	100	0	0
692	Kudule	Makawanpur	35	21	8
693	Dhorku khola	Nuwakot	120	120	120
694	Dumre chour	Nuwakot	160	100	80
695	Kanlepachisi	Nuwakot	47	20	0
696	Sunkhani	Nuwakot	60	60	60
697	Wankal	Nuwakot	48	30	12
698	Angutar	Nuwakot	80	40	0
699	Archale phant	Nuwakot	60	30	0
700	Baspani	Nuwakot	28	14	0
701	Basukot	Nuwakot	200	100	0
702	Darshantar	Nuwakot	60	30	0
703	Sinkestin	Nuwakot	11	7	3
704	Simara	Nuwakot	400	240	96
705	Duneswara	Rasuwa	35	35	35
706	Machet khola	Rasuwa	80	80	40
707	Sangle khola	Rasuwa	105	40	0
708	Sipchong	Rasuwa	114	45	0
709	Betagauda	Rasuwa	100	40	0
710	Rupse phant	Rasuwa	60	30	0
711	Dudurung	Dhading	12	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
712	Bartipur	Nawalparasi	100	0	0
713	Tang khola	Nawalparasi	100	0	0
714	Dhawa tar	Gorkha	50	0	0
715	Bangre besi	Lamjung	50	0	0
716	Rishinch patan kutia	Tanahu	30	0	0
717	Chaile	Mustang	6	0	0
718	Chetang	Mustang	20	0	0
719	Chuksang	Mustang	4	0	0
720	Jhang	Mustang	20	0	0
721	Tangwe	Mustang	35	0	0
722	Anandpur	Chitwan	10	0	0
723	Krishnapur	Chitwan	160	0	0
724	Kusatta overseas	Chitwan	120	0	0
725	Lower kerunga	Chitwan	20	0	0
726	Pungi khola	Chitwan	60	0	0
727	Upper kerunga	Chitwan	80	0	0
728	Andheri khola	Nuwakot	240	0	0
729	Gaidakot	Nawalparasi	20	0	0
730	Hulasi diversion	Nawalparasi	200	0	0
731	Potaha reservoir	Nawalparasi	60	0	0
732	Kudle and kathe kul	Baglung	60	0	0
733	Chisankha besi	Lamjung	120	0	0
734	Mulmule	Lamjung	24	0	0
735	Babia chour	Myagdi	20	0	0
736	Marpark i	Dhading	40	0	0
737	Marpark ii	Dhading	60	0	0
738	Satyadevi	Dhading	100	0	0
739	Gwali chour	Gulmi	100	0	0
740	Kumal tari	Gulmi	90	0	0
741	K majuwa	Kaski	60	0	0
742	Lahachowk	Kaski	100	0	0
743	Takanja tar	Kaski	150	0	0
744	Binapathe	Palpa	35	0	0
745	Baguwakar	Syangja	60	0	0
746	S phant	Syangja	60	0	0
747	Kumroj d/s	Chitwan	390	0	0
748	Kumroj u/s	Chitwan	60	0	0
749	Jhilkeni	Makawanpur	24	0	0
750	Thade	Makawanpur	20	0	0
751	Tistung	Makawanpur	28	0	0
752	Baray tar	Makawanpur	39	0	0
753	Bhorle	Nuwakot	25	0	0

S.N.	Name of Project	District	Irrigated Land (Ha)		
			Summer	Winter	Spring
754	Jilling	Nuwakot	25	0	0
755	Samari	Nuwakot	30	0	0
756	Sano bhorle	Nuwakot	25	0	0
757	Khola y gaon	Nuwakot	110	0	0
758	Lechyang	Nuwakot	36	0	0
759	Sandera devi	Nuwakot	80	0	0
760	Pyaudi	Gorkha	20	0	0
761	Taklung	Gorkha	14	0	0
762	Thalechowk	Gorkha	60	0	0
763	Sunder bazar	Lamjung	12	0	0
764	Masine khola	Makawanpur	50	25	0
765	Nande khola	Makawanpur	50	25	0
766	Rapti khola	Makawanpur	125	60	0
767	Dubo khola	Makawanpur	20	12	0
768	Gadhan khola	Makawanpur	25	15	0
769	Khaiite khola	Makawanpur	100	60	0
770	Lohajwar khola	Makawanpur	100	60	0
771	Manahari khola	Makawanpur	35	21	0
772	Surtana	Chitwan	50	0	0
773	Ratomatemaghi	Dhading	28	0	0
774	Richet	Dhading	30	0	0
775	Salang	Dhading	56	0	0
776	Padamphokhari	Makawanpur	80	0	0
777	Hatti khola	Nuwakot	30	0	0
778	Kumari gaon	Nuwakot	65	40	0
779	Purana gaon	Nuwakot	100	40	0
780	Urleni	Nuwakot	100	40	0
781	Bhutaha khola	Nawalparasi	201	0	0
782	Andhari khola	Baglung	40	0	0
783	Loha khola	Baglung	15	0	0
784	Bardi khola	Gulmi	150	60	0
785	Mulki	Gulmi	50	0	0
786	Godebas	Palpa	12	0	0
787	Kunhar khola	Palpa	30	15	0
788	Nimtung kulo	Palpa	15	0	0
789	Sinu kulo	Palpa	15	10	0
790	Thulo kulo	Palpa	15	10	0
791	Dhapa khola	Parbat	150	60	0

(Source: Department of Irrigation 2007 and unpublished data 2012)

Annex 11.1: Percentages of Different Energy Types Used in CHAL Districts

District	Wood	Kerosene	L.P. Gas	Biogas	Cow dung	Other	Unknown	Total
Nuwakot	80.74	10.27	3.08	3.14	0.00	1.63	1.14	100
Rasuwa	90.70	7.30	1.40	0.00	0.00	0.10	0.50	100
Dhading	93.06	4.71	1.01	0.92	0.00	0.08	0.22	100
Makwanpur	51.60	25.80	15.60	3.60	0.00	2.50	0.90	100
Chitwan	46.89	44.10		6.92	0.85		1.24	100
Gorkha	80.60	7.12	8.26	2.92	0.00	0.00	1.10	100
Lamjung	82.22	5.85	3.38	7.74	0.00	0.07	0.74	100
Tanahu	65.75	25.36		7.60	0.31		0.98	100
Manang	99.16	0.68	0.00	0.00	0.00	0.00	0.17	100
Mustang	63.08	10.95	0.00	0.00	25.20	0.28	0.49	100
Myagdi	91.55	4.28	3.23	0.84	0.00	0.10	0.00	100
Parbat	90.83	5.36	2.44	0.77	0.00	0.00	0.60	100
Baglung	77.32	13.58	9.10	0.00	0.00	0.00	0.00	100
Gulmi	92.80	5.50	0.00	0.79	0.08	0.00	0.83	100
Nawalparasi	67.21	12.18		2.22	17.78		0.61	100
Arghakhanchi	96.02	2.83	0.00	0.59	0.00	0.00	0.56	100

(Source: District Profiles 2010, CBS 2001)
Note: The statistics refer to the whole of districts

Annex 12.1: Population and Population Growth in CHAL

S.N.	Area	Population 2001			Population, 2011			Average House hold	Population Growth
		Total	Male	Female	Total	Male	Female		
Trishuli basin									
	Nepal	23,151,423	11,563,921	11,587,502	26,620,809	12,927,431	13,693,378	4.7	1.4
1	Nuwakot	288,478	142,731	145,747	278,761	134,071	144,690	4.50	-0.34
2	Rasuwa	44,731	23,355	21,376	43,798	21,775	22,023	4.41	-0.21
3	Dhading	338,658	165,864	172,794	336,250	157,928	178,322	4.43	-0.07
	Total	**671,867**	**331,950**	**339,917**	**658,809**	**313,774**	**345,035**	**4.41**	**-0.19**
Seti Basin									
1	Makwanpur	240,916	122,202	118,741	262,326	129,210	133,116	4,77	0.89
2	Chitawan	472,048	235,084	236,964	566,661	272,289	294,372	4.27	2.00
3	Tanahu	315,237	146,788	168,449	330,581	147,411	183,170	4.03	0.49
4	Kaski	380,527	184,995	195,532	490,429	235,576	254,853	3.75	2.89
5	Nawalparasi	296,648	146,649	149,999	335,079	158,450	176,629	4.83	1.30
	Total	**1,705,376**	**835,718**	**869,658**	**1,985,076**	**942,936**	**1,042,140**	**4.33**	**1.64**
Kali 'A' Basin									
1	Mustang	14,981	8,180	6,801	13,799	7,317	6,482	3.96	-0.79
2	Myagdi	114,447	53,178	61,269	113,731	51,656	62,075	4.06	-0.06
3	Parbat	157,826	72,942	84,884	147,076	65,357	81,719	4.08	-0.68
4	Baglung	268,937	123,528	145,409	270,009	119,021	150,988	4.25	0.04
	Total	**556,191**	**257,828**	**298,363**	**544,615**	**243,351**	**301,264**	**4.09**	**-0.21**
Kali 'B' Basin									
1	Gulmi	284,671	127,082	157,589	269,398	116,677	152,721	4.18	-0.54
2	Palpa	198,320	92,358	105,962	198,921	88,000	110,921	4.28	0.03
3	Syangja	317,320	143,619	173,701	288,040	125,872	162,168	4.08	-0.92
4	Arghakhanchi	133,966	61,939	72,027	128,851	56,764	72,087	4.15	-0.38
	Total	**934,277**	**424,998**	**509,279**	**885,210**	**387,313**	**497,897**	**4.17**	**-0.53**
Marsyangdi Basin									
1	Gorkha	288,134	134,407	153,727	269,388	120,541	148,847	4.01	-0.65
2	Lamjung	177,149	83,406	93,743	169,104	77,505	91,599	3.84	-0.45
3	Manang	9,587	5,034	4,553	6,527	3,664	2,863	4.37	-3.19
	Total	**474,870**	**222,847**	**252,023**	**445,019**	**201,710**	**243,309**	**4.07**	**-0.63**
	Grand Total	**4,342,581**	**2,073,341**	**2,269,240**	**4,518,729**	**2,089,084**	**2,429,645**	**4.21**	**0.41**

(Source:CBS 2011)

Annex 12.2: Employment of Men and Women in CHAL (2011)

Region	Employment		
Trishuli	Male	Female	Total
Rasuwa	13,224	11,278	24,502
Dhading	82,259	82,812	165,071
Nuwakot	67,731	56,108	123,839
Total	**163,214**	**150,198**	**313,412**
Seti			
Chitwan	102,398	63,139	165,537
Nawalparasi	133,263	110,401	243,684
Kaski	88,580	81,133	154,526
Makwanpur	89,877	50,815	140,692
Tanahun	100,544	90,358	190,902
Total	**514,662**	**395,846**	**895,341**
Region	**Employment**		
Kali "A"			
Baglung	47,890	56,270	104,160
Parbat	31,396	41,367	72,763
Mustang	5,218	3,679	8,897
Myagdi	22,995	27,615	299,145
Total	**107,499**	**377,466**	**484,965**
Marsyandi			
Manang	2,881	2,249	5,130
Lamjung	36,693	44,283	80,976
Gorkha	NA		
Total	**39,574**	**46,532**	**86,106**
Kali "B"			
Syanja	55,890	75,597	131,487
Palpa	62,272	75,897	138,176
Gulmi	64,037	86,833	150,874
Arghakhanchi	44,849	38,519	83,368
Total	**227,048**	**276,846**	**503,905**

(Source: District Profiles 2010, CBS 2001)

Annex 12.3: Status of employment in the study communities within CHAL (2012)

Village	Female	Male	Dalits	Total Population	% Employed
Bhadaure, Kaski	6	74	21	135	59
Dahapani, Baglung	11	29	17	141	28
Babiyachour, Myagdi	3	17	8	150	13
Pamling, Pamling	14	24	0	111	34
Jumdanda Jhapri, Tanhu	2	7	0	75	12
Simpani Devkot, Makawanpur	8	57	6	99	66
Panchakanya, Chitwan	5	8	9	75	17

Village	Female	Male	Dalits	Total Population	% Employed
Bankali, Lamjung	4	15	3	90	21
Rajdevi, Gorkha	10	35	5	72	63
Kalikasthan, Dhading	10	39	2	90	54
Ramche, Rasuwa	16	99	0	168	68
Bidur-3, Nuwakot	15	43	11	240	24
Bandre, Synjya	15	20	3	60	58
Satpatre, Palpa	4	30	5	75	45
Ghiukhola, Nawalparansi	5	14	10	42	45
Total	9 (8%)	34 (31%)	7 (6 %)	108	41

(Source: Community consultation, 2012)

Annex 12.4: In and out Migration Situation in the Studied Communities

Name of village	HHs migrated out of the village during 2002 to 2011	HHs migrated into their village and nearby their settlements (2002-2011)
Bhadaure, Kaski	5	0
Dahapani, Baglung	2	0
Babiyachour, Myagdi	1	0
Pamling, Mustang	3	0
Jumdanda Jhapri, Tanhu	2	10
Simpani Devkot, Makawanpur	1	200
Panchakanya, Chitwan	5	400
Bankali, Lamjung	2	0
Rajdevi, Gorkha	4	30
Kalikasthan, Dhading	3	3
Ramche, Rasuwa	5	0
Bidur-3, Nuwakot	0	0
Bandre, Synjya	1	0
Satpatre, Palpa	0	2
Ghiukhola, Nawalparansi	2	7

(Source: Community consultation, 2012)

Annex 12.5: Landless Households in the Studied Communities

Name of Village	Total HHs	Landless HHs	%	Land not registered
Bhadaure, Kaski	45	2	4	5
Dahapani, Baglung	47	3	6	2
Babiyachour, Myagdi	50	1	2	1
Pamling, Mustang	37	4	11	11
Jumdanda Jhapri, Tanhu	25	0	0	1
Simpani Devkot, Makawanpur	33	6	18	120
Panchakanya, Chitwan	25	7	28	0

Name of Village	Total HHs	Landless HHs	%	Land not registered
Bankali, Lamjung	30	0	0	0
Rajdevi, Gorkha	24	4	21	9
Kalikasthan, Dhading	30	4	13	9
Ramche, Rasuwa	56	2	4	2
Bidur-3, Nuwakot	80	0	0	3
Bandre, Synjya	20	0	0	0
Satpatre, Palpa	25	5		3
Ghiukhola, Nawalparansi	14	3	21	10
Total	36	3	9	12

(Source: Community consultations, 2012)

Annex 12.6: Participation of Various Social Groups in CFUG Committee

Forest User Groups	BCN		Ethnic groups		Dalits		Total
	Male	Female	Male	Female	Male	Female	
Bhadaure	0	0	6	4	0	1	11
Dahapani	3	3	0	1	4	2	13
Babiyachour	5	2	0	1	2	3	13
Pamling	0	0	3	2	1	1	7
Jumdanda Jhapri	2	0	3	6	0	0	11
Simpani Devkot	3	2	5	3	0	2	15
Panchakanya	9	3	3	2	0	0	17
Bankali	4	0	1	0	3	1	9
Rajdevi	2	1	9	0	0	1	13
Kalikasthan	9	2	0	0	2	0	13
Ramche	0	0	7	10	0	0	17
Bidur-3	3	2	0	1	3	2	11
Bandre	7	11	0	0	0	1	19
Satpatre	2	1	5	3	1	0	12
Ghiukhola	3	1	2	2	1	0	9
Total	52	28	44	35	17	14	190

(Source:Focus Group Discussion 2012)

Annex 12.7: Good Governance Practice in CFUGs and Cooperatives in CHAL

Name of Forest User Groups	Criteria								Total
	Degree of participation	Decision making	Knowledge and transparency	Accountability	Leadership quality	Linkage and coordination	Trust and solidarity	Organizational strength	
Bhadaure	45	Consensus	40	50	57	60	60	40	352
Dahapani	38	"	50	60	75	70	60	50	403
Babiyachour	60	"	20	45	60	50	60	50	345
Pamling	40	"	45	50	55	60	50	50	350

Name of Forest User Groups	Criteria								Total
	Degree of participation	Decision making	Knowledge and transparency	Accountability	Leadership quality	Linkage and coordination	Trust and solidarity	Organizational strength	
Jumdanda Jhapri	65	"	50	55	65	50	60	55	400
Simpani Devkot	60	Voting	60	55	60	60	55	55	405
Panchakanya	50	Consensus	50	55	55	60	45	60	375
Bankali	45	"	50	55	70	50	55	50	375
Rajdevi	60	"	50	50	75	50	60	50	395
Kalikasthan	50	"	50	55	60	45	55	55	370
Ramche	50	"	50	55	60	50	55	50	370
Bidur-3	55	"	50	55	65	50	60	55	390
Bandre	60	"	50	60	75	55	55	50	405
Satpatre	65	"	50	60	80	75	75	75	480
Ghiukhola	55	"	50	50	60	70	60	55	400

(Source:Focus Group Discussion 2012)

Annex 12.8: List of NGOs and Civil Societies Working in CHAL

River Basin	Dhading		Nuwakot	Rasuwa	
Trisuli	RIMS/UMN, Practical Action NAF		CARDSON, Heifer International, MEDEP	NAF MEDEP/SEEDS RACE Nepal DEPROSC	
Kali "A"	Baglung		Parbat	Myagdi	Mustang
	NESDO SEED IMPRED NCCDC CDRM		BYC DCRDC CYC BIRDC	Milan Myagdi Sangam HRDC REEC District Micro-Enterprise Group	ACAP
Seti	Makwanpur	Chitwan	Nawalparasi	Tanahu	Kaski
	Manohari Development International, FORWARD/Plan Nepal, Little Flower Society, NGO Federation,and CRMC, Hetauda	Nepal Lake Protection Manch, Nature and Bishajari Tal Protection Committee, Gauri Ganj, NGO Federation	VDRC Gaidakot, NGO Federation	NGO Federation, Rupakot Samaj Sewa Committee NAF etc.	NGO Federation, Panchase Development Committee
Kali "B"	Palpa		Syangja	Gulmi	Argakachi
	Chandeshwori Women Sastha, Nayar, Hemawanti, Economic Development Organization, Sahamati, Indreni, Shiva Sakti Maize Seed Production Association, NGO Federation, and Association of Coffee Growers		JMSIP Japan NGO Federation	Association of Coffee Growers Srijansil Community Development Centre NGO Federation	Association of Coffee Growers and NGO Federation
Marsyangdi	Manang		Lamjung	Gorkha	
	ACAP		ACAP, RCDC, Besisahar, CHEES, Nepal, SEED, Nepal, CECOD, Nepal, Sundar Bazar, Rural Development and Community Service Centre, Besisahar NGO Federation	Gorkha-Jalbire Saving and Credit Groups, NGO Federation	

(Source: Key informants Interview 2012)

Annex 13.1: Major Tourism Sites in Chitwan-Annapuna Landscape

Districts	Existing and Potential Tourism Sites
Kaski	Fewa Tal, Pokhara Bazar, Batulechaur, Devis waterfalls, Hyangja, Lumle, Mahendra Gufa, Bidhyabasini, Bhadaure- Tamahi, Panchase.
Baglung	Dhor-Patan, Ghumte Dhuri-Galkot, Bihu-Shibalaya, Dhamneta, Baglung Kalika- Gaurighat, Bhakudeswor Lake- Baglung Municipality, Gajako daha- Resa VDC, and Gumtekolekh
Parbat	Sky bridge-Kusma, Beni, Modi Beni, Seti Beni, Phalebas, Birethanti, Gupteswor cave (Dana Maula VDC), Panchase Forest (Painyu and Durlungkot VDCs), Panchase etc.
Myagdi	Punhill, Ghodepani, Dhorpatan Reserve, Takamkot, Shiwalaya, Tatopani, Community tourism in Ramche VDC, Galeswor temple-Ghatan VDC, Maharanisthan- Arthunge, Phulasram- Pulachaour, Hotsprings- Singha, Bhurung, Modibagar, Dana gurj.
Gulmi	Tamghas, Resunga, Madane, Ridi, Wami, Darbar Devisthan, Arkulkot Bharse, Musikot
Arghakhanchi	Narapani, Argharajsthan, Kanchikot, Thanda, Pattharkot, Chutrabesi, Jukena, Uluk, Chatraganj, Sandikharka
Mustang	Muktinath temple, Lomangthan- Upper Mustang, Kagbeni-Pamling, Phalak and Dhagarjon villages
Tanahu	Bandipur, Chimkalekh, Chabdi-barah, Dewaghat, Rising, Tanahu-soor, Jyamruk-Bhangyang, Damauli, Phirphire, Bhuji kot (Home stay), Khaireni, Gaighat (Rafting), Bhimad (Sidda Gufa, Chamero-Gufa etc.)
Makwanpur	Hetauda, Bhimphedi, Tistung, Palung, Daman, Makwanpur-Gadi, Sahid-Park, Manohari-9 Devkot
Chitwan	Bharatpur, Dewghat, Meghauli, Triveni, Chamero-Gufa, Saurah, Rampur, Madi, Chepang villages (Eco-tourism)
Lamjung	Besisahar, Gausahar, Kuncha-Bazar, Tarkughat, Khudi, Ghale gaon, Hile Taksar, Dhud Pokhari, Gauda, Dhermu (Dhulie Pokhari), rainaskot, Jitakot, Bhorletar
Gorkha	Gorka-Darbar, Barapak, Pokharithok, Bhimsen thapa ko Ghaderi, Gorakhkali, Manakamana, Nala Gumba, Rinji Gumba, manaslu Gumba, Sti Gupa, Sidha Gupa, Bakreshor Gupa etc.
Dhading	Dhadingbesi, Abuthume lake, benighat (Rafting), Gajuri-Bazar, Katunji Bazaar, Sunauli Bazar, Chamere Cave-Khalte VDC, Sidhigupha- Dhola VDC, Home stay- Naubise, Tasarphu VDCs
Rasuwa	Kangin valley, Tatopani, Godhatabela, Chandanbari, Syapru, Uttargaya, Gosaikunda- Syapru VDC, Parbatikunda- Gatlang VDC, Tatopani- Chilime, Langtang National Park, Ganesh Himal
Nuwakot	Trisulibazar, Bidur, Battar, Kakani, Devighat, Dupcheswar, Nuwakot, Panchakanaya cave, Nuwakotdarbar- Bidur -3, Betrabati (Uttargaya)-Bidur, Gupteswor- Samundratar VDC etc.
Syangja	Syangja Bazar, Putalibazar, Nuwakot, Waling Bazar, Chapakot, Ramdi, Sirubari, Sirsekot, Panchase etc.
Palpa	Tansen, Ridi, Ranighat palace, Bhairabsthan, Palpa, Srinagar hill, Nuwakot gadi, Jitgadi, Wakumgadi, Rishikesh temple, Mirkhande, Madan pokhara, Suketal (Dovan)
Nawalparasi	Parasi, Tribeni azaar, Tribhuwantar, Suryapura, Nanda Tal, Bardhanghatand, Pahli, Daunne Devi, Kailash, Tribeni Dham

(Source: Community and district consultation, 2012)

Annex 13.2: Tourism Products

District	Tourism Products
Kaski	Potato, woolen bags, lokta paper
Baglung	Agarbatti, mahin batti, bags, timur powder
Parbat	
Myagdi	Local potato, Gauriya rice
Gulmi	Orange (Naya gaon), Organic coffee, Kafal (Chahara, Resungja and Madane), Bako ko Gundruk
Arghakhanchi	Coffee
Mustang	Bhote jira, apple chips, apple brandy, jimphoo
Tanahu	Orange and fresh vegetables
Makwanpur	Bamboo-Tama
Chitwan	Tharu dance,
Lamjung	Radi-Pakhi, Bakhuu, Hasiya-Khurpeto, oranges
Gorkha	Radi-Pakhi, Bakhuu, oranges

District	Tourism Products
Dhading	Fresh vegetables and local fish of Malekhu
Rasuwa	Chirayito, red mosroom, local bean, seabuckthorn joice
Nuwakot	Fresh vegetables and walnut (Kakani)
Syangja	Cap, prange, ginger and local chiken
Palpa	Palpale Dhaka, Karuwa, local potato (Divan VDC)
Nawalparasi	Jackfruits and Amriso ko Kucho

(Source: Key Informants Interview 2012)

Annex 13.3: Mineral Resources within CHAL

(A) Metallic Minerals

COPPER

District	Location	Latitude (Degree)	Longitude (Degree)	Status
Myagdi	Rumakhani	28.400	83.333	Occurrence, old working
Gorkha	Gyazi	28.104	84.688	Occurrence, old working
Tanahun	Bhutkhola	27.833	84.433	Sub-economic, old Working
Gulmi	Portighat	28.050	83.558	Occurrence, old working
Syangja/Tanahun	Minamkot	27.983	83.917	Occurrence, old working
Makawanpr	Kitini	27.579	85.162	Occurrence, old working
Makawanpur	Kulekhani	27.588	85.156	Occurrence, old working
Dhading/Nuwakot	Deurali	27.883	84.983	Occurrence, old working
Makwanpur	Ipa	27.511	85.225	Occurrence, old working
Makwanpur	Arkule	27.516	85.211	Occurrence, old working
Bagllung	Pandap Khani	28.216	83.316	Occurrence, old working
Nawalparasi	Kottham	27.816	84.250	Occurrence
Nawalparasi	Chandauli	27.783	84.283	Occurrence
Nawalparasi	Gaighat	27.716	84.366	Occurrence
Myagdi/Baglung	Okharbot	28.400	83.316	Occurence, old working
Chitwan/Tanahun	Khola Khani	27.800	84.525	Occurence, old working
Dhading	Dhusa	27.733	84.816	Sub-economic, old Working
Makwanpur	Agra Khola	27.650	85.030	Occurrence
Makwanpur	Kali Tar	27.366	85.060	Sub-economic
Arghakhanchi	Khani Gaoun	27.950	83.125	Occurrence
Gulmi	Mulkhani\ Jokhimkhani	28.058	83.558	Occurrence, old working

GOLD

District	Location	Latitude (Degree)	Longitude (Degree)	Status
Chitwan	Marodi Khola	27.467	84.25	Placer, showing
Dhading/Nuwakot	Trisuli River	27.783	85.1	Placer, showing
Myagdi	Myagdi River	28.337	83.55	Placer, occurrence
Parbat	Jyamrijhat	28.100	83.63	Placer, occurrence
Parbat	Modi Khola	28.08	83.681	Placer, showing

District	Location	Latitude (Degree)	Longitude (Degree)	Status
Tanahun	Madi Khola	28.080	84.25	Placer, showing
Tanahun	Marshyangdi	27.833	84.417	Placer, sohowing
Dhading	Arughat	27.994	84.8	Placer, occurrence
Gorkha	Bungkotghat	27.883	84.743	Placer ,occurrence
Dhading	Darbung	27.800	84.717	Placer, occurrence
Dhading	Benighat	27.750	84.767	Placer ,occurrence
Makwanpur	Chadi Khola	27.258	85.333	Primary, showing
Myagdi	Tatopani	28.500	83.656	Placer, occurrence
Makwanpur	Damar	27.536	85.172	Primary ,showing
Myagdi	Mure Gurjea Khola	28.508	83.383	Placer occurrence
Myagdi	Khiwang Khola	28.500	83.4	Placer, occurrence
Myagdi	Kuine Khani Khola	28.483	83.417	Placer, occurrence
Myagdi	Rakhor Khola	28.491	83.517	Placer, occurrence
Mustang	Ching Khola	28.708	83.7	Placer, occurrence
Myagdi	Rahughat	28.383	83.553	Placer, occurrence
Myagdi	Bag Khola	28.450	83.617	Placer, occurrence
Myagdi	Ghare Khola	28.433	83.733	Placer, occurrence
Myagdi	Sikhe Khola	28.450	83.717	Placer, occurrence
Myagdi	Mistri Khola	28.517	83.683	Placer, occurrence
Chitwan	Rau Khola	27.450	84.333	Placer, occurrence

Iron

District	Location	Latitude (Degree)	Longitude (Degree)	Status
Baglung	Kalche	28.123	83.25	Showing old working
Nawalparasi	Benighat	27.750	84.000	Showing
Myagdi	Kauein khahi	28.500	83.45	Showing
Gulmi	Dahagaon	28.152	83.291	Occurrence
Baglung	Lukerban	28.354	83.275	Occurrence
Baglung	Arlang kot	28.177	83.362	Occurrence
Baglung	Khola Kharka	28.317	83.283	Occurrence
Baglung	Dhamja	28.311	83.283	Coourrence, old working
Baglung	Mangale	28.266	83.517	Occurrence
Parbat	Khanijoan	28.116	53.7	Showing
Palpa	Hulangdi Khala	27.808	83.516	Showing old working
Tanahun	Dhole	28.033	84.025	Showing
Tanahun	Labdi Khola	27.841	84.458	Sub-economic old working
Dhading	Parpu	27.783	84.72	Showing
Dhading	Gothban Jyang	27.754	74.725	Showing
Dhading	Jirbang	27.750	84.733	Occurrence
Dhading	Shmbarng	27.733	84.733	Showing
Chitwan	Hugpung	27.700	84.733	Showing

District	Location	Latitude (Degree)	Longitude (Degree)	Status
Mankanpur	Hatti Khola	27.500	84.863	Showing
Pyuthan	Sulibang	28.312	82.95	Occurrence
Makwanpur	Manhari	27.567	84.879	Showing
Makwanpur	Likche	27.572	84.921	Showing
Dhading	Thuldi	27.766	85.133	Showing
Parbat	Dhuwakot	28.133	83.7	Showing old Working
Gulmi	Thale Pokhara	28.178	83.392	Showing
Nawalparasi	Kiran Khola	27.754	84.103	Showing

Silver

District	Location	Latitude (Degree)	Longitude (Degree)	Status
Rasuwa/Dhading	Ganesh Himal	28.231	85.188	Occurrence
Gulmi	Tamghas	28.067	83.250	Occurrence
Arghakhanchi	Samer bhamer	28.083	83.100	Occurrence
Gulmi	Neta Dorling	28.250	83.183	Occurance
Arghakhanchi	During Khola	28.050	83.017	Showing
Dhading	Manjit Khola	28.200	85.083	Showing
Makwanpur	Barghare	27.517	85.192	Occurance
Palpa	Hundi Khola/Andhi Khola	27.917	83.675	Showing

(B) Non Metalic Minerals

Magnesite

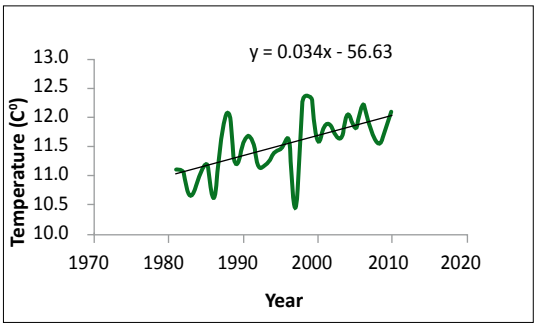
District	Location	Latitude (Degree)	Longitude (Degree)	Status
Palpa	Rani ghat	27.917	83.533	Occurrence
Palpa	Baragdi Khola	27.917	80.55	Showing

Oil and Gas

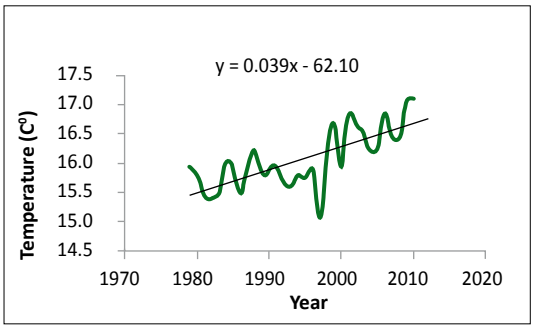
District	Location	Latitude (Degree)	Longitude (Degree)	Status
Mustang	Muktinath	28.808	82.889	Occurrence

(Source: Department of Mines and Geology 2012, Unpublished)

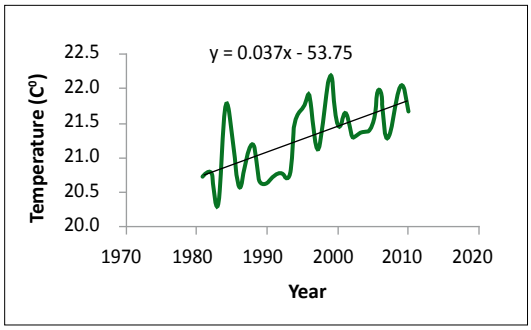
Annex 15.1: Long-term (1979-2010) Analysis of Average Temperature Change



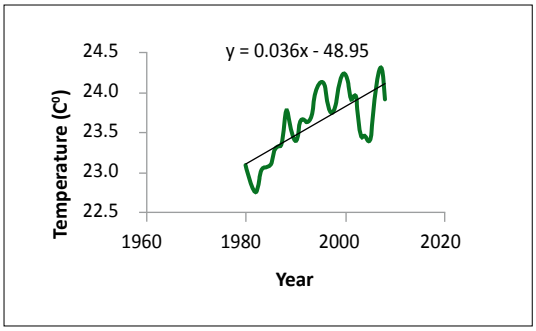
a. Jomsom, Mustang



b. Lumle, Kaski



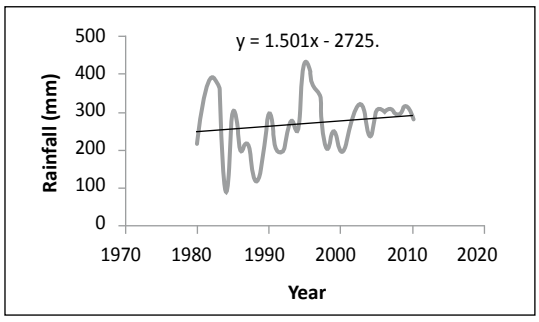
c. Dhunibeshi, Dhading



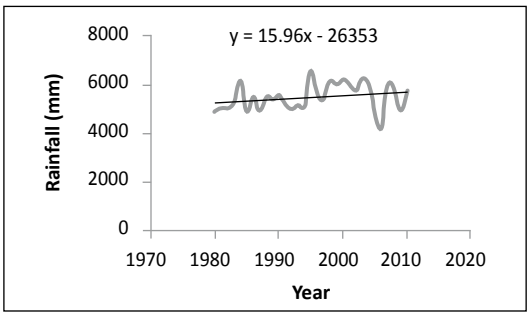
d. Siwalik, Hetauda and Rampur, Chitwan

(Source: Adapted from DHM, 2010)

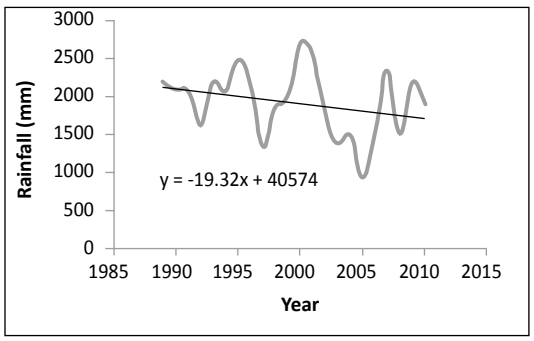
Annex 15.2: Long Term (1979-2010) Trend Analysis of Rainfall



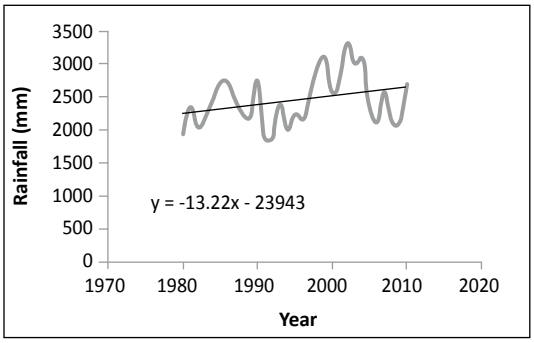
a. Jomsom, Mustang



b. Lumle, Kaski



c.Walling, Syanja



d. Hetauda, Makwanpur

(Source: Adapted from DHM, 2010)

Annex 15.3: Districts and VDCs Located in the Siwalik Hills in CHAL

Palpa	Nawalparasi	Tanahu	Chitwan	Makwanpur
Mityal	Hupsekot	Devghat	Darachok	Kalika tar
Archale	Dhurkot	Kota	Dahakhini	Kankada
Jhirubas	Dumkibas	Chhimkeswori	Kabilas	Churiyamai
Mudlli	Kulwa	Chhipchhipe	Kaula	Ransirang
Chidipani	Honga		Korak	Manahari
Chandravan	Dauneya		Lothar	Padam Pokhari
	Mainaghat		Shakitikhor	Hadikhola
			Siddi	Sarikhet

(Source: Present study)

Table 16.1: Major Climatic Hazards and Losses in CHAL in Different Time Periods

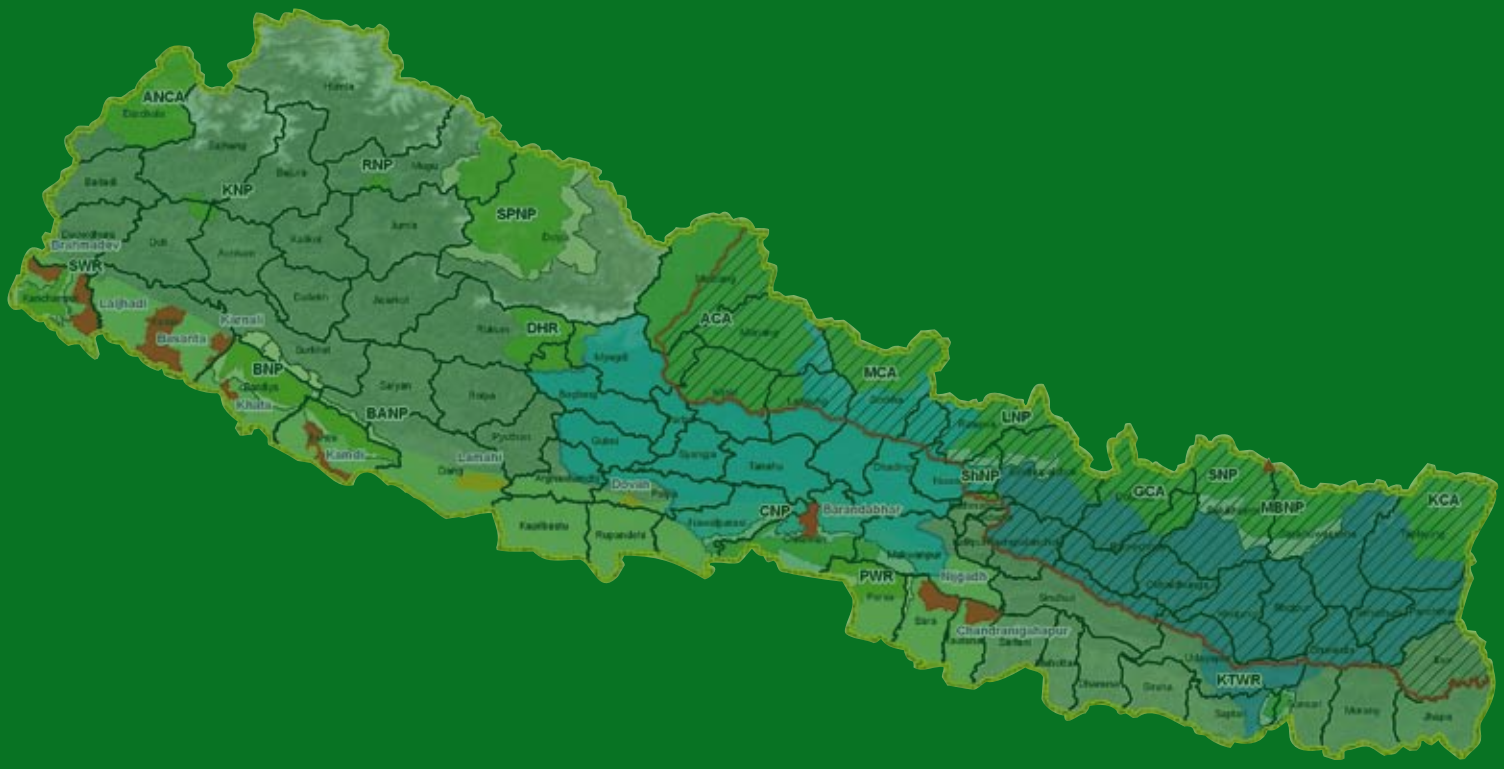
Climatic hazard	Year	Location	Human loss (No)	No of HHs	Remarks
Landslide and flood	2012 (May 5)	Upper Pokhara Valley of Seti River, Kaski	About 10	About 10	NA
Landslide	2010	Thanau, Nubakot, Kaski,Gorkha, Dhading	7	350	NA
Landslide	2007	Thanau, Baglung, Palpa, Kaski	37	20	About 500 people affected
Landslides	2003 (31 July)	Chitwan- Muglin Narayanghat Road			More than 70 landslides in 36km in 24 hours
Landslide	2003 to 2009	Rashua (Ramcha)	More than 37	100	About 1 million US $
Landslide combined with Flood	1993,	Dhading, Makwanpur and Chitwan Districts	About 1,336	73000	Three bridge along the Prithivi Highway, Kulakhani Hydropower Plant damaged and many ha of agriculture land
Flood/landslide (Cloud burst)	1989	Chitwan. Nawalparasi	NA	NA	Damage highway and agriculture land
Landslide	1988	Magdi (Magdikhola)	NA	NA	Human deaths and HH damage
Landslide	1968	Dhading/Gorkha (Budigandaki River)			29 hours blockage and damage Arughat Bazaar.
Drought	2005	Chitwan, Gulmi, Syanja, and Kaski	NA	NA	NA
Drought	1994	Gulmi, Nawalparasi	NA	NA	Severely decreased maize yield
Drought	1993	Nawalparasi	NA	NA	
Drought	2008/09	Many parts of the country	NA	NA	Fifty percent low winter rainfall and More than 300,000 ha of agriculture land affected.
Forest fire	2004/05				Many part of the forest damaged
Forest fire	2008				1,500 forest patch area
Forest fire	2009				More than one million hectare forest damage.

(Sources: ICIMOD, 2007, MOHA 2009, Dixit 2010, and Singh 2010).

Table 16.2: Vulnerability Index of the Different Districts in CHAL

District	Rainfall/ Temp. Vulnerability	Ecological. Vulnerability	Landslide	Flood	Drought	GLOF	Combined
Lamjung	0.959	0.146	0.801	0	0.18	0.9	0.948
Dhading	0.41	0.247	0.648	0	0.517	0.733	0.758
Gorkha	0.267	0.216	0.701	0	0.405	0.937	0.733
Chitwan	0.68	0.119	0	0.768	0.251	0.585	0.725
Manang	0.396	0.218	0.473	0	0.444	0.96	0.65
Baglung	0.451	0.125	0.775	0	0.231	0.593	0.574
Mustang	0.178	0.225	0.45	0	0.414	0.95	0.559
Parbat	0.413	0.123	0.736	0	0.193	0.538	0.525
Tanahu	0.32	0.114	0.557	0	0.171	0.691	0.503
Makwanpur	0.677	0.117	0.738	0	0.271	0	0.496
Myagdi	0.448	0.109	0.645	0	0.195	0.575	0.492
Nowakot	0.347	0.216	0.686	0	0.446	0	0.426
Rashua	0.359	0.393	0.686	0	0.446	0	0.426
Nawalparasi	0.288	0.119	0	0.519	0.204	0.561	0.414
Kaski	0.606	0.039	0.686	0	0.224	0	0.389
Gulmi	0.204	0.186	0.506	0	0.286	0.461	0.28
Arghakhanchi	0.173	0.178	0.56	0	0.333	0	0.23
Syanja	0.095	0.078	0.539	0	0.07	0.391	0.182
Palpa	0	0.09	0.388	0	0.223	0	0.003

(Souce: Adapted from MOE, 2010)
(Higher the index value, higher the vulnerability i.e = 1 Very High, 0.5= High, 0.3= Moderate, 0.2= Low and 0.1= Very Low).



The Hariyo Ban Program is named after the famous Nepali saying 'Hariyo Ban Nepal ko Dhan' (Healthy green forests are the wealth of Nepal). It is a USAID funded initiative that aims to reduce the adverse impacts of climate change and threats to biodiversity in Nepal. This will be accomplished by working with the government, communities, civil society and private sector. In particular, the Hariyo Ban Program works to empower Nepal's local communities in safeguarding the country's living heritage and adapting to climate change through sound conservation and livelihood approaches. Thus the Program emphasizes the links between people and forests and is designed to benefit nature and people in Nepal. At the heart of Hariyo Ban lie three interwoven components – biodiversity conservation, payments for ecosystem services including REDD+ and climate change adaptation. These are supported by livelihoods, governance, and gender and social inclusion as cross-cutting themes. A consortium of four non-governmental organizations is implementing the Hariyo Ban Program with WWF Nepal leading the consortium alongside CARE Nepal, FECOFUN and NTNC.

WWF Nepal
PO Box: 7660, Baluwatar, Kathmandu, Nepal
T: +977 1 443820, F: +977 1 4438458
Email: hariyobanprogram@wwfnepal.org, info@wwfnepal.org
Website: www.wwfnepal.org/hariyobanprogram