Environmental Impact Assessment

February 2014

NEP: South Asia Subregional Economic Cooperation (SASEC) Power System Expansion Project (SPEP)

Prepared by Nepal Electricity Authority for the Asian Development Bank.

Asian Development Bank
Nepal: South Asia Subregional Economic Cooperation (SASEC)
Power System Expansion Project (SPEP) On-grid Components

ENVIRONMENTAL IMPACT ASSESSMENT

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TABLE OF CONTENTS

List of Tables

Abbreviations and Units

ACA	Annapurna Conservation Area
ADB	Asian Development Bank
CARE	Cooperative for Assistance and Relief Everywhere
CBS	Central Bureau of Statistics
CFUG	Community Forest Users Group
CHAL	Chitwan Annapurna Landscape
CITES	Convention on International Trade in Endangered Species
DDC	District Development Committee
EA	Executing Agency
EBA	Endemic Bird Area
EIA	Environmental Impact Assessment
EMP	Environmental Management Program
EPA	Environmental Protection Act
EPR	Environmental Protection Regulations
ESSD	Environmental and Social Studies Department of NEA

FAO	Food and Agriculture Organisation
FECOFUN	Federation of Community Forestry Users in Nepal
FRP	Fire Radiative Power
Gal	0.01m/s^2
GLOF	Glacier Lake Outburst Flood
GON	Government of Nepal
GRM	Grievance redress mechanism
GWh	Giga-watt hour (a measure of energy output)
IBA	Important Bird Area
ICIMOD	International Centre for Integrated Mountain Development
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
km	Kilometer
kV	Kilovolt
LDOF	Landslide Dam Outburst Flood
m	Meter
MODIS	Moderate Resolution Imaging Spectroradiometer
MW	Megawatt (a measure of power capacity)
NASA	National Aeronautics and Space Administration
NEA	Nepal Electricity Authority
NTNC	National Trust for Nature Conservation
PCB	Poly-chlorinated biphenyls
PIU	Project Implementation Unit
REDD	Reducing Emissions from Deforestation and Forest Degradation
ROW	Right-of-way
TAL	Terai Arc Landscape
TCL	Tiger Conservation Landscape
tCO_2e	tons carbon dioxide equivalent
USAID	United States Agency for International Development
VDC	Village Development Committee
WPD	Wind Power Density
WWF	World Wide Fund for Nature

1. EXECUTIVE SUMMARY

1.1 Introduction

The proposed South Asia Subregional Economic Cooperation (SASEC) Power System Expansion Project (the Project) is included in the Asian Development Bank (ADB) Country Partnership Strategy 2010-2012 for Nepal, and the Country Operations Business Plan 2013-2015.

Project Components. The project includes 3 components:

(i) Transmission system expansion, including new transmission lines and substations which will facilitate cross-border power exchange and future power exports, and augmentation of existing substations to improve grid efficiency;
(ii) Distribution system expansion; and
(iii) Renewable energy (RE) based mini-grids in remote villages.

Project implementation services will be provided, including support for design, bid specifications, procurement, environmental and social safeguards implementation, and livelihood improvement in the transmission corridors. Detailed project description is presented in Section 3.

This draft Environmental Impact Assessment (EIA) was prepared on behalf of the Nepal Electricity Authority (NEA), the Executing Agency (EA) for the Project, by consultants retained under ADB TA-8272. Under the Nepal environmental regulatory framework, the proposed transmission lines require an Initial Environmental Examination (IEE) except for lines in protected areas which require an EIA. This report content and format are consistent with ADB *Environmental Assessment Guidelines 2003* and *Safeguard Policy Statement 2009*. This report covers the on-grid project components. The off-grid RE based mini-grids component was developed under a separate project preparatory technical assistance; the IEE for the off-grid component is presented as a companion report.

1.2 Summary Findings

The proposed Project comprises clearing of right-of-way, construction of new high-voltage transmission lines, construction of new substations, and augmentation of

existing transmission substations. Potential impacts during construction will arise from temporary access road construction, clearing of vegetation, equipment staging, construction of substations, erection of transmission towers, stringing of conductors on the towers, and temporary construction camps. Potential impacts could also arise from improper management of decommissioned equipment. The anticipated impacts are localized, minimal, temporary, and reversible. Any loss of trees and other vegetation will be directly offset by reforestation and indirectly offset by reduction in fossil fuel powered generator sets. The proposed Project is the best alternative with respect to economic, environmental, financial, and social criteria.

Potential negative environmental impacts can be mitigated by implementation of the environmental management program (EMP). The EMP cost estimates and work program comprise routine baseline and periodic monitoring, and support for reforestation. The EIA and EMP will be updated and revised as necessary to ensure that environmental and ecological objectives in the project area are met (as discussed in Section 7).

The environmental assessment to date complies with ADB and Nepali policy and guidance for energy sector projects. This EIA is a dynamic document: assurances will be incorporated into loan and project agreements to ensure that the EIA and EMP are updated as necessary and are fully implemented.

Under the Nepal environmental regulatory framework, the NEA will obtain survey and transmission licenses for individual transmission lines rather than for the entire Project, and each proposed transmission line requires an IEE, or an EIA for lines in protected areas. The Project includes a 25 kilometer (km) transmission line from Manang to Khudi, with substations at either end, which all lie within the Annapurna Conservation Area (ACA); an EIA will be required for this transmission line and substations. The Manang-Khudi line and substations are not scheduled to go into service until 2019, with construction expected to commence in 2 years prior to operations; thus, there are more than 2 years to complete the EIA prior to construction. For other transmission lines, the earliest construction activities are expected to begin in early 2015, allowing about 1 year to complete IEEs. Thus, this report serves as input to the IEEs and EIA for the individual transmission lines to completed going forward.

1.3 Report Organization

The following sections include:

- Section 2 describes the policy, legal, and administrative framework for the project including the environmental assessment process.
- Section 3 describes the need for the project, proposed design, analysis of alternatives, and expected benefits.
- Section 4 provides a description of the environment.
- Section 5 discusses potential environmental impacts, benefits, and mitigation measures.
- Section 6 describes public participation and consultation activities, information disclosure, and grievance redress mechanism.
- Section 7 presents the Environmental Management Plan (EMP).
- Section 8 presents conclusions and recommendations.
- Appendix 1 lists important flora and fauna along areas in or close to the project site with rich biodiversity. Appendix 2 presents habitat maps of important species. Appendix 3 summarizes various activities which may indirectly offset environmental impacts caused by the Project. Appendix 4 presents detailed routing maps for one transmission segment in the Annapurna Conservation Area (ACA) plus selected photographs of the project areas.

2. Policy, Legal, and Administrative Framework

Nepal integrated environment aspects in all its development activities and projects only from early 1980s. Environment conservation was included in the policies since the Fifth Plan (1975-1980). The second milestone was taken during the Sixth Plan. The Sixth Plan under the environment and land use policy emphasized the integration of environmental aspects into the construction of large-scale development projects. Then finally, in the Seventh Plan it was stated that developmental programs would be implemented only after an approved EIA/ IEE report. The plan outlined the need for carrying out EIA/IEE processes for industrial, tourism, transportation, water resources, urbanization, agriculture, forests and other development programs to identify and mitigate adverse impacts on the environment. The Eighth, Ninth and Tenth five year plans have further emphasized the making of more effective EIA systems. The formulation of Sectoral Guidelines, promotion of participatory EIA/IEE system and inclusion of mitigation cost into the total project cost were some of the activities included in these three five year plans. The major policies, acts and regulations and guidelines related to the project are discussed below.

The prevailing Acts, Policies, Regulations and Guidelines, which are required for the construction and operation of Transmission Line Projects in Nepal, have been reviewed while preparing the present IEE report and some of the important guidelines and acts and their relevancy in transmission line and hydropower development have been discussed below:

Plan & Policy

i. Nepal Environmental Policy and Action Plan, 2050 (1993) and 2055 (1998)

Nepal Environmental Policy and Action Plan (NEPAP) were endorsed to further institutionalize environmental protection in the development processes. NEPAP recognize that a growing number of people are exposed to pollute from industrial enterprises. NEPAP identifies the following factors as contributing to this process:

- Industrial plan inappropriately cited close to population centers
- Insufficient emphasis on fuel efficiency.
- Little, if any pollution abatement equipment used for reducing emission, and
- A total lack of industry pollution standards.

Hence, the NEPAP emphasized the need for mitigating adverse environmental impacts

to address urban and industrial development, air and water pollution and infrastructures development.

ii. Forestry Sector Policy

The Forest Sector Policy of Nepal such as the National Forestry Plan, 1976, Master Plan for the Forestry Sector, 1988, Periodic Five Year Plan and Forestry Sector Policy, 2000 have emphasized for people participation in the forestry management. Nepal's main forest management is based on people's participation and various management models are underway. Similarly, Forestry Sector Policy, 2000 stresses on conservation of biodiversity, ecosystem and protection of land degradation by soil erosion, landslide, floods desertification and other ecological disturbances. The Public participation in forest management is sought through community forestry, collaborative forest management, leasehold forestry etc. The mitigation measures such as plantation, NTFP programme and other social and community support programme proposed by the project will implemented by mobilizing the local people which is in line with the Forest Sector Policy.

The procedural guidelines for the use of forest land for other purpose stated that feasibility study will be carried out with no use of forest land to the extent possible. If it is not possible, the alternate will be considered with minimum use of forest land. This guideline also stated that the project proponent will be responsible for the plantation of 25 tree species for the loss of one tree and their management for 5 years and handing over to the concerned forest office of the district.

iii. Hydropower Development Policy, 2058 (2001)

The Hydropower Development Policy was promulgated in 2001. The main objectives of the policy include producing clean energy through the development of hydroelectric projects and to help conserve the environment. It is stipulated that one of the policies is to extend the use of electricity for achieving a reduction in the utilization of fuel wood and to render necessary assistance in the conservation of forest and environment.

iv. Policy for Construction and Operation of Physical Infrastructure within Conservation Area, 2065 (2008)

The policy describes the terms and conditions required for implementing projects inside protected areas. Implementation of mitigation measures, allocation of royalty for conservation activities, payment for use of natural resources and monitoring are some

of the conditions mentioned in the policy.

v. National Wetlands Policy of Nepal 2059 and 2069 (2003 and 2012)

National Wetlands Policy defines wetlands as perennial water bodies that originate from underground sources of water or rains. It means swampy areas with flowing or stagnant fresh or salt water that are natural or man-made, or permanent or temporary. Wetlands also mean marshy lands, riverine floodplains, lakes, ponds, water storage areas and agricultural lands. The Nepali term for wetland is Simsar and the new National Wetland Policy accepted in 2069 BS (2012) mentions the need for conservation, restoration and effective management of wetlands. In addition to this its objectives explain wise utilization of wetland resources and support for community dependent on such wetlands. It also makes clear that development activities should not lead to reduced quality and area of wetland. The policy mentions 750,000 ha (5%) of Nepal's land consists of wetlands.

Power and Water Sector Acts and Regulations

The current provisions for the environmental review of power and water sector projects as set out in the Acts and Regulations are described as follows:

Acts

vi. Environment Protection Act, 2053 (1997)

Nepal has enacted a comprehensive and umbrella type Act, the Environment Protection Act, 1998 (EPA, 97) which is now enforced through appropriate regulatory measures. The EPA provides a legal basis for the concerned authorities for regulation an initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA).

Section 3 of the Act requires the proponent to conduct an IEE or EIA in relation to the prescribed proposals. The Act uses the word proposal instead of Projects which makes the scope of the Act much broader in relation to environmental studies. Proponent includes any government, semi government or non-government agency or organization submitting an application for the approval of a proposal and possessing the responsibility to work according to such a proposal or implementing the proposal.

According to the provision in section 6 (1) of the Act, the relevant agency is empowered to grant approval for the IEE and EIA report, only if it finds that no significant adverse effects will be caused to the environment by the implementation of the proposal. Implementation of any proposal without the approval of the relevant agency is prohibited by the Act.

vii. Water Resources Act, 2049 (1992)

The objectives of the Water Resources Act, 2049 is to make legal arrangements for determining beneficial uses of water resources, preventing environmental and other hazardous effects thereof and also for keeping water resources free from pollution. The Act strives to minimize environmental damage to water bodies, especially lakes and rivers through environmental impact assessment studies and the proponents who wish to use water resources for various purposes should prepare IEE report before a license can be granted. The Act stipulates that soil erosion, flooding, landslides or any significant impact on the environment should be avoided in all uses of a water resource.

viii. Electricity Act, 2049 (1992)

Electricity Act, 2049 is related to survey, generation, transmission and distribution of electricity. Electricity includes electric power generated from water, mineral oil, coal, gas, solar energy, wind energy etc. Under Section 3 of the Act it is stated that survey, generation, transmission or distribution of electricity without obtaining a license is prohibited. The Electricity Act, 2049 also contain provisions to minimize soil erosion, flood, air pollution and damage on environment while producing electricity and transmission of the power (Article 24). The Electricity Rule, 2050 emphasize environmental analysis, which should include environmental mitigation measures to minimize adverse impacts likely to occur while developing hydro-electricity (Rule 12 and 13).

ix. Land Reform Act, 2021 (1964)

The Land Reform Act, 1964 is considered as a revolutionary step towards changing the existing system of land tenure by establishing rights of tenants and providing ownership rights to actual Tiller. To date it has been amended five times. Article sets ceiling on land ownership according to geographical zones. Article 25(1) of this act deals with tenancy rights that also exists.

x. Land Acquisition Act, 2034 (1977)

One of the important acts that have a bearing on the implementation mechanisms and mitigation adverse impacts of power projects is the Land Acquisition Act. This Act, 2034 covers all aspects of land acquisition and compensation of land and other assets. It authorizes the government to acquire land for public purposes by providing compensation to the private landowners.

The compensation paid under this Act will be given in cash. To decide the amount of the compensation, the Land Acquisition Act (1977) has made provisions for the constitution of a Compensation Fixation Committee (CFC). That committee consists of the CDO, Chief District Land Administration and Revenue Office, Project Chief or an officer designated by the CDO and the Representative of the DDC.

xi. Forest Act, 2049 (1993)

The Forest Act, 2049 (amendment 2055) recognizes the importance of forests in maintaining a healthy environment. One of the major objectives of the enhancement and enforcement of the Forest Act is the promotion of a healthy environment. The Act requires decision-makers to take account of all forest values, including environmental services and bio-diversity. It emphasizes the development and implementation of an approved work plan for different categories of forest, i.e. community forests, leasehold forests, private forests and religious forests.

xii. Child Labor Act, 2049 (1991)

This act is enforced by GoN in 2049/2/2. This act classified below 15 years as child and 'anabolic' for the age group of above 14 years and below 18 years. The act has also made provision of labour court and department of labour. The act clearly mentioned that the appointment letter should be issued for all the employees which include their working hours, working time, wages and other benefits. The act allows for the time bond contract for the manpower required for development work. The act specifies that working hours for the Anabolic and women must be within 6 AM to 6 PM which clearly restrict to deploy women in night works. The act also stated that equal opportunity shall be given to women as men. Similarly working period for the other employees must not exceed 8 hours a day and 48 hours in a week. If some people work beyond that period, over-time allowances must be paid which is 150% of the normal per hour wages and such over-time must not exceed 4 hours in a day. According to this act wages rate of the employees shall not be less than the rate fixed by the concerned offices of GoN.

xiii. Soil and Watershed conservation Act, 2039 (1982)

In order to manage the watersheds of Nepal, the Soil and Watershed Conservation Act, 1982 was enacted. The act is devoted only to the protection of watersheds. Under Section 10 of SWCA, power is extended to the Watershed Conservation Officer to grant permission to construct dams, drainage ditches and canals, cut privately owned trees,

excavate sand, boulders and soil, discharge solid waste and establish industry or residential areas within any protected watersheds. The Act outlines the essential parameters necessary for proper watershed management.

xiv. Aquatic Animals Protection Act, 1961

This Act provided legislative protection of the habitats of aquatic species. Under this Act, it is offence to introduce poisonous, noxious or explosive material in to a water source or destroy any dam, bridge, fish ladder or water system with the intent of catching or killing aquatic life. The Act was amended in 1988 to prohibit the use of unsafe pesticides.

xv. Local Self-Governance Act, 2055 (1998)

The Local Self-Governance Act, 2055 contains several provisions for the conservation of soil, forest and other natural resources and implementation of environmental conservation activities. Section 28 and 19 of the Act provide that the Village and the District Development Committees are responsible for the formulation and implementation of the programs related to the protection of the environmental bio-diversity. Section 96 stipulates that it is the duty of the municipality to protect the environment through the control of air, water and sound pollution. It also obligates the Municipality to maintain environmental cleanliness through the implementation of solid waste management, flood and landslide control programmes.

Rules and Regulations

xvi. Conservation Area Management Rule 2053 (1996)

Conservation Area Management Rule in Rule 16 under sub rule 1 and 2 directs prohibited activities inside Conservation Area. These activities include hunting, removal of plant materials, excavation, and using helicopters for transportation. Any activities within its premises need to strictly follow through written permission or approval of the Chief of the protected area with such activity giving priority to local consumers as mentioned in Rule 21 in Sub rule 1, 2 and 3. Rule 23 prescribes conditions on the privilege of using transit in road of the protected area.

Nepali regulations allow flexibility with respect to development in conservation areas. Chapter 5, paragraph 16, of the *Conservation Area Management Rules* published on 2 December 1996 (pursuant to Section 33 of *National Parks and Wildlife Conservation Act* of 1973), prohibits hunting, removal of trees and other vegetation, mining, use of explosives, etc., without written permission of the chief. These rules note further that a

license for commercial activities shall be taken from the chief, that any commercial activities must be consistent with the conservation area management plan(s). Large-scale infrastructure is allowed if environmental assessments are conducted and approved prior to securing the necessary license (s).

In the case of electric power infrastructure, the *Conservation Area Management Rules* have been interpreted to allow for large scale hydropower and associated grid expansions, e.g., as is the case with the 456 MW Upper Tamakoshi hydropower project in the Gaurishanker Conservation Area in eastern Nepal, and in the case of the ACA which is host to well over 1000 MW of proposed hydropower capacity. The ACA management plan notes 6 key outcomes which include conservation of key flora and fauna, improvements in livelihoods, and ecotourism benefitting the local population (especially the poor and disadvantaged groups). In this context, provision of energy services from run of river hydropower and other renewable energy resources (e.g., solar and wind) are clearly preferable to continued reliance on traditional biomass which contributes to deforestation and habitat loss. Section 2.7 of the *Management Plan of the ACA 2009-2012* (yet to be updated) specifically notes that micro-hydropower is allowed; the plan is otherwise not specific about large-scale infrastructure but as noted above the *Conservation Area Management Rules* have been interpreted to allow for large scale hydropower and associated grid expansions.

xvii. Environment Protection Rule, 2054 (1997)

The Environment Protection Rule (EPR) was endorsed in June 1997 and was made under the provisions of the Environment Protection Act. The EPR has been amended several times, with amendments noting the need to conduct IEE study for transmission line above the voltage level of 66 kV. An amendment in 2009 (2065/11/26) schedule-1, pertaining to rule 3 further states that if the implementation of transmission line with 220 kV or more requires clearance of more than 5 ha of forest, then EIA study is required. [There is some uncertainty about whether this criteria is routinely enforced, as GoN has also waived many EIA requirements due to the ongoing power shortages.] The EPR adopts the environmental assessment criteria mentioned in the EIA guidelines. The EPR establishes the administrative framework for assessing, exhibition and determination of the EIA/IEE, in terms of issues needing to be addressed and the format/layout of the EIA/IEE document.

Under section (18) of EPA, any person who contravenes any of the provisions of the

Act, or the Regulations or the guidelines issued under the Act, shall be punishable with a fine up to Rs 50,000. If a proposal is implemented without the approval of the Ministry of Environment (in case of IEE, Ministry of Energy) or relevant government agency, or the person implementing the proposal is not complying with the conditions of the approval or license, the authorized official is empowered to close down that activity and may impose fine of up to Rs. 100,000 on such person or organization.

xviii. Forest Rule, 2052 (1992)

Rule 65 of Forest Riles stipulates that in case the execution of any project having national priority in any forest area causes any loss or harm to any local individual or community, the proponents of the project itself shall bear the amount of compensation to be paid. Similarly, the entire expenses required for cutting the transporting the forest products in a forest area to be used by the approved project should be borne by the proponents of the project.

xix. Electricity Regulation, 2050 (1993)

Regulations on electricity sectors have been formulated for the implementation of the provisions made in the Electricity Act, 2049. Rule 12 (f) and Rule(g) are related to the EIA/ IEE process which emphasize that the IEE report should include measures to be taken to minimize the adverse effects of the project on social, biological and physical environments and should also elaborate utilization of local labour, source of materials, benefits to the local people after the completion of the project, training to local people in relation to construction, maintenance and operation, facilities required for construction site and safety arrangements.

xx. Water Resources Regulation, 2050 (1993)

It is mandatory under Rule 17(e) of the regulation that any person or corporate body, who desires to obtain a license for utilization of water resources must state in his application that appropriate measures will be taken to lessen the adverse effects due to the project on the overall environment. Rule 19 stipulates that the water resources committee shall publish a notice giving detail information about the project to the people.

xxi. Local Self Governance Regulations, 2000

Local Self Governance Regulation empower the local bodies to coordinate and implement development program and for rationale utilization of local natural resources.

Article -7 (69) empowers the VDCs for monitoring and supervision of development work implemented in the VDC. The Article - 4 of DDC has provision of 3 members (Agriculture, Forest and Environment) committee to look after the concerned issues. Article-6 (206) specifies that the need of social, economic, environmental and public facilities should be consider while planning the project. Article -7 (210) focuses on environmental studies and stresses due consideration while implementing the project like sand quarry, stone quarry and coal mines etc.

Guidelines and Conventions

xxii. National Environmental Impact Assessment Guidelines, 1993

The National EIA Guidelines, 1993 developed by the National Planning Commission in conjunction with IUCN, set out the process for the environmental review and management of infrastructure projects in all sectors and the respective roles of certain GoN agencies and project proponents. The guideline was part of a comprehensive program to develop the national and sectoral guidelines for establishing a national system for Environmental Impact Assessment which was part of GoN's National Conservation Strategy. The EIA Guideline was endorsed by GoN on 27 September 1992 and gazette on 19 July 1993.

The schedules attached to the Guidelines include:
Schedule 1 : Projects requiring an IEE Report
Schedule 2 : Projects requiring an EIA
Schedule 3 : EIA based on project sites
Schedule 4 : Projects requiring an IEE Report
Schedule 5 : Format for Terms of Reference
Schedule 6 : Environmental Impact Report Format

xxiii. EIA Guidelines for Forestry Sector 1995

The GoN in keeping with the spirit of the National Environmental Impact Assessment Guidelines, 1993 framed EIA guidelines for the forestry sector in 1995. The Guideline aim to facilitate the sustainable use of forest resources for socio- economic development and meeting basic need to the community regarding the forest products, to make proposals socio culturally acceptable, economically feasible, and environmental friendly to conserve genetic resources and biodiversity and minimize environmental damage in forest areas and facilitate in identification of positive and negative impacts of programs to be implemented by other agencies in forest areas. The guideline

emphasized the need of carrying out an EIA /IEE study of development projects and programs proposed for implementation in forest areas.

xxiv. Forest, Production, Collection and sales Distribution Guidelines, 2057 (1998)

The guidelines clauses 3 to 10 have specified various procedure and formats for getting approval for vegetation clearance, delineation of lands for vegetation clearance, evaluation of wood volume etc. and government offices and officials responsible for the approval, delineation and evaluation. These provisions have a direct relevance to the development of the project and need compliance to these provisions.

xxv. EIA Guidelines for Agriculture Sector, 2003

The guideline was developed to minimize impacts on the agriculture sector due to increase in agriculture products and productions and the activities of projects implemented by other organizations. The construction of the proposed project will require acquisition of agriculture land. Hence the provisions of the guideline are relevant to the proposed project.

xxvi. National Health Care and Waste Management Guideline, 2002

The guideline sets procedures for handling of health care waste which includes details of collection, separation and final disposal of the waste for the safety of human health and hygiene vis a vis environmental contamination

xxvii. Biodiversity Convention, 1992

The convention contains a series of far reaching obligations related to the conservation of biological diversity and sustainable uses of its components. One of these obligations is the requirement for environmental study. The purpose of an environmental study in relation to biodiversity conservation is to identify in advance:

- The aspects of the project which is likely to have significant adverse effects on biological diversity at genetic, species and ecosystem level, and
- The steps to be taken to avoid or minimize significant adverse effects to ensure that the proposed project comply with existing environmental legislation.
- The GoN under National Park and Wildlife Conservation Act 2029, (1973) has included 38 species of wild animals and the Forest Act 2049, (1993) has included 17 species of plants in the protection list. If the project area is in the core habitat of these species and project activity will likely to affect them, mitigation measures shall be proposed and be implemented to avoid and/ or mitigate the adverse impacts. Nepal is a party to the

convention of Biological diversity and in accordance to the article 14, adequate attention should be given to minimize and or avoid the impacts.

xxviii. Convention in international Trade in Endangered Species of Wild Fauna & Flora (CITES)

Nepal became a contracting party to the convention on 18 June 1975.That aims to control the trade of certain wildlife species to prevent further endangered of their survival. CITES classified species according to the following criteria:

- Species threatened with extinction
- Species which could become endangered.
- Species that are protected

As Nepal is party to the convention related to species conservation, attention should be given to evaluate the impacts of the project activities on meeting their obligation. It is relevant to IEE study that species protection list could also be used to evaluate the significant of the identified and predicted impacts. Plant and wild animal species under legal protection provides a basis to purpose EMPs for their conservation and for least damaging them during project implementation.

xxix. Community Forest Guidelines, 2058 (2001)

This guideline has been prepared by including amendments of acts, rules by officials of GoN and related experts. Through these guidelines persons involved in the development and management of community forest like facilitators, users groups, forester and managers etc will get help to understand about the process and stages of development of community forest. Forest users group, forest officials, NGOs and INGOs are getting benefit by this guideline. Till date, more than 15000 community forests have been handed over to the community forest users groups.

xxx. Community Forest Inventory Guidelines, 2005

The guideline for inventory of community forests advice to classify the forest into timber trees, pole size trees and regeneration on the basis of diameter. It has recommended using 20m x 20m size of quadrant for timber trees, 10m x10m for shrub and 5m x 5m for regeneration plots in the community forest. Plants having dbh (diameter at breast height, i.e. 1.3m above ground) greater than 30 cm is considered as trees. Trees having dbh between 10 and 29.9 cm are categorized as pole and plants having less than 10 cm dbh belong to regeneration species.

xxxi. International Labour Organization (ILO) Convention of Indigenous and Tribal Peoples (No.169)

Nepal ratified ILO Convention No. 169 on September 14, 2007. In 2007 the UN Declaration on the Rights of Indigenous Peoples was adopted by the General Assembly. The declaration reaffirms the importance of the principle and approaches provided for under convention No. 169 and its adoption therefore provide a fresh impetus for promoting the ratification and implementation of 169. ILO Convention No. 169 highlights the need to recognize indigenous and tribal people's specific knowledge, skills and technologies as the basis for their traditional economies and self determined development process. Article -1 of the convention provide definition of the tribal indigenous people. Article- 6 deals the consultation of the peoples concerned through appropriate procedure in particular through their representative institutions.

In Article 15, the rights of the people concerned to the natural resources pertaining to their lands shall cover the total environments of the areas which the peoples concerned occupy or other use. The peoples concerned shall wherever possible participate in the benefit of such activities and shall receive fair compensation for any damage which they may sustain as a result of such activities. Article 16 (2) clearly mentions that where the relocation of these peoples is considered necessary, exceptional measures such as relocation shall take place only with their free and inform consent. Where their consent cannot obtained, such relocation shall take place only following appropriate procedures established by national laws and regulations, including public inquiries where appropriate , which provide the opportunity for effective representation of the peoples concerned . Article 16 (3) mention that whenever possible these peoples shall have the right to return their traditional land as soon as the grounds for relocation cease to exist. Article 16 (5) elaborated the persons thus relocated shall be fully compensated for any resulting loss or injury.

Air and Water Standards

Relevant ambient air and water quality standards are presented in Tables 2.1 and 2.2. The ambient air quality network in Nepal is limited to stations in the Kathmandu urban area and a remote station near Mt. Everest. The operation of the stations in the

Kathmandu area is at risk due to electricity shortages.[1] Analytical capacity is also limited to laboratories in the Kathmandu area. Nepal is developing a hazardous waste management regulatory system but it is not yet fully operational.

Table 2.1: National Ambient Air Quality Standards (micrograms per cubic meter)

Parameters	Averaging Time	Ambient Concentration (maximum)	Test Methods
Total Suspended Particulates	Annual	-	
	24-hours[a]	230	High Volume Sampling
PM10	Annual[b]	-	
	24-hours[a]	120	Low Volume Sampling
Sulphur Dioxide	Annual	50	Diffusive Sampling based on weekly averages
	24-hours[c]	70	To be determined before 2005
Nitrogen Dioxide	Annual	40	Diffusive Sampling based on weekly averages
	24-hours[c]	80	To be determined before 2005
Carbon Monoxide	8 hours[b]	10,000	To be determined before 2005
	15 minutes	100,000	Indicative Samplers[d]
Lead	Annual	0.5	Atomic Absorption Spectrometry, analysis of PM10 samples[c]
	24-hours	-	
Benzene	Annual	20[e]	Diffusive Sampling based on weekly averages
	24-hours	-	

Source: (MoEN, 2010)

Notes:

[a] 24 hourly values shall be met 95% of the time in a year. 18 days per calender year the standard may be exceeded but not on two consecutive days

[b] If representativeness can be proven, yearly averages can be calculated from PM10 samples from selected weekdays from each month of the year.

[c] 24 hourly standards for NO_2 and SO_2 and 8 hours standard for CO are not to be controlled before MOPE has recommended appropriate test methodologies. This will be done before 2005.

[d] Control by spot sampling at roadside locations: Minimum one sample per week taken over 15 minutes during peak traffic hours, i.e in the period 8am-10am or 3pm-6pm on a workday. This test method will be re-evaluated by 2005.

[e] To be re-evaluated by 2005

[1] Nepal Ministry of Environment. *A Brief Note on Environmental Pollution Control and Monitoring.* Accessed on 10 June 2011 from: http://www.moenv.gov.np/newwebsite. The air quality network was established with funding from the Danish government. According to this note, the most recent air quality monitoring report covered years 2006-2007, and the monitoring system was shut down due to load shedding. One solution to this problem would be to re-tool the monitoring stations using solar photovoltaic power supply. An additional option would be to combine the re-tooled monitoring stations with billboards ("hoardings"); part of the income from the billboard rentals would pay for re-tooling and operations.

Table 2.2: Generic Standard: Tolerance Limit for Industrial (Wastewater) Effluents Discharged into Inland Surface Waters and Public Sewers				
SN	**Parameters**	**Industrial waste into Inland Surface Waters**	**Wastewater into inland Surface Waters from CWTP***	**Industrial Effluents into Public Sewers***
1	TSS, mg/l	30-200	50	600
2	Particle size of TSS	Shall pass 850-micron Sieve	Shall pass 850-micron Sieve	
3	pH Value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4	Temperature ^{o}C[1]	<40	<40	45
5	TDS, mg/L, max			2100
6	Colour and Odour			
7	BOD for 5 days at 20 degree C, mg/L Max	30-100	50	400
8	Oils and grease, mg/L, Max, Max	10	10	50
9	Phenolic compounds, mg/	1	1	10
10	Cyanides (as CN), mg/L, Max	0.2	0.2	2
11	Sulphides (as S), mg/L, Max	2	2	2
	Sulphates (SO_4), mg/L, Max			500
12	Radioactive materials: a. Alpha emitters, c/ml, Max b. Beta emitters, c/ml, Max	 10^{-7} 10^{-8}	 10^{-7} 10^{-8}	
13	Insecticides	Absent	Absent	Absent
14	Total residual chlorine, mg/L	1	1	1000 as chlorides
15	Fluorides (as F), mg/L, Max	2	2	10
16	Arsenic (as AS), mg/L, Max	0.2	0.2	1
17	Cadmium (as, Cd), mg/L, Max	2	2	2
18	Hexavalent chromium (as Cr), mg/L, Max	0.1	0.1	2
19	Copper (as Cu), mg/L, Max	3	3	3
20	Lead (as Pb), mg/L,	0.1	0.1	0.1

Table 2.2: Generic Standard: Tolerance Limit for Industrial (Wastewater) Effluents Discharged into Inland Surface Waters and Public Sewers

SN	Parameters	Industrial waste into Inland Surface Waters	Wastewater into inland Surface Waters from CWTP*	Industrial Effluents into Public Sewers*
	Max			
21	Mercury (as Hg), mg/L, Max	0.01	0.01	0.01
22	Nickel (as Ni), mg/L, Max	3	3	3
23	Selenium (as Se), mg/L, Max	0.05	0.05	0.05
24	Zinc (as Zn), mg/L, Max	5	5	5
25	Sodium, %, max			
26	Ammonical nitrogen, mg/L, Max	50	50	50
27	COD, mg/L, Max	250	250	250
28	Silver, mg/L, Max	0.1	0.1	0.1
29	Mineral Oils, mg/L, Max			10
30	Inhibition of nitrification test at 200ml/l			<50%

Source: MOEN, 2010

Notes: CWTP= Combined Waste Water Treatment Plant; Under enforcement since BS 2058/1/17 (30 April 2001); *Under enforcement since BS 2060/3/9 (23 June 2003); [1] Shall not exceed 40^{o}C in any section within 15 m downstream from the effluent outlet

3. Description of the Project

Project Components

The Government of Nepal (GoN) and ADB have identified the following components for inclusion in the project:

(i) Transmission system expansion, including new transmission lines and substations which will facilitate cross-border power exchange and future power exports, and augmentation of existing substations to improve grid efficiency;
(ii) Distribution system expansion; and
(iii) Renewable energy (RE) based mini-grids in remote villages.

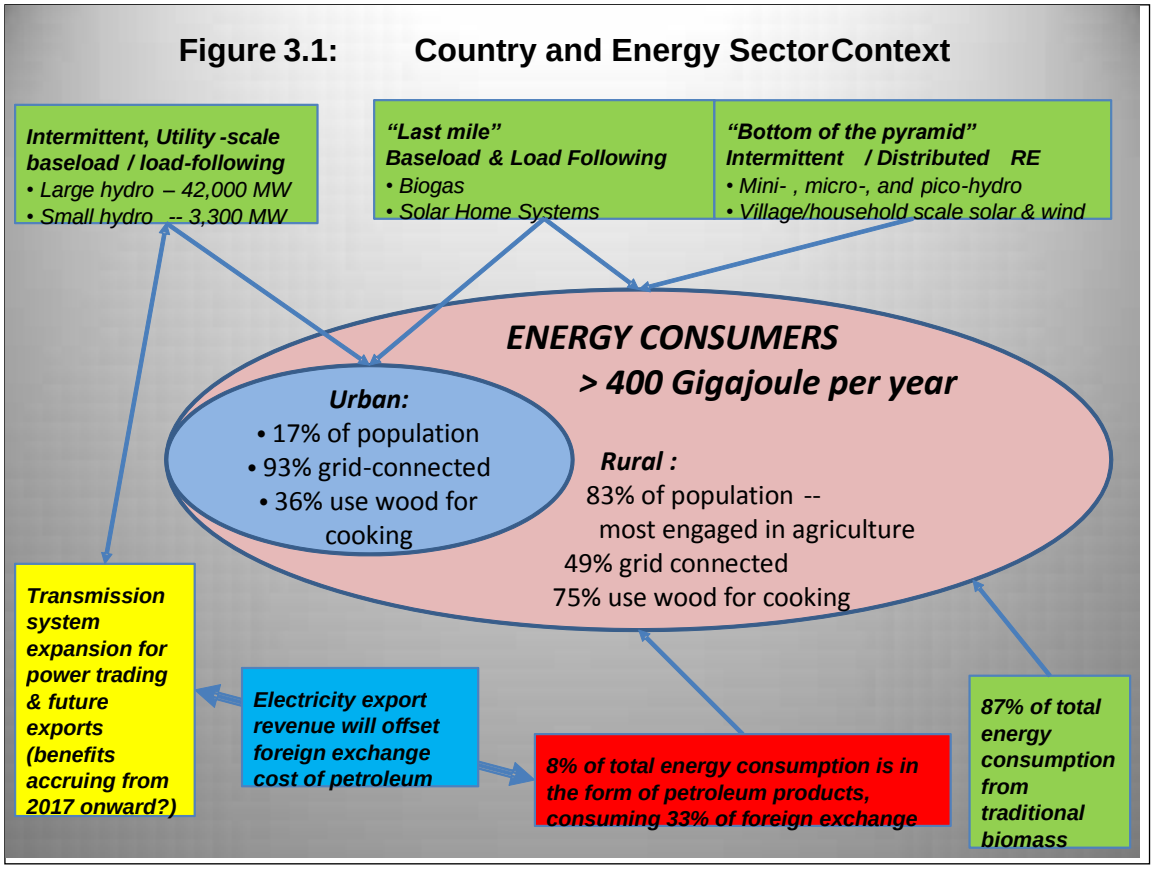
Project implementation services will be provided, including support for design, bid specifications, procurement, environmental and social safeguards implementation, and livelihood improvement in the transmission corridors.

Rationale and Need for the Project

The Project is designed to address Nepal's overall energy development, in particular the urgent needs of the Nepal power system. Lack of investment in generation, transmission, and distribution has led to unreliable and inadequate power supplies. The majority of the population still relies on traditional biomass (animal dung, agricultural residues, and wood) for basic energy needs, mainly cooking and heating. Traditional biomass accounted for 86% of total final energy demand in 2006. Per capita gross domestic product and per capita energy demand are among the lowest of South Asian countries. The electrification rate is about 33%, among the lowest in Asia, and about the same as Bangladesh and Bhutan.[2] Agricultural, commercial, and residential uses account for most electricity consumption. The country and sector context is presented in Figure 3.1.

The Project targets the strengthening and expansion of transmission systems that will enable Nepal to further benefit from power trading and development of its abundant hydropower resources. Transmission network strengthening and expansion, in conjunction with current hydropower generation development, is a precondition to reducing load shedding and increased cross border electricity trade. The project components are presented in Table 3.1 and shown schematically in Figure 3.2.

[2] ADB. 2009. *Energy Outlook 2009*. Manila.



The major demand centers are in eastern and central Nepal. Large hydropower and associated transmission development programs in central Nepal and the Tamakoshi Valley in eastern Nepal are at an advanced stage of development with technical and financial support from ADB projects approved in 2013 and 2011.[3] At present, the highest priorities for development are the Marsyangdi and Kali Gandaki corridors which will serve the central Nepal demand center and enable cross-border power exchange between Bardaghat and Gorakhpur in India (see Figure 3.2).

There is no large-scale, short-term, supply-side solution based on domestic resources, as large hydropower plants typically require 5 to 7 years for construction and commissioning. Improving end-use and grid operational efficiency and expanding distributed generation capacity will alleviate load shedding; these activities are being pursued with technical and financial support from ADB under a project approved in

[3] *Tanahu Hydropower Project*. ADB Project 4328-013, approved in 2013. *Nepal Electricity Transmission Expansion and Supply Improvement Project*. ADB Project 41155-013, approved in 2011.

2009.[4] NEA is implementing a program to reduce technical and non-technical losses. Increasing power imports from India presents the only supply-side solution which can be achieved at the scale necessary to close the demand-supply gap in a timely fashion.

Table 3.1: Project Components

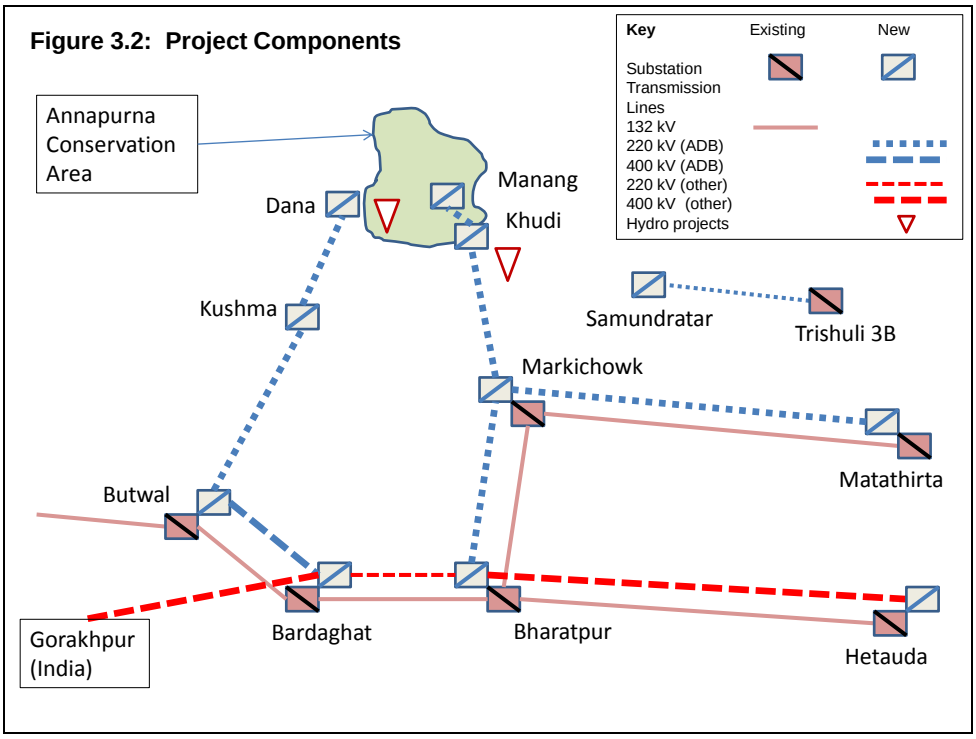
Components	Details
NEA's transmission system expansion	
1. Kali Gandaki basin to boarder	i. Dana - Kusma 220kV transmission line, and substations at Dana, Kusma; ii. Kusma - New Butwal 220kV transmission line, and substation at New Butwal; iii. New Butwal - Bardaghat 400kV transmission line, and substation at Bardaghat;
2. Marsyangdi Corridor	i. Khudi- Udipur- Marki Chowk- Bharatpur 220kV transmission line, and substation at Khudi, switchyard at Udipur, and bay extension at Bharatpur; ii. Manang-Khudi 220kV transmission line, and associated substations at Manang and and bay extension at Khudi
3. Marsyangdi to Kathmandu	**i.** Marki Chowk- Matatirtha- 220kV transmission line, and associated Marki Chowk substation, and bay extension at Matatirtha;
4. Grid substations reinforcement	i. Gandak 132/33/11kV (30MVA+16.6MVA); Middle Masyangdi 132/33kV (20MVA); Butwal 132/33 (63MVA); Bharatpur 132/33kv (63MVA); Dhalkebar 132/33kV (63MVA); Lahan 33/11kV (2*16.6MVA); Banepa 66/11kV (2*22.5MVA); Attaria 132/33kV (2*30MVA)
NEA's distribution system augmentation	
1. Distribution system	i. Distribution system along Kaligandagi, Marsyangdi, and Marsyangdi-Kathmandu transmission corridors, and other identified area
AEPC's mini-grid based RE development	
1. Mini hydropower mini-grid development	i. Sani Veri Mini HPP (300 kW) ii. Simurutu Mini HPP (200 kW), and others
2. Solar power and solar-wind power hybrid mini-grid development	i. Kyangshing Solar Mini grid (12.6 kW) ii. Bhorleni Solar-wind hybrid mini-grid (35 kW) iii. Chisapani Solar-wind hybrid mini-grid (20 kW) and others

kV = kilovolts, kW = kilowatts, MVA = megavolt-amperes
Source: ADB review mission Aide Memoire, February 2014.

[4] *Nepal Energy Access and Efficiency Improvement Project.* ADB Project 40553-013.

The power sector presents the most severe infrastructure constraint for economic growth. Demand is projected to continue growing at 7.6% annually until 2020. Due to the shortfall in power delivery capacity, the NEA introduced scheduled service interruptions (load shedding or "rolling brownouts") of 12 hours per day in 2010. These conditions provide a major opportunity for supply side and demand side energy efficiency (EE) improvements, as well as for use of other renewable energy (RE) sources to provide immediate relief to the grid, however EE and RE potential (not including large hydropower) are insufficient to bridge the demand-supply gap in the near term. At present, there is a peak power deficit of about 500 MW on a daily basis, as shown in Figure 3.3.

Figure 3.2: Project Components

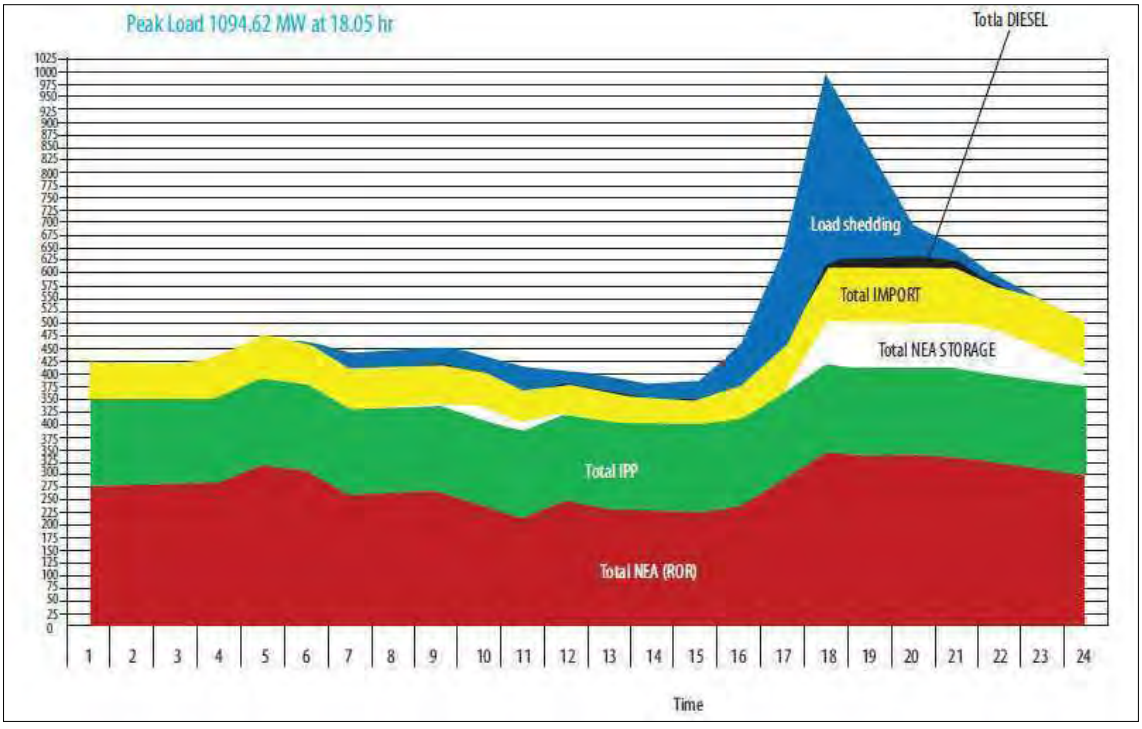


Nepal's commercially exploitable hydropower potential is estimated to be 42,000 megawatts (MW).[5] The Government of Nepal plans to develop 10,000 MW of this resource during the near- to medium term, but the potential remains largely untapped with less than 1000 MW of installed capacity as of early 2014. Figure 3.4 shows the load forecast projected through year 2027-28 in terms of megawatts and gigawatt-hours.

[5] SAARC. March 2010. *SAARC Regional Energy Trade Study*. Kathmandu, Nepal

A “chicken and egg” situation exists wherein private sector hydropower projects rely on the Nepal Electricity Authority (NEA) to provide adequate transmission capacity, without which future commercial investment will be discouraged. At the same time, NEA has limited funds and capacity for rapid expansion of the transmission network and new generation capacity. The Project will support the construction and operation of a national high-voltage transmission backbone which will facilitate expansion of electricity supply to consumers in Nepal, enhance voltage stability, and expand cross-border power trading capacity. In the near term, power trading will be mainly imports from India, with some export of wet season surplus power in the medium term. In the longer term, power trading will be mainly exports as a year-round daily power surplus is developed; however, this potential surplus will not be created unless the high-voltage transmission network is expanded to support large-scale hydropower development.

Figure 3.3: System Load Curve for Peak Load Day

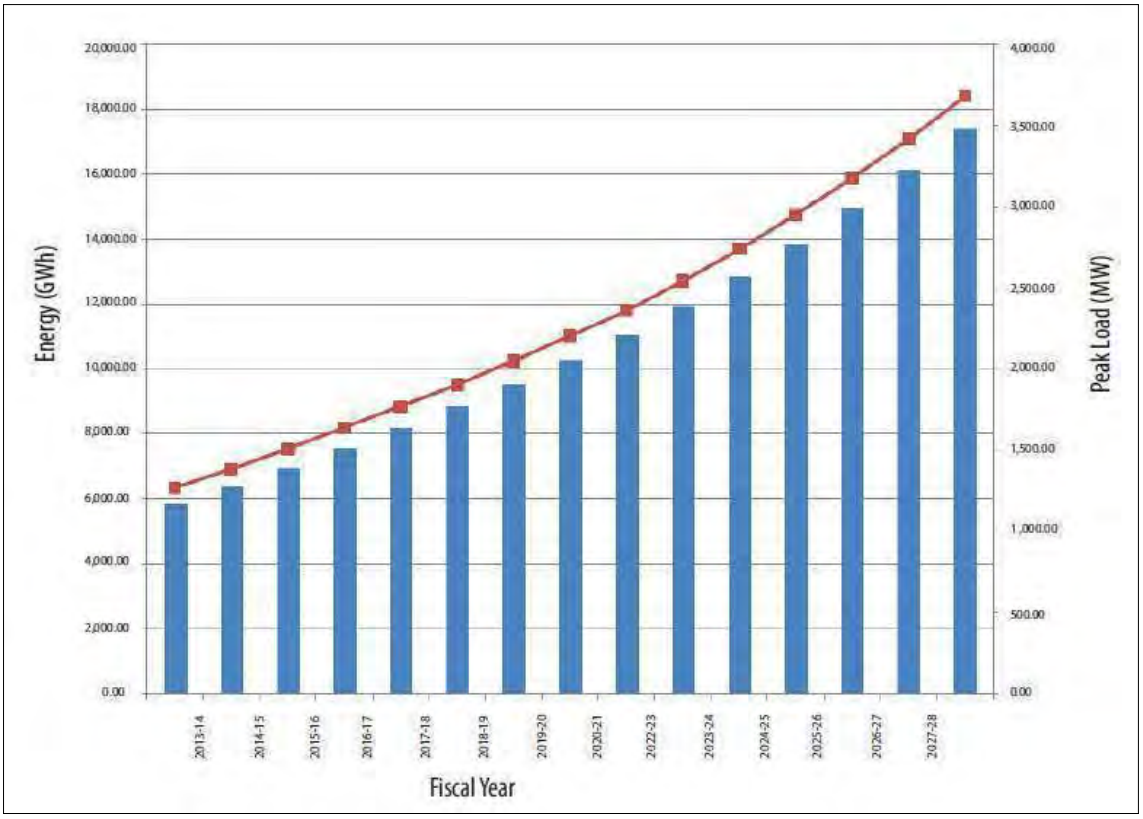


Source: Nepal Electricity Authority. 2013. *A Year In Review – Fiscal Year 2012/2013*. NEA, Kathmandu

The transmission lines will improve efficiency of transmission system operations, expand delivery of clean energy, and reduce end-users need for back-up generators which use petroleum-based fuels. The associated hydropower plants currently under construction will add 103 MW to the grid with about 451 GWh per year of additional

energy. This represents about 10% of peak demand of 1095 MW, and almost 11% of the estimate peak energy demand of 5446 GWh in 2012/2013.[6] There are several additional hydropower projects under development in the Kaligandaki and Marsyangdi corridors, with about 1000 MW of new capacity in each corridor; the transmission lines will utilize advanced high-temperature low-sag conductors in order to facilitate these future capacity additions.

Figure 3.4: Electricity Load Forecast



Note: Energy (GWh) is represented by blue bars; peak load (MW) is represented by the red squares and line. Source: Nepal Electricity Authority. 2013. *A Year In Review – Fiscal Year 2012/2013*. NEA, Kathmandu

Improved quality and reliability of electricity supplies will reduce load shedding and the need for back-up generators, which in turn will reduce conventional air pollutant and greenhouse gas (GHG) emissions and improve local air quality with direct local health benefits. Expanding the delivery and use of clean energy will reduce GHG intensity (emissions per unit of economic output).

[6] Source: Nepal Electricity Authority. 2013. *A Year In Review – Fiscal Year 2012/2013*. NEA, Kathmandu

Reducing demand for petroleum fuels for back-up power generation will reduce the foreign exchange outflow which is a serious drag on the economy as indicated in Figure 3.1. Peak demand for electricity in Nepal overshot the installed capacity after 2007. This was followed by an increase in the ratio of imported petroleum products relative to commodity exports from 57% in 2006/2007 to 126% in 2011/12. Similarly, sales of diesel doubled from 2008 to 2010 with increase in imports of captive generating sets from 56 MW in 2009 to 69 MW in 2012[7]. Based on Nepali Oil Corporation and NEA prices for petroleum fuels and electricity in 2012 and 2013, the monthly life cycle cost of cooking with electricity in urban households is 43% less than that of kerosene and 9% less than that of liquefied petroleum gas (LPG). In an earlier study done in 2001, productive energy-use cost was found to be the least for saw dust stove which was lower than cost of electricity, and kerosene was cheaper than both LPG and electricity[8]. As the price of crude oil has increased in the last several years, grid-supplied electricity is now cheaper than refined petroleum products.

Alternatives to the Proposed Project

There are no practical alternatives to the Project based on financial, economic, and environmental factors. New high-voltage transmission capacity is required to deliver power from the proposed transmission corridors into the national grid and to facilitate cross border power exchange.

No Action. In the "no project" scenario, the power system will continue to experience operational difficulties due to demand-supply gaps, poor quality of power, and reduced reliability of service to end-users. Load shedding and scheduled blackouts will increase, and reliance on back-up generators will increase without the project.

Improving End-use Efficiency and Expansion of Distributed Generation Capacity to Eliminate Need for High Voltage Transmission. Improvement of end-use efficiency in the near term could reduce demand by perhaps 5-10% or more. This would reduce, but not eliminate, the need for the Project due to the magnitude of suppressed demand. Distributed generation already exists in the form of backup

[7] Nakarmi, A. M. (2013, August 26). Power Requirements in Future Energy Scenarios of Nepal. *Power Summit 2013:Hastening pace of hydropower development*. Kathmandu, Bagmati, Nepal: IPPAN.
[8] Pokharel, S. (2004). Energy economics of cooking in households in Nepal. *Energy, 29*, 547-559.

generator sets fired with diesel or gasoline (petrol). ADB is providing technical and financial assistance for distributed generation with renewable resources via a project being developed in parallel with the proposed Project.

Expansion of generation capacity closer to major load centers (e.g., the Tanahu hydropower project noted above, see footnote 3) would reduce but not eliminate the need for high voltage transmission and associated hydropower development. Distributed generation in the form of rooftop solar PV is being pursued and is included as a component of the ADB project approved in 2009 (see footnote 4), but solar PV is currently more expensive that grid-supplied hydropower. Solar PV is cost-competitive with off-grid petroleum-based generation, but has inherent limitations because it is has variable power output. Small hydropower (less than 10 MW per plant) can fill some local demand-supply gaps in the near term, but requires mobilization of capital and additional investments to connect new hydropower plants to end-users and the grid.[9] Traditional biomass is currently used by the majority of the population of Nepal for basic energy needs, but upgrading with modern technology would be required to improve and increase the effective use of biomass. Geothermal potential has not been quantified. Wind potential is limited and cannot be expected to come online fast enough to alleviate power shortages. Development of these other renewable resources could reduce the need for the Project in the short term, and would facilitate future exports of power as generation surplus develops in the long-term. Rehabilitation of existing hydropower plants will have similar short-term vs. long-term effects.

Routing Alternatives for Transmission Lines

Routing alternatives for the proposed transmission lines have been evaluated to minimize line length, forest clearance, and sensitive ecosystems. For each transmission line, NEA conducted a preliminary desk study to identify the corridors, and evaluated 3 alternative routes within each corridor. The criteria utilized for comparison are based on accepted engineering, environmental, and social considerations. The preferred routing alternative minimizes the number of road crossings, river crossings, settlements affected, and minimizes forest crossings, thus minimizing the overall environmental and social impacts.

The preferred alternative. The proposed Project is consistent with least-cost

[9] Small hydropower development is being pursued under Nepal's Scaling Up Renewable Energy Program (SREP) Investment Plan via a joint program of ADB's Private Sector Operations Department and the International Finance Corporation (IFC).

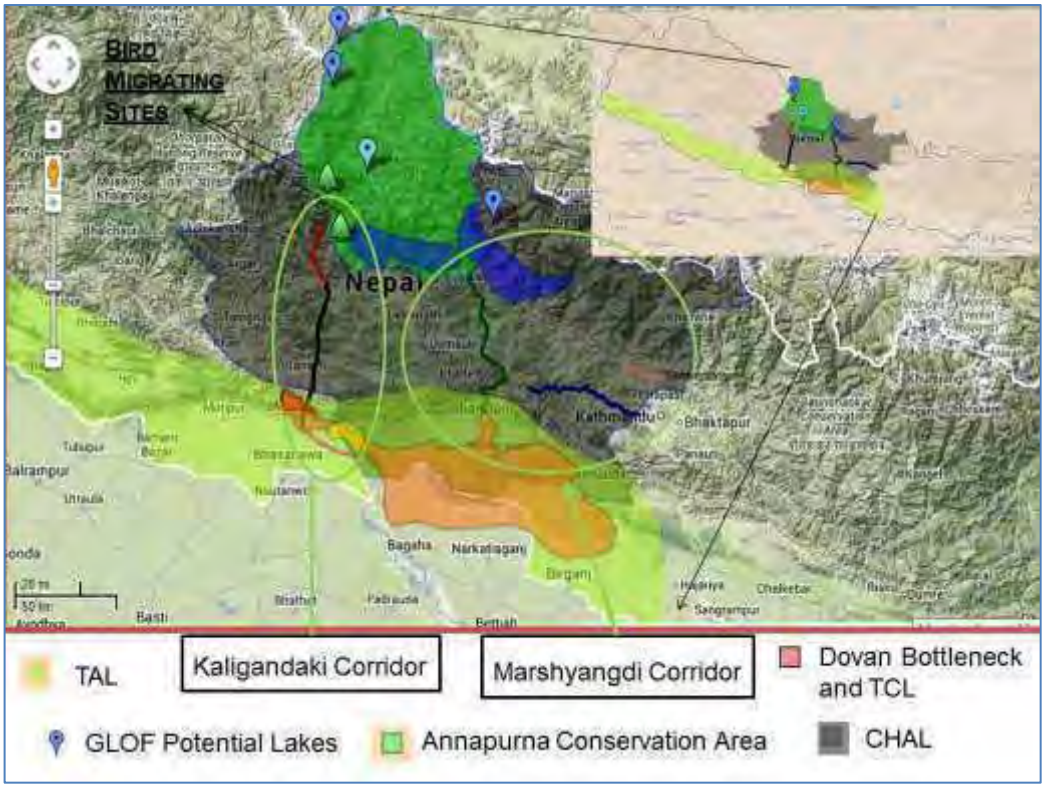
expansion plans for electric power system operations in Nepal, and for improving access to energy in the proposed transmission corridors, with minimal environmental and social impacts. The proposed transmission lines are critical for delivery of clean energy to the major load centers of the country and to facilitate cross-border power trading. Other investments in end-use efficiency and distributed generation being implemented in parallel will complement the proposed Project, but would not provide sufficient energy savings and end-use generation to eliminate the need for the transmission components proposed.

4. Description of the Environment

4.1 Project Area and Boundaries

The Project components are located mainly in the Western and Central Development Region in Nepal as shown in Figure 4.1.

Figure 4.1 Project Location Map



CHAL = Chitwan Annapurna Landscape, GLOF = Glacier Lake Outburst Flood, TAL = Terai Arc Landscape, TCL = Tiger Conservation Landscape

The Kaligandaki Corridor line will traverse a total of 155 km beginning approximately 50-km aerial distance northwest of Pokhara in Middle Mountains close to western boundary of Annapurna Conservation Area (ACA) to areas near Butwal, Lumbini and Chitwan National Park in the terai. In one section at Ghar VDC the routing crosses over to the left bank of Kaligandaki River and traverses for approximately 2.4 km inside the ACA.[10] The Marsyangdi Corridor line will be routed to the east of Pokhara and will run from 40 km aerial distance north east of Pokhara from south eastern parts of the

[10] On the basis of ACA Management Plan the transmission line passes through 2.4 km of the ACA. However, based on Topographic Map Published by Department of Survey of Government of Nepal the transmission line does not cross into the Conservation Area.

ACA to Bharatpur Municipality in inner terai of southern Nepal. Likewise, the Marsyangdi to Kathmandu line will 85 km run from Marki Chowk about 25 km from Pokhara to Kathmandu. The Trishuli 3B Transmission Hub consists of a 24 km transmission line and a substation at Samundratar, in an area northwest of Kathmandu and east of Pokhara.[11] The Grid Service substations are at Gandak and Marsyangdi. The distribution system augmentation project sites are spread from Eastern to Far Western Development Region of Nepal.

The detail of elevation profile is in Figure 4.2 a and b. The upper part of the figure shows the approximate route of the DKBB route as a red line. In the lower part of the figure, the route of the MKMB line is shown as a red line.

Figure: 4.2a Location Map and Elevation Profile of the Proposed Kaligandaki Corridor

Kaligandaki Corridor

[11] As of 19 February 2014, this line and substations are proposed to be dropped from the project.

Figure: 4.2b Location Map and Elevation Profile of the Proposed Marsyangdi Corridor

Marsyangdi Corridor

4.1.1. Kaligandaki Corridor

The project area for the DKBB[12] transmission line covers 46 Village Development Committees (the smallest administrative and political units of Nepal) of Seven Districts. The administrative units traversed by the transmission line are listed in Table 4.1. The transmission line at Dana, Tatopani, Ghar and Histan Mandali passes close to the ACA. Based on ACA Management Plan, a 2.4 km section of the line passes through the ACA occupying a footprint of 2.2 ha of cultivated land, 5.7 ha of forest Land (Schima Castonopsis Forest with 50 to 70% crown cover close to the Beni Jomsom Road) and 4.1 ha of barren or bushy areas (using 50m RoW). Furthermore, the transmission line crosses over three Corrugated Galvanised Iron (CGI) (this information have been included based on survey report of NEA) roofed house after AP 44. Similarly, at Rupandehi and Nawalparasi District the transmission line comes close to two World Heritage Sites, Lumbini and Chitwan National Park. The Butwal-Bardhaghat Section of the 400kV Line will tentatively be 25 km and 10 km from these protected and sensitive areas.

[12] The line includes substations at Dana, Kushma, Butwal and Bardaghat, hence the acronym DKBB is used to clearly distinguish it from other lines.

Table 4.1: Administrative units traversed by the DKBB Transmission Line

District Name	VDC Name	Settlements
Myagdi	Dana	Dana, Dwarikholagaun, Suwa
	Tatopani	Tatopani
ACA	Ghar	Pokharebagar, Ratopani
	Histan Mandali	Mahabhir
	Dowa	
	Beghkhola/Bagarkhola	Chhapa
	Rakhubhagwati	Nava Baishar, Risinge Chautari
	Piple	Ranipauwa
Parbat	MajhphantMallaj	Nepane, Kamidanda, Mallaj, Phatkadhunga, Pachaiya, Lundi
	Dhairin	Bhedabari, Phausin
	Nanliban	Lasti, Wallo and Pallo Nanliban
	Pan	Bagaicha, Nuwar, Regmithok
	Khurkot	Bagaicha
	Mudikuwa	Sannesibagar
	Phalebas Devisthan	Bhusalchaur, Kajibaur
	Khurga	Chhadhai
	Panran	Shreekanbesi, Panran, Karnas
	Bachchha	Kaphleswara
	Uranpokhara	Salyan, Lugrin
	Wahakhi/Bahakithanti	Banipokara
	Saligram	Khabran, Chilaunekharka, Mithlan, Setibani
Baglung	Paiyupata	Dhad, Kharsedanda, Pathakthar, Paiyupata
	Amalachaur	Tallosarangi
Syangja	Pidikhola	Jogimara, Thangkharka
	Bagthala	Numbuwakharka
	ShreekrishnaGandaki	Bardanda, Ghyansindanda, Chap, Kyansyandi, Jaruwa
Palpa	Yamgha	Gunga
	Yarlamdanda	Lawadanda
	Chhapani	Balthumkidanda, Batulechaur, Phulun
	Nayarnamtales	Bagnas
	Chirtundhara	Piple
	Madanpokhara	
	Koldada	Jorpipal, Khamauri, Setai Berrena
	Dobhan	
Rupandehi	Devdaha	Budhar gau, Mudabas
	Markhar	
	Kerwani	Bhawanipur, Semarhawa
Nawalparasi	Sunwal	Asandiya
	Amraud	
	Swathi	Mukhyatol, Swathi,
	Ramnagar	Santapur, Harkatwa,
	Ramgram NP	
	Manari	Tilauli,
	Tilakpur	

District Name	VDC Name	Settlements
	Panchnagar	Bhagyugani, Gainhara
	Makar	Betahani
Seven Districts	Fourty Six VDC's	

The DKBB line consists of 3 subprojects:

1. Dana-Kushma 220kV Line: This line will be routed from west of Annapurna Conservation Area next to a popular trekking route near Tatopani through 35km up to Kushma.
2. Kushma- Butwal 220 kV and New Butwal- Bardaghat 400kV Line: This line will be routed from Kushma for 75 km up to New Butwal 5 km east of Butwal Municipality then reach Bardaghat 45 km east of New Butwal and 12 km North West of Indian border.
3. Associated 220kV and 400kV Substations: These substations will be located at Dana, Kushma, New Butwal and Bardhaghat.

4.1.2 Marsyangdi Corridor

The Project area of the Marsyangdi Corridor covers 12 VDCs of five districts. The administrative units traversed by the Manang-Khudi-Marki Chowk-Bharatpur (MKMB) transmission line are listed in Table 4.2. The transmission line will cross through the ACA at Manang District and Ghermu, Tagring (subject to change based on final detailed Survey Report) and Khudi VDC of Lamjung District. Similarly, near Bharatpur the transmission line will pass about 4 km away from Chitwan National Park.

Table 4.2: Administrative units traversed by the MKMB Line

District Name	VDC Name	Settlements
Manang	Dharapani	Dharapani, Khurke, Tal, Taldanda
Lamjung	Ghermu	Sat Talle Gaun, Ghermu, Chipla, Pudhakhale
	Tagring	Puranojagat, Chamche, Sitchaure, Thakan, Chhabise
	Bahundada	Nyaupane Phant
	Khudi	Thakan,Rabangaun, Dhakai Besari, Chhabise
	Bhulbhule	Bhulbhule
	Chandisthan	Badagaun, Goliyathok, Chanaute, Odare, Satbise
	Bajhakhet	Besisahar, Akkarbajar,
	Gaunsahar	Ranikuwa, Barhabise, Asimure, Tallophant, Dhipichaure, Rakse
	Udipur	Sanosimire, Thuloghimire, Udipur
	Chiti	Gairagaun(Bhoteni), Seraphantbesi,

District Name	VDC Name	Settlements
		Bajarkhutta, Khutta Bazar, Devistha
	Bhoteoodar	Gairi, Ramdi, Bhaite Puchhartar, Akalamuni, Belghari, Bhoteodar, Bhakti Chwok
Tanahu		
Gorkha		
Chitwan		

The Marsyangdi Corridor consists of 2 subprojects:

1) Manang-Khudi-Marki Chowk-Bharatpur (MKMB) 220kV transmission line. The transmission line will route from the eastern part of the ACA for about 25 km from Dharapani to Khudi, and then 110 km to Bharatpur of Chitwan District.
2) Associated 220kV Substations at Dharapani, Khudi, Marki Chowk and Bharatpur.

4.1.3 Marsyangdi (Marki Chowk) to Kathmandu

The Project area of Markichowk-Kathmandu (M-K) line covers 17 VDCs of five districts. The administrative units traversed by the transmission line are listed in Table 4.3.

Table 4.3: Administrative units traversed by the Marki Chowk - Kathmandu Transmission Line

District Name	VDC Name	Settlements
Tanahu	Abukhaireni	Markichowk Bazaar, Akala
Gorkha	Deurali	Jaikot, Yangkot, Aambote
	Manakamna	Mathillo Gyaja, Jhyamdanda
	Ghyalchok	Siurenitar, Kaltar
Chitwan	Darechok	Tokdam, Gaunda, Kuringtar, villages, Lewatar, Cheresh
Dhading	Jogimara	Thingbang village
	Salang	Majhigaun, Nibuwatar, Majhuwa, Aadhmara Village
	Benighat	Bishaltar
	Kumpur	Luini Danda village
	Kalleri	
	Pida	
	Baireni	
	Goganpani	Biruwatar
	Kewalpur	Sherapakha village, Ragmigaun, Bhujel gaun
	Thakre	Ganeshe Chaur
	Naubise	

District Name	VDC Name	Settlements
Kathmandu	Baad Bhanjyang	
Five Districts	Seventeen VDC's	

4.1.4 Samundratar-Trishuli Transmission Line[13]

A 25.7 km, 132 kV transmission line will be constructed from Archale of Manakamna VDC in Nuwakot District along the right bank of Trishuli River to Samundratar. This component includes the Trishuli 3B Transmission Hub, a 132/33 kV substation located at Archale of Manakamna VDC in Nuwakot District and substation at Samundratar of Nuwakot District. The Samundratar-Trishuli (ST) Transmission covers 11 VDCs of 1 District, as listed in Table 4.4.

Table 4.4: Administrative units traversed by the S-T Transmission Line

District Name	VDC Name	Settlements
Nuwakot	Manakamna	Archale
	Tupche	Dadathok
	Gerkhu	Satbise, Syale, Upallo Gerkhu
	Bageshwari	Gairikharka, Upallogaun, Katunjegaira
	Lachyang	Chhap, Gairigaun
	Narjamandap	Amare
	Kharanitar	Praudanda, Kosgade
	Ralukadevi	
	Thaprek	
	Sundaradevi	Satbise, Bhyangle
	Balkumari	
One District	Eleven VDC's	

[13] As of 19 February 2014 this section is expected to be dropped from the project.

4.1.5 Grid service S/S replacement

The subprojects are for substation upgrade only and will not require land acquisition or major construction. These subprojects are considered to be ADB environment Category C. Details are to be provided by NEA and will be added to this report when available.

4.1.6 Distribution system augmentation

The subprojects will include village electrification in the transmission corridors, other rural electrification, possibly some distribution system rehabilitation including advanced metering installation, and other demand-side activities such as loss reduction program. These subprojects are considered to be ADB environment Category C or B. Details are to be provided by NEA and will be added to this report when available.

4.2 Geography, Geology, and Soils

4.2.1. Kaligandaki Corridor

The DKBB tansmission line passes through the following geographic areas with respective portion of total line length: undulating slopes of Middle Mountain 21%, Hills 47%, Siwalik Region 7%, to Terai 25% of Central Nepal. The minimum elevation is 116.6 m in the Pancahnagar VDC of Nawalparasi District. The highest elevation is 1680 m at a ridge line close to Lugrin of Uranpokhara VDC (Parbat District).

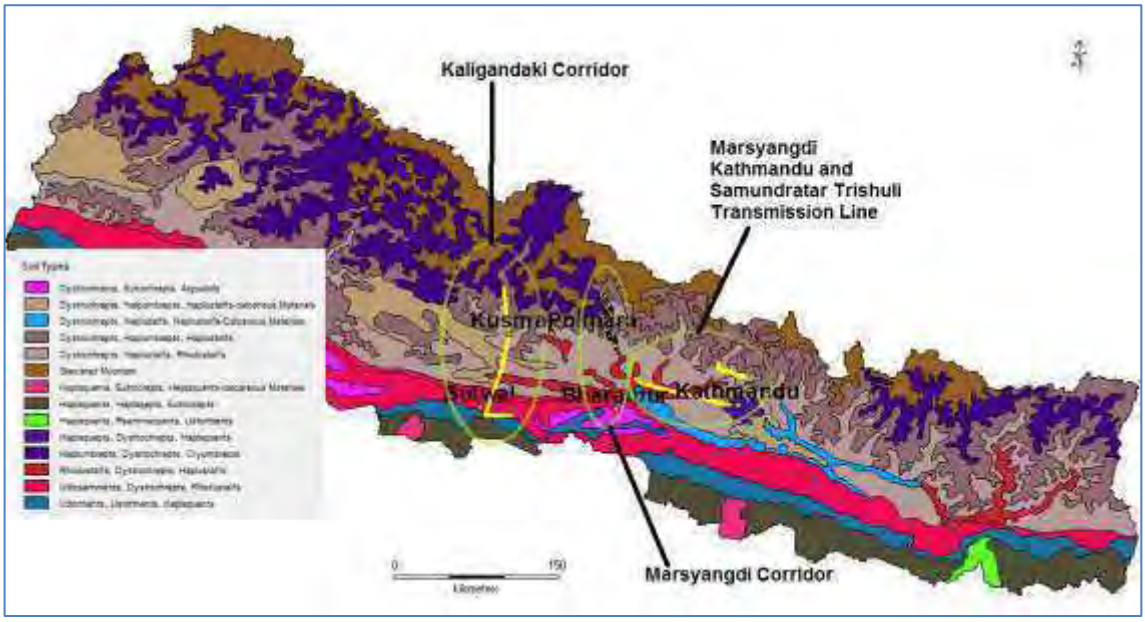
The environmental characteristics (topography, soils, water, and air quality) are variable across this broad area. Major soil types along the project site include: Dystrochrepts, Haplumbrepts, Haplustalfs, Rhodustalfs, Haplustalfs-calcarious Materials, Udipsamments, Udorthents, Ustorthents and Haplaquents Materials for M-B Line (Figure 4.3).

The proposed transmission line crosses two tectono-stratigraphic geological zones. The Main Central Thrust that separates the Higher Himalaya in the north with Lesser Himalaya to the south is crossed near Tatopani of Tatopani VDC in Myagdi District. Similarly near Sattawati of Kol Danda VDC in Palpa District it crosses over Main Boundary Thrust that separates Lesser Himalaya to its north and Sub Himalaya to its south.

The Site Geology begins in north with Higher Himalayan Crystallines which consists of Precambrian high grade metamorphic rocks comprising gneisses, quartzites and marbles, while migmatities, and granite gneisses occur in the upper part; about 25 km

of the route covers this section. Going southward, a 105 km section crosses over Lesser Himalayan Metasediments initially crossing a 5 km section of the Nawakot Group; these are Precambrian to Lower Paleozoic, mainly shallow marine sediments with lower part dominantly clastic (phyllites, sandstones, quartzites and calcareous sandstones). Stromatolitic limestones and black slates occur in the upper part. The next 40km south of this group forms the Kuncha Group. This Group consists of Precambrian, mainly flyschoid sequence (bedded schists, phyllites and metasandstones), locally shallow water quartzite beds and basic sills and dykes. Further south about 50km zone cross the Nawakot Group again.

Figure 4.3: Soil Map



Source: (ICIMOD)

The next 15km is crosses the Tansen Group, consisting of Permo-Carboniferous to Mid-Miocene clastic sediments with local limestone beds. This group consists of 3 sub series of which the transmission crosses over all. The first to cross over is the Permo-Carboniferous Series. This series composes Permo-Carboniferous, partially glaciomarine and predominantly glaciofluvial and fluvial sediments (diamictities, shales/slates, sandstones and siltstones) with flora and fauna. Secondly, the routing crosses over Mesozoic series which consists of Upper Hurasic to Cretaceous with lower part continental fluvial sediments (conglomerates, sandstones, siltstones and shales/slates. The upper units are partly marine (limestone and shales) dominantly fluvial sediments. The Third Series is the Tertiary Series of Eocene to Mid-Miocene consisting of lower part with marine shales and limestone together with Foraminifera

while the upper part consists of sandstones and shales of fluvial floodplain origin havin plant remains. Finally to its south the transmission line crosses over 15km zone of Siwalik Group and then into the Gangetic Plain. The Siwalik Group is of Middle Miocene to Plio consisting of Pleistocene molassic fluvial deposits, conglomerates, sandstone and shale with vertebrate fossils. While the Gangetic Plain consists of Quaternary Alluvial River Deposists[14].

4.2.2. Marsyangdi Corridor

The proposed transmission line will start from middle mountains in the north and end in inner terai at the south end. The minimum elevation is at Bharatpur 230 masl and the highest elevation it passes through is 1968.5 masl in Dharapani of Manang District. Approximately 25 of the line will cross the ACA from Manang to Khudi.

Major soil types found along the routing includes Dystrochrepts, Haplustalfs, Rhodustalfs, Haplumbrepts, Udipsamments, Eutrochrepts and Argiudolls. Like the K-B Line this north-south corridor too will cross two tectono-stratigraphic geological zones the Main Central Thrust at Tanahu District and Main Boundary Thrust near Bharatpur of Chitwan District.

The site Geology begins in north with Higher Himalayan Crystallines similar to the DKBB Line followed by Lesser Himalayan Metasediments of Nawakot Group.and then the Kuncha Group. Finally at Bharatpur the Siwalik Group is found.

4.2.3. Samundratar-Trishuli Corridor

The proposed transmission line will start from middle mountains in the northwest and end Hills in the southeast. The minimum elevation is near Betrawati Bazaar 610 masl on the bank of Trishuli River and the highest elevation it passes through along the mountain ridge between AP 19 to AP 26 at 1522 masl in Bageshwari VDC.

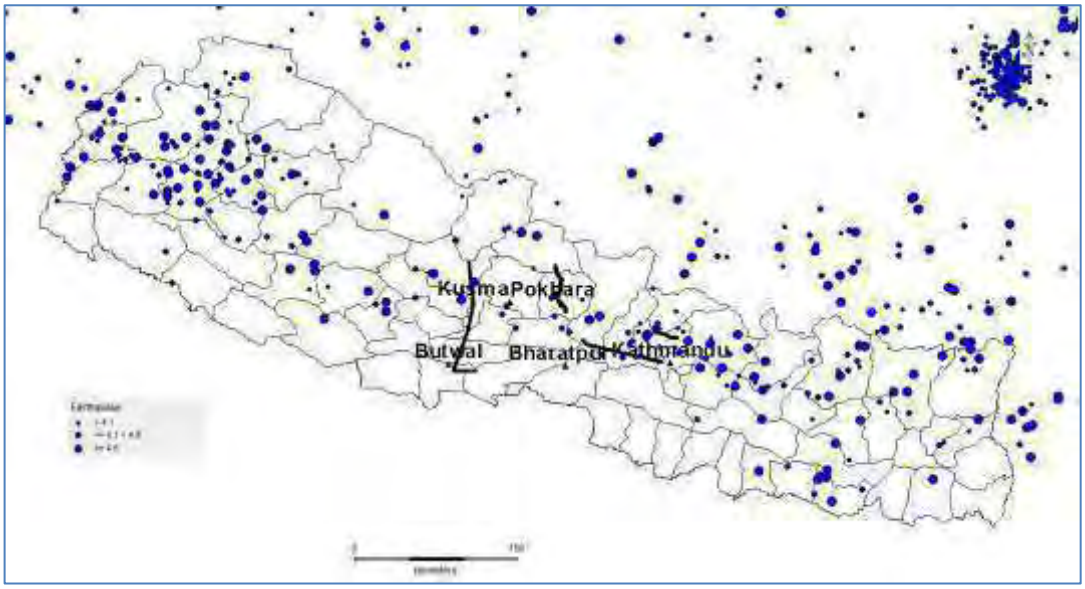
Major soil types found along the routing includes Dystrochrepts, Haplumbrepts, Haplustalfs and Rhodustalfs. The site Geology begins in northwest with Kuncha Group of the Lesser Himalayan Metasediments followed by Nawakot Group.and then the Higher Himalayan Crystallines.

[14] HMG, 1993

4.2.4 Seismology

All of Nepal is seismically caused by subduction of Indian tectonic plate under the Tibetan Plate. According to National Seismological Center of Nepal several big earthquakes have been felt in Nepal including the Assam Great Earthquake in 1897, the Kangra Earthquake in 1905, the Bihar-Nepal Earthquake in 1934 and the 1950 Assam Earthquake in 1950, all causing loss of human life and infrastructure. The most recent earthquake with epicenter in central Nepal in the past one year was at Baglung (Richter magnitude 4.1)[15]. West of 85°E longitude, no major earthquakes in Nepal have been observed in the past 500 years. Seismic activity in Nepal between 1973 and 2000 is shown in Figure 4.4.

Figure 4.4: Earthquake Magnitude in Nepal from 1973 to 2000



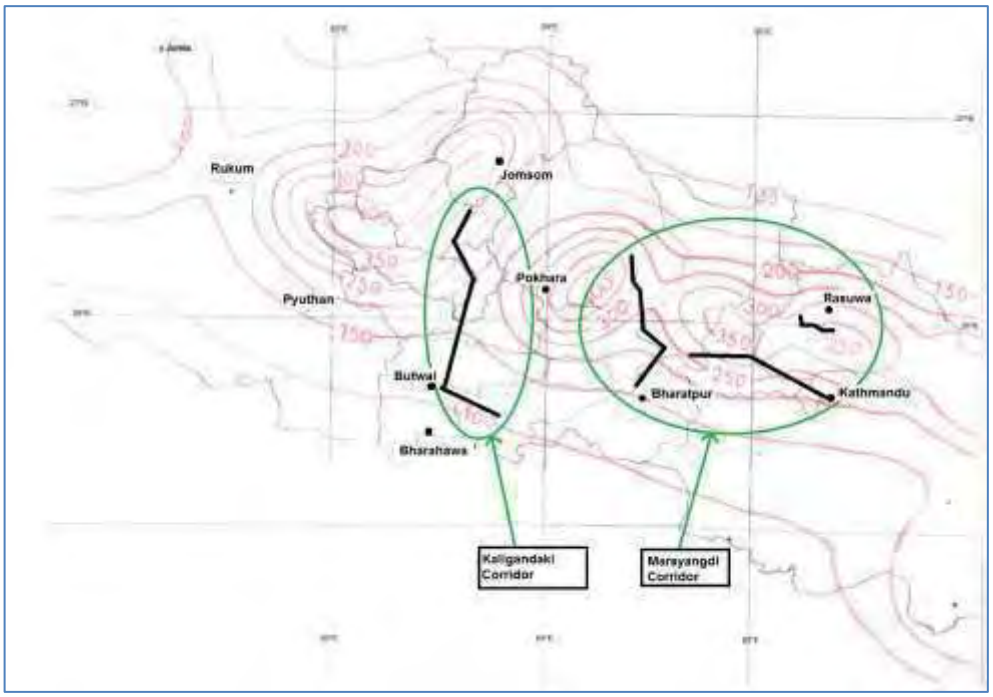
Source: (ICIMOD)

The Peak Horizontal Acceleration at bed rock that has 10% probability of exceedence over 50 years for three different corridors varies from 100 to 300 gals (0.1 to 0.3 g). For the DKKB Line at the Dana Substation area it is 300gals (0.3 g) which decreases to 200 gals (0.2 g) when reaching Kushma Substation and drops down to 100 gals (0.1 g) at the Bardhaghat Substation area. Similarly, for MKMB line the highest value of 300 gals is observed at Khudi VDC with minimum of 150 gals being observed at Bharatpur. For the M-K Line the highest value of 300gals is observed at Gorkha District with the

[15] National Seismological Center, 2013

lowest value of 200 gals observed at Kathmandu. Similarly for the S-T Line the highest value of 350 gals is observed in areas close to Samundratar (Figure 4.5).

Figure 4.5: Seismic Hazard Map of Project Area (Bedrock Peak Ground Acceleration Contours in gals)



Source: National Seismological Centre, Department of Mines and Geology, Government of Nepal

4.3 Climatic and Meteorological Conditions

Meteorological data analysis is considered by using New_LoClim Local Climate Estimator, FAO[16]. Sheperds Method is used for result from FAO Database of nearest 11 stations from desired meteorological stations/location of the transmission line are various points. The various meteorological stations do not all record the same parameters, e.g., at some stations wind parameters are not recorded, and hence the wind data from the next closest station with wind data is utilized.

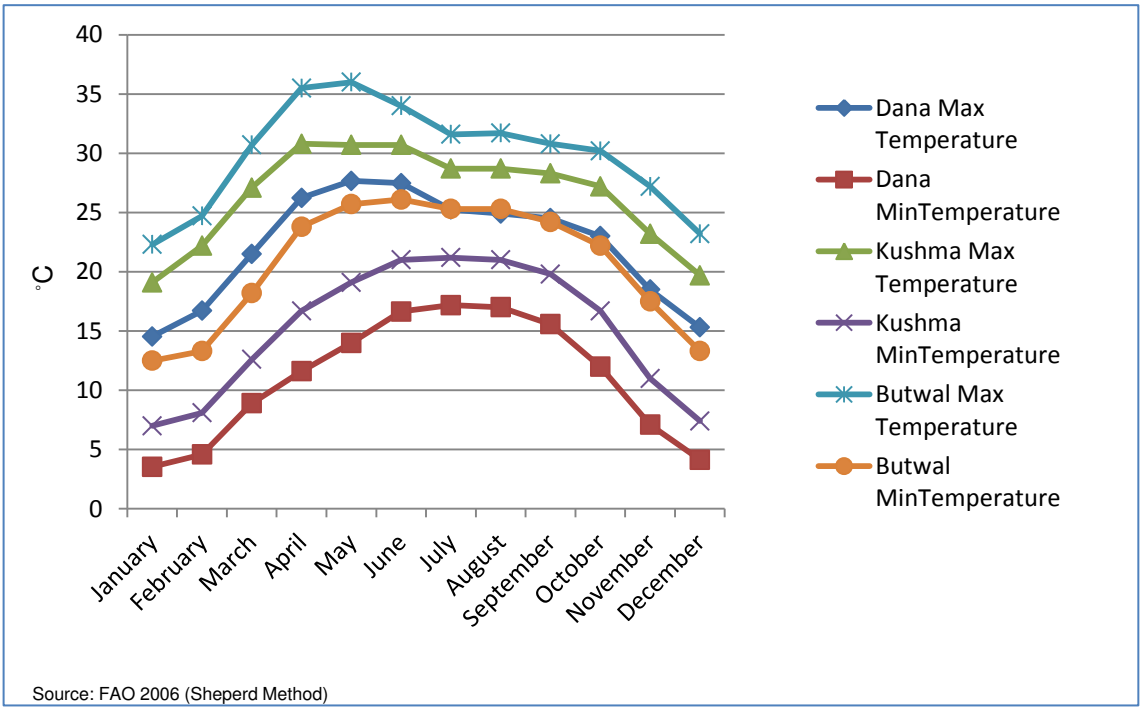
4.3.1 Kaligandaki Corridor

Climatic conditions prevalent along the alignment vary from Warm Temperate with dry winter and hot summer in areas of Dana Substation, Kusma Substation falling under the Koppen Class Cwa however as the routing crosses over the Siwalik Hills to Butwal

[16] FAO, 2006

the Climatic conditions change to Aw (Equatorial Climate Savannah with dry winter)[17]. Best estimate of average annual rainfall amounts to 2943.04mm of which 91% falls mainly from May to October with slandered error and bias of 77.27 and -3.10. The annual average temperature ranges from below 17.5^{0}C in January to 26.6^{0}C in May[18] (see Figure 4.6 and Figure 4.7).

Figure 4.6: Kaligandaki Corridor Monthly Temperature



Source: FAO 2006 (Sheperd Method)

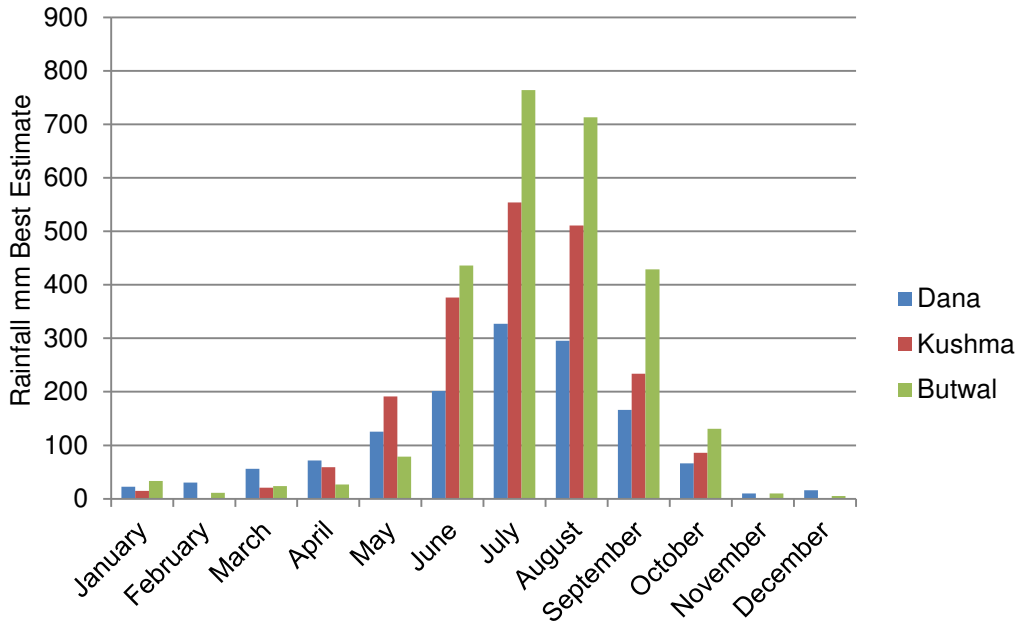
The evaluation of ground frost frequency for Dana varies from a lowest of 1% in March to a highest of 17% in January. Altogether, five months from November to March record frost with highest percentage occurring from December to July. Similarly, for Kushma three months have frost frequency of 3%, 4% and 2% for December, January and February. The runoff based of Budyko's model varies from 435 mm/year, 958 mm/year and 1463 mm/year for Dana, Kushma and Butwal.

The vegetation period analyzed show a single vegetation period for both Dana and Kushma that begins from April 28 and ends in October 22 with climatic net primary production of 1806 g(DM)/m^2/year for Dana and 2229 g(DM)/m^2/year for Kushma (Figure: 4.8). However, there are two vegetation period for Butwal one beginning from

[17] FAO, 2006
[18] MoFSc, DOSC, 2005

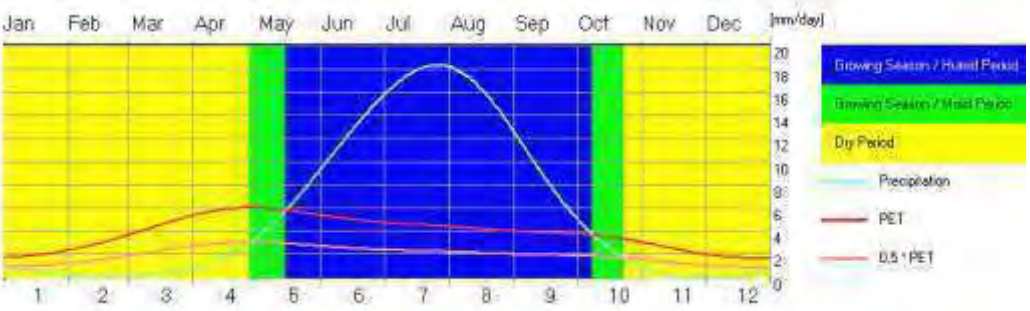
January 8 and ending on January 25 while other begins on May 17 and ends on October 28. The climatic net primary production here is 2488 g(DM)/m2/year.

Figure 4.7: Monthly Rainfall in Kaligandaki Corridor

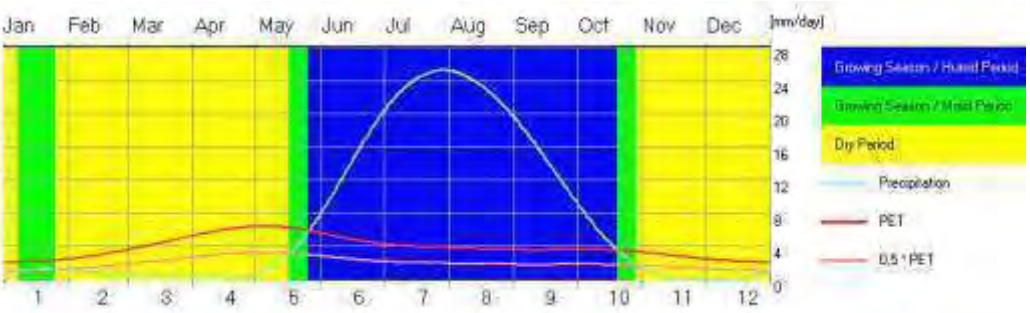


Source: FAO 2006 (Sheperd Method)

Figure 4.8: Vegetation Period for different stations of DKBB Line



Dana and Kushma



Butwal

Source: (FAO, 2006)

The mean monthly maximum temperature ranges from 22.3℃ (at lowest altitude Butwal) to 14.5℃ (at highest altitude Tatopani) in January to 36℃ to 27.7℃ in May, while the mean monthly minimum temperature ranges from 3.54 to 12.5℃ in January (Dana) to 17.2 in July to 26.1℃ in June (Butwal). The observations show a standard error of 3.02 and 2.39 for maximum and minimum temperature with 0.15 and -0.01 biases respectively. The mean daily sunshine duration in varies from 2.5 to 4 hours in the month of July to 7 to 8 hours in the Month of May[19].

From meteorological data analysis three proposed substation sites along the 155 km length of the transmission line have been taken. Substations site include Dana (1400 masl) from northern end, Kushma (1240 masl) and Butwal (360 masl) in the southern end of the site. Records have been taken for monthly data for wind speed.

The average monthly wind speed for the three stations was observed to be above 3.6 km/h from Janary to October and lowest to 2.88 km/h in November and December (Figure 4.9). The estimates had a standard error of 0.01 with a -0.01 bias. It has been observed that highest wind speed is recorded reaching as high as 6.12 km/h in April and May.

In addition to the above recordings, there are areas with very good wind energy potential close to proposed Dana Substation site in Myagdi District (Figure 4.10)[20]. An area of 97km^2 has been considered as having wind power density (WPD) greater than 300W/m^2 wind energy totaling 489MW in total with 5MW/km^2. The area has been selected within 15km from National Grid, with low population density, with slope less than 45^o and with no forest land.

[19] Bajracharya, 1996

[20] UNEP, GEF, 2008

Figure 4.9: Monthly Wind Speed from 1999 to 2008 of DKBB Line

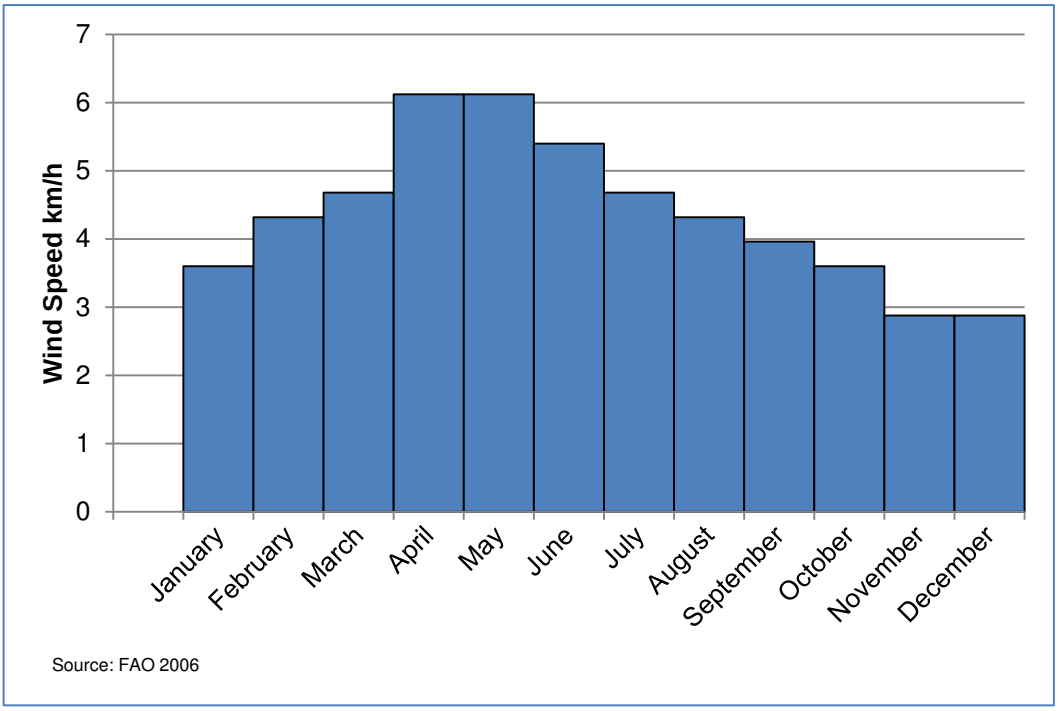
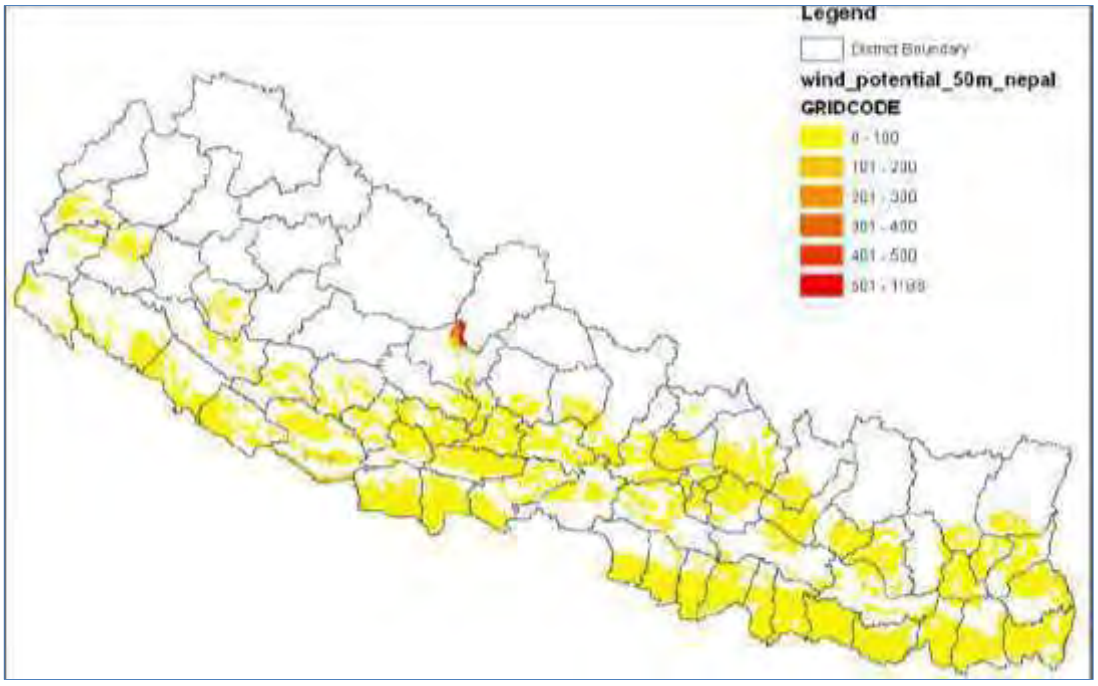


Figure 4.10: Wind Power Potential Map of Nepal



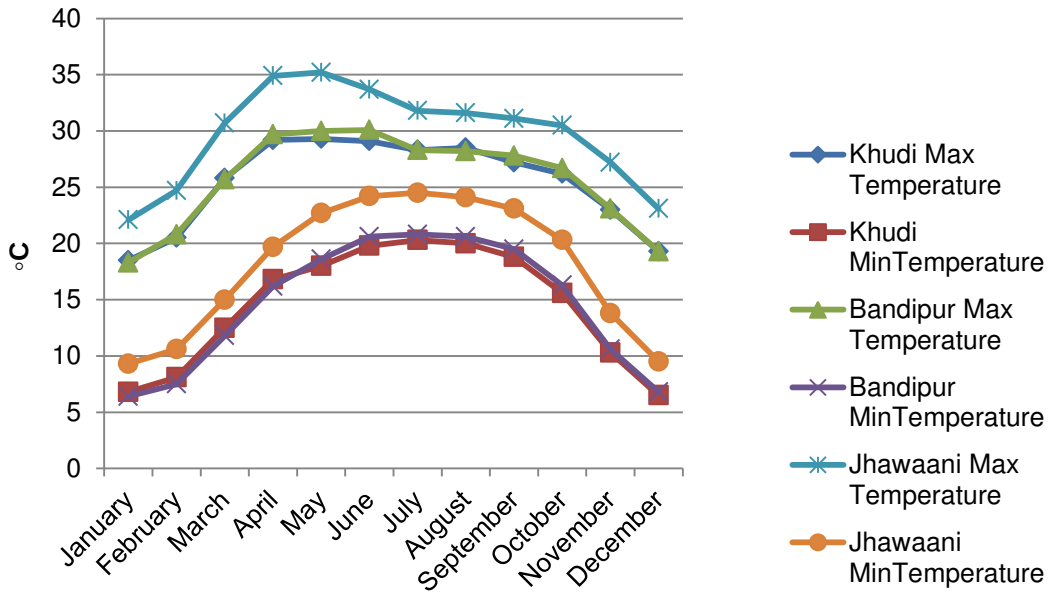
Source: SWERA, Nepal Final Report, GIS Part. 2008.

4.3.2 Marsyangdi Corridor

Climatic conditions prevalent along the alignment is Warm Temperate with dry winter

and hot summer in areas of Khudi as well as Jhaawani (15km South East of Bharatpur) falling under the Koppen Class Cwa.[21]. Best estimate of average annual rainfall amounts to 2333 mm of which 93% falls mainly from May to October with a standard error of 55.55 and a bias of 15.32. The annual average temperature ranges from below 23.3^{0}C in January to 12.6^{0}C in May[22] (see Figure 4.11 and Figure 4.12). The evaluation of ground frost frequency for Khudi varies from a lowest of 2% in February to a highest of 5% in December. Altogether, three months from December to February record frost. Similarly, for Bandipur three months have frost frequency of 4%, 5% and 3% for December, January and February. The runoff based of Budyko's model varies from 2108 mm/year, 837 mm/year and 599 mm/year for Khudi, Bandipur and Jhaawani.

Figure 4.11: Monthly Temperature of MKMB Line

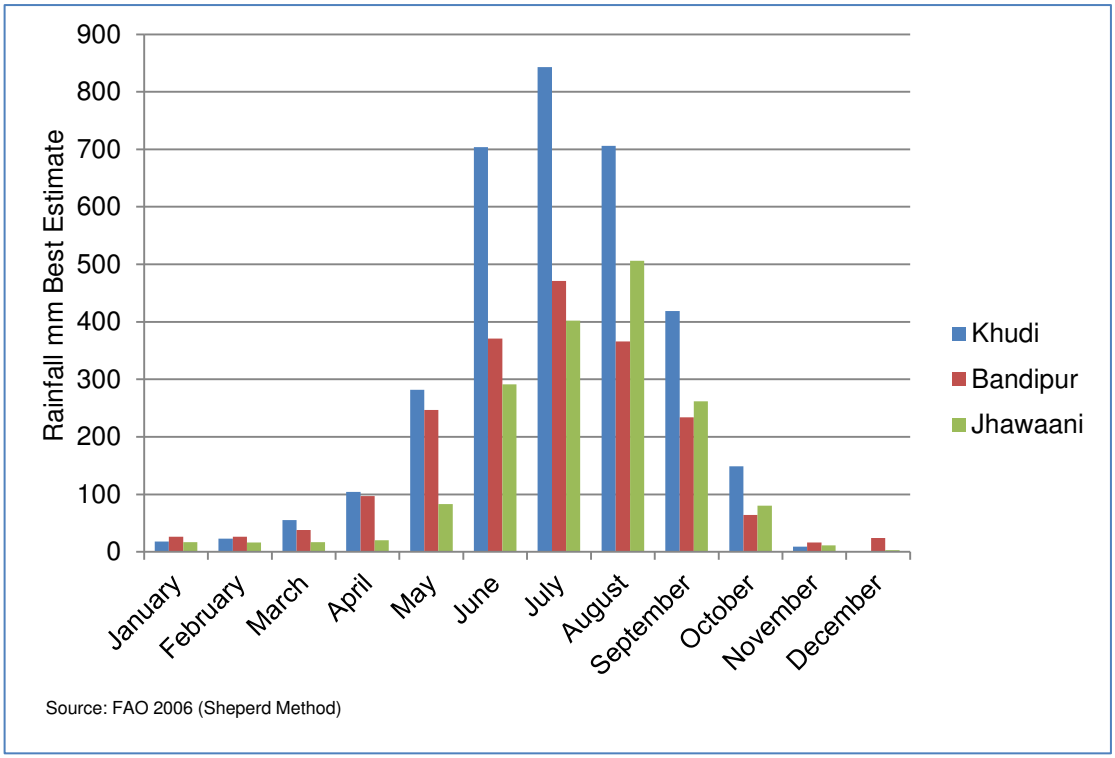


Source: FAO 2006 (Sheperd Method)

[21] FAO, 2006

[22] MoFSc, DOSC, 2005

Figure 4.12: Monthly Rainfall of MKMB Line



The mean monthly maximum temperature ranges from 22.1℃ (at lowest altitude Jhawaani near Bharatpur) to 18.5℃ (at highest altitude Khudi) in January to 27.7 to 36℃ in May, while the mean monthly minimum temperature ranges from 9.3 to 6.8℃ in January to 24.5 to 20.3℃ in July at the lowest and highest altitude weather stations respectively. The analysis of above data has a standard error of 2.75 and 2.19 with a bias of -0.27 and -0.13 for maximum and minimum temperatures. The mean daily sunshine duration in varies from 4 to 4.5 hours in the month of July to 7.5 to 9 hours in the Month of May[23].

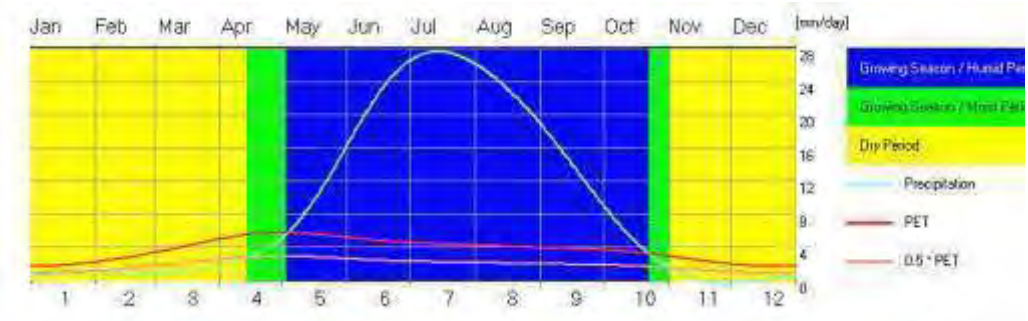
The vegetation period analyzed show a single vegetation period for Khudi and Jhaawani which begins from April 14 and ends in November 1 for Khudi and May 18 to October 22 with climatic net primary production of 2226 g(DM)/m^2/year (gram dry matter (DM) per square meter per year of biological production) and 2035 g(DM)/m^2/year for Khudi and Jhaawani (Figure 4.13). However, there are two vegetation period for Bandipur one beginning from April 13 and ending on October 20 while other begins on December 22 and ends on January 14. The climatic net primary

[23] Bajracharya, 1996

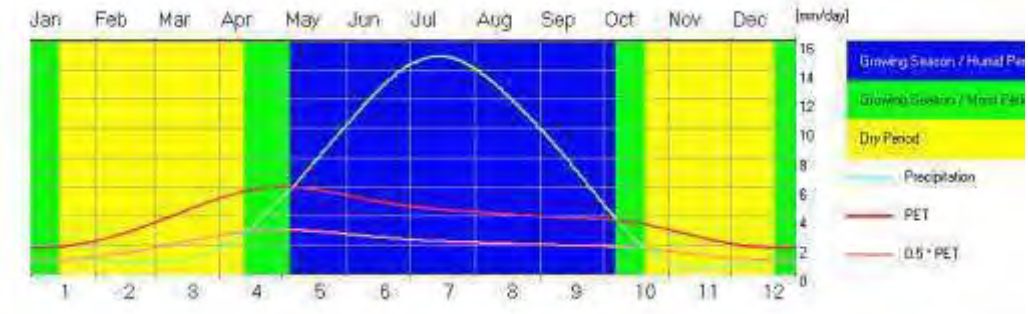
production here is 2194 g(DM)/m^2/year.

The average monthly wind speed for the three stations was observed to be above 3.1 km/h from January to August and lowest to 1.8 km/h in November and December (Figure 4.14). The highest observed wind speed recorded is 6.03 km/h in May. The results calculated have mean standard error of 0.54 with bias of 0.26 for Khudi, 0.67 with bias of 0.13 for Bandipur and 1.35 with bias of -0.06 for Jhwaani.

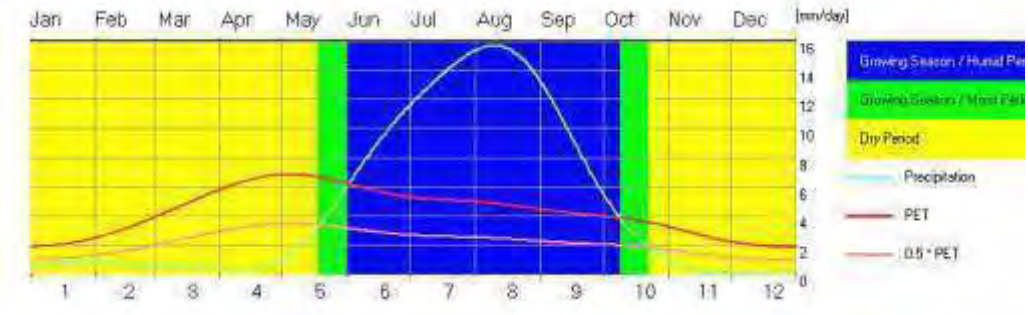
Figure 4.13: Vegetation Period for different stations of MKMB Line



Khudi



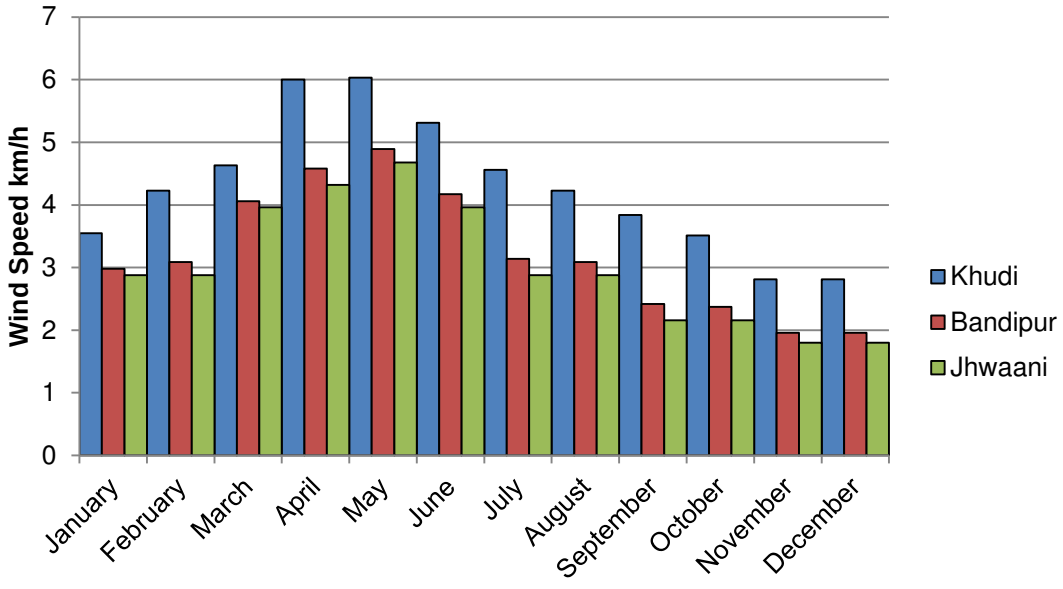
Bandipur



Jhaawani

Source: (FAO, 2006)

Figure 4.14: Monthly Wind Speed of MKMB Line



Sourcee: FAO 2006 (Sheperd Method)

4.3.3 M-K Line

The route traverses through areas with Warm Temperate with dry winter and hot summer in areas Gorkha as well as Kathmandu falling under the Koppen Class Cwa.[24]. Average annual rainfall amounts to 1968.9 mm of which 90% falls from May to October. The annual average temperature ranges from below 14^0C in January to 25^0C in May[25] (see Figure 4.15 and Figure 4.16). The evaluation of ground frost frequency for Gorkha varies from a lowest of 1% in December to 2% in January. Altogether, two months December to January record frost. Similarly, for Kathmandu five months have frost frequency of 4%, 19%, 22%, 15% and 3% for November, December, January, February and March. The runoff based of Budyko's model varies from 699 mm/year and 1016 mm/year for Gorkha and Kathmandu.

The vegetation period analyzed show a two vegetation period for both Gorkha and Kathmandu first one begins from April 19 and ends in October 23 for and second period begins from December 20 and ends in January 8 with climatic net primary production of 2099 g(DM)/m^2/year for Gorkha (Figure 4.17). However, for Kathmandu

[24] FAO, 2006

[25] MoFSc, DOSC, 2005

(Thankot Station) vegetation period begins in January 2 and ending on January 7 while other begins on April 17 and ends on October 26. The climatic net primary production here is 1940 g(DM)/m^2/year.

Figure 4.15: Monthly Temperature Marsyangdi-Kathmandu Line

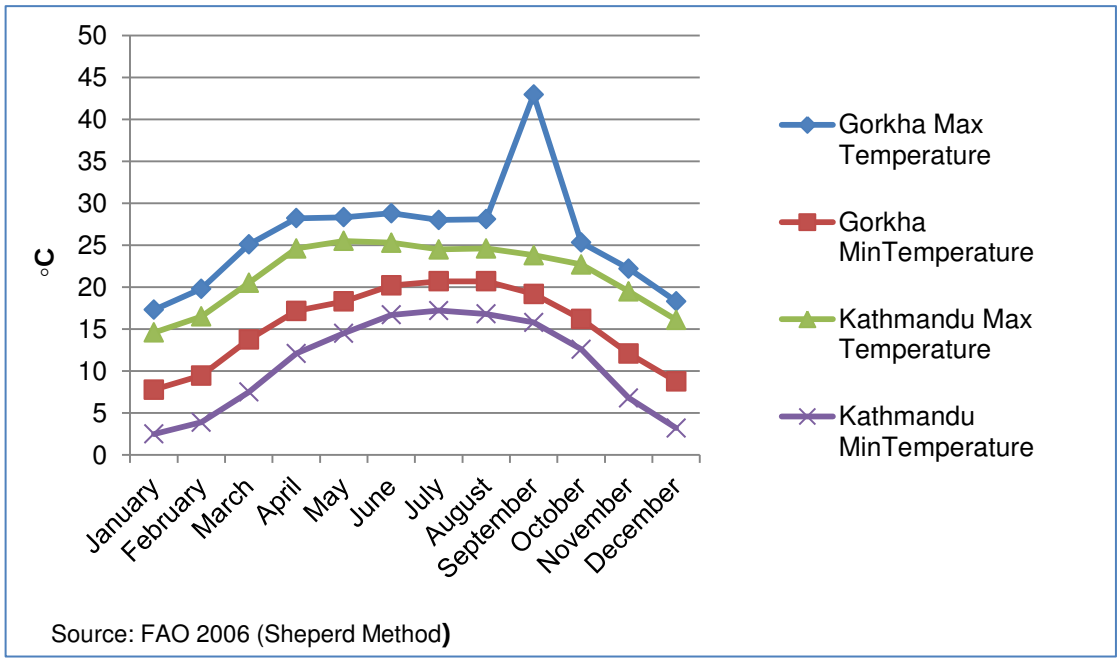


Figure 4.16: Monthly Rainfall of Marsyangdi-Kathmandu Line

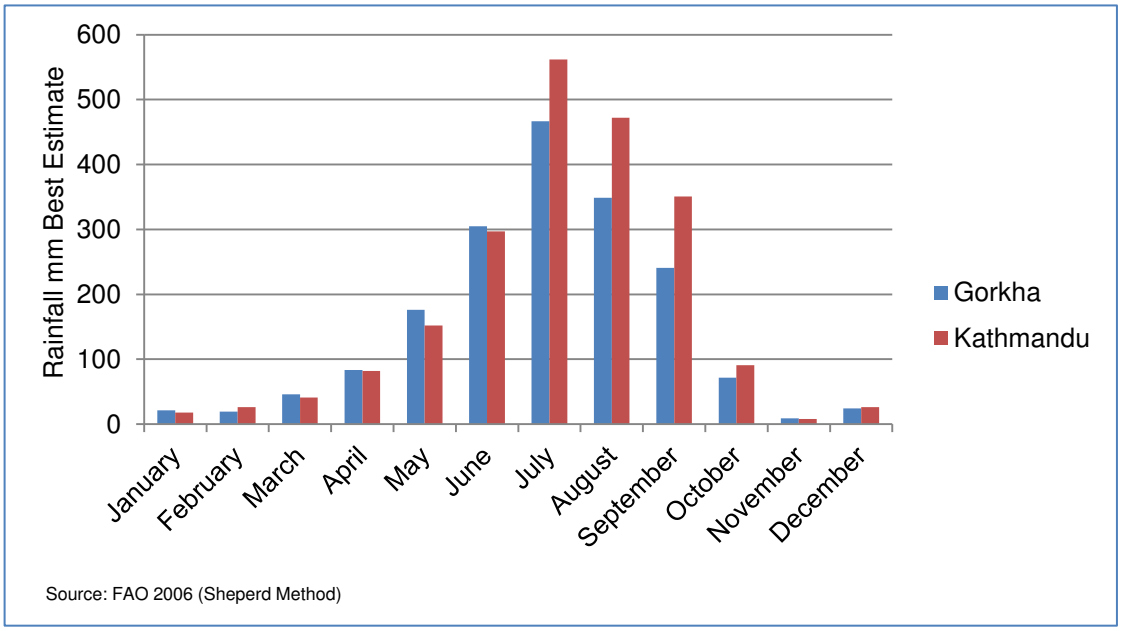
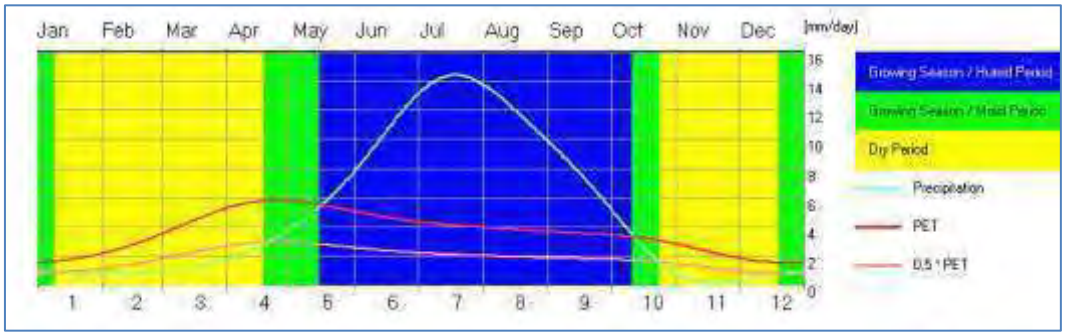
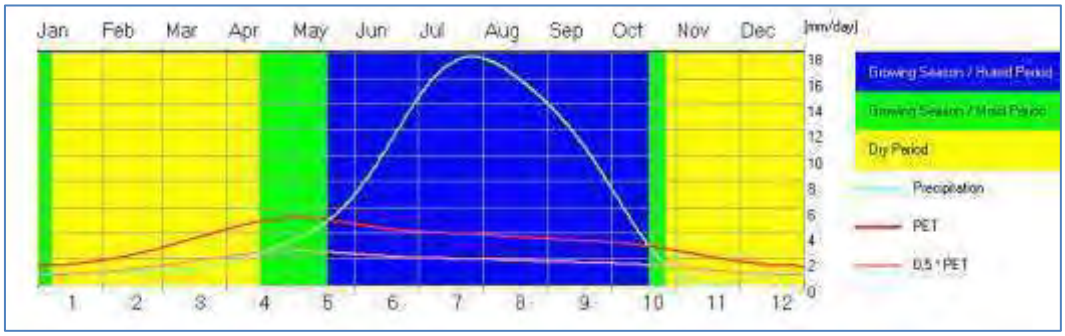


Figure 4.17: Vegetation Period for different stations of M-K Line



Gorkha



Kathmandu

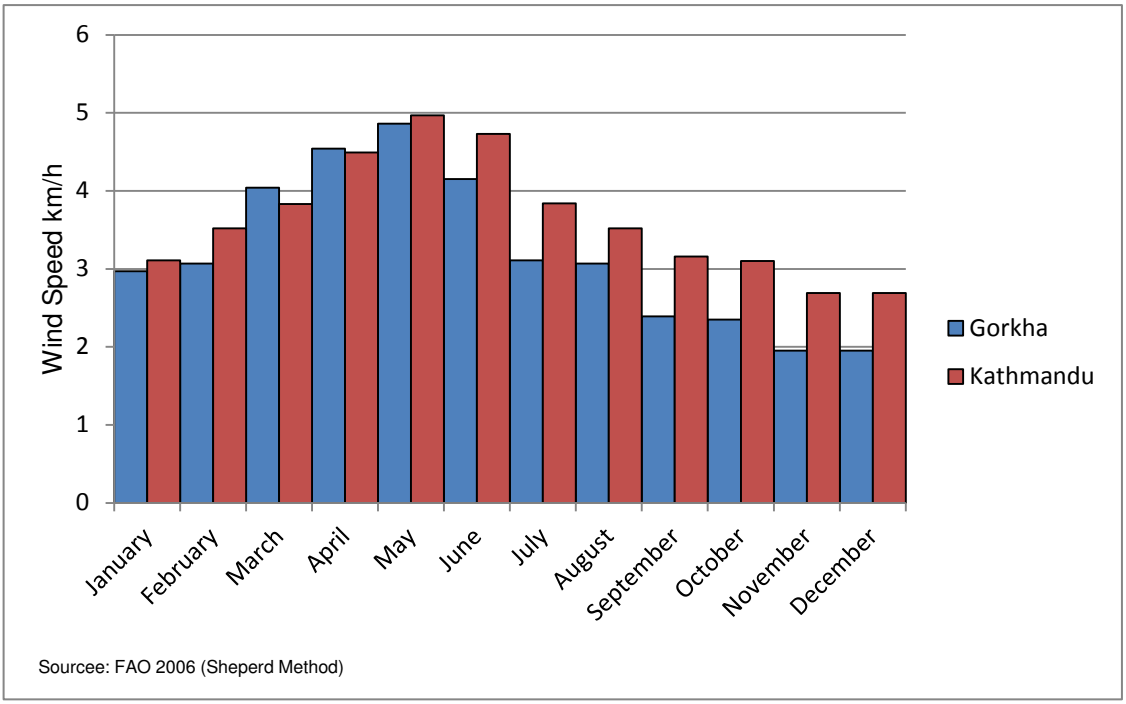
Source: (FAO, 2006)

The mean monthly maximum temperature ranges from 17.31℃ (at Gorkha) to 14.6℃ (at Thankot near Kathmandu) in January to 28.3℃ to 25.5℃ in May, while the Mean Monthly Minimum Temperature ranges from 2.5 to 7.8℃ in January to 20.69 to 17.2℃ in July at western and eastern parts of the transmission line. However, the mean monthly temperature based on FAO's database indicates an abnormal recording of 43^0C in September for Gorkha. The mean daily sunshine duration varies from <2 to 3.5 hours in the month of July to 7 to 8 hours in the Month of May[26].

The average monthly wind speed for the two locations was observed to be above 2.9 km/h from January to August and lowest to 1.95 km/h in November and December for Gorkha (Figure 4.18). The highest wind speed recorded was 4.97 km/h in May in Kathmandu. The results calculated have mean standard error of 1.12 with bias of 0.37 for Gorkha, 1.13 with bias of -0.15 for Kathmandu.

[26] Bajracharya, 1996

Figure 4.18: Monthly Wind Speed of Marsyangdi-Kathmandu Line



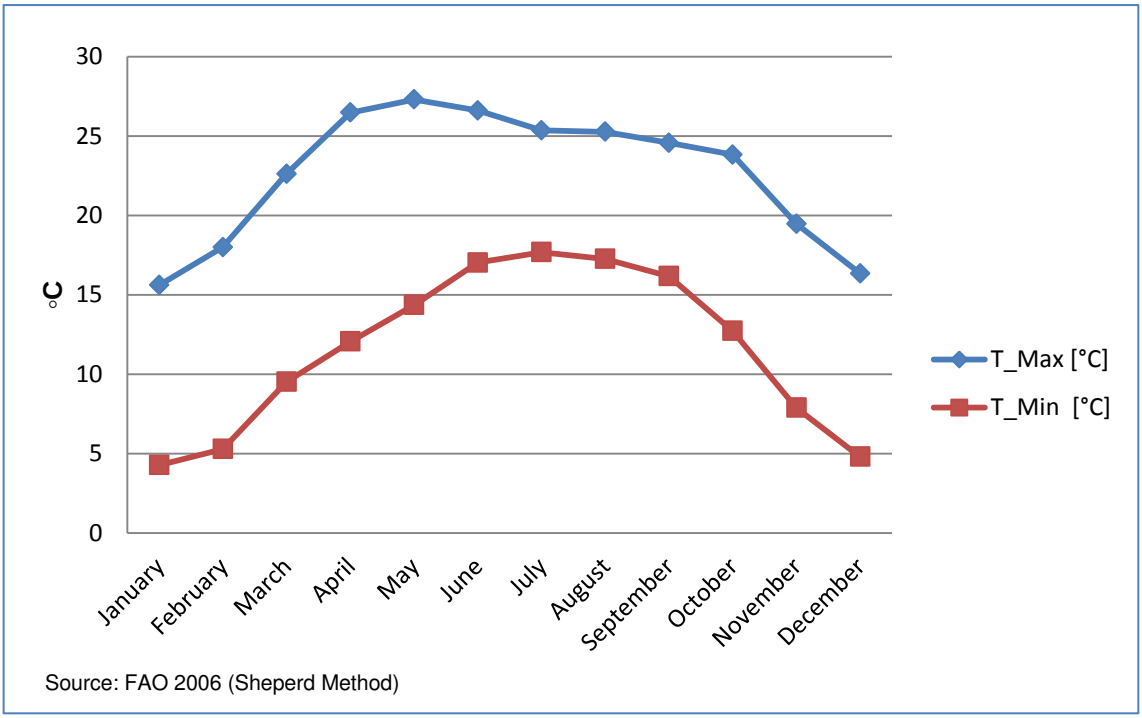
4.3.4 S-T Line

The routing of this component of the project traverses through areas with Warm Temperate with dry winter and warm summer falling under the Koppen Class Cwb.[27]. Average annual rainfall amounts to 1639 mm of which 94% falls from May to October. The annual average temperature ranges from below 16.3^{0}C in January to 26.6^{0}C in May[28] (see Figure 4.19 and Figure 4.20). The evaluation of ground frost frequency for Nuwakot varies from a lowest of 2% in November to 13% in January. Altogether, four months November to February record frost. The runoff based of Budyko's model measures 607 mm/year. The vegetation period analyzed show a single vegetation period which one begins from May 15 and ends in October 18 with climatic net primary production of 1990 g(DM)/m^2/year (Figure 4.21).

[27] FAO, 2006

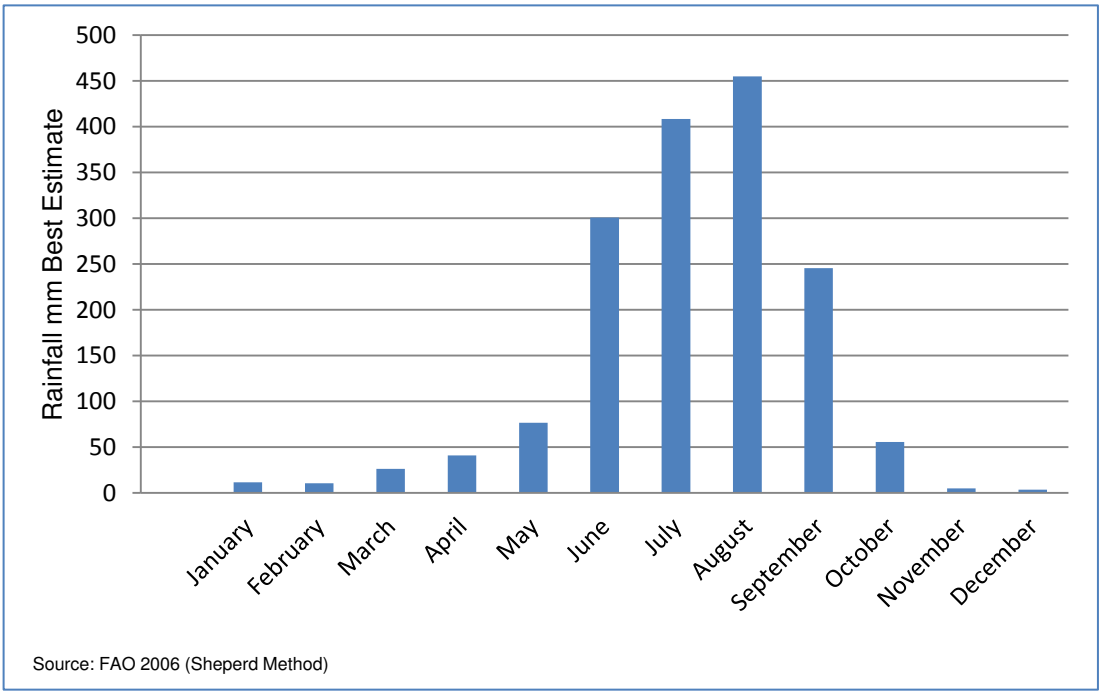
[28] MoFSc, DOSC, 2005

Figure 4.19: Monthly Temperature Along S-T Line



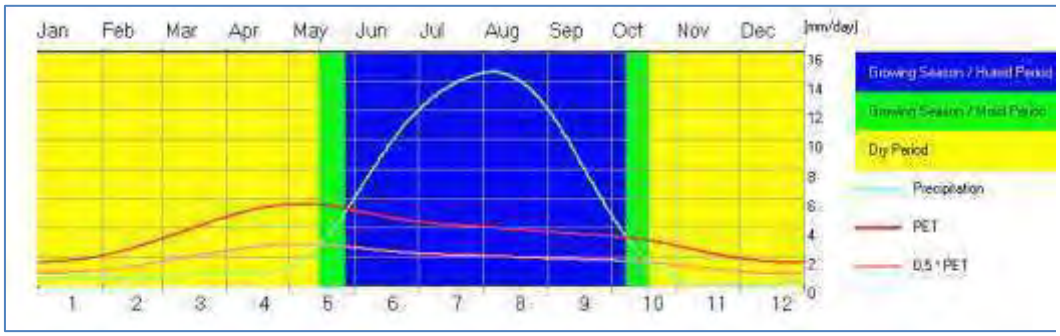
Source: FAO 2006 (Sheperd Method)

Figure 4.20: Monthly Rainfall of S-T Line



Source: FAO 2006 (Sheperd Method)

Figure 4.21: Vegetation Period For Different Stations of S-T Line



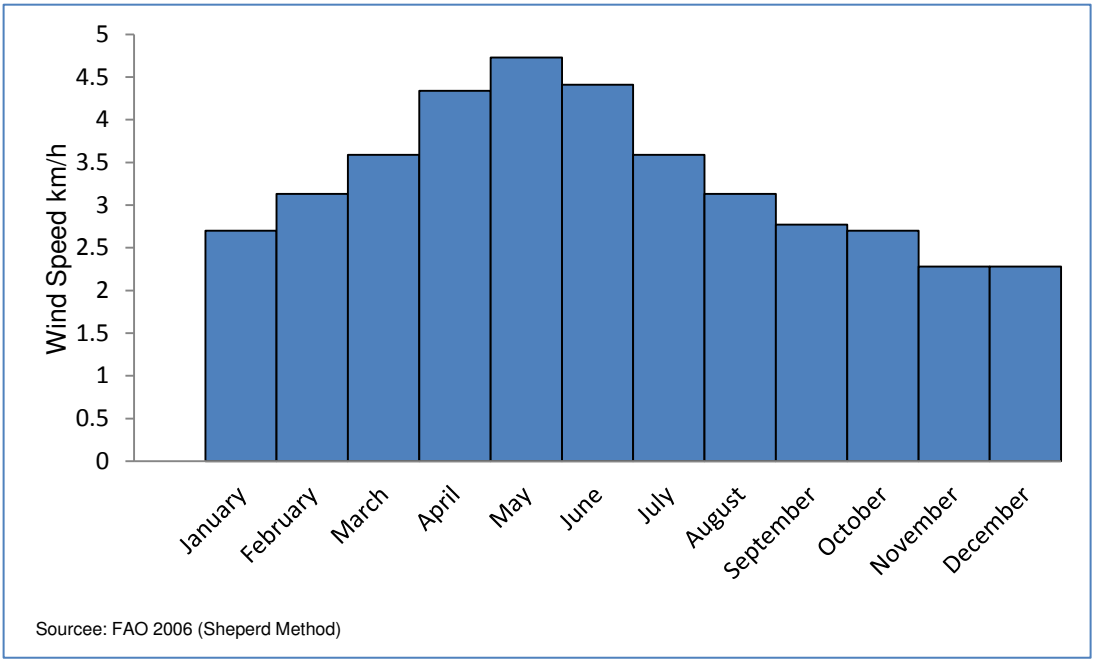
Source: (FAO, 2006)

The Mean Monthly Maximum temperature ranges from 15.61℃ in January to 27.3℃ in May, while the Mean Monthly Minimum Temperature ranges from 4.3 in January to 17.7℃ in July. The mean daily sunshine duration varies from 2-3 hours in the month of July to 7-8 hours in the Month of May[29].

Here too the meteorological data is analyzed for best estimate using New_LoClim Local Climate Estimator, FAO. The best estimate of average monthly wind speed for was observed to be above 3.13 km/h from February to August and lowest to 2.7 km/h in October and January (Figure 4.22). It has been observed that highest wind speed is recorded reaching 4.73 km/h in May. The results calculated have mean standard error of 1.13 with bias of -0.15 (Since, only the closest station of Kathmandu was observed to record wind at a distance of approximately 40km it has been included in the data).

[29] Bajracharya, 1996

Figure 4.22: Monthly Wind Speed of S-T Line



Sourcee: FAO 2006 (Sheperd Method)

4.4 Water Resources

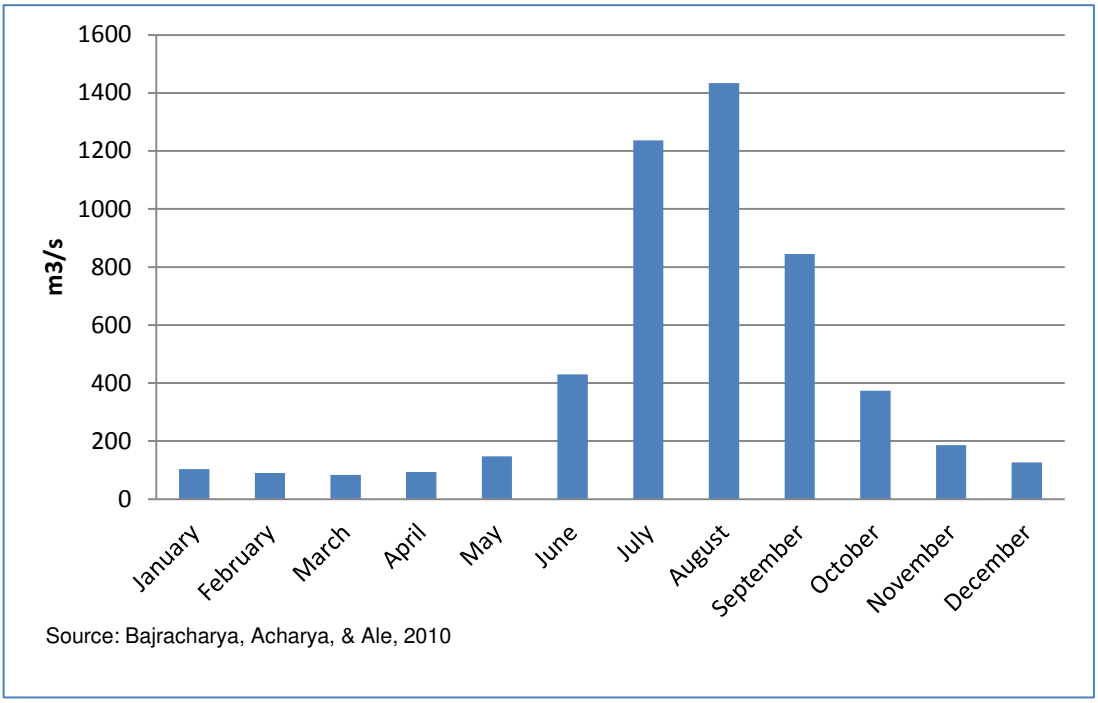
Study from Topographic Sheets and NEA Survey Reports the transmission line has 10 Rivers/Stream crossings between Dana Substation and Kushma Substation. Likewise from Kushma to New Butwal it crosses at 38 places and from New Butwal to Bardhaghat at 13 places[30].

There are three major rivers (Kaligandaki, Marshyangdi and Trishuli) along the project sites. Among them the Kaligandaki is an antecedent drainage river. Maximum Peak Discharge of the major rivers taken from the year 1996 to 2006 for River Kaligandaki at Andhighat Station have been observed to reach a maximum of 2420 m^3/s in August 2008 and minimum of 69.20m^3/s in March 2006. The monthly values of discharge are given in Figure 4.23. The flows of the rivers in Gandaki Basin have been observed to be decreasing and hence will result in decrease in full capacity generation of hydro power plants in the region[31]. This study found annual average flow to be decreasing at 19.82m^3/s/year for Kaligandaki. However, Marshyangdi and Trishuli River has an increase of 0.3149 m^3/s and 2.7366 m^3/s/year respectively. In spite of this both the

[30] NEA, 2010
[31] Bajracharya, Acharya, & Ale, 2011

rivers reveal decreasing dry season discharge of 0.338 and 0.2206 m^3/s/year (November to April). According to Climatic and Hydrological Atlas of Nepal, average drainage density for Myagdi, Parbat, Baglung, Palpa and Syangja is 0.3 to 0.31km/km^2. This is equal to the average drainage density of Nepal which is 0.31. While for Rupandehi and Nawalparasi Districts it is less than 0.3km/km^2.

Figure 4.23: Monthly Average Discharge of Kaligandaki River



Source: Bajracharya, Acharya, & Ale, 2010

Flash Floods

Flash Floods pose great risk to lives and infrastructure close to rivers in Nepal. They can be described as a sudden intense discharge of water with little or no warning which is caused by heavy rainfall, glacier lake outburst event, failure of dam and landslide dammed lake. Among them 24 Glacier Lake Outburst Flood (GLOF) events have been recorded in Nepal which 14 have occurred within the country[32]. Of these events two have been described to have occurred at Kaligandaki River in Mustang region. However, date of occurrence has not been documented. Similarly from 1967 to 1996 twelve major LDOF events have been recorded in Nepal[33]. On 26 September, 1998 a huge landslide occurred on left bank of Kaligandaki near Tatopani Bazaar of

[32] Pradeep K Mool, 2011

[33] Shrestha & Bajracharya, 2013

Myagdi District. Routing of K-B Line passes close to the river in both these VDCs. The landslide had originated at Goganpani of Shikha VDC and had a length of 1498m and width of 400m depositing large amounts of boulders and sediments in Kaligandaki River (close to AP 45 to AP 46). This event blocked the river for eight hours resulting in the water levels to rise up to 15m and a 500m lake. A total of NRS 5 million worth of damage was reported[34]. The above report mentions following five major causes for the landslide:

(i) Presence of platy minerals like chlorite and mica.
(ii) Steep slope 40-45 degrees
(iii) Thick debris cover
(iv) Excessive Rainfall spread over a long period of time and
(v) Cultivation in the upper mountain slope.

The whole Dana Kushma-Section of the routing falls mostly in areas of High Hazard Class according to Landslide Hazard Zonation Map. These areas have frequent occurrences of active old or dormant landslides with presence of limited stable area for infrastructure development and hence stability measures are must for any type of construction activity[35].

Kaligandaki Basin has 96 Glacial Lakes of which four have been considered to be potentially dangerous[36]. One of these is 119 km upstream from the proposed Dana Substation Site [location code Gka_gl 67 (T)] and a second one is 105.3km upstream from Dana [location code Gka_gl 38 (S)]. Similarly, this report has identified 76 glacial lakes in Marsyangdi Basin of which one is categorized as potentially dangerous: the Thulagi Lake, discussed below.

Thulagi Lake

Thulagi Lake is located at head of the Dona Khola a tributary of Marsyangdi River that joins its left bank in Dharapani at Manang District. The lake is at an altitude of 4044 m and is considered as potentially dangerous glacial lake in Nepal. The lake's area has increased by 18% in the past 15 years. Extreme events as heavy snow fall, rise in temperature and earthquake could trigger a GLOF event at this lake. Modeling studies show that in case of a flood event, areas as far as 95 km downstream in River

[34] Poudyal, 2002
[35] DMG, 2010
[36] ICIMOD, UNEP RRC.AP, 2002

Marsyangdi will experience a water surge of more than 4 meters, and up to 18m at a distance of 50 km[37]. Khudi VDC will fall approximately 40 km downstream from the Glacial Lake while Dharapani VDC of Manang District is present 13 to 20 km downstream.

4.5 Biological Resources[38]

Nearly 58% of total length of the DKBB line and all of the other transmission lines are within the Chitwan Annapurna Landscape (CHAL), an area that is critically important for ensuring effective conservation and sustainable livelihood.[39] It represents Eastern Himalayan Alpine Shrub and Meadows, Eastern Himalayan Broadleaf and Conifer Forest, Terai Duar Savannah and Western Himalayan Temperate Forests of the WWF's Global 200 Ecoregions. The routing of DKBB Line crosses over the Western Himalayan Temperate Forests and Himalayan Subtropical Broadleaved Forest only.

The S-T Line crosses over 1.8 km section through Sal, Chir Pine and Chirpine Broad Leaved Forest. Of this, a 350 m section of the transmission line in Gerkhu VDC will cross through very dense Chir Pine Forest[40] with 70% crown cover and according to locals wild animals as leopard, monkeys, pheasants and several other have their habitat. The Chitwan Annapurna Landscape has conservation activities under the Hariyo Ban Program of WWF in partnership with Cooperative for Assistance and Relief Everywhere (CARE), Federation of Community Forestry Users in Nepal (FECOFUN) and National Trust for Nature Conservation through grant from USAID. Some important challenges highlighted with reference to conservation in the Landscape include poaching of wild animals, recurrent forest fires and encroachment of forests. Approximately 15,441 ha of forest have been encroached mainly through illegal occupation[41]. Major animal species conserved here include Snow Leopard, Himalayan Thar, Red Panda, Musk Deer, Himalayan Black Bear and Clouded Leopard in the mountains and Tiger, Gharial, One Horned Rhinoceros in the Terai. Several plant species of medicinal values have been identified in the region.

Furthermore, the area specially closer to the upper area of the Kaligandaki Corridor

[37] Pradeep K Mool, 2011
[38] Appendix 1 presents lists of protected flora and fauna and other potentially sensitive species. These are defined by various Nepal regulatory acts and the Convention on International Trade in Endangered Species (CITES).
[39] The Sacred Himalayan Landscape is not a protected area under Nepali environmental regulations.
[40] ICIMOD
[41] Gautam, et al., 2012

serves as a corridor for migrating birds between Tibetan Plateau and Gangetic Plains. According to Bird Life International, Central Asian Flyway is an area acquiring an area of 34,089,399 km^2 and 307 species of migratory birds use this route. This route although classified at Continent level (generalization) and is not a strictly followed route a deeper study may be required if there are any Palertic breeders like Bar-headed Goose (*Anser indicus*) crossing over the proposed alignment. There are 2 critically endangered birds, 5 endangered birds, 13 vulnerable and 10 near threatened species that use this flyway[42]. According to Bird Life International, Nepal has 3 Endemic Bird Areas namely Western Himalayan, Central Himalaya and Eastern Himalaya. These areas consists restricted range bird species. Kaligandaki Valley serves as a boundary between Western and Eastern Himalaya where most of the species breed in Temperate Forests.

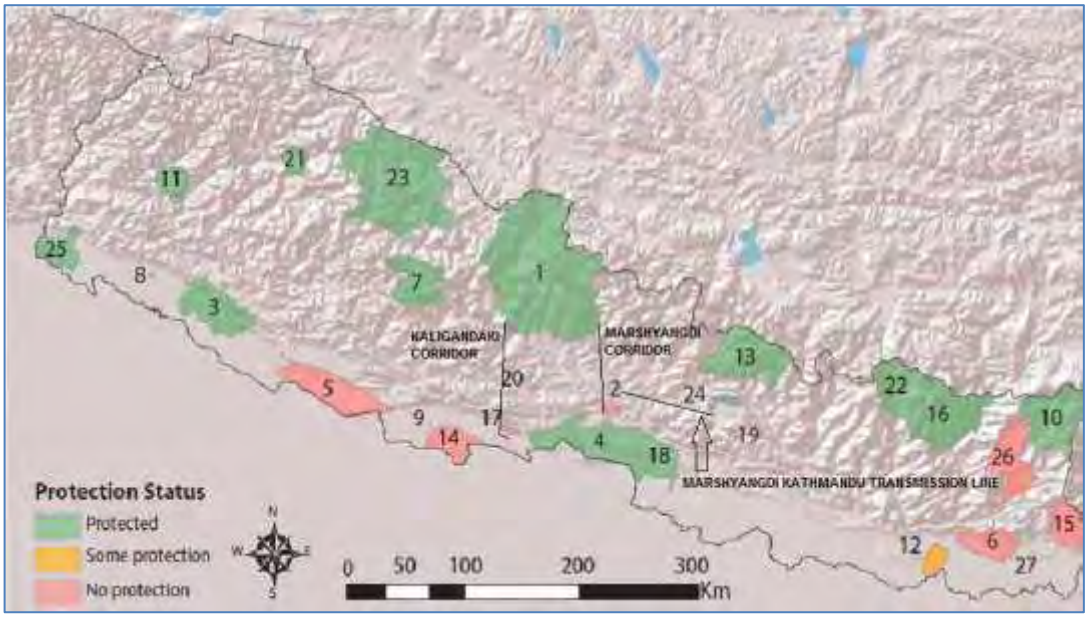
Five important bird areas (IBA, see criteria below) are close to the routing (Figure 4.24). Annapurna Conservation Area (Number 1), Farmlands in Lumbini (Number 14) and Nawalparasi Forest (Number 17) are close to the K-B Line. Similarly ACA and Bharandabhar Forest (Number 2) and wetlands (Forest areas north of Bharatpur at the Left Bank of Narayani River) are close to M-B Line and Shivapuri-Nagarjun National Park (Number 24) is close to the M-K Line. Furthermore, approximately 5km section of Marshyangdi Corridor at the northern most section crosses through the Annapurna Conservation Area. Also, if the M-B line routing does not avoid the northern Forest parts left bank of Narayani River of Bharatpur it will cross through the Bharandabhar Forest and wetlands. IBA is located close to the proposed Kaligandaki alignment between 83°39'1.00 East, 28°32'8.29" North to 83°37'49.11"East, 28°27'50.61"North and 83°37'14.91"East 27°34'55.60"North for Annapurna, Nawalparasi and Chitwan.

There are several wetlands along the route (for instance the transmission line passes close to Sattawati Pond located in middle of forest at 1000 masl in Koldada VDC of Palpa District). Kaligandaki gorge is considered important in terms of biodiversity as it is the boundary between eastern and Western Himalaya. Kaligandaki Valley is a migratory corridor for birds which move south to winter in India. Approximately 40 migrating bird species have been recorded migrating along the valley including Demorselle Crane and 20 raptors. Documentation of large numbers of birds of prey

[42] International, 2011

along the Karne/Lumle saddle has been done during autumn and these migrations occur east to west. In another location of Ghorepani over the Deorali pass, 54 Steppe Eagles and 1 Imperial Eagle was recorded migrating east to west in 20 minutes in November 1986[43]. The Ghorepani zone is located at 28° 24' N and 83° 43' E; this area is 12 km East of the Dana-Kushma Section of the DKBB line in VDC's Rakhu Bhagwati, Bagarkhola and Tatopani.

Figure 4.24: Important Bird Areas in Nepal



Source: Bird Conservation Nepal

Furthermore, large number of birds of prey, totaling over 8,000 individuals of 20 species including Greater Spotted Eagle (*Aquila clanga*) has been seen in one season[44]; the study recorded 8 globally threatened, 7 near threatened and 6 restricted range species in the valley. Some important species mentioned is Cheer Phesant (*Catreus wallichi*), Satyr tragopan (*Tragopan satyra*) and Spiny Babbler (*Turdoides nipalensis*). Two locations at the edge of Annapurna Conservation Area are considered as internationally important raptor migration sites that also represent it in the Himalayan Region[45]. The first site is in Khare which lies at the southern boundary of Annapurna Conservation Area. The second site is located at upper reaches of Kaligandaki River in its eastern bank. A list of bird species found in these IBA is provided in table in Appendix 1, Table

[43] Carol & Inskipp, 2003
[44] Baral & Inskipp, 2005
[45] Baral & Inskipp, 2005

1.

IBA Criteria

The IUCN and IBA criteria as referred from IUCN[46] and Birdlife International[47] websites are explained as follows.

A1. Globally threatened species:

The site qualifies if it is known, estimated or thought to hold a population of a species categorized by the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In general, the regular presence of a Critical or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection. Thresholds are set regionally, often on a species by species basis. The site may also qualify if holds more than threshold numbers of other species of global conservation concern in the Near Threatened, Data Deficient and, formerly, in the no-longer recognized Conservation Dependent categories. Again, thresholds are set regionally.

A2. Restricted-range species:

The site is known or thought to hold a significant component of a group of species whose breeding distributions define an Endemic Bird Area (EBA) or Secondary Area (SA). This category is for species of Endemic Bird Areas (EBAs). EBAs are defined as places where two or more species of restricted range, i.e. with world distributions of less than 50,000 km^2, occur together. More than 70% of such species are also globally threatened. Also included here are species of Secondary Areas. A Secondary Area (SA) supports one or more restricted-range species, but does not qualify as an EBA because less than two species are entirely confined to it. Typical SAs include single restricted-range species which do not overlap in distribution with any other such species, and places where there are widely disjunct records of one or more restricted-range species, which are clearly geographically separate from any of the EBAs.

A3. Biome-restricted species:

the site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome.

[46] http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf
[47] http://www.birdlife.org/datazone/info/ibacritglob

A4. Congregations Site:
The site is thought to hold on a regular basis 1% of a biogeographic population of a congregatory water bird species or/and 1% of global population of congregatory seabird or terrestrial species and/or 20,000 water birds or 10,000 pairs of seabirds of one or more species and/or site known or thought to exceed thresholds set for migratory species at bottleneck sites.

IUCN Categories

Critically Endangered means a taxon is facing extremely high risk of extinction in the wild, and meet any of the following criteria A to E. Criteria A denote reduction in population greater than or equal to 80% if three generation or 10 years. Similarly Criteria B denotes in form of either extent of area or area of occupancy or both where the extent of area being less than 100km^2 and area of occupancy being less than 10km^2. The criteria C denote population size estimated to be less than 250 mature individuals. Criteria D indicates population size estimated to number fewer than 50 mature individuals. Criteria E means Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer.

Endangered species means when the best available evidence indicates that it is considered to be facing high risk of extinction meets any of the following criteria A to E. Criteria A denote a reduction in population size of greater than or equal to 50 or 70% in 10 years of three generations. Criteria B means geographic range in the form of extent of occurrence or area of occupancy or both where extent of occurrence being less than 5,000km^2 and are of occupancy being less than 500km^2. Criteria C indicates population size estimated to number fewer than 2,500 mature individuals. Criteria D qualifies for population size estimated to number fewer than 250 mature individuals. Criteria E means quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer.

Vulnerable species means when the best available evidence indicates that it is considered to be facing high risk of extinction and meets any of the following criteria A to E. Criteria A denote a reduction in population size of greater than or equal to 50 or 30% in 10 years of three generations. Criteria B means geographic range in the form of extent of occurrence or area of occupancy or both where extent of occurrence being less than 20,000km^2 and are of occupancy being less than 2,000km^2. Criteria C indicates population size estimated to number fewer than 10,000 mature individuals.

Criteria D qualifies for population size estimated to number fewer than 1,000 mature individuals with restricted area of occupancy typically less than 20km^2. Criteria E means quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Among all these species of birds it has been found that bustards, cranes and raptors (Accipitridae) have small binocular fields with large blind areas are vulnerable to collisions with power lines[48]. The collision of birds with power lines is mostly associated with shield wires because these are the highest wire on a tower and are smaller in diameter than individual phase conductors making them difficult to see[49]. The reason of susceptibility is functions of species characteristics as body size, weight, wing shape, flight behavior and nesting habits. In general birds of prey are good fliers, have the ability to avoid obstacles, and are not prone to collisions. However, when they are engaged in activities such as territorial defense and pursuing prey the collision risk increases. Several means with different rate of success have been observed with marking devices that tend to increase visibility. These include aviation marker balls, spiral vibration dampers, air flow spoilers, bird flight diverters of various designs and dimension, and several devices that have movement, such as swinging plates or flappers. However, several issues as added weight of ice and snow at high altitudes, adverse actions of wind, and corona discharge also need to be taken into account while placing such devices[50].

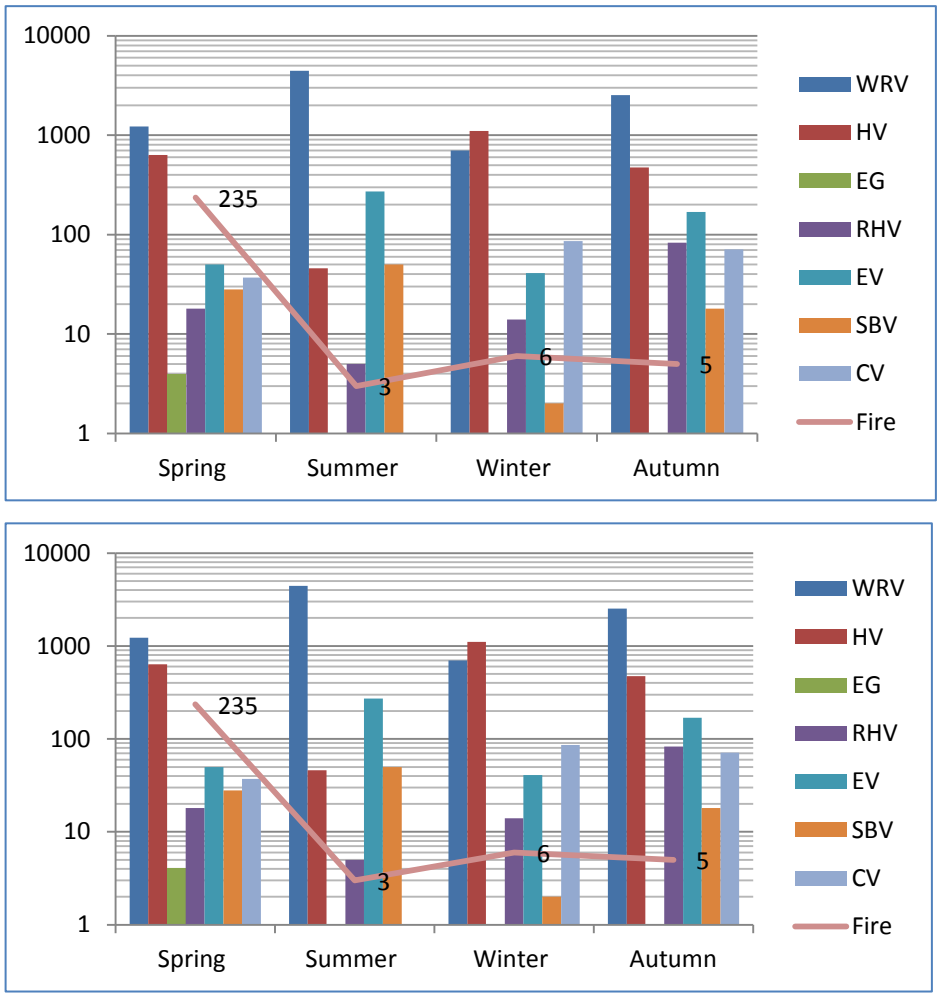
The New Butwal to Bardhaghat Section that lies close to two IBAs “Farmlands in Lumbini Area” and “Nawalparasi Forest” a Vulture Safe Feeding Site is located 25km south west of New Butwal Substation site where birds as Saras Crane and seven of eight vulture species have been recorded. These include migratory species as Cinereous Vulture, Himalayan Vultures and Eurasian Griffons[51]. Similarly at the Nawalparasi that is 3 km north of the transmission line and Bardhaghat Substation White-rumped Vulture (*Gyps bengalensis*) a resident species 71 nests in 2002-2003 have been recorded for White Rumped Vulture[52].

Based on observation of fire occurrences in areas close to these IBA sites it can be

[48] Martin & Shaw, 2010
[49] Avian Power Line Interaction Committee (APLIC), 2012
[50] Bridges, Theodore, Shulund, Linda , & Tim , 2008
[51] Dhakal, Sharma, & Chaudhary, 2013
[52] Baral & Inskipp, 2005

noted that most occurs in the spring season when largest number of species were recorded including large numbers of migratory birds (Figure 4.25).

Figure 4.25: Seasonal Variation in Vultures at Rupandehi VSFS and Fire Occurrences provided by NASA



Comparisons between (Dhakal, Sharma, & Chaudhary, 2013) and (Maryland, 2002) data

WRV: White Rumped Vulture, HV: Himalayan Vulture (Migratory), EG: Eurasian Griffons (Migratory), RHV: Red Headed Vulture, EV: Egyptian Vultures, SBV: Slender-billed Vultures, CV: Cinereous Vultures. (Migratory)

The observation of birds at the Vulture Safe Feeding Site of Rupandehi have been used from data of Ibisbill Journal of Himalayan Ornithology 2013 and compared with fire occurrence data between January 2012 and July 2013 provided by NASA. It can be observed that greatest number of fire occurrences is concentrated at Siwalik Region immediately north of these two IBA which is mostly confined in forests and also when the season when the largest number of species is recorded coincides. The RoW of

transmission line will also aid in preventing spread of forest fire.

In another study conducted for a resident vulture Lammergeier (*Gypaetus barbatus*) (habitat range 1200 to 4100masl) from Muktinath to Beni along the Kaligandaki Valley including sections of the DKBB line, lowest numbers were observed in Dana[53], while highest numbers were observed in Upper Mustang and Lower Mustang areas which are upstream and beyond the project sites. This study mentions several factors as less suitable nesting site, less rocky areas and unavailability of food as possible major causes for reduced numbers downstream. Therefore, more information on possible measures to increase visibility of the transmission line and hence reduce mechanical accidents in certain sections will be an advantage. In addition to habitat suitability studies done on bird distribution in ACA suggest Lower and Upper Temperate zone (2000 to 3800 masl more species rich)[54] yet good number of species have been observed in Subtropical Zone (1000-2000 masl) in Ghasa and Gorepani (areas closer to Bhurung Tatopani, Ghar, Histan Mandali and Sikha). The transmission routing is all at elevations below the temperate zone, but is generally within the Subtropical Zone elevation range (as shown in Figure 4.2a and b above).

4.6 Fire

Several incidents of fire in the past have been observed along the proposed routes. There were 304 fire incidents in 7 districts of the DKBB Corridor, 589 incidents of fire in MKMB Corridor Districts and 641 incidents of fire along the M-K line Districts between 1 January 2012 to 30 July 2013[55]. Based on routing surveys to date and NASA data for Kaligandaki Corridor the highest density of fire incident along the routing was observed at forests of Siwalik Hills of Dobhan, Devdhaha and Sunwal VDCs of Rupandehi, Palpa and Nawalparasi districts respectively. Relatively fewer number of fires were recorded in Baglung, Parbat and Syangja Districts. In the areas where the MKMB and M-K transmission lines cross over the Siwaliks Hills in Chitwan, there were 400 fires incidents recorded in one year. The areas where the K-B line crosses hills of Tanahu District and Gorkha Districts had 63 and 60 fire incidents, respectively. In Nuwakot District along the Samundratar Trishuli Transmission Line 13 fire incidents have been recorded. The maximum number of occurrences, approximately 50%, were in the month of April in all the areas. Almost all the

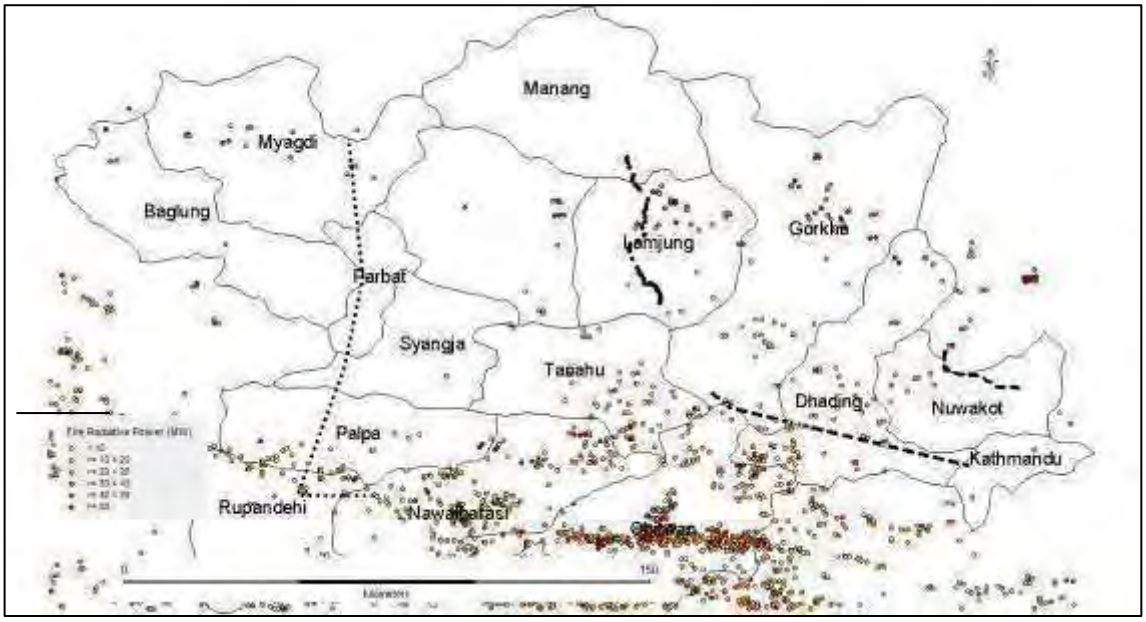
[53] Giri, 2013

[54] Carol & Inskipp, 2003

[55] Maryland, 2002

occurrences were in forest with Fire Radiative Power (FRP) varying from as low as 5 MW in Palpa District to 207 MW in Gorkha District. The highest frequency these activities occurred between 10-15 MW of FRP, see Figure 4.26. The areas with highest occurrence of fire can be observed in Nawalparasi and Chitwan District of the in Terai Arc Landscape. Besides, Strategic Plan for TAL for 2004-2014 indicates Forest Fire as one of the seven direct causes of Biodiversity loss and environmental Degradation in TAL. Therefore, adequate maintenance of the RoW of the transmission line can be considered to maintain fire line and hence aid in reducing degradation.

Figure 4.26: Fire Occurrence in Project Districts between January 2012 and July 2013



Source: (Maryland, 2002)

……. Kaligandaki Corridor ---------- Marshyangdi Kathmandu Transmission Line
Marshyangdi Corridor

4.6 Potentially Sensitive Ecosystems

The Tenth Five Year Plan (2003-2008) of Government of Nepal incorporated landscape approach as a new strategic and operational direction to conservation and sustainable use of biological resources. Accordingly Ministry of Forest and Soil Conservation in collaboration with its development partners are implementing landscape-specific programmes in various designated areas. This approach to conservation has been adopted to enhance ecological processes and conservation of endangered species, as many of the protected areas are ecological “islands” and too small to support viable

population of endangered species and ecological processes.

4.6.1. The Chitwan Annapurna Landscape

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. Landscapes are not legally protected areas, but they include and complement protected areas. The GoN recognized two landscapes in Nepal, 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. Recognizing the need to develop a north-south linkage that is vital to provide a safe passage of 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."

The geographic area encompasses an elevation range of over 8000 m, and includes all of the major physiographic zones of Nepal. Figure 4.27 shows the CHAL, which includes all of the Annapurna Conservation Area, most of the Chitwan and Langtang National Parks, and most of the Manaslu Conservation Area (see Table 4.5). The CHAL overlaps with the Terai Arc Landscape (discussed below). Figure 4.28 shows the CHAL relative to other protected areas. Figures 4.27 and 4.28 show clearly that the CHAL occupies roughly a quarter of the total area of Nepal. The 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.

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 river and sub-river basins: Trishuli, Marsyagndi, Seti, Kali Gandaki, Budi Gandaki, Rapti and Narayani; these rivers comprise several thousand megawatts of hydropower potential with numerous hydropower projects at various stages of development, and almost all of the proposed transmission routes are in these basins. Environmental degradation and high poverty rates create a potent mix of threats to both people and biodiversity in the CHAL.

Figure 4.27: Chitwan Annapurna Landscape

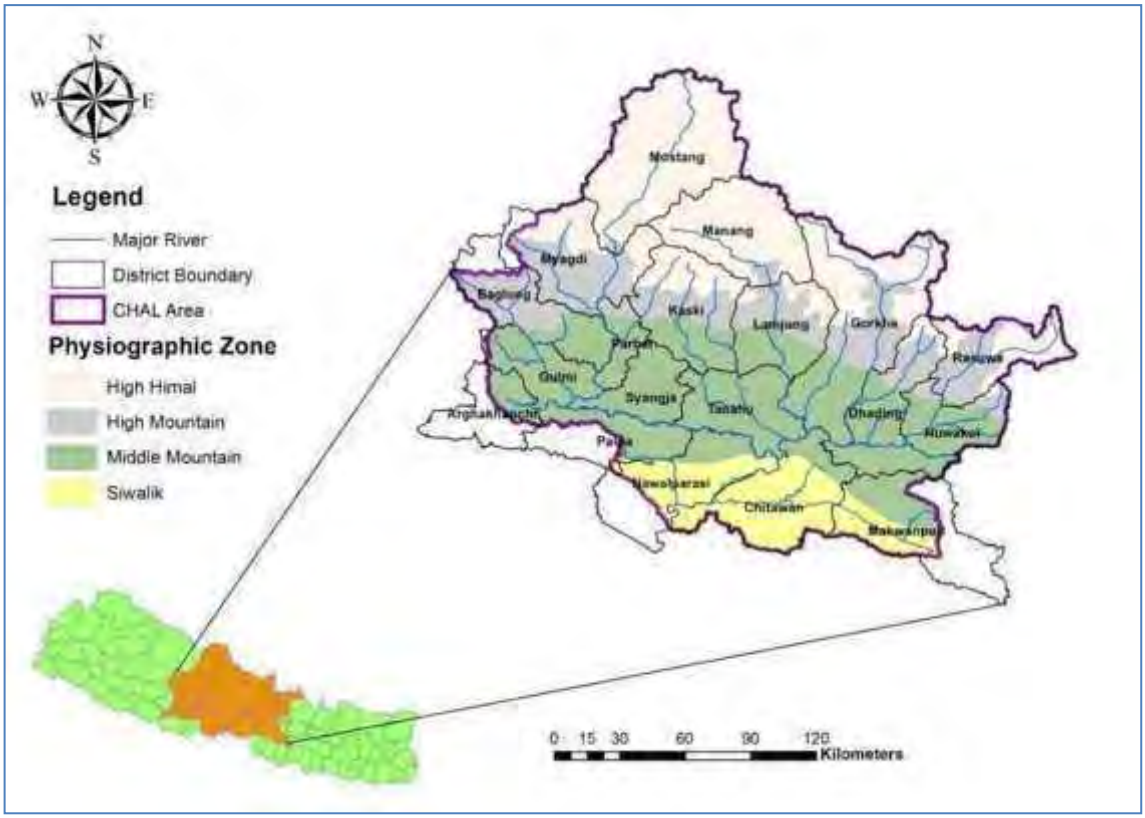


Table 4.5: Protected Areas in and Adjacent to the Chitwan Annapurna Landscape

Protected Area	Year Established	Total Area (ha)	Area in CHAL (ha)
Annapurna Conservation Area	1992	762,900	762,900
Chitwan National Park	1973	93,200	81,200
Dhorpatan Hunting Reserve	1987	132,500	5,400
Langtang National Park	1976	171,000	100,300
Manaslu Conservation Area	1998	166,300	164,000
Parsa Wildlife Reserve	1984	49,900	7,900
Shivpuri National Park	2002	14,400	2,600
Total		1,390,200	1,124,300

Figure 4.28: Protected Areas In and Adjacent to CHAL

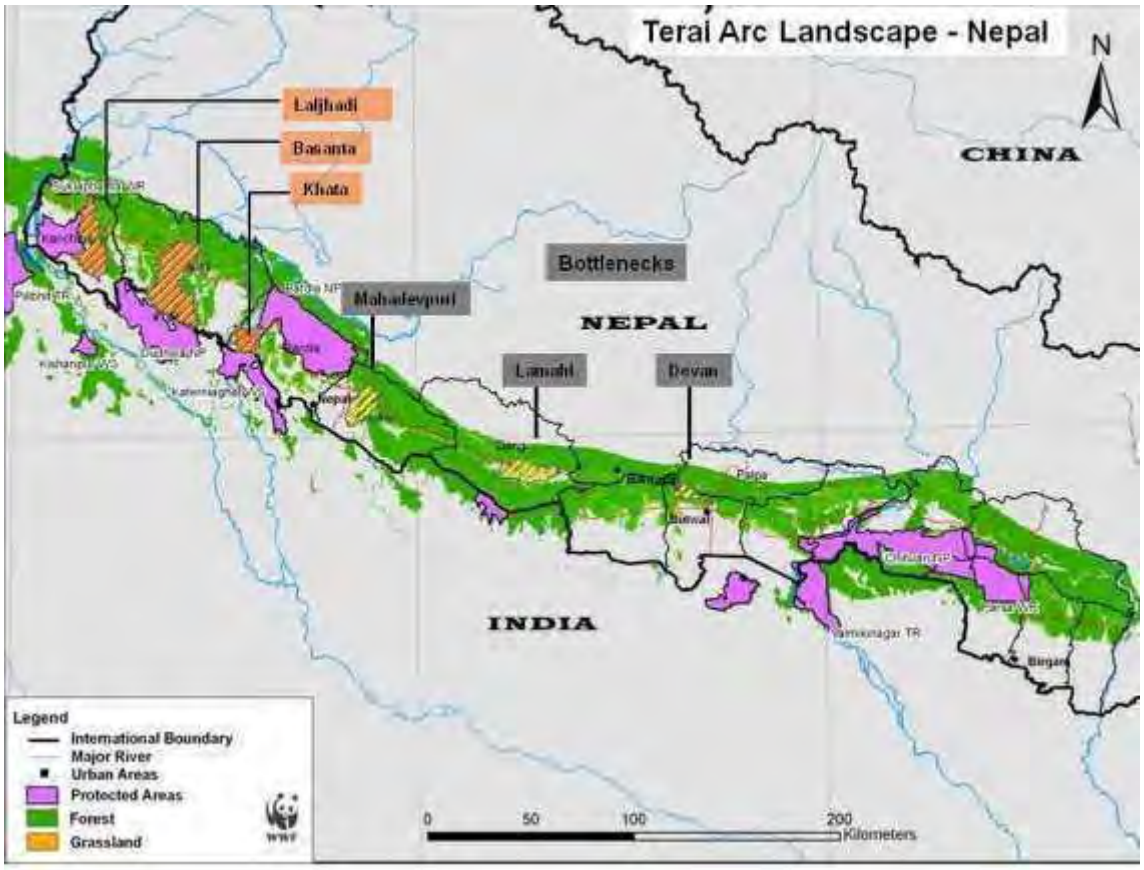
4.6.2. The Terai Arc Landscape

The Terai Arc Landscape (TAL) is composed of eleven Nepalese and Indian trans-border ecosystems of the Terai (Sanskrit for “lowlands) and nearby foothills of the Himalayas. The areas spans approximately 5 million hectares and includes Nepal’s Bagmati River to the east and India’s Yamuna River to the west (see Figure 4.29). Unlike the CHAL which has an elevation range of 8000 meters, the TAL is defined as part of the physiographic lowlands.

The TAL is home to many endangered mammals including the Bengal tiger (of which it has one of the world’s highest densities), the Indian rhinoceros, the gaur, the wild Asian elephant, the hispid hare, the sloth bear, the South Asian river dolphin and the chital, as well as over 500 species of birds, many endangered. Examples of birds are the endangered Bengal Florican, The Sarus Crane, and the Black Stork. The following are the protected areas within the boundaries of the TAL:

- Parsa Wildlife Reserve, Nepal
- Royal Chitwan National Park, Nepal
- Valmikinagar Wildlife Sanctuary, India
- Sohelwa Wildlife Sanctuary, India
- Royal Bardia National Park, Nepal
- Katarniaghat National Park, India
- Dudhwa National Park, India
- Kishanpur Wildlife Sanctuary, India
- Sukla Phanta Wildlife Reserve, Nepal
- Corbett National Park, India
- Rajaji National Park, India

Figure 4.29: The Terai Arc Landscape



4.6.3. Tiger Conservation Landscape

Tiger Conservation Landscapes are not legally protected areas, but are defined as "areas where there is sufficient habitat for at least five tigers and tigers have been confirmed to occur in the last ten years"[56]. Worldwide, the various TCLs are classified as global priority, regional priority, long term priority, and insufficient data. Regional priority landscapes are areas with moderate probability of persistence of tigers in the long term; they are important for a bioregional tiger conservation strategy. The goal for regional priority TCLs is to restore to Class I status in ten years"[57]. Class I means a habitat which can support a minimum of 100 tigers.

Only 25% of tiger habitat in the world is in protected areas, the rest being in forest where human activity is a dominant component in the ecological system. According to the Global Tiger Initiative, the tiger conservation landscape (TCL) in Nepal is represented by the TAL, see Figure 4.29) stretching over an area of 23,199 km^2 between the Bagmati River in the east and the Mahakali River bordering India in the west.[58]

The Royal Chitwan Landscape is a project commissioned by Save The Tiger Fund and classified as a regional priority landscape; it is not a legally protected area. The Royal Chitwan Landscape (which will be crossed by the Kaligandaki transmission corridor) is considered to have Class II status which means a landscape having a habitat sufficient for 50 tigers with moderate level of threats that can be mitigated in 10 years and a basis for conservation that needs to be improved. The Royal Chitwan Landscape extends across parts of Nepal and India with an area of 4,055km^2; 31% of the total area is considered to be tiger habitat[59]. The area includes 3 biomes (Tropical & Subtropical Moist Broadleaf Forests, Tropical & Subtropical Coniferous Forests and Tropical & Subtropical Grasslands, Savannas & Shrublands). The Royal Chitwan Landscape near Butwal has been proposed by researchers as part of corridors to connect the tiger sub population in the west. Based on recent survey of tiger population their numbers have increased in Nepal including those in Chitwan National Park.

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[56] Dinerstein, et al., 2006
[57] Dinerstein, et al., 2006
[58] Global Tiger Initiative Secretariat. 2012. *Managing Tiger Conservation Landscapes and Habitat Connectivity: Threats and Possible Solutions. Experiences from Bangladesh, India, Indonesia, Malaysia, Myanmar, Nepal, Thailand, and Vietnam*. The World Bank, Washington, D.C.
[59] Sanderson, et al., 2006

A subset of the TCL is a Tiger Survey Landscape which is defined as "Large Areas of low structural land cover under low human influence where tiger status is unknown. To our knowledge these areas have not been surveyed since 1995"[60]. Although the actual status of tigers is unknown, these landscapes assume that tigers might still be present as these areas are large enough to support at least five tigers[61]. Some of these areas have been surveyed, yet no tigers have been confirmed to be there.

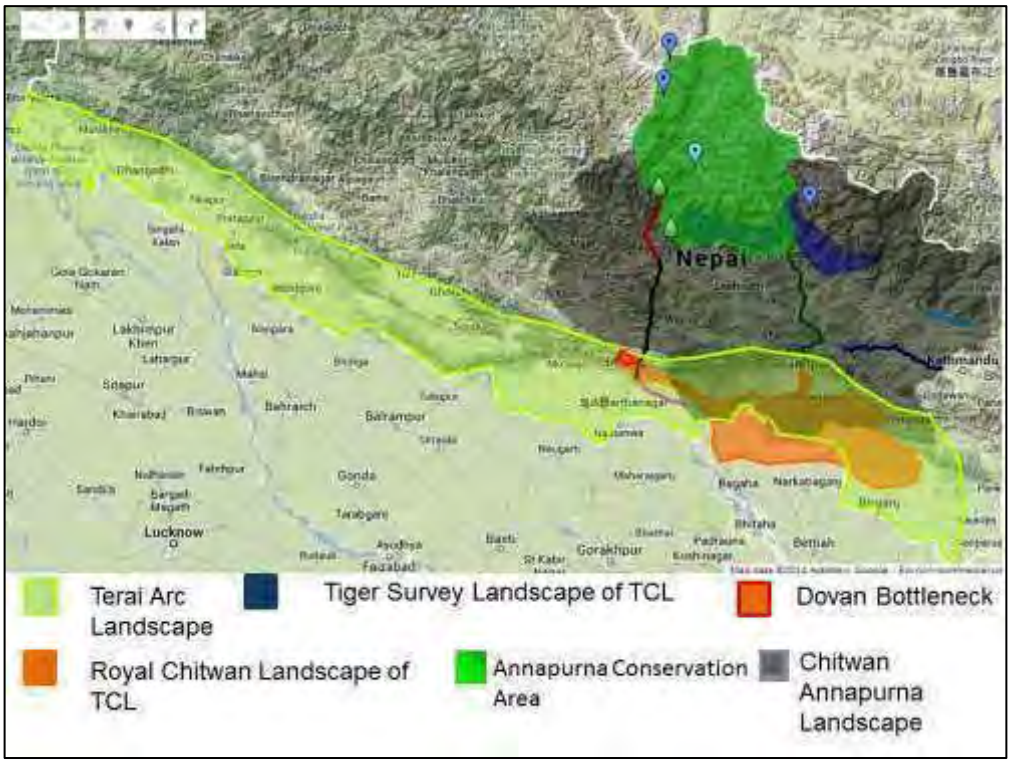
Based on studies done in forest outside protected areas in Terai Arc Landscape it has been found that forests of Dang, Chitwan, Rautahat and Rupandehi Districts have higher probability of tiger occupancy compared to other forest areas outside protected areas in Terai Arc Landscape which act as wildlife corridors[62].

4.6.4. The Dovan Bottleneck

Dovan Bottleneck is located in the Dovan VDC of Palpa District and included as part of Terai Arc Landscape. It is defined as a bottleneck because it is an area where the movement of wildlife is restricted due to geographic and anthropogenic pressure (i.e., human presence). Wildlife in small habitats face genetic and demographic threats due to inbreeding of these isolated populations which depletes their gene pools. In order to maintain a healthy genetic mix, isolated populations need to be linked via corridors for wildlife migration; such migration corridors are important in areas with minimal forest and/or vegetative cover and high human pressure. The Dovan Bottleneck has been identified as an area for connectivity of various species, including the tiger population, between the Chitwan and Bardia National Parks. The draft Nepal Biodiversity Strategy and Action Plan prepared by the Environment Division of Ministry of Forest and Soil Conservation identifies a strategic corridor[63] (not a legally protected area) linking Annapurna Conservation Area with Chitwan National Park as shown in Figure 4.30 a and b. Part of the MKMB line north of Bharatpur Municipality could cross into. In the Dovan VDC approximately 1km section of the Kushma-New Butwal segment of the DKBB line is of Hill Sal forest with 35% crown cover.

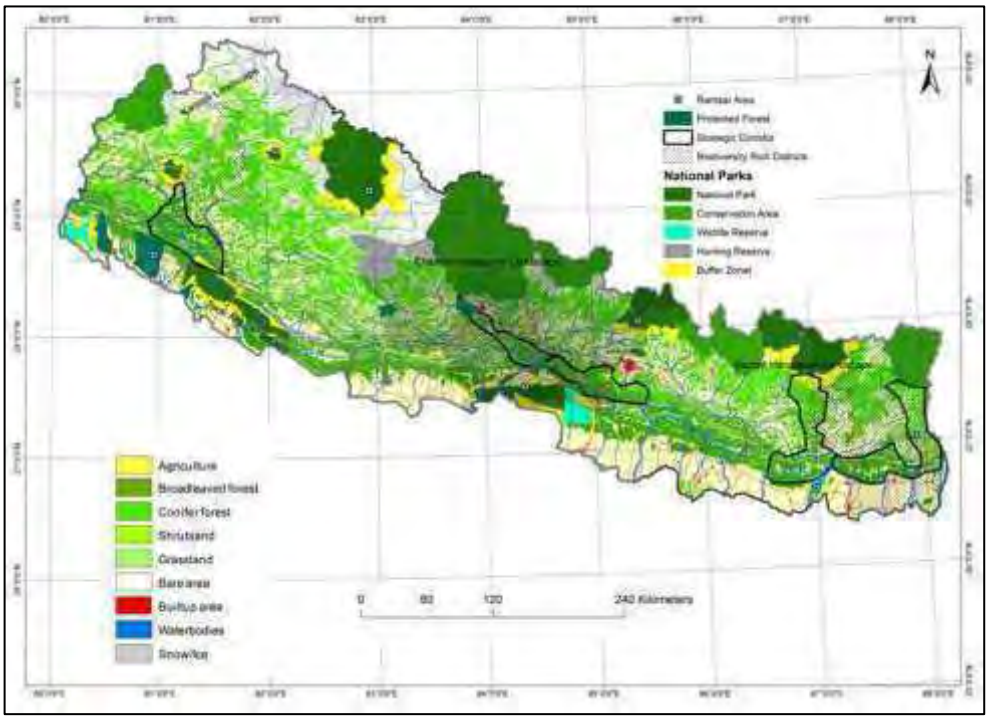
[60] Sanderson, et al., 2006
[61] Dinerstein, et al., 2006
[62] Karki J. B., 2011
[63] MoFSC. (n.d.). *Nepal National Biodiversity Strategy and Action Plan.* Retrieved January 20, 2014, from http://www.mfsc.gov.np/noticefile/NBSAP_Draft%20report_138735552

Figure 4.30a: Potentially Sensitive Ecosystems



CHAL = Chitwan Annapurna Landscape, GLOF = Glacier Lake Outburst Flood, TAL = Terai Arc Landscape, TCL = Tiger Conservation Landscape

Figure 4.30b: Potentially Sensitive Ecosystems



4.6.5. Annapurna Conservation Area

The ACA will be directly affected by the DKBB and MKMB transmission line. ACA is an IUCN Management category VI protected area. ACA was gazetted in 1992 with its management responsibilities handed by Government of Nepal to National Trust for Nature Conservation (NTNC, an autonomous and not for profit organization). It has an area of 7,629 km^2 with 57 VDCs. As shown in Figure 4.31, about 49.7% of the total area is forest, shrubland, and grasslands, about 6.7% is snow, rocks, gravel, rivers, lakes and glaciers, and 3.1% is cultivated land.

Figure 4.32 shows the land use zones within the ACA. Protected forest (which is not distinguished as wilderness zone or intense use zone) and seasonal grazing zone together comprise about 47% of the total area. The proposed routing of the transmission lines is all within intensive land use zones which comprise about 0.018% of the total area (considering 50m RoW). Appendix 4 shows the routing through ACA overlaid over topographic map.

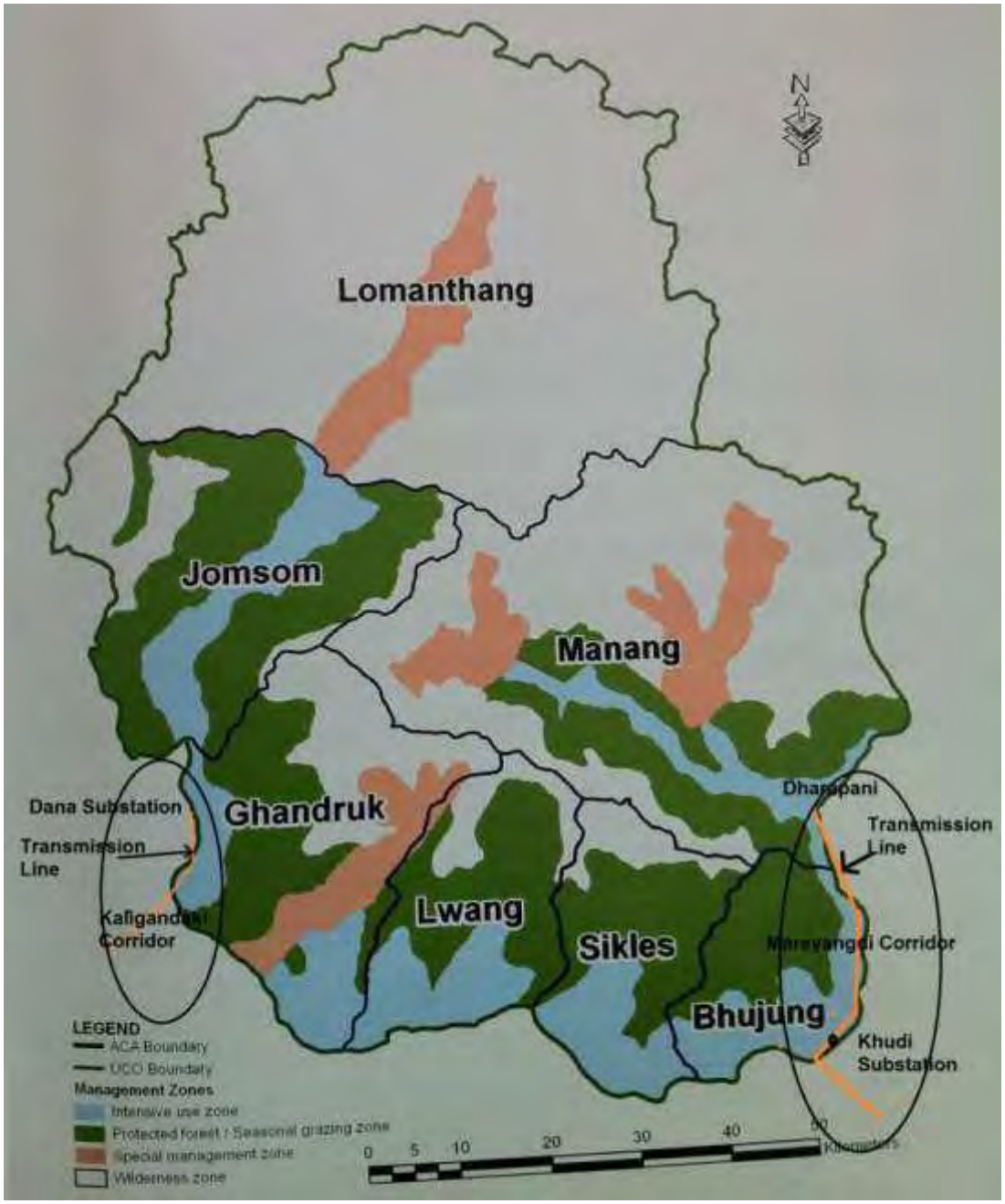
The ACA is the largest protected area and one of the most popular tourist and trekking destinations in Nepal. It is host to the Annapurna mountain range as well as the Kali Gandaki Gorge, the world's deepest. According to 2011/12 data of tourist visiting different protected areas in Nepal provided by Ministry of Culture, Tourism & Civil Aviation of Government of Nepal, a total of 313,126 people visited different protected areas, of which 42% visited Chitwan National Park and 33% visited ACA. This makes it the most visited protected area of the mountainous region of Nepal. According to a recent study, tourists categorized view of the area as the most important factor for attraction to a site[64]. The section between Ghar VDC till Dana VDC that follows close to this trekking route could have some negative impacts.

[64] Sharma, 2013

Figure 4.31: Land Use Map of ACA

Source: NTNC, 2008

Figure 4.32: Land Use Zones in ACA with Respect to Project Components



ACA has the largest number of vegetation types in Nepal with forest types being: Hill Sal forest, Subtropical Decidious Hill forest, Schima Castonopsis Forest, Subtropical Semievergreen hill forest, *Pinus roxburghii* forest, *Quercus semecarpifolia* forest, *Quercus lamellose* forest, Lower temperate mixed broadleaved forest, Upper temperate mixed broad leaved forest, Rodhodendron Forest, *Betula utilis* forest, *Abies*

spectabilis forest, *Tsuga dumosa* forest, *Pinus wallichiana* forest, *Picea smithiana* forest, *Cupressus torulosa* forest, *Alnus* wood, *Populus ciliate* wood, *Hippophae* scrub, Moist alpine scrub, Dry alpine scrub and *Juniperus wallichiana* forest (NTNC, 2008). The list of the protected plants found in the ACA is given in the Appendix 1[65].

The Kaligandaki Corridor Line passes close to the ACA western boundary next to Kaligandaki River for 6.2 km. Major forest crossed by the transmission line in these sections (based on MENRIS, ICIMOD and Google Earth information) include Alder Forest and Schima Castonopsis Forest. The Alder forest consists of *Alnus nepalensis* and is well known to occur in areas with good moisture such as ravines, river banks and fresh landslide. Furthermore, Schima-Castonopsis Forest mainly composes *Schima wallichii*, *Castonopsis indica*, and *Engelhardia spitica*[66]. The sections of Kaligandaki Corridor crosses over Schima Castonopsis Forest for 1.13km between altitude 1200 to 1250 masl.

The Marsyangdi corridor transmission line crosses approximately 25 km of the eastern part of the ACA between Manang and Khudi, at altitudes of 872-1057 masl. Here too the transmission line crosses over Schema-Castonopsis Forest, 15% with crown cover[67]. Referring to the management zones categorized in the ACA Management Plan, the Manang-Khudi and the Kaligandaki transmission segments noted above are within the intensive use zone (see Figure 4.32) in Bhujung Region (based on Administrative Division of Management Plan) and Lower Marsyangdi Valley respectively (based on Topographical Division of Cis-Himalayan region by the Management Plan).

In general the Marysangdi valley is occupied by extensive human settlement. The “Intensive Use Zone” is generally human settlement area where natural resources have been highly impacted. The human activities are intensive due to agriculture, livestock, fodder, and firewood collection”[68]. The routing through Bhujung and Gandruk districts is within Intensive Land Use zone as shown in Figure 4.32, and most of the proposed ROW will be in agriculture areas rather than forest or other areas. In the Manang district, the proposed ROW will be in agro-pastoral and tourist areas[69].

[65] NTNC, 2008
[66] TISC, 2010
[67] Mulligan, 2005
[68] NTNC, 2008
[69] Yonzon, 1997

Most part of the ACA area is barren land (46.8%) followed by 32.24% of grazing land, forest 14.43%., agriculture land 3.17%, shrubland 2.88%, waterbodies 0.41% and landslides 0.07%. The Khudi-Manang transmission segment will pass through the Bhujung, Ghandruk, and Manang Conservation Management Units. The forest and grazing land constitutes 51.76% for Ghandruk, 62.11% for Bhujung and 29.08% for Manang. In contrast to other Units it is observed that Bhujung has larger areas of Forest 53.86% and Landslide (0.53%) while Manang has the least agriculture land 0.58%. The agriculture land distribution being 0.12 ha per person in Manang 0.35 ha per person for Ghandruk and 0.22 ha per person for Bhujung[70].

The fauna of major importance within the protected area includes 97 mammal species, 476 birds, 56 herpato and two fish species[71]. The list of potentially sensitive species is presented in Table 4.6; a more comprehensive set of tables with flora and fauna in potentially sensitive areas is presented in Appendix 1. This number of bird species found here is over half of that found in Nepal. Among these birds the only endemic breeding bird of Nepal Spiny Babbler (*Turdoides nipalensis*) is also found here. Musk Deer in the Conservation Area is found between 3300 to 3700 masl[72]. The Clouded Leopard have been found between 1500 to 3000 masl[73]. However, common leopard, spotted lingsang, Chinese Pangolin, Assamese Monkey, Mustang Frog, Annapurna Ground Skink, Burmese Rock Python, Rat Snake and King Cobra are some important species whose altitudinal range overlaps with the routing elevation in the Conservation Area.

Table 4.6: Important Protected Species in Annapurna Conservation Area

Common names	Scientific names	NPWC Act	NRDB (1995)	IUCN	CITES
Mammals					
Red panda	*Ailurus fulgens*	P	E	VU	I
Snow leopard	*Uncia uncial*	P	E	EN	I
Jungle cat	*Felis chaus*		S	LC	II
Leopard cat	*Prionailurus bengalensis*	P	V	LC	II
Golden cat	*Catopuma temminckii*		V	NT	I
Clouded leopard	*Pardofelis nebulosa*	P	V	VU	I
Marbled cat	*Pardofelis marmorata*		V	VU	I
Himalayan lynx	*Lynx lynx isabellinus*	P	E	LC	II
Forest leopard	*Panthera pardus*		S	NT	I

[70] NTNC 2008

[71] Bhuju, Shakya, Basnet, & Subha , 2007

[72] Aryal, 2006

[73] Chapagain & Dhakal , 2002

Dhole	*Cuon alpinus*		V	EN	II
Grey wolf (occupy arctic tundra to forest, prairie, and arid landscapes and prey on musk deer) Source: http://animaldiversity.ummz.umich.edu/accounts/Canis_lupus/ and Musk Deer in Nepal Report	*Canis lupus*	P	V	LC	I
Red fox	*Vulpes vulpes*		S	LC	III
Tibetan sand fox	*Vulpes ferrilata*		S	LC	
Asiatic black bear	*Ursus thibetanus*		V	VU	I
Himalayan brown bear (3800-5500m)	*Ursus arctos*	P	V	LC	I
Indian flying fox	*Pteropus giganteus*			LC	II
Common otter	*Lutra lutra*		S	NT	I
Smooth-coated otter	*Lutrogale perspicillata*		S	VU	II
Spotted lingsang (150-2700 m) IUCN	*Prionodon pardicolor*	P		LC	I
Tibetan argali	*Ovis ammon hodgsoni*	P	C	NT	I
Tibetan gazelle	*Procapra picticaudata*			NT	
Tibetan wild ass	*Equus kiang kiang*			LC	II
Himalayan musk deer	*Moschus chrysogaster*	P	E	EN	I
Himalayan goral	*Naemorhedus goral*		S	NT	I
Mainland serow	*Narmorhedus sumatraensis*		S	NT	I
Chinese pangolin (below 1500 m) Source: IUCN Red List	*Manis pentadactyla*	P	S	EN	II
Assamese monkey (mainly above 1000m) Source IUCN Red List	*Macaca assamensis*	P		NT	II
Rhesus monkey	*Macaca mulatta*		S	LC	II
Herpatofauna					
Indian bull frog	*Hoplobatrachus tigerinus*			LC	II
Mustang frog (2400m) Source: Herpatofauna of Southern Annapurna Region, K.B. Shah	*Paa rostandi*		S	VU	
Annapurna ground skink (2100 to 3360 m) Source: Herpatofauna of Southern Annapurna Region, K.B. Shah	*Asymblepharus capitaneus*		S		
Golden monitor	*Varanus flavescens*	P	S	LC	I
Burmese rock python (1314 to 1800 m) Source: Herpatofauna of Southern Annapurna Region, K.B. Shah	*Python bivittatus*	P	V	VU	I
Rat snake (1080-1700 m) Source: Herpatofauna of Southern Annapurna Region, K.B. Shah	*Ptyas mocosus mocosus*		S		II
King cobra (1800-2300m) Herpatofauna of Southern Annapurna Region, K.B. Shah	*Ophiophagus hannah*		V	VU	I
Source: (NTNC, 2008), (IUCN, 2013), Wikipedia, Birdlife International and CITES Appendix from 5th August 2013. Legend: C= critical, E= endangered, S= susceptible, V= Vulnerable, P= protected, LC (IUCN)= least concern, EN= endangered, VU= vulnerable, CITES (I, II, III)= Appendices					

The figures depicting the potential habitat range of important mammals and bird species are in Appendix 2. The information for these figures was collected from IUCN red list spatial data polygons and ICIMOD's Mountain Geoportal. The habitat ranges

cover all potential sites in Nepal. Elevation-based habitat preferences of some important mammals are also presented in Appendix 2.

4.6.6. REDD Forest Demonstration Site

Approximately, 1.5km section of the routing will pass through Banhjakhet VDC of Lamjung District whose community forest (in wards 1, 2 and 3) have been included by NEFIN as demonstration site for REDD activities. Since accurate routing information is not available the tentative site denotes a section crossing over a forest with 30% crown cover.

4.6.7. Summary of Potentially Sensitive Areas Crossed by Proposed Transmission Routes

Table 4.7 summarizes the key locations where sensitive flora and fauna may be impacted by the transmission lines noting prospective mitigation options (mitigation measures are discussed in Sections 5 and 7). The main concern is disturbance of potentially sensitive habitat in forested areas which may be cleared for the ROW. Almost all of the transmission routes proposed lie within the CHAL (see Figure 4.30). About 2.4 km of the Dana-Kushma transmission segment will cross just inside the southwest boundary of the ACA, and about 25 km of the Manang-Khudi transmission segment will be inside the southeast boundary of the ACA (as discussed above). Approximately 30% of the Kushma-New Butwal section of the Kaligandaki Corridor line crosses the TAL, and approximately 15.8 km of this transmission section crosses over the Tiger Conservation Landscape. The Dovan Bottleneck is traversed by approximately 1.8 km section of the Kushma-New Butwal segment of the DKBB line. The MKMB transmission line will probably cross over sections of Tiger Survey Landscape at Bhanu VDC of Tanahu District, Kabilas VDC, Devghat VDC and Bharatpur Municipality.

Table 4.7: Summary of Potentially Sensitive Project Locations, Impacts, and Mitigation Options

Location	Sensitive species	Potential Impacts	Mitigation Options
Khudi-Manang segment in ACA (25 km, 220 kV)	Clouded Leopard between 1500 to 3000 m, but preferred habitat is above 2000m	Potential disruption of migration pathways, breeding and/or hibernation areas	• 220 kV ➔ not 400 kV • Reforestation @ 25:1 • Minimize RoW width with stacked conductor array • Allow re-vegetation to grow 1-2 meters high in ROW • Additional biodiversity offset?
Dovan "bottleneck" (~ 1.8 km)	Tiger	Disruption of migration paths due to R-o-W clearing	• Reforestation @ 2:1 • Allow re-vegetation to grow up to 1 – 2 meters high, facilitating migration • Additional biodiversity offset?
Samundratar - Trishuli 132kV Line[a]: Gerkhu VDC Segment	Assamese Monkey Leopard Cat		

Note: [a] As of 19 February 2014 this section is expected to be dropped from the project.

4.7 Socioeconomic Conditions

4.7.1. Kaligandaki Corridor

Socio-economic conditions are summarized in Table 4.8. The seven districts of the Western Development Region in Dhawlagiri, Gandaki and Lumbini Zones fall within the project site with a population size of 326,792 constituting 141,835 males and 169,664 females[74]. The mean household size is 4 with 0.2 ha (using 2011 population census data) of cultivated land per person[75]. Subsistence agriculture with livestock raising is the main source of Livelihood in all these Project VDCs. Agricultural land and livestock holdings of households in all the project VDCs is summarized in Table 4.9. Ownership of land is common with 80% of household reporting ownership.

Table 4.8: VDC Population of Kaligandaki Corridor

District	VDC	Population					
		Male	Female	Total	Sex Ratio	Total House hold	House-hold Size
Myagdi	Dana	885	988	1,873	90%	484	4
	Tatopani	409	386	795	84%	216	4
	Ghar/Darwang	1,645	1,950	3,595	101%	904	4
	Sikha	1,043	1,169	2,212	84%	621	4
	Histan Mandali	738	937	1,675	86%	492	3
	Dowa	472	591	1,063	80%	294	4

[74] CBS, 2012
[75] MoFSc, DOSC, 2005

	Beghkhola / Bagarkhola	678	844	1,522	80%	402	4
	Rakhubhagwati	1,461	1,895	3,356	77%	932	4
	Rakhupiple	1,719	2,217	3,936	78%	1,015	4
Parbat	MajhphantMallaj	3,664	4,423	8,087	83%	2,100	4
	Dhairing	1,592	1,864	3,456	85%	896	4
	Nanliwang	1,236	1,515	2,751	82%	683	4
	Pang	1,985	2,581	4,566	77%	1,201	4
	Khurkot	1,724	2,226	3,950	77%	958	4
Baglung	Paiyupata	2,091	2,950	5,041	71%	1,347	4
	Amalachaur	1,878	2,709	4,587	69%	1,206	4
Parbat	Mudikuwa	761	1,108	1,869	69%	467	4
	Falebas Devisthan	1,347	1,657	3,004	81%	697	4
	Khurga	1,316	1,610	2,926	82%	655	4
	Pangrang	958	1,265	2,223	76%	484	5
	Bachchha	816	1,038	1,854	79%	444	4
	Urampokhara	1,064	1,351	2,415	79%	508	5
	Wahakhi / Bahakithanti	719	999	1,718	72%	383	4
	Saligram	1,184	1,497	2,681	79%	578	5
Syangja	Pidikhola	2,161	2,795	4,956	77%	1,119	4
	Bagthala / Bhatkhola	700	959	1,659	74%	450	4
	Shreekrishna Gandaki	3,884	4,931	8,815	79%	1,993	4
Palpa	Yamgha	1,465	2,108	3,573	69%	901	4
	Yarlamdanda / Darlamdanda	878	1,219	2,097	72%	519	4
	Chhapani	852	1,223	2,075	70%	517	4
	Nayarnamtales	951	1,202	2,153	79%	534	4
	Chirtungdhara	1,815	2,451	4,266	74%	1,000	4
	Madanpokhara	2,723	3,558	6,281	77%	1,541	4
	Koldada	1,788	2,077	3,865	86%	661	6
	Dobhan	3,215	3,657	6,872	88%	1,436	5
Rupandehi	Devdaha	12,836	15,378	28,214	83%	6,435	4
	Makrahar	7,634	8,880	16,514	86%	3,479	5
	Kerwani	6,847	7,892	14,739	87%	3,132	5
Nawalparasi	Sunwal	13,347	15,870	29,217	84%	6,537	4
	Amraud	2,374	2,579	4,953	92%	921	5
	Swathi	4,978	5,648	10,626	88%	2,102	5
	Ramnagar	7,103	8,503	15,606	84%	3,315	5
	Ramgram NP	12,807	13,183	25,990	97%	4,972	5
	Manari	2,771	3,011	5,782	92%	1,074	5
	Tilakpur	3,597	4,077	7,674	88%	1,520	5
	Panchnagar	4,483	5,337	9,820	84%	2,156	5
	Makar	11,241	13,356	24,597	84%	5,639	4

Source: Population Census, 2011, CBS

Table 4.9: Ownership of Agricultural Land and Livestock in Kaligandaki VDCs

District	VDC	Households Owning %				
		Agricultural Land Only	Land and Livestock	Land, Livestock and Poultry	Other	Total House-holds
Myagdi	Dana	61	92	252	54	459
	Tatopani	12	30	92	78	212
	Ghar / Darwang	52	96	442	126	716
	Sikha	255	658	286	167	1,366
	Histan Mandali	75	271	169	29	544
	Dowa	63	112	91	21	287
	Beghkhola / Bagarkhola	29	126	174	109	438

	Rakhu-bhagwati	78	178	460	70	786
	Rakhupiple	73	326	379	80	858
Parbat	Majhphant Mallaj	199	368	406	317	1,290
	Dhairing	78	495	111	116	800
	Nanliwang	57	242	159	115	573
	Pang	82	614	168	177	1,041
	Khurkot	67	551	159	81	858
Baglung	Paiyupata	176	792	150	128	1,246
	Amalachaur	96	754	178	75	1,103
Parbat	Mudikuwa	26	313	93	55	487
	Falebas Devisthan	44	281	210	125	660
	Khurga	39	340	257	60	696
	Pangrang	22	218	247	56	543
	Bachchha	11	180	237	34	462
	Uram-pokhara	6	265	205	20	496
	Wahakhi / Bahakithanti	19	281	64	20	384
	Saligram	37	292	145	74	548
Syangja	Pidikhola	38	581	445	94	1,158
	Bagthala / Bhatkhola	41	208	176	46	471
	ShreekrishnaGandaki	69	992	426	1,109	2,596
Palpa	Yamgha	32	587	242	22	883
	Yarlamdanda / Darlamdanda	27	316	123	82	548
	Chhapani	32	239	250	19	540
	Nayarnamtales	45	75	282	102	504
	Chirtungdhara	53	219	554	58	884
	Madanpokhara	109	469	500	157	1,235
	Koldada	10	7	494	15	526
	Dobhan	53	283	754	136	1,226
Rupandehi	Devdaha	889	1,457	1,105	904	4,355
	Makrahar	540	987	869	356	2,752
	Kerwani	380	1,089	569	400	2,438
Nawalparasi	Sunwal	816	1,481	1,199	1,387	4,883
	Amraud	131	306	196	170	803
	Swathi	313	529	554	249	1,645
	Ramnagar	306	933	597	404	2,240
	Ramgram NP	572	1,077	803	1,441	3,893
	Manari	111	271	362	175	919
	Tilakpur	113	277	505	219	1,114
	Panchnagar	185	506	587	372	1,650
	Makar	478	966	828	1,731	4,003

Source: Population Census, 2001, CBS

Out-migration for 2001 in each of these districts varies from 3965 for Myagdi, 12,685 in Parbat, 17,668 in Baglung, 15,546 in Syangja, 24,483 in Palpa, 189,327 in Rupandehi and 97,539 in Nawalparasi Districts[76]. Similarly according to "Districts of Nepal: Indicators of Development" jointly prepared by CBS, Nepal and ICIMOD, these districts are ranked as the most developed area except Nawalparasi District in terms of Socio-

[76] KC, 2003

economic and Infrastructure Development Index. Ranking for Myagdi, Parbat, Baglung, Syangja, Palpa, Rupandehi and Nawalparasi is 25, 20, 24, 9, 8, 13 and 37 respectively. According to CBS, 2001 87% of the population in 48 VDC's according to Ethnic composition include Hill Bhramin 26.5%, Magar 18.8%, Dalit 14%, Tharu 11.8%, Chhetri 10.4%, Gurung 3.3%, Newar 2.1% and the rest is 13.2% include Yadav, Muslim, Thakuri, Kumal, Kewat, Teli, Sanyasi, Rajbhar, Gharti, Thakali, Majhi, Chhantyal, Kurmi, Mallah, Rai, Lodha and Others (see Table 4.10).

Table 4.10: Ethnic Composition by VDC for Kaligandaki Corridor

VDC		Population						
	Brahmin (Hill)	Magar (Janajati)	Dalit	Tharu (Janjati)	Chhetri	Gurung (Janajati)	Newar (Janajati)	Other
Dana	72	1163	370	0	215	61	13	144
Tatopani	22	478	191	0	57	16	8	107
Ghar	367	1684	788	0	108	172	0	240
Sikha	38	3368	693	0	1491	27	8	148
Histan Mandali	6	2002	102	0	16	0	0	11
Dowa	0	1105	97	0	0	5	0	21
Beghkhola / Bagarkhola	49	1661	284	0	11	21	0	42
Rakhu-bhagwati	236	66	562	0	2277	0	123	230
Piple	441	213	1405	0	844	33	10	1027
Majhphant Mallaj	698	112	1996	0	2460	73	257	469
Dhairin	1943	336	954	0	259	0	0	169
Nanliban	799	267	628	0	961	27	112	39
Pan	2442	42	1248	0	714	12	159	290
Khurkot	2345	23	733	0	688	5	7	287
Paiyupata	1972	12	362	0	104	10	0	50
Amalachaur	1476	139	393	0	268	73	611	282
Mudikuwa	1713	20	499	0	476	578	37	124
Phalebas Devisthan	638	24	651	0	1250	19	33	74
Khurga	313	94	506	0	724	547	56	65
Panran	938	7	669	0	283	18	0	540
Bachchha	2851	95	1475	0	340	903	0	38
Barrachaur	1553	0	56	0	171	0	0	0
Uranpokhara	1324	436	791	0	222	0	147	101
Wahakhi / Bahakithanti	2841	92	1278	0	1300	0	8	84
Saligram	3151	13	1375	0	504	0	9	206
Pidikhola	2757	1177	834	0	699	338	32	123
Numbu-wakharka	2044	1968	385	0	71	0	0	100
Shreekrishna Gandaki	5538	3606	815	75	308	84	372	654
Yamgha	2744	697	563	0	44	0	0	587
Yarlamdanda	1342	1091	71	0	33	0	45	12
Chhapani	994	1173	279	0	113	0	49	100
Nayarnamtales	303	1381	303	0	95	0	390	91
Chirtundhara	765	2872	334	0	48	0	112	597

VDC		Population						
	Brahmin (Hill)	Magar (Janajati)	Dalit	Tharu (Janjati)	Chhetri	Gurung (Janajati)	Newar (Janajati)	Other
Madanpokhara	2211	2052	1047	0	389	12	187	324
Koldada	6	3667	301	0	0	0	0	28
Dobhan	1038	3418	765	0	994	110	138	276
Devdaha	6338	6437	2321	823	2221	1649	552	1781
Markhar	2417	2017	1514	4377	1490	760	328	1517
Kerwani	2920	2095	1809	2224	583	677	186	2555
Sunwal	5786	4439	2480	3005	3393	1815	765	3375
Amraud	203	212	755	1703	184	30	5	1692
Swathi	1257	939	1039	1806	838	622	70	3131
Ramnagar	4588	1048	1079	2724	622	255	287	1922
Ramgram NP	780	190	3813	4390	840	54	407	12156
Manari	100	11	596	3948	12	0	15	1015
Tilakpur	1067	141	405	3890	159	7	29	846
Panchnagar	2210	517	678	3354	857	109	232	621
Makar	5604	2869	2517	3692	2041	1112	685	2074
Total	**81,240**	**57,469**	**42,809**	**36,011**	**31,777**	**10,234**	**6,484**	**40,365**

Source: Population Census, CBS 2001.

4.7.2 Marsyangdi (MKMB) Corridor

For this corridor five districts of Western and Central Development Region of Gandaki and Narayani Zone will be traversed. The total population of these districts sum up to 134,8595 with 623,112 male and 725,483 female with average household size of 4.2 and 0.2 ha of cultivated land per person. Subsistence agriculture with livestock raising is the main source of Livelihood in all these Project VDCs. Agricultural land and livestock holdings of households in all the project VDCs is summarized in Table 4.11. Ownership of land is common with 80% of household reporting ownership.

Table 4.11: Ownership of Agricultural Land and Livestock in Marsyangdi Corridor VDCs

District	VDC	Households Owning (%)				Total Households
		Agricultural Land Only	Land and Livestock	Land, Livestock and Poultry	Other	
Manang	Dharapani	25	49	71	189	176
Lamjung	Ghermu	39	82	222	120	382
	Taghring / Tharding	65	75	255	57	454
	Bahundada	26	179	190	614	474
	Khudi	64	203	325	92	732
	Bhulbhule	64	183	310	26	664
	Chandisthan	28	107	216	392	411
	Bajhakhet / Beshisahar	72	240	310	47	706
	Gaunsahar	133	516	727	36	1511

	Udipur	56	288	163	160	623
	Chiti	55	304	725	296	1179
	Bhoteoodar	115	357	276	22	1295

Source: Population Census, 2011, CBS

Out-migration for 2001 in each of these districts varies from 1,253 for Manang, 10,877 in Lamjung, 32,482 in Tanahu, 11,667 in Gorkha and 162,528 in Chitwan Districts (KC, 2003). According to "Districts of Nepal: Indicators of Development" jointly prepared by CBS, Nepal and ICIMOD, these districts are ranked as the intermediate developed area except Manang and Chitwan District in terms of Socio-economic and Infrastructure Development Index. Ranking for Manang, Lamjung, Tanahu, Gorkha and Chitwan is 10, 30, 31, 45 and 4 respectively. According to CBS, 2001 87% of the population in 48 VDC's according to Ethnic composition include Hill Bhramin 26.5%, Magar 18.8%, Dalit 14%, Tharu 11.8%, Chhetri 10.4%, Gurung 3.3%, Newar 2.1% and the rest is 13.2% include Yadav, Muslim, Thakuri, Kumal, Kewat, Teli, Sanyasi, Rajbhar, Gharti, Thakali, Majhi, Chhantyal, Kurmi, Mallah, Rai, Lodha and Others[77].

4.7.3 M-K Line

Altogether four districts of Western and Central Development Region of Gandaki and Narayani Zone will be traversed. Total population of these districts is 2,931,352 with 1,470,962 male and 1,460,389 female having 4.2 as average household size as shown in Table 4.12[78]. Average cultivated land person here is 0.1 ha. Subsistence agriculture with livestock raising is the main source of Livelihood in all these Project VDCs. Agricultural land and livestock holdings of households in all the project VDCs is summarized in Table 4.13. Ownership of land is common with 88% of household reporting ownership.

[77] Additional details will be added when complete VDCs of the Marshyangdi-Bharatpur routing by NEA survey is provided.
[78] CBS, 2012

Table 4.12: VDC Population of Marki Chowk - Kathmandu Line

District	VDC	Population					
		Male	Female	Total	Sex Ratio	Total House hold	House hold Size
Gorkha	Deurali	2,449	3,065	5,514	80%	1,422	4
	Manakamna	2,876	3,327	6,203	86%	1,392	4
	Ghyalchok	2,759	3,193	7,744	86%	1,442	5
Chitwan	Darechok	4,836	4,771	9,607	101%	2,029	5
Dhading	Jogimara	3,842	3,902	5,952	98%	1,298	5
	Salang	2,655	2,995	5,650	89%	1,140	5
	Benighat	4,854	4,863	9,717	100%	2,123	5
	Kumpur	4,636	5,376	10,012	86%	2,122	5
	Kalleri	4,059	4,793	8,852	85%	1,921	5
	Pida	5,415	5,628	11,043	96%	2,214	5
	Baireni	6,630	6,739	13,369	98%	2,795	5
	Goganpani	2,696	2,867	5,563	94%	1,133	5
	Kewalpur	2,412	2,598	5,010	93%	1,104	5
	Thakre	4,781	5,057	9,838	95%	2,141	5
	Naubise	7,203	7,350	14,553	98%	3,184	5
Kathmandu	Baad Bhanjyang	1,873	1,906	3,779	98%	817	5

Source: Population Census, 2011, CBS

Table 4.13: Ownership of Agricultural Land and Livestock in Marki Chowk - Kathmandu VDCs

District	VDC	Households Owning (%)				Total Households
		Agricultural Land Only	Land and Livestock	Land, Livestock and Poultry	Other	
Gorkha	Deurali	90	273	692	189	1244
	Manakamna	97	579	409	120	1205
Gorkha	Ghyalchok	51	174	164	57	446
Chitwan	Darechok	133	338	563	614	1648
Dhading	Jogimara	46	436	583	92	1157
Dhading	Salang	14	314	660	26	1014
	Benighat	121	882	279	392	1674
	Kumpur	49	481	1198	47	1775
	Kalleri	31	438	1222	36	1727
	Pida	77	380	1197	160	1814
	Baireni	90	861	888	296	2135
	Goganpani	24	279	605	22	930
	Kewalpur	38	447	501	25	1011
	Thakre	122	748	534	195	1599
	Naubise	184	1148	987	411	2730
Kathmandu	Baad Bhanjyang	95	266	201	104	666

Source: Population Census, 2001, CBS

Similarly out-migration for 2001 in each of these districts varies from 1,1667 for

Gorkha, 162,528 in Chitwan, 13,949 in Dhading and 346,190 in Kathmandu Districts[79]. Kathmandu and Chitwan rank as among the most developed in terms of socioeconomic and infrastructural development index while Dhading District is considered as among the least developed[80]. Ranking for Gorkha, Chitwan, Dhading and Kathmandu is 45, 4, 54 and 1 among 75 districts of Nepal. According to CBS, 2001 87% of the population in 16 VDC's according to Ethnic composition include Hill Bhramin 19%, Chhetri 17%, Tamang 12%, Dalit 12%, Magar 12%, Newar 9%, Gurung 7% and others 13%. The others include Chepang, Gharti/Bhujel, Sanyasi, Muslim, Thakuri, Tharu, Sherpa, Kumal, Rai, Darai and rest (Table 4.14).

Table 4.14: Ethnic Composition by VDC for M-K Line

VDC	Population							
	Brahmin (Hill)	Chhetri	Tamang (Janjati)	Dalit	Magar (Janajati)	Newar	Gurung (Janjati)	Others
Deurali	747	1,673	130	969	887	376	344	594
Manakamna	363	91	16	659	3,130	758	1,453	51
Ghyalchok	1,408	683	7	1,209	397	811	909	716
Darechok	916	727	228	562	1,680	619	2,243	2,134
Jogimara	555	691	25	346	811	486	762	3,306
Salang	1,074	66	0	888	2,741	607	12	519
Benighat	2,392	1,437	336	1,582	476	579	497	1,007
Kumpur	1,619	464	0	1,752	1,357	2,135	1,848	881
Kalleri	2,345	1,007	5	2,080	2,048	1,375	0	735
Pida	1,560	1,908	1,570	1,017	541	574	99	3,027
Baireni	2,406	2,497	3,930	1,410	297	604	64	613
Goganpani	1,008	827	1,604	555	574	387	70	408
Kewalpur	2,201	994	973	690	84	506	93	225
Thakre	1,597	4,099	1,692	323	158	193	90	913
Naubise	3,554	3,199	4,055	1,124	179	1,110	89	1,358
Baad Bhanjyang	752	1,251	724	287	36	118	20	98
Total	**24,497**	**21,614**	**15,295**	**15,453**	**15,396**	**11,238**	**8,593**	**16,585**

Source: Population Census, 2001.

The average electrification rate for lighting for Nepal is 67%[81]. Based on the district traversed by the project transmission line it has been observed to be higher than national average varying from 69% in Myagdi to 98% in Kathmandu. The average electrification rate being 80%, 81%, 79% and 85% for DKBB, MKMB, M-K and ST lines respectively.

Major crops cultivated here in subsistence manner are paddy, wheat, corn, millet, and

[79] KC, 2003
[80] ICIMOD, 2003
[81] CBS, 2012

potatoes followed by sugarcane, barley, legumes, vegetables and fruits[82]. Suitable areas along the corridors for the potential of growing major crops are provided in the Appendix 2 Figure 1 to 7 (these are based on software analysis of agro ecological zones of FAO). Almost all farmers do subsistence farming. DKBB corridor has a population density by agriculture land from 4, 5, 5, 5, 5, 9 and 9 persons per hectare for project VDCs of Myagdi, Parbat, Baglung, Syangja, Palpa, Rupandehi and Nawalparasi Districts respectively. Similarly, based on per capita food production for 2001 indicate Rupandehi and Syangja as most developed with 4250 and 3640 Kilocalories. Parbat, Nawalparasi, Myagdi and Palpa have been classified as Intermediate with 3518, 3366, 3143 and 2792 Kilocalories respectively. Baglung with 2634 Kilocalories is designated under least developed[83].

4.7.3 S-T Line

One district of Central Development Region of Bagmati Zone will be traversed. Total population of this district is 277,471 with 132,787 male and 144,684 female having 4.69 as average household size as shown in Table 4.15.[84] Average cultivated land person here is 0.21 ha. Subsistence agriculture with livestock raising is the main source of Livelihood in all these Project VDCs. Agricultural land and livestock holdings of households in all the project VDCs is summarized in Table 4.16. Ownership of land is common with 96% of household reporting ownership.

Table 4.15: VDC Population of S-T Line

District	VDC	Population					
		Male	Female	Total	Sex Ratio	Total Household	Household Size
Nuwakot	Manakamna	1,537	1,784	3,321	86%	789	4
	Tupche	2,401	2,885	5,286	83%	1,279	4
	Gerkhu	2,888	3,494	6,382	83%	1,421	4
	Bageshwari	2,382	2,604	4,986	91%	1,073	5
	Lachyang	2,238	2,242	4,480	100%	876	5
	Narjamandap	2,656	2,679	5,335	99%	1,012	5
	Kharanitar	779	830	1,609	94%	375	4
	Ralukadevi	2,299	2,264	4,563	102%	916	5
	Thaprek	1,902	2,040	3,942	93%	760	5
	Sundaradevi	1,207	1,204	2,411	100%	511	5
	Balkumari	1,230	1,256	2,486	98%	496	5

Source: Population Census, 2011, CBS

[82] Gautam, et al., 2012
[83] ICIMOD, 2003
[84] CBS, 2012

Table 4.16: Ownership of Agricultural Land and Livestock in S-T Project Area VDCs

District	VDC	Households Owning%				
		Agricultural Land Only	Land and Livestock	Land, Livestock and Poultry	Other	Total Households
Nuwakot	Manakamna	38	181	484	17	720
	Tupche	57	343	703	59	1,162
	Gerkhu	63	369	822	87	1,341
	Bageshwari	45	314	593	63	1,015
	Lachyang	26	65	659	13	763
	Narjamandap	53	319	553	38	963
	Kharanitar	18	188	94	35	335
	Ralukadevi	56	157	681	31	925
	Thaprek	14	63	650	14	741
	Sundaradevi	59	106	495	21	681
	Balkumari	35	48	383	20	486

Source: Population Census, 2001, CBS

Similarly out-migration for 2001 in this district was 12,367[85]. For 2001 Nuwakot ranked as among the intermediate with rank 32 in terms of socioeconomic and infrastructural development index in Nepal[86]. Similarly, according to CBS, 2001 43% of the population in 11 VDC's according to Ethnic composition include Tamang, Hill Bhramin 20%, Chhetri 19%, Dalit 6%, Newar 4%, Gurung 2%, Magar 1%, and others 4%. The others include Rai, Gharti/Bhujel, Sherpa, Sanyasi, Kumal, Thakuri, Bhote and rest (Table 4.17).

[85] KC, 2003

[86] ICIMOD, 2003

Table 4.17: Ethnic Composition by VDC for S-T Line

VDC		Population						
	Tamang (Janajati)	Brahmin (Hill)	Chhetri	Dalit	Newar (Janajati)	Gurung (Janajati)	Magar (Janajati)	Others
Manakamna	1,831	790	64	198	34	575	0	252
Tupche	1,425	1,925	1,769	725	37	12	89	282
Gerkhu	1,984	2,485	1,325	283	498	112	271	369
Bageshwari	2,089	1,410	881	420	58	130	319	137
Lachyang	3,694	0	46	105	34	228	0	18
Narjamandap	2,510	1,375	722	262	274	40	0	228
Kharanitar	487	461	192	101	410	0	0	72
Ralukadevi	2,477	592	1,240	406	311	102	0	83
Thaprek	2,062	32	1,455	235	56	0	24	205
Sundaradevi	701	530	744	223	243	0	0	23
Balkumari	1,653	75	484	99	54	0	0	80
Total	**20,913**	**9,675**	**8,922**	**3,057**	**2,009**	**1,199**	**703**	**1,749**

Source: Population Census, 2001.

The average electrification rate for lighting for Nepal is 67%[87]. Based on the district traversed by the project transmission line it has been observed to be higher than national average with 85% having electricity for lighting (with or without solar).

Major crops cultivated here in subsistence manner are paddy, wheat, corn, millet, and potatoes followed by barley, legumes, vegetables and fruits[88].

[87] CBS, 2012
[88] Gautam, et al., 2012

References

Aryal, A. (2006). Himalayan Musk Deer In Annapurna Conservation Area, Nepal. 11-17.

Avian Power Line Interaction Committee (APLIC). (2012). *Reducing Avian Collisions with Power Lines: State of the Art in 2012.* Washington D.C.: Edision Electric Institute, Avian Power Line Interaction Committee.

Bajracharya, B. T. (1996). *Climatic and Hydrological Atlas of Nepal.* Kathmandu: ICIMOD.

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

Baral, H. S., & Inskipp, C. (2005). *Important Bird Area: Key Sites for Conservation.* Kathmandu: Birdlife International, RSPB, Bird Conservation Nepal, Cambridge.

Bhattarai, T. P., Skutsch, M., Midmore, D. J., & Eak , R. B. (2012). The Carbon Sequestration Potential of Communitybased Forest Management in Nepal. *The International Journal of Climate Change: Impacts & Responses, 3*(2), 233-254.

Bhuju, U. R., Shakya, P. R., Basnet, T. B., & Subha , S. (2007). *Nepal Biodiversity Resource Book: Protected Areas, Ramsar Sites, and World Heritage Sites.* Kathmandu: ICIMOD, MoEST. UNEP.

Bridges, J. M., Theodore, A. R., Shulund, D., Linda , S., & Tim , C. (2008). Minimizing Bird Collisions: What Works for the Birds and What Works for the Utility? In J. W. Goodrich-Mahoney, J. L. Ballard, & S. M. Tikalsky (Ed.), *Environmental Concerns in Rights-of-Way Management:Eighth International Symposium* (pp. 331-335). Elsevier B.V.

Carol, & Inskipp, T. (2003). *Bird Conservation Priorities of the Annapurna Conservation Area.* Lazimpat, Kathmandu: Bird Conservation Nepal.

CBS. (2012). *National Population and Housing Census 2011 (Village*

Development Comittee/Municipality). Kathmandu, Nepal: Government of Nepal, National Planning Comission Secratariat, Central Burea of Statistics.

CBS. (2012). *National Population and Housing Census 2011: National Report.* Kathmandu, Nepal: Central Burea of Statistics, National Planning Commission Secratariat, Government of Nepal.

Chapagain, D., & Dhakal , J. (2002). *An Introduction to CITES implementation in Nepal.* Babar Mahal, Kathmandu: Departmentof National Parks and Wildlife Conservation .

Dhakal, H., Sharma, H. P., & Chaudhary, A. (2013). Status of vulture species visiting a Vulture Safe Feeding Site (Rupandehi) for carcass feeding in different seasons, Nepal. *Ibisbill Journal of Himalayan Ornithology, 1*(2), 119-125.

Dinerstein, E., Loucks, C., Heydlauff, A., Wikramanayake, E., Bryja, G., Forrest, J., et al. (2006). *Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005–2015. A User's Guide.* Washington, D.C. – New York: WWF, WCS, Smithsonian, and NFWF-STF.

DMG. (2010). Landslide Hazard Zonation Map of Parts of Myagdi, Baglung, Parbat and Kaski Districts. Lainchaur, Kathmandu: Department of Mines and Geology, Ministry of Industry, Government of Nepal.

EPA. (2011). *Irelands Plan on Action for Climate Change*. Retrieved 06 13, 2011, from Change CMT Calculator : http://cmt.epa.ie/Global/CMT/emission_factor_sources.pdf

FAO. (2006, September 14). New Local Climmate Estimator 1.10. Rome, Italy.

Federation, N. W. (2010). *Save The Tiger Fund*. Retrieved October 29, 2010, from Priority Tiger Conservation Landscapes: http://www.google.com/url?q=http%3A%2F%2Fwww.savethetigerfund.org%2FContent%2FNavigationMenu2%2FApply%2FLandscapelevelConservation%2Fdefault.htm&sa=D&sntz=1&usg=AFQjCNHiKDGdVLWqD4984zqCywcMINGnnA

Gautam, A. P., Thapa, B. R., Pandit, B. H., Dhungana, B. M., Tiwari, K. R., Neupane, M. P., et al. (2012). *Chitwan Annapurna Landscape: A Rapid Assessment.* Kathmandu: Kathmandu, Forestry College, WWF.

Giri, J. B. (2013). Population of Lammergeier Gypaetus barbatus in Lower Mustang Nepal. *Ibisbill Journal of Himalayan Ornithology, 1*(2), 114-118.

HMG. (1993). Geological Map of Nepal. (K. M. Amatya, B. M. Jnawali, P. L. Shrestha, N. D. Makse, & P. Hoppe, Compilers) Survey Department, Kathmandu, Nepal.

ICIMOD. (2003). *Districts of Nepal, Indicators of Development Update.* Kathmandu, Nepal: ICIMOD and CBS.

ICIMOD. (2013). *Nepal Forest Fire*. Retrieved August 1, 2013, from Mountain GeoPortal: http://apps.geoportal.icimod.org/NepalForestFire/#

ICIMOD. (n.d.). *Mountain Environment and Natural Resources Information (MENRIS)*. Retrieved November 16, 2010, from Mountain GeoPortal: http://geoportal.icimod.org/

ICIMOD, UNEP RRC.AP. (2002). *Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods Monitoring and Early Warning Systems in the Hindu Kush-Himalayan Region Nepal*. (P. Mool, S. R. Bajracharya, S. P. Joshi, K. Shakya, & A. Baidya, Producers) Retrieved July 29, 2013, from http://www.rrcap.ait.asia/glofnepal/guide/movie.html

International, B. (2011). *Flyways Factsheet: Central Asia/South Asia.* Retrieved July 12, 2011, from http://www.birdlife.org/datazone/userfiles/file/sowb/flyways/7_Central_Asia_Factsheet.pdf

IUCN. (2010). *The IUCN Red List of Threatened Species*. Retrieved October 14, 2010, from http://www.iucnredlist.org

Karki, J. B. (2009). *Tiger and Their Base Prey Abundance in Terai Arc Landscape Nepal downloaded on November 28, 2010 from http://www.dnpwc.gov.np/publication.asp.* Kathmandu: Department of Natonal Park and Wildlife Conservation, MoFSC, Department of Forest and WWF Nepal Program.

Karki, J. B. (2011). Occupancy and abundance of Tigers and theire prey in the Terai Arc Landscape, Nepal. *Thesis*. Derhadun, India: Forest Research Insittute University, Wildlife Institute of India.

KC, B. K. (2003). *Central Burea of Statistics.* Retrieved 06 08, 2011, from Population Monograph of Nepal: http://cbs.gov.np/?p=502

Martin, G. R., & Shaw, J. M. (2010, November). Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation, 143*(11), 2695-2702.

Maryland, N. o. (2002). *MODIS Hotspot / Active Fire Detections. Data set. MODIS Rapid Response Project*. (NASA/GSFC, Producer, & University of Maryland) Retrieved July 31, 2013, from Available on-line [http://maps.geog.umd.edu]

MFSC/GEF/UNDP. (2002). *Nepal Biodiversity Strategy.* Kathmandu: Ministry of Forests and Soil Conservation supported by Global Environment Facility and UNDP cited by Batu Krishna Upreti in 2003.

Ministry of Energy, G. o. (2009). *Twenty Years Hydro Electricity Development Plan.* Singha Durbar, Kathmandu: Ministry of Energy Sownloaded on November 25, 2010. https://docs.google.com/viewer?url=http://www.moen.gov.np/pdf_files/Twenty-Year-Task-Force-Report_merged.pdf.

MoFSc, & Nepal, W. (2007). *Western Terai Landscape Complex Project for Churia Region.* Kathmandu: Ministry of Forest and Soil Conservation, Nepal.

MoFSc, DOSC. (2005). *District-wise Watershed Information Book.* Kathmandu: His Majesty's Government, Department of Soil Conservation and Watershed Management.

Mulligan, M. (2005). *Google Earth*. Retrieved 05 28, 2011, from Earth Gallery: http://earth.google.com/gallery/kmz/forest_cover_change.kmz

MoFSC. (n.d.). *Nepal National Biodiversity Strategy and Action Plan.* Retrieved January 20, 2014, from http://www.mfsc.gov.np/noticefile/NBSAP_Draft%20report_138735552

NEA. (2010). *Detailed Survey of Kaligandaki 220/132 kV Transmission Line Corridor Project.* Kathmandu: NEA, Engineering Services, Project Development Department, Ratnapark, Kathmandu.

Neelam Kumar Sharma, S. R. (2008). *Village Development Committee: Profile*

of Nepal. Kathmandu: Upahar Offset Press.

NPC. (July, 2010). *The Food Security Atlas of Nepal.* Kathmandu, Nepal: Food Security Monitoring Task Force, National Planning Commission, Government of Nepal, WFP and NDRI.

NSC, D. o. (2013). *National Seismological Centre (NSC)*. Retrieved July 15, 2013, from Past Earthquakes: http://www.seismonepal.gov.np/

NTNC. (2008). *Management Plan of Annapurna Conservation Area (2009-2012).* Jawlakhel, Lalitpur: National Trust for Nature Conservation.

NTNC. (2009). *Scoping Study to Develop Gaurishankar into a Protected Area.* Lalitpur: NTNC.

Poudyal, M. B. (2002). Mitigation, Management and Floods in South Asia. In *Mitigation, Management and Control of Floods in South Asia Volume One* (Vol. 1, pp. 51-52). Nairobi: UN-HABITAT, UNEP.

Pradeep K Mool, P. R. (2011). *Glacial Lakes and Glacial Lake Outburst Floods in Nepal.* (G. R. Isabella Khadka, Ed.) Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD).

Pradhan, B. K. (2007). *Disaster Preparedness for Natural Hazards: Current Status in Nepal.* Kathmandu, Nepal: ICIMOD.

Sanderson, E., Forrest, J., Loucks, C., Ginsberg, J., Dinerstein, E., Seidensticker, J., et al. (2006). *Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005-2015. The Technical Assessment.* New York – Washington, D.C.: WCS, WWF, Smithsonian, and NFWF-STF.

Sharma, S. (2013). Modelling of trekking routes and their impacts on Galliformes: a case study from the Annapurna Conservation Area, Nepal. *Ibisbill Journa of Himalayan Ornithology, 1*(2), 55-65.

Shrestha, A. B., & Bajracharya, S. R. (2013). *Case Studies on Flash Flood Risk Management in the Himalayas: In support of specific flash flood policies.* (A. B. Shrestha, & S. R. Bajracharya, Eds.) Kathmandu, Nepal: ICIMOD.

TISC. (2010). *Forest and Vegetation Types of Nepal.* Hattisar, Kathmandu: Tree

Improvement and Silviculture Component, Department of Forest, Ministry of Forest and Soil Conservation, Government of Nepal.

UNEP, GEF. (2008). *Solar Wind Energy Resource Assessment in Nepal (SWERA).* Khumaltar, Lalitpur, Nepal: AEPC, Government Nepal, Ministry of Environment, Science and Technology.

Uprety, B. K. (2003). *Safeguarding the Resources Environmental Impact Assessment: Process and Practice.* Kathmandu: Mrs Uttara Uprety.

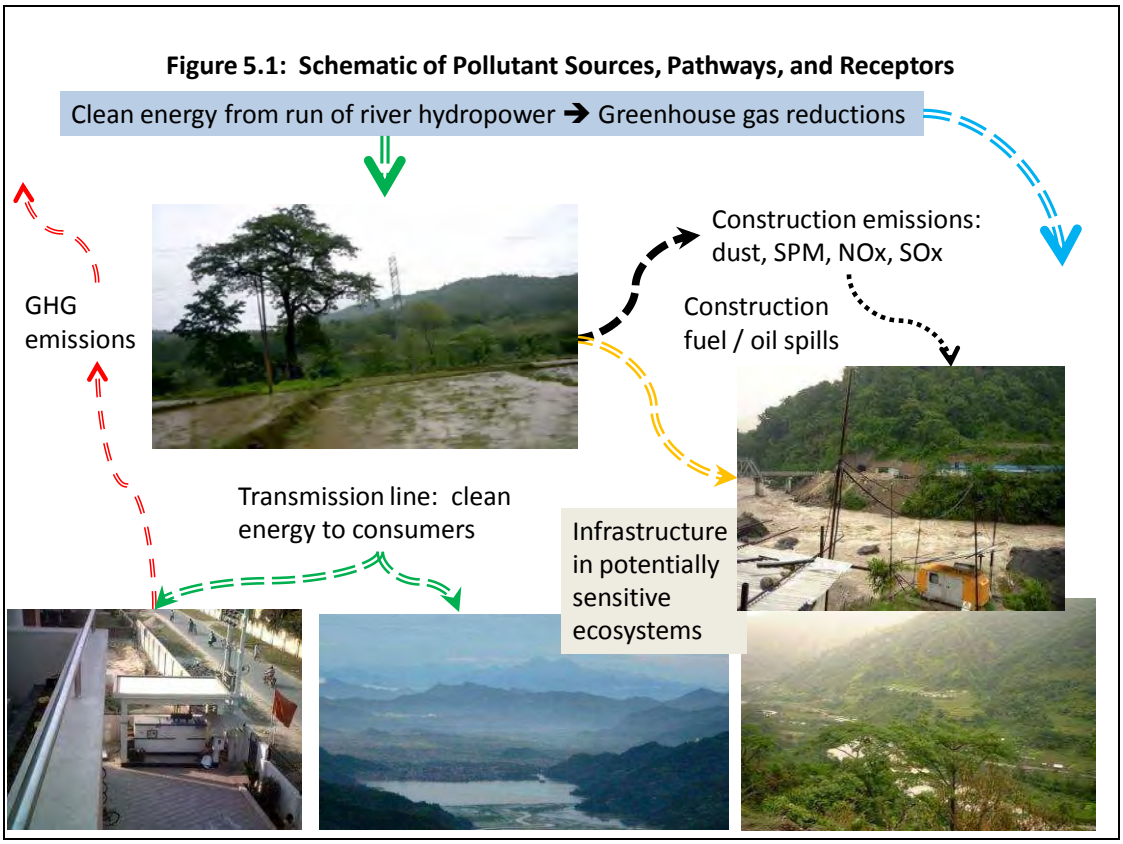
W.W. BELL, T. D. (2011). *TSHO ROLPA GLOF WARNING SYSTEM PROJECT*. Retrieved May 13, 2011, from The International Association for Hydro-Environment Engineering and Research: http://www.iahr.org/membersonly/grazproceedings99/doc/000/000/175.htm

Yonzon, P. (1997). Ground Truthing in the Protected Areas of Nepal. In J. Bornemeier, M. Victor, & P. Durst (Ed.), *Ecotourism for Forest Conservation and Community Development* (pp. 82-94). Bangkok: FAO/RAP Publications.

5. Anticipated Environmental Impacts and Mitigation Measures

Potential impacts arising from the project are depicted in Figure 5.1, which illustrates possible pollutant sources, pathways, and receptors.

Figure 5.1: Schematic of Pollutant Sources, Pathways, and Receptors



A total of 399 km of transmission line are included in the project, plus 9 substations. The total footprint of these facilities is about 1,880 ha.[89] The transmission lines have potential environmental sensitivity, in particular the 25 km segment from Manang to Khudi which includes 2 new substations. The Manang-Khudi facilities have a total footprint of 135 ha, which is about 7% of the total project footprint. There are also 2 associated hydropower projects under construction in the Annapurna Conservation Area (ACA), with several more in the development queue.

The project activities comprise clearing of right-of-way, construction of new transmission towers and substations, and augmentation of 2 existing substations. Disturbance during construction will arise from temporary access road construction, clearing of vegetation,

[89] For purposes of environmental assessment, this assumes 9 substations with 5 ha per substation, and 399 km of transmission ROW with a width of 46 meters. The actual footprint is expected to be smaller.

equipment staging, construction of substations, erection of transmission towers, and stringing of conductors on the towers. The potential impacts will occur mainly during construction due to minor earthworks, equipment staging, and temporary construction camps. The anticipated impacts are mostly localized, minimal, temporary, and reversible, and can be readily mitigated.

As shown in Figure 5.1, the project will have long-term benefits by facilitating power trading, connection of clean energy capacity to the grid, reducing load shedding, and reducing reliance on diesel-fired generators. The project will create short-term employment opportunities during construction, mostly for unskilled and semi-skilled labor.

5.1 Transmission Construction Procedures

Tower Foundation

The construction of tower foundation will be undertaken by manual labor assisted by the mechanical plant wherever possible. The mechanical plant will be limited to small demountable steel skid framed concrete mixers, air compressors, air drills/chisels and tamping/compaction tools. Excavation and the concreting of the tower foundations will be carried out as per the design requirements and after necessary curing, the foundations will be backfilled with suitable material.

Erection of Galvanized Steel Towers

Galvanized steel lattice tower components manufactured in the factory will be transported to the individual tower locations. Towers are erected manually by employing pulleys, winches, etc. into the tower foundations. Construction cranes will not be used.

Insulator Fittings, Conductor and Ground Wire Stringing

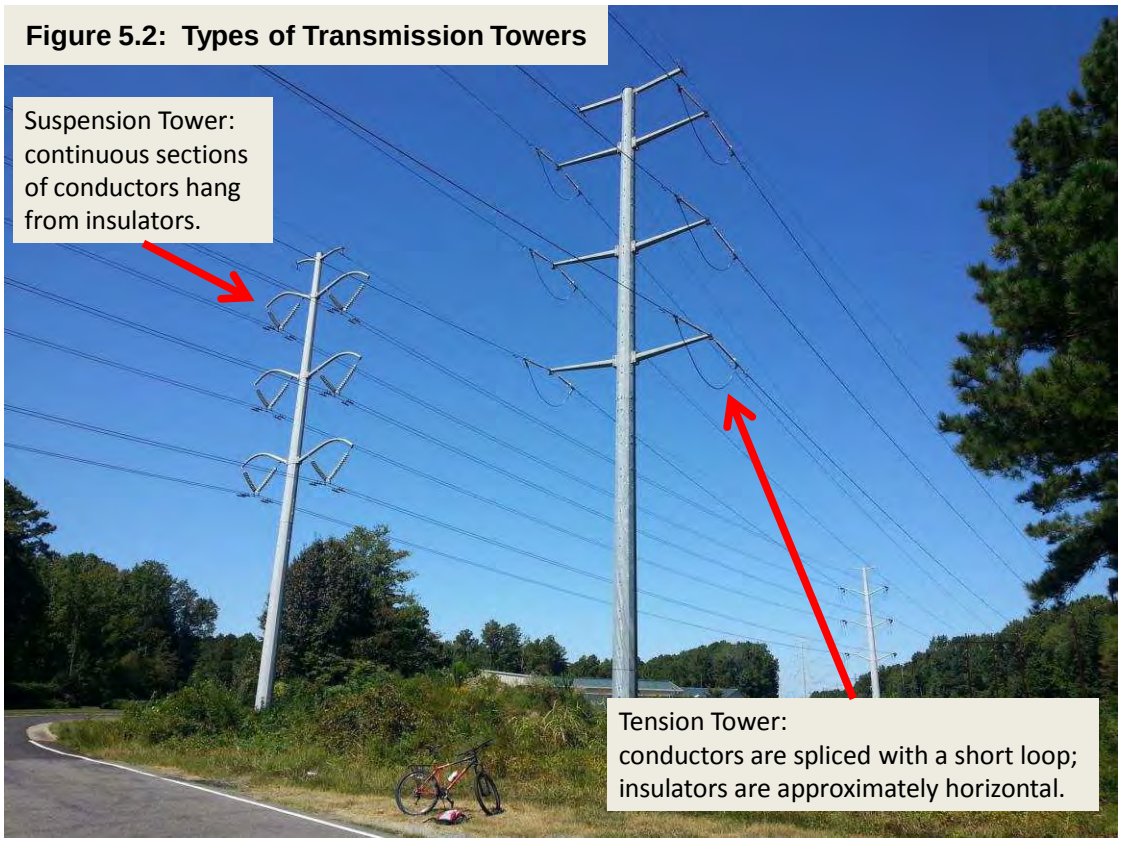
Conductors, ground wires, insulators and necessary accessories will be transported manually to the tower locations. The fitting of insulators on the tower and stringing of conductors and ground wire will be carried out manually as per design requirements. Construction cranes will not be used.

The transmission line utilizes 2 types of towers: (i) tension towers, where conductors are spliced with a loop across insulators; and (ii) suspension towers, from which the conductors (wires) are hung from insulators (see Figure 5.2). Suspension towers are used for straight segments of the line, while tension towers are normally used for angles

in the alignment. Typically there are several suspension towers between tension towers. This allows for a continuous conductor to be installed across several suspension towers between 2 tension towers.

A series of pulleys are installed on the transmission towers in a working segment between tension towers. A guide rope or wire is passed from one end of the segment through the successive pulleys until the other end of the segment is reached. The guide rope installation requires traversing the ROW either manually or with a tractor or truck.[90] The conductors are attached to one end of the guide rope, which is then pulled by a powered winch. After the conductors are pulled through the working segment, they are drawn mechanically to the design tension, and then attached to the insulators. The construction technique results in limited disturbance to flora and fauna in the ROW.

Figure 5.2: Types of Transmission Towers



Source: D. Millison, 2013; location is in York County, Virginia USA.

The typical construction crew comprises around 25 people, with maximum of 40 people.

[90] It is technically possible to string lines with helicopters but this technique has not been used in Nepal. Construction contractors are at liberty to propose this technique.

Multiple crews will be working along the route at any given time. Construction staging areas and camps will be occupied for a maximum of one month. The largest work teams will be deployed for construction of tower footings. The excavation and concreting work will require about 7 – 10 days per tower site. Smaller teams will be deployed for installing insulators and stringing conductors, and will be at each work site for about 4 days. About 30% of the labor force is expected to be local. The mobile workforce will be housed in temporary camps.

5.2 Potential Impacts

Planning and Design Stage

Transmission systems have an inherently small footprint compared to other "linear" infrastructure such as expressways and other roads which typically alter topography and drainage in an irreversible manner. Geotechnical and structural engineering considerations favor flat, open areas with bedrock or stable soils which are not being used for other economic purposes. Rivers, lakes, and wetlands are avoided, as these types of sites tend to be relatively unstable, requiring special foundation engineering which increases design and construction costs. Tall vegetation and forests are viewed by design engineers as a nuisance to be avoided, because clearing of vegetation adds to construction and operations cost. Protected areas are avoided if possible, as the approval process to obtain ROW in such areas is tedious and time-consuming, which also increases transaction cost at the planning and approvals stage. At the planning and design stage, environmentally-sensitive areas are avoided on engineering and government policy bases (as discussed in Section 3).

Disturbance of topography, soils, and drainage patterns is minimal, with some minor alterations occurring at new substation sites; disturbance is localized and minimal in the ROW due to minor topographical changes around tower footings. Direct impacts will occur in the ROW and at substation sites. Indirect impacts will occur at construction staging areas and camps which are outside the ROW and substation sites.

The total area required for transmission lines and substations is estimated at 1,880 ha.[91] A total of about 30 km of the ROW will cross forested areas, with a footprint of about 138 ha. The land to be acquired for substations is mostly agricultural land, and landholders

[91] Area is calculated as follows: 399 km x 46 m x 1000 m/km x 1 ha/10,000m^2 = 1,835.4 ha for lines, and 9 substations at 5 ha/substation = 45 ha; 1,835.4 + 45 = 1,880.4 ha. The actual footprint will be smaller as most of the transmission lines will be 220 kV with 30 m right of way.

will be compensated as per GON norms. Substations will not be located in reserved forests or protected areas, with the exception of the Manang and Khudi substations which will be located in the intensive land use zone of ACA. Substations will be sited and designed to ensure noise level at the site boundary will not exceed 70 dB(A) at any time. Substations will be equipped with appropriate sanitation facilities. Transformers containing polychlorinated biphenyls (PCBs) will not be used.[92]

Construction Stage

Given the small construction and operations footprint noted above, topography, soils, and drainage will not be altered significantly by the project. The land surface beneath transmission towers can be returned to previous use, except for the tower footings, which typically require a total of less than 20 square meters (m^2) per tower. Tower footings will include erosion control features such as retaining walls and silt fences as necessary. Minor changes in surface water flow may result from substation construction, but potential impacts are not considered to be significant because the substation sites are dispersed and are limited to 5 ha per site, and any contribution to change in river flows would be difficult or impossible to quantitatively monitor.

During construction, the principle impacts are clearing of vegetation in the ROW; excess loss of vegetation (e.g., harvesting of biomass for cooking by construction workers); potential air, soil, and water pollution from construction equipment and crews (including any construction camps); and access to conservation areas by construction teams which could facilitate animal poaching.

The area required for a new substation is a maximum of 5 ha; total land area for substations will be about 45 ha. Permanent access roads to substations will be required, which in most cases will comprise existing roads and short extensions from existing roads. Surface soils will be disturbed by civil works, but drainage patterns are not expected to be permanently altered. New equipment and materials will be brought to the site. Minor quantities of construction waste will be generated.

Potential impacts from the installation procedures described in section 5.1 arise from (i) clearing of vegetation in the ROW and for temporary access roads; (ii) soil disturbance during installation of tower footings, tower erection, and installation of insulators and conductors; and (iii) disturbance due to staging of the conductors and equipment in the

[92] New transformers available in the international markets do not contain PCBs.

ROW. These impacts are minimal, temporary, and reversible.

Operations Stage

The major impact is long-term change in land use in the transmission ROW and at substations. Most of the land in the ROW can be returned to previous use. Potential impacts during operations are mainly due to routine trimming of vegetation in the ROW, noise and electro-magnetic fields from transmission lines and substations, and domestic and industrial waste generation from substations.

Potential impacts and mitigation measures which apply to the overall project are summarized in Table 5.1. Table 5.2 summarizes potential impacts and mitigation measures for specific areas where sensitive species may be present. Table 5.3 summarizes the footprint in the Annapurna Conservation Area (ACA). Mitigation measures are discussed below in Section 5.3 and are also included in the EMP in Section 7.

Table 5.1: Potential Impacts and Mitigation Measures for Overall Project

Project Activity	Potential Impacts	Mitigation Measures	Institutional Responsibility
Design Stage			
Clearing of transmission right-of-way (ROW)	Clearing of vegetation and improved access may increased stress on wildlife and sensitive species	Routing to minimize clearing of vegetation. Consider stacked conductor design in sensitive ecosystems (see Figure 5.3). Access restrictions to be included in contract specifications and construction plans.	NEA to commission additional environmental surveys as necessary to obtain construction license. NEA to develop appropriate contract specifications ADB to review and give “no objection”
Noise from transmission lines and associated substations	Noise could exceed 70 dB(A) at site boundary	Locate substations 70–100 m from nearest receptor if possible; greenbelt to provide partial noise barrier if necessary	
Construction Stage			
Access to right-of-way (ROW) in protected areas	Loss of vegetation and habitat; possible increase in poaching	Construction contracts to include provisions for worker awareness, anti-poaching, and supply alternate fuels.	NEA to include appropriate contract clauses for implementation of Environmental management plan (EMP). ADB to confirm that bid documents and
Clearing of vegetation in ROW and temporary access roads	Temporary loss of biomass and habitat	Reforestation or other offset activities as agreed with protected areas management. Compensation payments for reforestation at 25:1 as per Nepal regulatory system.	

Project Activity	Potential Impacts	Mitigation Measures	Institutional Responsibility
Noise from construction equipment	Noise could exceed 70 dB(A) at project site	Equipment to meet national noise standards; personal protective gear to be provided to construction workers	contracts incorporate EMP. Implementation consultants to assist in EMP implementation (see Section 7) including emissions monitoring, inspecting wastewater and solid waste controls, and regular reporting to NEA and ADB.
Soil erosion and wastewater from work sites and construction camps	Suspended solids, BOD, and fecal coliform contamination	Run-on / run-off control including retention ponds, silt traps, and other treatment if needed Construction staging areas and camps to be located outside of ecologically sensitive areas	
Wastewater, waste lubricants, and minor fuel spills	Petroleum and detergent contamination		
Construction dust and exhaust gases	Increased SPM, NO_2, SO_2 levels at construction sites, and surrounding areas	Dust control with water sprays. Contractor's equipment to meet national equipment and vehicle emissions standards	
Operations and Maintenance Stage			
Noise from transmission lines and associated substations	Noise could exceed 70 dB(A) at site boundary	Greenbelt to provide partial noise barrier around substations	NEA to include EMP provisions in operations and maintenance program; industrial waste management services to be procured with licensed contractors as necessary. NEA to ensure adequate maintenance of spill control systems.
Domestic wastewater and solid wastes from substations and storage yards	BOD, fecal coliform contamination in groundwater and surface water	Recycling and disposal of solid wastes. Primary treatment of domestic wastewater if needed.	
Wastes from substation augmentation (scrap metal and oils) and other decommissioned equipment and scrap materials	Potential soil and groundwater contamination	Secure on-site storage, or off-site disposal at licensed facility if necessary.	
Greenhouse gas emissions including from equipment using CFCs and halons (e.g. fire suppression systems)	Emissions reductions are expected via delivery of more clean energy to consumers. Minor GHG releases to atmosphere from fire suppression equipment.	Specify non-CFC and non-halon equipment; dispose in accordance with GoN standards.	

BOD = biochemical oxygen demand, CFC=chlorofluorocarbons, dB(A) = decibel acoustic, NEA = Nepal Electricity Authority, NO_2 = nitrogen dioxide, NO_x = nitrogen oxides, PCO = Project Implementation Unit, ROW=right-of-way, SO_2 = sulfur dioxide, SPM = suspended particulate matter.

Table 5.2: Potentially Sensitive Locations, Impacts, and Mitigation Options

Location	Sensitive species	Potential Impacts	Mitigation Options
Khudi-Manang segment in ACA (25 km, 220 kV)	Clouded Leopard between 1500 to 3000 m, but preferred habitat is above 2000m	Potential disruption of migration pathways, breeding and/or hibernation areas	• 220 kV ➔ not 400 kV • Reforestation @ 25:1 • Minimize RoW width with stacked conductor array • Allow re-vegetation to grow 1-2 meters high in ROW • Implement reforestation as a biodiversity offset?
Dovan "bottleneck" (~ 1.8 km)	Tiger	Disruption of migration paths due to R-o-W clearing	• Reforestation @ 2:1 • Allow re-vegetation to grow up to 1 – 2 meters high, facilitating migration • Implement reforestation as a biodiversity offset?
Samundratar - Trishuli 132kV Line[a]: Gerkhu VDC Segment	Assamese Monkey Leopard Cat		

R-O-W = right of way, VDC = village development committee
Note: [a] As of 19 February 2014 this section is expected to be dropped from the project.

Table 5.3: Summary of Existing Infrastructure and Project Footprint in the ACA

Infrastructure	Footprint in ACA
Existing Roads – 2 lane, unimproved	446 km x 15 m = 669 ha
Existing Housing & other buildings	18,680 households x 400 m^2 per household = 747.2 ha
2 substations and assumed transmission right-of-way (ROW) in conservation area	25 km x 50 m = 125 ha + 10 ha = 135 ha total
Relative transmission footprint (ROW / total housing and roads)	135 / 1416.2= 9.53 %
Relative transmission footprint (ROW / total conservation area)	135 / 762,900 = 0.018 %

ACA = Annapurna Conservation Area, ha = hectare, ROW = right of way

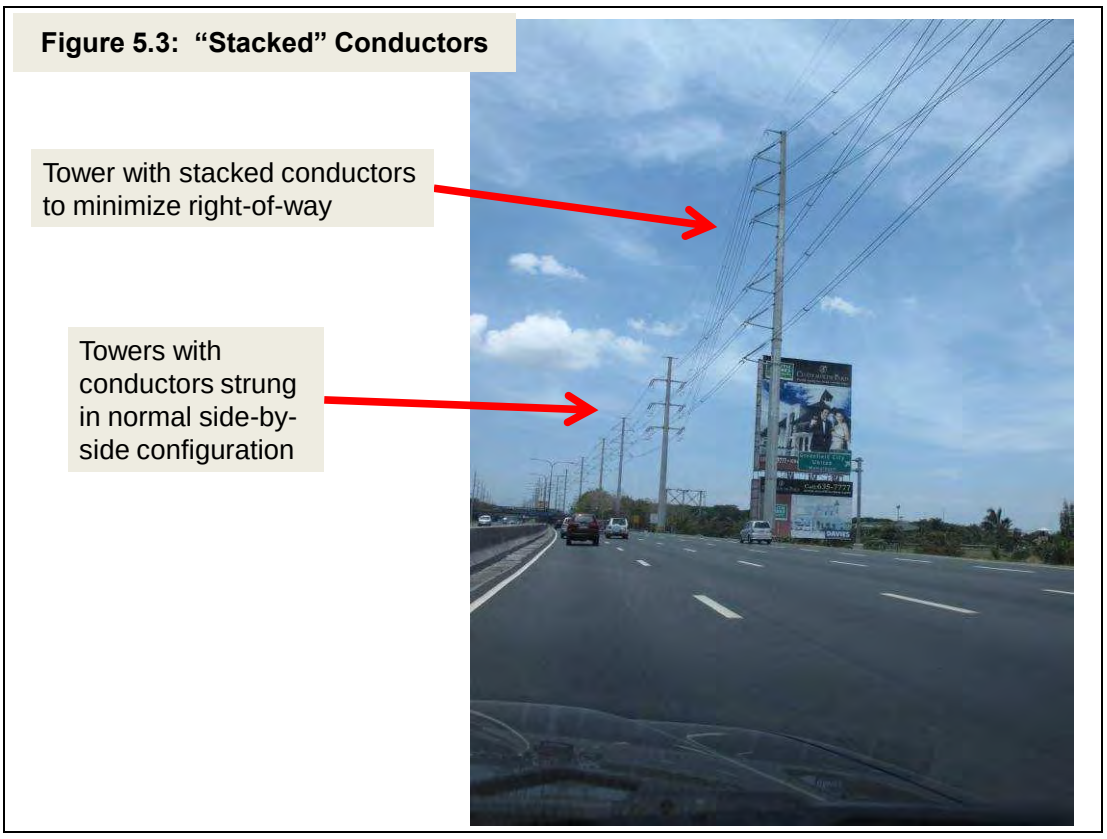
5.3 Mitigation Measures

Table 5.2 summarizes mitigation options, which are inherently limited due to the nature of transmission systems. At the design stage, potential impacts are mitigated by careful routing to avoid sensitive ecosystems such as forests and wetlands, steep terrain, and populated areas to the maximum extent possible (as discussed in Section 3). The proposed project will utilize high-temperature / low-sag (HTLS) conductors which have about twice the capacity of conventional conductors but have approximately the same weight. The section from Kushma to Butwal was initially proposed to be 400 kV rated line, and some consideration has been given to 400 kV lines in the entire

Marsyangdi Corridor; use of HTLS conductors allows 220 kV voltage with a narrower ROW (only 30 m vs. 46 m, or 35% less area than conventional design). The technical analyses conducted for the project determined that all of the 220 kV lines could utilize HTLS conductors as an optimum solution except for the Butwal-Bardaghat segment which will be 400 kV with conventional conductors; this will avoid the need for 400 kV lines in the Marsyangdi corridor, including the Khudi-Manang section in the ACA.

In ecologically sensitive areas which cannot be avoided, the transmission ROW can be narrowed by using "stacked" conductors, as shown in Figure 5.3. A double circuit transmission line has 2 sets of 3 wires for each circuit, normally strung on each side of the transmission tower as shown in Figure 5.2. Figure 5.3 shows how the 2 sets of 3 wires can be arrayed vertically to narrow the effective ROW.

Figure 5.3: "Stacked" Conductors



Source: D. Millison, 2011; location is on South Luzon Expressway in the Philippines. Similar stacked conductors have been utilized in the Kathmandu urban area.

Soil Erosion and Loss of Vegetation

The majority of the ROW is more than 1 kilometer from existing roads and tracks. Temporary access tracks will be needed in some areas. Soil erosion and silt runoff will

be minimal as excavation is required only for tower footings. Erosion control measures such as dikes and retaining walls will be constructed as necessary to ensure tower footings are stable; this will also minimize soil erosion and runoff. Drainage controls will also be included in substation design.

The ROW will be acquired prior to construction and the affected people will be compensated. Trimming of vegetation for routine maintenance will be conducted on an annual or as-needed basis after construction. Minor damage to crops may be unavoidable, and any crop damage will be compensated as per the existing rules. The lines will cross a total of about 138 ha of forested area (assuming a 46 m ROW); the rest of the ROW is mostly cultivated land. New trees will be planted to offset those removed during construction. Replanting will be at a ratio of 25:1 in the ACA and 2:1 elsewhere. Additional offset activities are discussed below in Section 5.4.

Precautionary measures focused on the protection of vegetation and wildlife are essential while working in all of the forest areas, particularly during the construction stages. Unnecessary felling of the trees and use of old trees for firewood by the workforce should be discouraged during the construction. RoW vegetation clearance should be done manually and herbicides should not be used in any case. Trimming of vegetation will be limited to the ROW and temporary access roads, which will be minimized. No vegetation outside the ROW will be disturbed. Cleared vegetation may be taken by community forest users for local use. Forest rehabilitation will be conducted under Ministry of Forests and Soil Conservation procedures for compensation, with 25:1 replanting ratio. The EMP includes monitoring provisions to confirm the replanting activities are documented.

Air and Noise

Air and noise pollution will be avoided by minimizing use of heavy machinery during construction. Construction will generate air and noise emissions for a short duration in predominantly rural locations, and is considered insignificant. Construction contractors will be required to deploy equipment which meets Nepali air and noise control standards. Construction will occur primarily during daytime hours for safety considerations.

Waste Management

Any used equipment and other construction wastes will be disposed of following the best practices and the local rules. Health hazards from potential explosions or fire,

electric shocks, and accidents to staff and the public will be minimized through implementation of measures including (i) designs using appropriate technologies to minimize hazards, (ii) safety awareness raising for construction and operational staff and the public, (iii) substations equipped with modern fire control systems, (iv) provision of adequate water supply and sanitation facilities for substations and construction camps, (v) provision of adequate staff training in operations and maintenance, and (vi) security fences and barriers around substations and transmission towers in populated areas and in the proximity of public places such as schools.

Mitigation at Substation Sites

The new substations will be located on unused land or agricultural land, which will be cleared of crops prior to construction. Substation construction will require some earthmoving to prepare the sites for buildings and equipment installation. Erosion control measures will be incorporated into substation design in accordance with site conditions. Run-on and run-off controls will be built-in to maintain integrity of building and equipment foundations, and avoid run-off of potentially contaminated water.

Air and noise pollution will be avoided by minimizing use of heavy machinery during construction. Temporary nuisance to the residents and pedestrians during movement of the equipment and materials for substation components such as transformers may be unavoidable, and will be minimized by informing affected people in advance of construction, and requiring contractors to implement noise abatement measures. Construction activities will be restricted during the nighttime.

Due to the relatively small area required for the substations, the impact on air quality will be limited and localized. Water sprays will be used as necessary for dust suppression. Contractors' equipment will be required to meet Nepal air and noise control standards.

Flora and Fauna

A ban on poaching of birds and animals in the areas adjacent to the transmission ROW will be enforced during construction.[93] Kerosene or other alternate fuels will be provided to construction camps so that workers will not need to gather wood for cooking.

[93] In eastern Nepal, hunting and poaching is not a major issue. The EIA summary for the Tamakoshi 3 hydropower project noted that hunting and poaching is not common and no obvious signs of such activity were observed during the EIA surveys; hunting is banned in the community forests. SWECO Norge AS. 2009. *Tamakoshi 3 Hydroelectricity Project, Executive Summary – Volume XI, Document for Disclosure, Final Report – November 30, 2009*. Oslo, Norway.

Construction contractors will provide information briefings to the workforce as well as regular spot checks to enforce restrictions on poaching and gathering of firewood. The construction work in community forest areas will be coordinated through DFO and CFUGS, respectively.

As discussed in Section 4, regional mapping by IUCN and ICIMOD indicates that potentially endangered species may be found over large portions of Nepal. Construction may be restricted during breeding and migration seasons, if warranted. The EMP includes provision for reforestation to offset potential impacts on sensitive ecosystems (see discussion below in Section 5.4). There are various programs and projects being implemented in Nepal which will partially offset potential impacts on sensitive species including those in the ACA; these programs are discussed below (Section 5.4) and summarized in Appendix 3.

Monitoring and Oversight

Monitoring and oversight are included in the EMP, which is discussed in Section 7. Construction contractors will prepare and implement environmental, health, and safety plans. Implementation consultants will conduct periodic inspections of construction sites and will conduct air, noise, and waste monitoring as necessary.

Greenhouse Gas Emissions Scenarios

GHG emissions scenarios are discussed in the context of cumulative and induced impacts in Section 5.5. Net GHG emissions resulting from the project are expected to be negative as the transmission line will connect a major new clean energy source to the grid.

5.4 Offset of Potential Impacts in Sensitive Habitats

The EMP includes revegetation and reforestation to offset potential impacts related to clearing and maintaining ROW (the EMP is presented in Section 7). Based on the reconnaissance visits, available data, and assessment conducted to date, the project will not impinge directly on critical or natural habitats: about 25 km of ROW and 2 new substations will be located in the “intensive use” zone of the ACA (see Figure 4.32); review of all available documents on the area indicate that the substations sites and ROW will not impact critical or natural habitats. Therefore, a biodiversity offset specific to flora and fauna in the ACA is not considered to be necessary, but a generic offset will be achieved through tree replacement at a ratio of 25 new trees for each tree removed

(25:1) in the ACA and at 2:1 in other areas.[94] Wildlife movement can be facilitated by allowing vegetation to grow to a height of 1-2 meters in the ROW; this may require increasing transmission tower height in some instances (see Table 5.2 above). The project will result in increased clean energy supplies and increased access to energy, which will reduce pressure on forests for fuelwood.

The National Rural Renewable Energy Program (NRREP) led by the Nepal Alternative Energy Promotion Center (AEPC) is implementing a broader clean energy program targeting areas with reliance on fuelwood and other traditional biomass. The RE-based mini grid component cofinanced by the Scaling Up Renewable Energy Program (SREP) has been developed under the aegis of the NRREP. Also under the NRREP and the SREP Investment Plan for Nepal, ADB's Private Sector Operations Department is developing a small hydropower investment program which is expected to be approved by ADB's Board in 2014. Various other hydropower projects are under development by the private sector. The status of compliance with relevant provisions of ADB environment safeguards is summarized in Table 5.4.

Ongoing Activities Which Indirectly Offset Impacts of the Project

There are numerous donor-funded activities in Nepal promoting and supporting protected areas and forest management, preservation of biodiversity and cultural diversity, capacity building for adaptation to climate change and for climate resilient development, community-scale renewable energy development, institutional development for reducing emissions from deforestation and degradation (REDD+), and capacity building for payment for ecosystems services (PES). Donor agencies, special funds, and other partners include ADB, the European Union, the Global Environment Facility (GEF), IUCN, the Pilot Program for Climate Resilience (PPCR), the program for Scaling Up Renewable Energy Program in Low-income Countries (SREP), and several bilateral programs (Finland, Germany, Japan, Norway, United Kingdom, and the United States). See Appendix 3 for further information on off-setting activities.

[94] NEA will commission an EIA specifically for the Manang-Khudi transmission components as required by Nepali regulations; this EIA may identify additional biodiversity protection measures if necessary. The line is scheduled to be completed by mid-2019, with a maximum construction period of 2 years, allowing more than 2 years for the EIA to be completed.

Table 5.4: Compliance with ADB requirements for Sensitive Habitats

ADB Safeguard Provision [a]	Degree of Impact
Critical Habitats Do not implement project activities unless: (i) There are no measurable adverse impacts on the critical habitat that could impair its ability to function (ii) There is no reduction in the population of any recognized endangered or critically endangered species (iii) Any lesser impacts are mitigated	The project facilities and right-of-way do not impinge on critical habitats. Small size of project "footprint" will result in no measurable adverse impacts on sensitive species in the project area. Potential impacts due to clearing of vegetation will be partly offset by reforestation activities included in the EMP, and other offsetting activities.
Legally Protected Areas Implement additional programs to promote and enhance the conservation aims of the protected area.	Parts of the transmission infrastructure and some associated hydropower facilities are located in the ACA, a multiple-use conservation area which allows large-scale infrastructure development (see Table 5.3).
Natural Habitats There must be no significant conversion or degradation, unless: (i) Alternatives are not available (ii) The overall benefits of the project substantially outweigh the environmental costs (iii) Any conversion or degradation is appropriately mitigated	The project facilities and right-of-way do not impinge on natural habitats. There are no viable alternatives to the project based on technical, environmental, economic, and social considerations. Potential environmental costs of the project are minimal, if any, and will be offset by benefits of the project and benefits accruing from various other ecological preservation activities (see Appendix 3).
Notes: [a] ADB *Safeguard Policy Statement 2009*, page 16, Environmental Safeguards, Policy Principle number 8.	

5.5 Cumulative and Induced Impacts

Suppressed power demand due to economic growth is inducing the Project rather than *vice versa*. Consumers rely on expensive diesel and gasoline (petrol) generators for back-up power, and new transmission capacity is necessary to alleviate the power demand-supply imbalance. The direct impacts are minimal, as discussed above. Various hydropower plants that will be connected to the transmission lines are associated facilities. "Downstream" of the transmission line, the demand centers in the main project corridors, the Kathmandu Valley, other cities, and future consumers in India,

are beneficiaries of the transmission system expansion and as such are an "associated facility."

EIAs have been or are being conducted for the associated hydropower plants as required by Nepali regulations. The hydropower plants currently under construction have completed EIAs which have been reviewed by ADB. These associated facilities have received the necessary environmental clearances and have not been subject to any notices of violation of Nepali environmental regulatory guidelines. The plants have rated aggregate capacity of about 145 MW[95] and the design output is estimated to be 635,100 MWh per year (assuming 50% plant load factor). The GHG emissions offset is calculated assuming a factor of 1.08 tons carbon dioxide equivalent per megawatt-hour (tCO_2e / MWh) of electricity produced by diesel generator sets.[96] The GHG offset is estimated to be 685,908 million tCO_2e per year, which will result in a net emissions reduction for the project as shown in Table 5.5.

Table 5.5: Estimated Greenhouse Gas Balance

Facility	**Capacity (MW)**	**Annual Output @ 50% PLF (MWh)**	**GHG Offset @ 1.08 tCO_2e/MWh**
associated HPPs	145	635,100	685,908
New Cement Plants	**Capacity (t/y)**	**GHG Emissions**	**Net GHG Emissions**
1 ton cement/ 1 MWh	635,100	317,550	- 368,358

CO_2e = carbon dioxide equivalent, GHG = greenhouse gas, HPPs = hydropower plants, MW = megawatts, MWh = megawatt-hours, PLF = plant load factor, t = tons

Evaluating induced impacts in the Kathmandu urban area and other demand centers is decidedly complicated. As noted above, economic growth has resulted in suppressed power demand throughout Nepal and in neighboring India. The transmission lines will facilitate bridging the demand-supply gap and will reduce the need for back up diesel generators. In the long term, the expanded power capacity and transmission grid will be facilitating economic growth, but managing economic development for sustainability --

[95] The Kaligandaki and Marsyangdi basins each have at least 1000 MW of hydropower potential which is considered to be technically and economically feasible. There are various hydropower projects in the development queue but the total capacity permitted and expected to be completed within the next 3 - 5 years is only 103 MW in these 2 corridors, of which 2 projects account for 92 MW: the 50 MW Upper Marsyangdi project on the Marsyangdi River and the 42 MW Mristi Khola project on the Kaligandaki. An additional 42 MW aggregate capacity is to be connected to the Samundratar-Trishuli 3B Hub corridor.

[96] This emissions factor includes black carbon, and is used for the ADB PSOD mini-grids proposal for Clean Technology Fund cofinancing (in progress).

especially urban growth -- is well beyond the control of the NEA.

Rather than attempting a comprehensive assessment of “downstream” impacts, a proxy assessment can be made. Urban growth relies on construction materials such as asphalt for roads, and cement and steel for buildings. Of these materials, cement is produced in Nepal while asphalt and steel are mainly imported; cement plants are a major potential consumer of energy. Cement production is therefore taken as a proxy for downstream impacts. Cement production consumes 3 to 6 gigajoules (GJ) of fuel per ton of cement produced. Assuming that Nepali cement plants are highly efficient, energy consumption is assumed to be 3.6 GJ per ton of cement; 3.6 GJ is equivalent to 1 MWh. If all of the electricity from the associated facilities were to be used for cement production, the production capacity would be about 635,100 tons cement per year.

GHG emissions from cement production are estimated to be 0.9 tons CO_2e per ton of cement produced, of which 50% is from the production process and about 40% is from fuel consumption. [Energy consumption and emissions factors were accessed on 25 April 2011 from: http://en.wikipedia.org/wiki/Cement]. Assuming that hydroelectricity is the fuel (instead of coal), the GHG emissions factor is taken as 0.5 tCO_2e per ton of cement. Table 5.5 shows that the net GHG emissions would be negative, i.e. there would be a net reduction.

The cumulative impacts from economic development will ultimately depend on implementation of sustainable transport systems, rational zoning and land use management, solid waste management, wastewater treatment, and promotion of green buildings (new and retrofit).

6. Information Disclosure, Consultation, and Participation

The citizens of Nepal are painfully aware of the need for additional electric power investments. About 44% of the population has no access to electricity and a majority of the population still relies on traditional biomass for energy needs. Load shedding of 12 hours per day or more directly impacts consumers who are connected to the electricity grid. Power shortages have grown more severe during the past several years, a fact which is widely known throughout the country. In effect, it is highly unlikely that people who are potentially affected by the project are not aware of the poor state of commercial energy services in Nepal in general and in the project area in particular.

NEA conducts informal consultations as part of its route surveys, and formal consultation during preparation of environmental assessments (IEEs and EIAs). Most of the transmission routes were identified with surveys conducted during 2010 – 2012, and are being or have been surveyed again for the proposed Project. The Manang-Khudi route was originally surveyed in 2010 when it was conceived as a 132 kV line; the route is being surveyed again for the proposed 220 kV line; potentially affected people along the ROW route have been informally consulted twice. As required under the Nepali regulatory framework, a detailed environmental assessment which includes public consultations will be conducted for the Manang-Khudi section (this section is scheduled for completion by June 2019, and with a 2-year construction schedule, there is ample time to complete the necessary IEE or EIA including extensive consultation with potentially affected people); environmental assessments will be prepared for other transmission sections as well.

The surveys being conducted for land acquisition and resettlement planning include consultation with directly affected people; the main environmental and social impacts arise from ROW clearing and substation construction, and social surveys therefore serve the purposed of consultation on potential environmental impacts. As most of the proposed transmission lines have been subject to 2 route surveys, a detailed social survey to develop land acquisition and resettlement plans, and a detailed environmental assessment, potentially affected people will have been consulted 3 or 4 times prior to construction.

The various hydropower projects in the transmission corridors are also required to conduct stakeholder outreach and consultation: it is possible that some potentially

affected people will have been informed on 5 separate occasions about the power system expansion projects prior to construction of the transmission system components. Residents in the project areas are familiar with the need for transmission system expansion and other infrastructure, and generally support the proposed project components.

NEA has an existing procedure to receive inquiries and complaints about project related activities (developed for other ADB projects), as well as responding to such inquiries and complaints. Feedback from potentially affected people will be used to establish a grievance redress mechanism (GRM) appropriate to the expected level of impacts.

The ADB *Safeguard Policy Statement 2009*, Appendix 1, paragraph 20, clearly notes that GRM is the responsibility of the borrower:

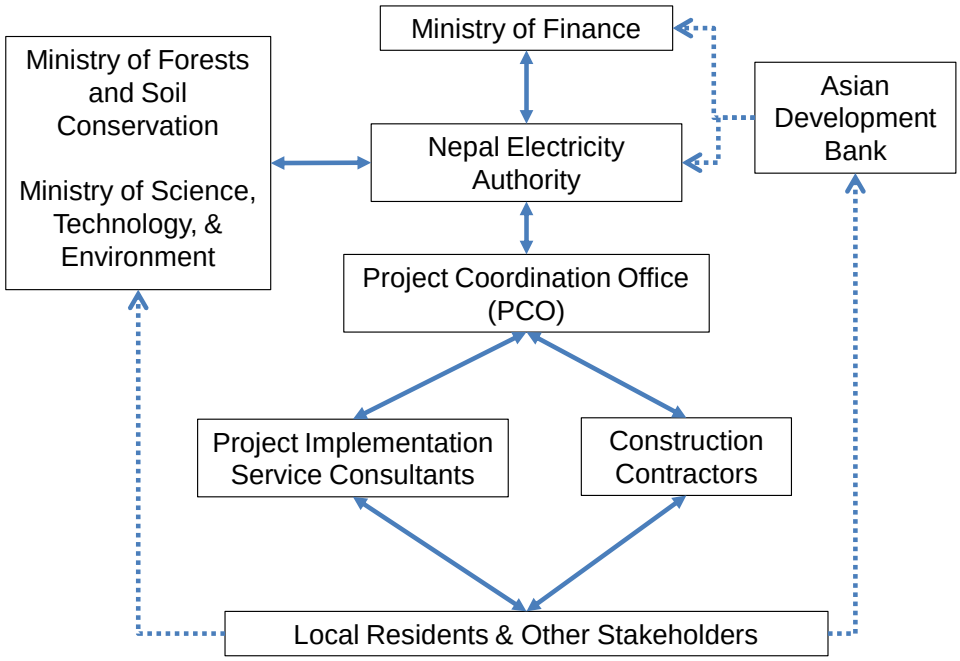
> *The borrower/client will establish a mechanism to receive and facilitate resolution of affected people's concerns, complaints, and grievances about the project's environmental performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people at no costs and without retribution. The mechanism should not impede access to the country's judicial or administrative remedies. The affected people will be appropriately informed about the mechanism.*

In the context of the proposed Project, there are potential language and other communication barriers. Potentially affected people may have mobile phones, radios, and televisions, but may not have ready access to internet.

Consultation of potentially affected people is still being undertaken for the Project, and there is a need for a sustained effort to address any concerns and complaints. The general information flow for registering and responding to concerns and complaints is illustrated in Figure 6.1. During construction, concerns and complaints would be brought to the attention of the construction contractors, project implementation services consultants, PCO, NEA, Ministry of Finance, and ultimately to ADB if necessary.

During operations, concerns and complaints shall initially be brought to the attention of NEA representatives in project area.

Figure 6.1: GRM Complaint Flow



Most complaints and concerns should be resolvable at the local level (i.e., in the project area). For those instances where this is not the case, an appeals committee could be included as part of the GRM as an appropriate forum for complaint resolution. The PCO will coordinate the further elucidation of a GRM for the Project, which should be in effect prior to commencement of construction.

7. Environmental Management Program

Key issues to be addressed by the EMP are :

- Clearance of ROW: determination of potential impacts on sensitive habitats and potentialy endangered species; and advance notice to affected communities
- Cleared vegetation can be utilized by Community Forest User Groups (CFUGs); however, no burning of vegetation in construction areas is allowed
- Construction schedule may be restricted if deemed necessary during migration season of sensitive species
- Construction contractors will implement corporate EH & S programs
- Implementation consultants will support monitoring and inspection activities, with support from other third-party service providers as necessary
- Provisions for reforestation are included to offset clearing of vegetation in the transmission ROW

The EMP has been developed as part of the environmental assessment to avoid, minimize, and mitigate potential negative impacts of the Project. The EMP comprises routine environmental monitoring to support proactive mitigation of any potential impacts from construction and operations. The EMP includes the following:

(i) proposed monitoring plan and parameters (Table 7.1)
(ii) proposed management and mitigation activities (Table 7.2)
(iii) description of responsibilities and authorities for mitigation and monitoring, reporting, and review
(iv) preliminary work program (Table 7.3), and
(v) preliminary cost estimates (Table 7.4)

7.1 Proposed Monitoring Plan

The purpose of the EMP is to guide the pre-construction, construction, and operational periods of the project as per Nepali and ADB environmental requirements. The EMP will be updated during the project design and implementation stages as necessary based on field conditions, construction contractor performance, and stakeholder feedback. Table 7.1 presents the minimum provisions for baseline ecological and environmental monitoring. Monitoring activities may be modified during implementation depending on contractor performance and analytical results. If field inspections, monitoring, and analyses indicate good environmental performance, then successive monitoring intensity and frequency may be reduced. Conversely, if

environmental performance is worse than expected, corrective measures will be identified and monitoring activities will be adjusted accordingly to resolve any problems.

Transmission systems and associated hydropower plants substations do not emit conventional pollutants, except for emissions from construction activities, used equipment and materials, and domestic wastes from substations. The associated hydropower plants are all run of river design with minimal storage capacity. Potential methane emissions will be non-existent or minimal compared to storage-type designs. Potential spills of fuel, lubricating oils, and transformer oils would be localized and unlikey to result in detectable pollution of surface waters. The conventional pollutant monitoring proposed in Table 7.1 will be of value primarily for establishing baseline conditions in the project area, and then for ambient quality monitoring.

7.2 Proposed Management and Mitigation Measures

Table 7.2 presents the overall EMP. The EMP will be implemented in 3 stages: (i) Pre-construction, (ii) construction, and (iii) operations and maintenance. The EMP is dynamic and will be updated and modified as necessary and appropriate based on contractor performance and monitoring results. Modifications to the EMP will be made by PCO and included in the twice-yearly progress reports submitted to ADB, or more frequently if necessary. Compensatory afforestation and reforestation is possibly the most significant activity of the EMP. After the detailed route surveys are completed, a Compensatory Planting Plan and Slope Stabilization Plan will be prepared in consultation with the Ministry of Forest and Soil Conservation and relevant District Forest Office. Criteria for afforestation and reforestation should be defined in terms of retaining and improving biodiversity and ecosystem connectivity, and logically should be concentrated in the ACA to complement on-going biodiversity conservation activities there.

7.3 Work Program

The preliminary work program for the first 3 years of implementation is summarized in Table 7.3. EMP related work will begin in early 2014. Procurement support will begin by mid-2104 and design review activity will begin in fourth quarter of 2014. Construction is not expected to commence until 2015 at the earliest. Any additional baseline and other survey and assessment work that may be required can be completed before construction commences.

Table 7.1: Minimum Provisions for Environmental Monitoring

Parameters to be Monitored	Location	Measurements	Frequency	Responsibility
Pre-construction Stage				
Air: PM, NOx, SOx Noise: dB(A) Water: pH, BOD / COD, suspended solids, fecal coliform	Up to 5 locations around project area by NEA / ESSD	"Grab" samples for air and water Spot check for noise and dust using portable monitoring devices	Air, noise, and water sampling and analyses: at least 1 event prior to start of construction.	PCO supported by Implementation Consultants and other third-party services NEA / PCO to include EMP in bidding documents; ADB to verify requirements in bidding documents.
Construction Stage				
Clearing / cutting vegetation and offsetting areas for afforestation and reforestion Air, Noise, and Water: same parameters as in pre-construction stage Construction wastes: on-site inspection	Forested areas of ROW and afforestation / reforestation sites 5 stations around project area (same as during construction) Visual inspection of active construction areas, including equipment staging areas and camps	Field inspection of vegetation clearing and reforestation to ensure that appropriate measures are implemented "Grab" samples for air and water Spot check for noise and dust using portable monitoring device Spot check / visual inspection of solid waste generation and disposal. Analysis of transformer oils to determine if polychlorinated biphenyls are present.	Vegetation clearing and reforestation: quarterly during construction period Air, noise, and water: quarterly during construction period Monthly spot checks for construction waste management	Contractors to implement corporate EHS plan, including wastewater and solid waste control. EMP Implementation consultants to conduct pollutant source emissions monitoring, and inspect wastewater and solid waste controls. PCO staff to provide oversight via regular field inspections, and submit semi-annual Safeguards Monitoring Report. ADB to audit during project review missions.
Operations and Maintenance Stage				
Reforestation monitoring	Reforestation sites agreed with NEA and other stakeholders	Spot checks based on visual inspections and any complaints	Twice-yearly surveys	NEA / PCO ADB to audit during project review missions

ADB = Asian Development Bank, BOD = biochemical oxygen demand, DO = dissolved oxygen, ESSD = Environment and Social Services Department of NEA, NEA = Nepal Electricity Authority, PCO = project Implementation unit, SPM = suspended particulate matter, TSS = total suspended solids

Table 7.2: Preliminary Environmental Management Plan

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Pre-construction Phase				
Regulatory clearance and permitting	Impact on potentially sensitive ecosystems: potential loss of productive agriculture and forest products, and potential loss of habitat and ecological value	Letter from National Planning Commission to indicate if the ADB-funded activities comprise a National Priority Project. Permitting for clearance of Right-of-way (ROW) prior to construction: (i) Advance notice and no objection from residents; (ii) Compensation arrangements for loss of cash crops (10-year valuation on fruit trees; current market value for timber and other crops); (iii) Permissions and letter agreements from relevant District Forest Office, Community Forest User Groups (CFUGs), and if necessary from Department of National Parks and Wildlife Conservation; and (iv) Prepare Compensatory Planting Plan and Slope Stabilization Plan with Ministry of Forest and Soil Conservation and District Forest Office. ROW demarcation and detailed survey: (i) Delineate ROW via survey; (ii) Consultation with potentially affected residents and CFUGs within 1 kilometer of ROW; (iii) Marking of trees to be cut, avoiding areas where “hollows” provide living space for sensitive wildlife; and (iv) Confirm locations for compensatory planting at least one month before commencing the construction work. Complete EIA for Manang-Khudi transmission components by Q4 2016	NEA / PCO to obtain letter, if necessary, from National Planning Commission NEA / PCO in consultation with Ministry of Forest and Soil Conservation, District Forest Offices, Department of National Parks and Wildlife Conservation District Forest Office to provide confirmation of tree marking and proposed compensatory planting areas EIA by ESSD/3rd party services	“No objection” from ADB prior to contract tender and awards Annapurna Conservation Area manangement chief to issue No Objection Certificate for Manang-Khudi transmission subproject

Table 7.2: Preliminary Environmental Management Plan (continued)

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Pre-construction Phase (continued)				
Transmission design and construction plan: (i) Selection of construction staging areas, equipment maintenance, waste management procedures, and access controls; (ii) Baseline monitoring	Components in ACA and any other ecologically sensitive areas Potential pollution from air, noise, and hazardous materials during construction and operations Safety during construction and operations	Transmission towers and lines to include high-visibility markers such as bird flight diverters in environmentally sensitive areas. Consider "stacked" conductor design to minimize right-of-way (ROW) in ecologically sensitive areas (see Figure 5.3). Construction equipment to meet national air and noise emissions standards. Construction contract to include provision for waste management including possible industrial hazardous wastes. Contractors to prepare and implement corporate EHS plan. Contractors to have established corporate environmental, health, and safety (EHS) program; ISO 14001 certification or equivalent is desired. Prior to clearing of ROW and other construction activities, conduct at least one round of pre-construction baseline monitoring for conventional pollutants (air, noise, and water) as outlined in Table 7.1	NEA / Design team Project Implementation Consultants (or ESSD) to conduct monitoring with third party services as necessary PPTA consultants to update list of offsetting activities	"No objection" from ADB prior to contract tender and awards
Qualification and selection of construction contractors	Environmental, health, and safety performance of construction contractors	Construction contracts to include provisions for corporate EHS program and/or ISO 14001. Special conditions of contract may include incentives and penalties for inadequate environmental performance.	NEA / PCO to include appropriate provisions in bidding documents and contracts	

Table 7.2: Preliminary Environmental Management Plan (continued)

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Construction Phase				
Physical construction: manual labor and mechanized construction	Worker / operator safety (noise, vibration) Equipment wear and tear	Construction techniques and machinery selection to minimize noise and vibration. Noise to be limited to 70 dB(A) at site boundaries. Construction equipment to be maintained in accordance with national standards for noise exposure to workers. Air, dust, noise, vibration, and water quality monitoring at least 2 times per year in ACA and any other protected areas, and at least 1 time per year in other areas. Results to be included in semi-annual Safeguards Monitoring Report.	Construction Contractors will implement corporate EHS plan. Project Implementation Consultants (or ESSD) to conduct monitoring and inspections utilizing 3rd-party services as necessary	PCO to conduct periodic spot checks to confirm compliance. ADB review Missions
Health and safety	Injury and sickness of workers and members of the public Potential BOD and fecal coliform contamination	Construction camps to be located outside of sensitive ecosystem areas. Any camps will include proper sanitation, water supply, and waste disposal facilities, including primary treatment for domestic sewage and secure disposal of domestic solid wastes. Contractor to prepare and implement a health and safety plan including worker training and daily/weekly briefings.		
Construction equipment maintenance	Wastewater from maintenance may cause soil and water contamination	Construction equipment staging and maintenance areas to be located outside of environmentally sensitive areas. Construction contractor to provide wastewater containment, and sedimentation and biological treatment, if necessary.		

Table 7.2: Preliminary Environmental Management Plan (continued)

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Construction Phase (continued)				
Ambient air quality and noise nuisance	Dust, exhaust, and noise emissions from construction equipment	Controlled construction activities and maintenance of machinery, timely scheduling of construction activities to avoid nuisance to sensitive ecosystems (and nearby communities). Construction equipment to meet national emissions and noise control standards. Water sprays to be used for dust control as necessary.	Construction contractors to implement EHS plan Project Implementation Consultants (or ESSD) to conduct monitoring and routine inspections	NEA / PCO ADB review missions
Storage of chemicals and any hazardous materials	Possible spills resulting in contamination of soil, water, and air	Fuel, lubricants, and any other hazardous materials will be staged outside of protected areas to the maximum extent possible, and will be securely stored to prevent spills. Contractors to provide spill response kit in accordance with Material Safety Data Sheets for chemicals and hazardous materials		
Construction waste management	Air, soil, and water pollution due to inadequate management and control	Construction wastes to be managed in accordance with national standards and best practices. Soil, rock, and other spoils to be used in run-off control structures to maximum extent practical. Waste lubricating oils to be disposed or recycled off-site by licensed service companies. Contractors' EHS plans to include contingency provisions for testing of polychlorinated biphenyls (PCBs) if any transformers are to be decommissioned; if necessary, arrange for secure storage at substation sites or controlled off-site disposal at licensed facilities.		

Table 7.2: Preliminary Environmental Management Plan (continued)

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Construction Phase (continued)				
Construction stage environmental monitoring	Inadequate/unsafe working conditions Environmental impairment at protected areas and other project sites	Appropriate contact clauses to ensure satisfactory implementation of contractual environmental, health, and safety measures. Implementation of environmental monitoring and reporting system using checklist of all contractual environmental requirements.	PCO	NEA, ADB
		Implement ambient air, noise, and water monitoring program as outlined in Table 7.1	Project Implementation Consultants (or ESSD)	NEA / PCO
Biodiversity protection and improvement	Preservation of sensitive habitats	Clearing of vegetation in transmission ROW should be minimized, e.g., cutting vegetation low to ground while preserving root structure rather than complete removal. Transmission towers and lines to include high-visibility markers such as bird flight diverters in environmentally sensitive areas. Reforestation as per Nepali and ADB requirements: implement Compensatory Planting Plan and Slope Stabilization Plan with Ministry of Forest and Soil Conservation and District Forest Office. Update list of offsetting activities on an annual basis.	Project Implementation Consultants (or ESSD)	NEA / Ministry of Forest and Soil Conservation ADB

Table 7.2: Preliminary Environmental Management Plan (continued)

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Operation and Maintenance Phase				
Routine operations and maintenance	Potential loss of vegetation and habitat in protected areas	Maintain warning / advisory signs in good condition Visual inspection of annual vegetation trimming in transmission right-of-way	PCO and Project Implementation Consultants (or ESSD)	NEA, Ministry of Environment ADB Review Missions
Periodic air, noise, and water quality monitoring at sensitive areas	Maintain EHS program to prevent pollutant emissions via source controls	Monitoring results to be reviewed by NEA and ADB to confirm that mitigation measures are adequately controlling pollution at the source and preventing ecosystem deterioration. Pollutant source monitoring parameters and frequency may be modified if results show no degradation. Evidence of degradation would trigger operational review to determine need for improved control measures.	PCO and Project Implementation Consultants (or ESSD)	NEA ADB Review Missions
Biodiversity protection and improvement	Preserve and improve ecosystem integrity	Biodiversity offset management and annual habitat / biodiversity surveys to be conducted if deemed necessary.		

Table 7.3: EMP Work Plan – Key Activities [to be revised]

Activity	2014		2015				2016				2017			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Monitoring Activities														
Visual inspections beginning with contractor mobilization -- monthly or more frequently by PCO / ESSD / consultants		X	X	X	X	X	X	X	X	X	X	X	X	X
Air, Noise, Water, and Solid Waste Management – quarterly monitoring by Implementation Consultants		X	X	X	X	X	X	X	X	X	X	X	X	
Vegetation removal and re-vegetation – PCO / ESSD quarterly inspections		X	X	X	X	X	X	X	X					
Reforestation / Offset Program														
Afforestation / Reforestation / Other offset activities	X	X	X	X	X	X	X	X	X					
Quarterly disbursements and twice-yearly monitoring reports	X	X	X	X	X	X	X	X	X					

IEE = initial environmental examination, EIA = environmental impact assessment, ESSD = Environmental and Social Safeguards Department of NEA, NEA = Nepali Electricity Authority, PIC = project implementation consultants, PCO = project implementation unit of NEA

7.4 Responsibilities for Mitigation, Monitoring, Reporting, and Review

NEA/PCO

The existing PCO includes officers responsible for environmental and social safeguards implementation. The PCO is responsible for the ongoing ADB-funded projects covering transmission system expansion and upgrade, energy efficiency and renewable energy development.

The PCO will ensure that bidding documents include criteria for EHS policy and environmental certification criteria as noted. Special conditions of contract may include penalties and incentives for environmental performance. The PCO will prepare monitoring reports 2 times per year and submit these reports to ADB. The PCO will prepare environmental management reports every 6 months during construction and annually through the first year of operations. The reports will cover EMP implementation with attention to compliance and any needed corrective actions. Additional public consultation will be conducted as necessary during construction. The PCO is in the process of updating its website to provide for public disclosure and public comments.

NEA/ESSD

NEA will have primary responsibility for completing the IEE as per Nepali regulatory requirements and for implementing the EMP. NEA will engage ESSD and/or other third-party firm as necessary to update and complete the EIA, IEEs and implement the EMPs. ESSD will conduct routine inspections of construction activities, including visual survey of ROW clearance, construction equipment staging areas, and construction camps. ESSD will take initial responsibility for the ambient environmental monitoring, including procurement and delivery of monitoring equipment, and conducting routine emissions monitoring during construction and operations. The scope of work is outlined below:

(i) Review construction contractors EHS plan, and recommended revisions as necessary;
(ii) Conduct environmental monitoring and analyses (air, dust, noise, vibration, and water quality) twice yearly and at least once prior to commencement of construction; conduct visual inspections of construction areas at least twice yearly and more frequently if deemed necessary;

(iii) Assist PCO in preparation and delivery of Safeguards Monitoring Report two times per year.

Construction Contractors

Construction contractors will be required to have a corporate environmental, health, and safety (EHS) policy, and environmental management certifications such as ISO 14001 (or equivalent). Contractors will have primary responsibility for worker health and safety at construction sites and camps. This includes provision of appropriate personal protective equipment (e.g., hard hats, safety boots, and hearing protection), provision of sanitation facilities, and controlled management and disposal of construction, domestic, and sanitary waste facilities.

Asian Development Bank

ADB will (i) review and endorse the IEE/EIA and EMP before contracts are finalized and construction commences; (ii) review monitoring reports; and (iii) officially disclose environmental safeguards documents on its Web site as necessary in accordance with the ADB *Public Communications Policy* (2005).

7.5 EMP Cost Estimates

Preliminary cost estimates for the EMP are shown in Table 7.4. These estimates cover the basic monitoring activities for a 3-year implementation period and are subject to revision. The EMP cost will be funded by the Project.

7.6 Additional Assessment and EIA/EMP Update

Additional work is required to complete the EIA and update the EMP. This includes incorporating information from surveys currently being conducted and from public consultation, as follows:

- Results from detailed route survey, expected by second quarter 2014
- Documentation of public consultations led by NEA, to be conducted in second and third quarters of 2014
- Internal review of draft EIA by ADB

Table 7.4: Preliminary EMP Cost Estimates (to be revised)

Activity	Unit	Unit Cost ($)	Total ($)
A. Routine Environmental Monitoring			
Contractor EHS Review by Implementation consultants	LS	10,000	10,000
Air, Dust, Noise, & Water Monitoring & Construction EHS Inspections – Equipment	LS	25,000	25,000
Implementation Consultants – International Professional for Monitoring [assumes 2 visits per year, 2 p-m per year x 3 years]	6 p-m	20,000	120,000
International Consultants – Travel (2 RT airfare/year @ $5000/RT; 60days per diem/year @ $150/day; + miscellaneous costs)	LS / year	20,000	60,000
Implementation consultants – National Professionals Remuneration for Monitoring and Visual Inspections (1 full-time equivalent, 3 years)	36 p-m	2,500	90,000
National Consultants – travel and per diem (local travel @ 250 / month x 36 months; local per diem 600 days total @ $50 / day plus miscellaneous costs)	LS	40,000	40,000
Subtotal			***345,000***
Contingencies	LS	55,000	55,000
TOTAL			**400,000**
B. Reforestation Activities			
Total 15 km ROW	LS	2	2,021,700
Trees for XXXkm	LS	2	298,860
Tree Planting		125,000	125,000
Subtotal			***2,445,560***
Contingencies	LS	25,000	25,000
TOTAL			**2,470,560**
GRAND TOTAL (A + B)			**$2,870,560**
% of total project cost (assumes $360 million total)	*1.00 %*		

Source: TA 8272-NEP consultant estimates.

8. Conclusions and Recommendations

8.1 Key Findings

The Project has potential environmental sensitivity as the transmission lines will support various associated hydropower facilities, including some which are located in the Annapurna Conservation Area. The proposed Project comprises clearing of right-of-way, construction of new transmission towers and substations, rehabilitation of grid substations, and electrification within transmission corridors. Disturbance during construction will arise from clearing of vegetation, equipment staging, construction of substations, erection of transmission towers, and stringing of conductors on the towers.

The potential footprint in the ACA is less than 0.018% of the total area of the ACA; the potential impacts of the project on the ACA will be difficult if not impossible to monitor in a quantitative manner. The proposed Khudi-Manang transmission line will be in the “intensive” land use zone which is not host to critical or natural habitat. If necessary, the ROW can be minimized in sensitive areas by use of stacked conductors (stacked conductors have been utilized in the Kathmandu urban area).

Negative environmental impacts accruing from the Project will be minimal, short-term, and reversible, and can be readily mitigated. Issues of land acquisition and resettlement of households will have some negative impacts on socio-economic resources. Most of these negative impacts will occur during the construction phase. During the operational stage minimum effects will occur and these too can be minimized with appropriate provisions in the Environmental Management Plan (EMP). There are also several positive effects such as reduced emission of greenhouse gases which will in fact aid in the efforts made for conservation of environmental resources. NEA will have the overall responsibility of the EMP implementation.

The potential impacts will occur primarily during construction and are minimal, temporary, and reversible. Longer term impacts result from establishing the transmission right-of-way and new substations. Adequate compensation arrangements will be made for necessary land acquisition.

The potential impacts on the ACA and other potentially sensitive sites are expected to be minimal and can be readily mitigated. The transmission footprint will be minimized by use of advanced HTLS conductors which allows for 220 kV design instead of 400 kV for

most of the proposed lines. Revegetation will be conducted to mitigate the impacts of clearing the ROW. Any negative environmental impacts will be offset via support to the Annapurna Conservation Area and multiple other donor-assisted activities directed toward climate-resilient development.

Key Issues Relevant to Environment Category

The proposed Manang-Khudi transmission segment and substations in the ACA are in the "intensive" landuse zone. There is no documentation available to indicate that these areas are critical and/or natural habitat. Rather, the intensive landuse zones are in essence being sacrificed to human and infrastructure development, so that the more sensitive ecosystems -- mostly at higher elevations -- can be preserved.

The various "landscapes" such as Chitwan Annapurna Landscape (CHAL) and Terai Arc Landscape (TAL) are not legally protected areas. CHAL and TAL are formal designations for conservation initiatives, but there is no documentation that the areas which may be crossed by transmission lines are critical or natural habitats. These landscapes are similar to buffer zones which complement the legally protected areas, but the various landscapes are not legally protected areas or legally defined buffer zones. The CHAL is home to 4.5 million people, including the city of Pokhara and all of the Pokhara Valley, and covers almost all of the proposed transmission routes.

Researchers note that tigers specifically disperse through sugar cane fields in northern India. The sugar cane fields are a "tall grasslands" analogy. Potential impacts on tiger and other ground-dwelling fauna in the various landscapes can be mitigated by allowing vegetation to grow to a height of 1 - 2 meters in the ROW. If necessary the transmission towers can be made higher than normal, and stacked conductor design might also be used.

Community forest management may be more effective at preserving biodiversity and sensitive flora and fauna that establishing new protected areas. To put this in context, since 1987, total protected areas in or partly covered by the CHAL (which covers most or all of the project area) have expanded from about 200,000 hectares to more than 1,240,000 hectares -- more than 562% -- but there is no obvious correlation between expansion of protected areas with improvement in biodiversity conservation.

Given the nature of transmission systems, there are limited mitigation measures

available (as discussed in section 5 and summarized in Table 5.2 above). Conducting a full EIA will not result in identification of any new mitigation options. If a biodiversity offset is deemed necessary, additional environmental surveys can be conducted as necessary and an offset program can be developed prior to construction; in effect, the required re-vegetation can be implemented as a biodiversity offset if necessary. Construction in the ACA is not expected to begin until 2017, so there is ample time to develop an offset program. As noted in Section 1, the Nepali regulatory requires that NEA commission an EIA for the transmission line and substations in the ACA. This EIA will identify the need for special bio-diversity conservation measures if necessary, and the required re-vegetation activity could be designed accordingly. Based on the investigation and assessment conducted to date, ADB environment category B is proposed. [In 2011, an ADB project proposed a 400kV line traversing about 30 km through the Gaurishanker Conservation Area in eastern Nepal which was confirmed by ADB-RSES as Category B. The proposed 220 kV Manang-Khudi line and substations will have a narrower right-of-way and smaller footprint than the earlier line proposed through the Gaurishanker Conservation Area, thus, Category B is considered appropriate.]

8.2 Conclusions and Recommendations

The proposed Project is the best alternative with respect to economic, environmental, financial, and social criteria. Potential negative environmental impacts can be mitigated by implementation of the EMP. As discussed in Section 7, the EMP will be updated and revised as necessary to ensure that environmental and ecological objectives in the project area are met.

The environmental assessment to date complies with ADB and Nepali policy and guidance for energy sector projects, and is sufficient to allow the Project to proceed to ADB Board consideration. Appropriate assurances should be incorporated into loan and project agreements to ensure that the EIA and EMP are updated as necessary and fully implemented.

References

Avian Power Line Interaction Committee (APLIC). (2012). *Reducing Avian Collisions with Power Lines: State of the Art in 2012.* Washington D.C.: Edision Electric Institute, Avian Power Line Interaction Committee.

Bajracharya, B. T. (1996). *Climatic and Hydrological Atlas of Nepal.* Kathmandu: ICIMOD.

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

Baral, H. S., & Inskipp, C. (2005). *Important Bird Area: Key Sites for Conservation.* Kathmandu: Birdlife International, RSPB, Bird Conservation Nepal, Cambridge.

Bhattarai, T. P., Skutsch, M., Midmore, D. J., & Eak , R. B. (2012). The Carbon Sequestration Potential of Communitybased Forest Management in Nepal. *The International Journal of Climate Change: Impacts & Responses, 3*(2), 233-254.

Bhuju, U. R., Shakya, P. R., Basnet, T. B., & Subha , S. (2007). *Nepal Biodiversity Resource Book: Protected Areas, Ramsar Sites, and World Heritage Sites.* Kathmandu: ICIMOD, MoEST. UNEP.

Bridges, J. M., Theodore, A. R., Shulund, D., Linda , S., & Tim , C. (2008). Minimizing Bird Collisions: What Works for the Birds and What Works for the Utility? In J. W. Goodrich-Mahoney, J. L. Ballard, & S. M. Tikalsky (Ed.), *Environmental Concerns in Rights-of-Way Management:Eighth International*

Symposium (pp. 331-335). Elsevier B.V.

Carol, & Inskipp, T. (2003). *Bird Conservation Priorities of the Annapurna Conservation Area.* Lazimpat, Kathmandu: Bird Conservation Nepal.

CBS. (2012). *National Population and Housing Census 2011 (Village Development Comittee/Municipality).* Kathmandu, Nepal: Government of Nepal, National Planning Comission Secratariat, Central Burea of Statistics.

CBS. (2012). *National Population and Housing Census 2011: National Report.* Kathmandu, Nepal: Central Burea of Statistics, National Planning Commission Secratariat, Government of Nepal.

Dhakal, H., Sharma, H. P., & Chaudhary, A. (2013). Status of vulture species visiting a Vulture Safe Feeding Site (Rupandehi) for carcass feeding in different seasons, Nepal. *Ibisbill Journal of Himalayan Ornithology, 1*(2), 119-125.

Dinerstein, E., Loucks, C., Heydlauff, A., Wikramanayake, E., Bryja, G., Forrest, J., et al. (2006). *Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005–2015. A User's Guide.* Washington, D.C. – New York: WWF, WCS, Smithsonian, and NFWF-STF.

DMG. (2010). Landslide Hazard Zonation Map of Parts of Myagdi, Baglung, Parbat and Kaski Districts. Lainchaur, Kathmandu: Department of Mines and Geology, Ministry of Industry, Government of Nepal.

EPA. (2011). *Irelands Plan on Action for Climate Change*. Retrieved 06 13, 2011, from Change CMT Calculator : http://cmt.epa.ie/Global/CMT/emission_factor_sources.pdf

FAO. (2006, September 14). New Local Climmate Estimator 1.10. Rome, Italy.

Federation, N. W. (2010). *Save The Tiger Fund*. Retrieved October 29, 2010, from Priority Tiger Conservation Landscapes: http://www.google.com/url?q=http%3A%2F%2Fwww.savethetigerfund.org%2FContent%2FNavigationMenu2%2FApply%2FLandscapelevelConservation%2Fdefault.htm&sa=D&sntz=1&usg=AFQjCNHiKDGdVLWqD4984zqCywcMINGnnA

Gautam, A. P., Thapa, B. R., Pandit, B. H., Dhungana, B. M., Tiwari, K. R., Neupane, M. P., et al. (2012). *Chitwan Annapurna Landscape: A Rapid*

Assessment. Kathmandu: Kathmandu, Forestry College, WWF.

Giri, J. B. (2013). Population of Lammergeier Gypaetus barbatus in Lower Mustang Nepal. *Ibisbill Journal of Himalayan Ornithology, 1*(2), 114-118.

HMG. (1993). Geological Map of Nepal. (K. M. Amatya, B. M. Jnawali, P. L. Shrestha, N. D. Makse, & P. Hoppe, Compilers) Survey Department, Kathmandu, Nepal.

ICIMOD. (2003). *Districts of Nepal, Indicators of Development Update.* Kathmandu, Nepal: ICIMOD and CBS.

ICIMOD. (2013). *Nepal Forest Fire*. Retrieved August 1, 2013, from Mountain GeoPortal: http://apps.geoportal.icimod.org/NepalForestFire/#

ICIMOD. (n.d.). *Mountain Environment and Natural Resources Information (MENRIS)*. Retrieved November 16, 2010, from Mountain GeoPortal: http://geoportal.icimod.org/

ICIMOD, UNEP RRC.AP. (2002). *Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods Monitoring and Early Warning Systems in the Hindu Kush-Himalayan Region Nepal*. (P. Mool, S. R. Bajracharya, S. P. Joshi, K. Shakya, & A. Baidya, Producers) Retrieved July 29, 2013, from http://www.rrcap.ait.asia/glofnepal/guide/movie.html

International, B. (2011). *Flyways Factsheet: Central Asia/South Asia.* Retrieved July 12, 2011, from http://www.birdlife.org/datazone/userfiles/file/sowb/flyways/7_Central_Asia_Factsheet.pdf

IUCN. (2010). *The IUCN Red List of Threatened Species*. Retrieved October 14, 2010, from http://www.iucnredlist.org

Karki, J. B. (2009). *Tiger and Their Base Prey Abundance in Terai Arc Landscape Nepal downloaded on November 28, 2010 from http://www.dnpwc.gov.np/publication.asp.* Kathmandu: Department of Natonal Park and Wildlife Conservation, MoFSC, Department of Forest and WWF Nepal Program.

Karki, J. B. (2011). Occupancy and abundance of Tigers and theire prey in the

Terai Arc Landscape, Nepal. *Thesis*. Derhadun, India: Forest Research Insittute University, Wildlife Institute of India.

KC, B. K. (2003). *Central Burea of Statistics.* Retrieved 06 08, 2011, from Population Monograph of Nepal: http://cbs.gov.np/?p=502

Martin, G. R., & Shaw, J. M. (2010, November). Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation, 143*(11), 2695-2702.

Maryland, N. o. (2002). *MODIS Hotspot / Active Fire Detections. Data set. MODIS Rapid Response Project*. (NASA/GSFC, Producer, & University of Maryland) Retrieved July 31, 2013, from Available on-line [http://maps.geog.umd.edu]

MFSC/GEF/UNDP. (2002). *Nepal Biodiversity Strategy.* Kathmandu: Ministry of Forests and Soil Conservation supported by Global Environment Facility and UNDP cited by Batu Krishna Upreti in 2003.

Ministry of Energy, G. o. (2009). *Twenty Years Hydro Electricity Development Plan.* Singha Durbar, Kathmandu: Ministry of Energy Sownloaded on November 25, 2010. https://docs.google.com/viewer?url=http://www.moen.gov.np/pdf_files/Twenty-Year-Task-Force-Report_merged.pdf.

MoFSc, & Nepal, W. (2007). *Western Terai Landscape Complex Project for Churia Region.* Kathmandu: Ministry of Forest and Soil Conservation, Nepal.

MoFSc, DOSC. (2005). *District-wise Watershed Information Book.* Kathmandu: His Majesty's Government, Department of Soil Conservation and Watershed Management.

Mulligan, M. (2005). *Google Earth*. Retrieved 05 28, 2011, from Earth Gallery: http://earth.google.com/gallery/kmz/forest_cover_change.kmz

Nakarmi, A. M. (2013). Power Requirements in Future Energy Scenarios of Nepal. *Power Summit 2013: Hastening pace of hydropower development.* Kathmandu: IPPAN.

NEA. (2010). *Detailed Survey of Kaligandaki 220/132 kV Transmission Line Corridor Project.* Kathmandu: NEA, Engineering Services, Project Development

Department, Ratnapark, Kathmandu.

Neelam Kumar Sharma, S. R. (2008). *Village Development Committee: Profile of Nepal.* Kathmandu: Upahar Offset Press.

NPC. (July, 2010). *The Food Security Atlas of Nepal.* Kathmandu, Nepal: Food Security Monitoring Task Force, National Planning Commission, Government of Nepal, WFP and NDRI.

NSC, D. o. (2013). *National Seismological Centre (NSC)*. Retrieved July 15, 2013, from Past Earthquakes: http://www.seismonepal.gov.np/

NTNC. (2008). *Management Plan of Annapurna Conservation Area (2009-2012).* Jawlakhel, Lalitpur: National Trust for Nature Conservation.

NTNC. (2009). *Scoping Study to Develop Gaurishankar into a Protected Area.* Lalitpur: NTNC.

Pokharel, S. (2004). Energy economics of cooking in households in Nepal. *Energy, 29*, 547-559.

Poudyal, M. B. (2002). Mitigation, Management and Floods in South Asia. In *Mitigation, Management and Control of Floods in South Asia Volume One* (Vol. 1, pp. 51-52). Nairobi: UN-HABITAT, UNEP.

Pradeep K Mool, P. R. (2011). *Glacial Lakes and Glacial Lake Outburst Floods in Nepal.* (G. R. Isabella Khadka, Ed.) Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD).

Pradhan, B. K. (2007). *Disaster Preparedness for Natural Hazards: Current Status in Nepal.* Kathmandu, Nepal: ICIMOD.

Sanderson, E., Forrest, J., Loucks, C., Ginsberg, J., Dinerstein, E., Seidensticker, J., et al. (2006). *Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005-2015. The Technical Assessment.* New York – Washington, D.C.: WCS, WWF, Smithsonian, and NFWF-STF.

Sharma, S. (2013). Modelling of trekking routes and their impacts on Galliformes: a case study from the Annapurna Conservation Area, Nepal. *Ibisbill Journa of Himalayan Ornithology, 1*(2), 55-65.

Shrestha, A. B., & Bajracharya, S. R. (2013). *Case Studies on Flash Flood Risk Management in the Himalayas: In support of specific flash flood policies.* (A. B. Shrestha, & S. R. Bajracharya, Eds.) Kathmandu, Nepal: ICIMOD.

TISC. (2010). *Forest and Vegetation Types of Nepal.* Hattisar, Kathmandu: Tree Improvement and Silviculture Component, Department of Forest, Ministry of Forest and Soil Conservation, Government of Nepal.

UNEP, GEF. (2008). *Solar Wind Energy Resource Assessment in Nepal (SWERA).* Khumaltar, Lalitpur, Nepal: AEPC, Government Nepal, Ministry of Environment, Science and Technology.

Uprety, B. K. (2003). *Safeguarding the Resources Environmental Impact Assessment: Process and Practice.* Kathmandu: Mrs Uttara Uprety.

W.W. BELL, T. D. (2011). *TSHO ROLPA GLOF WARNING SYSTEM PROJECT*. Retrieved May 13, 2011, from The International Association for Hydro-Environment Engineering and Research: http://www.iahr.org/membersonly/grazproceedings99/doc/000/000/175.htm

Appendix 1: Important Flora and Fauna

Table 1: List of Bird Species found in Annapurna Conservation Area
Annapurna Conservation Area
Central coordinates 84° 0.00' East 28° 32.00' North
Area 762,900 ha

Species	Season	Population estimate	IBA Criteria	IUCN Category
Snow Partridge *Lerwa lerwa*	resident	present [units unknown]	A3	Least Concern
Tibetan Snowcock *Tetraogallus tibetanus*	resident	frequent [units unknown]	A3	Least Concern
Himalayan Snowcock *Tetraogallus himalayensis*	resident	present [units unknown]	A3	Least Concern
Tibetan Partridge *Perdix hodgsoniae*	resident	present [units unknown]	A3	Least Concern
Hill Partridge *Arborophila torqueola*	resident	frequent [units unknown]	A3	Least Concern
Rufous-throated Partridge *Arborophila rufogularis*	resident	rare [units unknown]	A3	Least Concern
Blood Pheasant *Ithaginis cruentus*	resident	frequent [units unknown]	A3	Least Concern
Satyr Tragopan *Tragopan satyra*	resident	uncommon [units unknown]	A1	Near Threatened
Koklass Pheasant *Pucrasia macrolopha*	resident	frequent [units unknown]	A3	Least Concern
Himalayan Monal *Lophophorus impejanus*	resident	frequent [units unknown]	A3	Least Concern
Cheer Pheasant *Catreus wallichi*	resident	frequent [units unknown]	A1, A2	Vulnerable
Ferruginous Duck *Aythya nyroca*	passage	uncommon [units unknown]	A1	Near Threatened
Lesser Kestrel *Falco naumanni*	passage	uncommon [units unknown]	A1	Least Concern
Pallas's Fish-eagle *Haliaeetus leucoryphus*	passage	rare [units unknown]	A1	Vulnerable
White-rumped Vulture *Gyps bengalensis*	resident	rare [units unknown]	A1	Critically Endangered
Slender-billed Vulture *Gyps tenuirostris*	breeding	rare [units unknown]	A1	Critically Endangered
Himalayan Vulture *Gyps himalayensis*	resident	common [units unknown]	A3	Least Concern
Red-headed Vulture *Sarcogyps calvus*	resident	rare [units unknown]	A1	Critically Endangered
Cinereous Vulture *Aegypius monachus*	winter	rare [units unknown]	A1	Near Threatened
Pallid Harrier *Circus macrourus*	passage	rare [units unknown]	A1	Near Threatened
Greater Spotted Eagle *Aquila clanga*	passage	frequent [units unknown]	A1	Vulnerable
Eastern Imperial Eagle *Aquila heliaca*	passage	rare [units unknown]	A1	Vulnerable
Ibisbill *Ibidorhyncha struthersii*	unknown	present [units unknown]	A3	Least Concern
Wood Snipe *Gallinago nemoricola*	breeding	rare [units unknown]	A1, A3	Vulnerable
Snow Pigeon *Columba leuconota*	unknown	present [units unknown]	A3	Least Concern
Speckled Wood-pigeon *Columba hodgsonii*	resident	uncommon [units unknown]	A3	Least Concern
Slaty-headed Parakeet *Psittacula himalayana*	resident	common [units unknown]	A3	Least Concern
Asian Emerald Cuckoo *Chrysococcyx maculatus*	unknown	unknown [units	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
		unknown]		
Golden-throated Barbet *Megalaima franklinii*	resident	uncommon [units unknown]	A3	Least Concern
Blue-throated Barbet *Megalaima asiatica*	resident	frequent [units unknown]	A3	Least Concern
Yellow-rumped Honeyguide *Indicator xanthonotus*	resident	uncommon [units unknown]	A3	Near Threatened
Darjeeling Woodpecker *Dendrocopos darjellensis*	resident	frequent [units unknown]	A3	Least Concern
Bay Woodpecker *Blythipicus pyrrhotis*	resident	rare [units unknown]	A3	Least Concern
Black-winged Cuckooshrike *Coracina melaschistos*	unknown	unknown [units unknown]	A3	Least Concern
Short-billed Minivet *Pericrocotus brevirostris*	resident	rare [units unknown]	A3	Least Concern
Grey-backed Shrike *Lanius tephronotus*	resident	frequent [units unknown]	A3	Least Concern
Maroon Oriole *Oriolus traillii*	resident	frequent [units unknown]	A3	Least Concern
Black-headed Jay *Garrulus lanceolatus*	resident	uncommon [units unknown]	A3	Least Concern
Gold-billed Magpie *Urocissa flavirostris*	resident	common [units unknown]	A3	Least Concern
Grey Treepie *Dendrocitta formosae*	resident	common [units unknown]	A3	Least Concern
Yellow-billed Chough *Pyrrhocorax graculus*	resident	common [units unknown]	A3	Least Concern
Dark-grey Tit *Parus rufonuchalis*	resident	uncommon [units unknown]	A3	Least Concern
Rufous-vented Tit *Parus rubidiventris*	resident	common [units unknown]	A3	Least Concern
Coal Tit *Parus ater*	resident	common [units unknown]	A3	Least Concern
Grey-crested Tit *Parus dichrous*	resident	common [units unknown]	A3	Least Concern
Green-backed Tit *Parus monticolus*	resident	common [units unknown]	A3	Least Concern
Yellow-browed Tit *Sylviparus modestus*	resident	common [units unknown]	A3	Least Concern
Nepal House-martin *Delichon nipalense*	resident	frequent [units unknown]	A3	Least Concern
Black-throated Tit *Aegithalos concinnus*	resident	common [units unknown]	A3	Least Concern
White-throated Tit *Aegithalos niveogularis*	winter	rare [units unknown]	A2	Least Concern
Black-browed Tit *Aegithalos iouschistos*	resident	uncommon [units unknown]	A3	Least Concern
White-browed Tit-warbler *Leptopoecile sophiae*	resident	uncommon [units unknown]	A3	Least Concern
Striated Prinia *Prinia crinigera*	resident	common [units unknown]	A3	Least Concern
Striated Bulbul *Pycnonotus striatus*	resident	uncommon [units unknown]	A3	Least Concern
Himalayan Bulbul *Pycnonotus leucogenys*	resident	common [units unknown]	A3	Least Concern
Mountain Bulbul *Hypsipetes mcclellandii*	resident	frequent [units unknown]	A3	Least Concern
Asian Black Bulbul *Hypsipetes leucocephalus*	resident	common [units unknown]	A3	Least Concern
Chestnut-headed Tesia *Tesia castaneocoronata*	resident	frequent [units unknown]	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
Grey-bellied Tesia *Tesia cyaniventer*	resident	uncommon [units unknown]	A3	Least Concern
Chestnut-crowned Bush-warbler *Cettia major*	breeding	rare [units unknown]	A3	Least Concern
Aberrant Bush-warbler *Cettia flavolivacea*	resident	common [units unknown]	A3	Least Concern
Hume's Bush-warbler *Cettia brunnescens*	breeding	rare [units unknown]	A3	Least Concern
Grey-sided Bush-warbler *Cettia brunnifrons*	resident	common [units unknown]	A3	Least Concern
Smoky Warbler *Phylloscopus fuligiventer*	breeding	rare [units unknown]	A3	Least Concern
Tickell's Leaf-warbler *Phylloscopus affinis*	resident	frequent [units unknown]	A3	Least Concern
Sulphur-bellied Warbler *Phylloscopus griseolus*	unknown	present [units unknown]	A3	Least Concern
Buff-barred Warbler *Phylloscopus pulcher*	resident	common [units unknown]	A3	Least Concern
Ashy-throated Warbler *Phylloscopus maculipennis*	resident	common [units unknown]	A3	Least Concern
Large-billed Leaf-warbler *Phylloscopus magnirostris*	breeding	uncommon [units unknown]	A3	Least Concern
Grey-hooded Warbler *Phylloscopus xanthoschistos*	resident	common [units unknown]	A3	Least Concern
Grey-cheeked Warbler *Seicercus poliogenys*	resident	rare [units unknown]	A3	Least Concern
Black-faced Warbler *Abroscopus schisticeps*	resident	frequent [units unknown]	A3	Least Concern
Rusty-cheeked Scimitar-babbler *Pomatorhinus erythrogenys*	resident	common [units unknown]	A3	Least Concern
Slender-billed Scimitar-babbler *Xiphirhynchus superciliaris*	resident	rare [units unknown]	A3	Least Concern
Scaly-breasted Wren-babbler *Pnoepyga albiventer*	resident	frequent [units unknown]	A3	Least Concern
Nepal Wren-babbler *Pnoepyga immaculata*	resident	rare [units unknown]	A2	Least Concern
Rufous-capped Babbler *Stachyris ruficeps*	unknown	unknown [units unknown]	A3	Least Concern
Black-chinned Babbler *Stachyris pyrrhops*	resident	frequent [units unknown]	A3	Least Concern
Spiny Babbler *Turdoides nipalensis*	resident	frequent [units unknown]	A2	Least Concern
White-throated Laughingthrush *Garrulax albogularis*	resident	common [units unknown]	A3	Least Concern
Striated Laughingthrush *Garrulax striatus*	resident	common [units unknown]	A3	Least Concern
Rufous-chinned Laughingthrush *Garrulax rufogularis*	resident	uncommon [units unknown]	A3	Least Concern
Spotted Laughingthrush *Garrulax ocellatus*	resident	frequent [units unknown]	A3	Least Concern
Grey-sided Laughingthrush *Garrulax caerulatus*	resident	rare [units unknown]	A3	Least Concern
Streaked Laughingthrush *Garrulax lineatus*	resident	common [units unknown]	A3	Least Concern
Blue-winged Laughingthrush *Garrulax squamatus*	resident	rare [units unknown]	A3	Least Concern
Scaly Laughingthrush *Garrulax subunicolor*	resident	uncommon [units unknown]	A3	Least Concern
Variegated Laughingthrush *Garrulax variegatus*	resident	common [units unknown]	A3	Least Concern
Black-faced Laughingthrush *Garrulax affinis*	resident	common [units unknown]	A3	Least Concern
Red-billed Leiothrix *Leiothrix lutea*	resident	frequent [units unknown]	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
Himalayan Cutia *Cutia nipalensis*	resident	rare [units unknown]	A3	Least Concern
Black-headed Shrike-babbler *Pteruthius rufiventer*	resident	rare [units unknown]	A3	Least Concern
Green Shrike-babbler *Pteruthius xanthochlorus*	resident	uncommon [units unknown]	A3	Least Concern
Rusty-fronted Barwing *Actinodura egertoni*	unknown	unknown [units unknown]	A3	Least Concern
Hoary-throated Barwing *Actinodura nipalensis*	resident	frequent [units unknown]	A2	Least Concern
Blue-winged Minla *Minla cyanouroptera*	resident	frequent [units unknown]	A3	Least Concern
Chestnut-tailed Minla *Minla strigula*	resident	common [units unknown]	A3	Least Concern
Red-tailed Minla *Minla ignotincta*	resident	uncommon [units unknown]	A3	Least Concern
Golden-breasted Fulvetta *Alcippe chrysotis*	resident	frequent [units unknown]	A3	Least Concern
Yellow-throated Fulvetta *Alcippe cinerea*	unknown	unknown [units unknown]	A3	Least Concern
White-browed Fulvetta *Alcippe vinipectus*	resident	common [units unknown]	A3	Least Concern
Nepal Fulvetta *Alcippe nipalensis*	resident	uncommon [units unknown]	A3	Least Concern
Rufous-backed Sibia *Heterophasia annectens*	unknown	unknown [units unknown]	A3	Least Concern
Rufous Sibia *Heterophasia capistrata*	resident	common [units unknown]	A3	Least Concern
Stripe-throated Yuhina *Yuhina gularis*	resident	common [units unknown]	A3	Least Concern
Rufous-vented Yuhina *Yuhina occipitalis*	resident	common [units unknown]	A3	Least Concern
Great Parrotbill *Conostoma oemodium*	resident	uncommon [units unknown]	A3	Least Concern
Brown Parrotbill *Paradoxornis unicolor*	resident	uncommon [units unknown]	A3	Least Concern
Fulvous Parrotbill *Paradoxornis fulvifrons*	resident	uncommon [units unknown]	A3	Least Concern
Fire-tailed Myzornis *Myzornis pyrrhoura*	resident	rare [units unknown]	A3	Least Concern
White-tailed Nuthatch *Sitta himalayensis*	resident	common [units unknown]	A3	Least Concern
Bar-tailed Treecreeper *Certhia himalayana*	resident	frequent [units unknown]	A3	Least Concern
Rusty-flanked Treecreeper *Certhia nipalensis*	resident	frequent [units unknown]	A3	Least Concern
Long-billed Thrush *Zoothera monticola*	resident	uncommon [units unknown]	A3	Least Concern
Tickell's Thrush *Turdus unicolor*	breeding	uncommon [units unknown]	A3	Least Concern
White-collared Blackbird *Turdus albocinctus*	resident	frequent [units unknown]	A3	Least Concern
Grey-winged Blackbird *Turdus boulboul*	resident	frequent [units unknown]	A3	Least Concern
White-tailed Rubythroat *Luscinia pectoralis*	breeding	uncommon [units unknown]	A3	Least Concern
Indian Blue Robin *Luscinia brunnea*	breeding	frequent [units unknown]	A3	Least Concern
Golden Bush-robin *Tarsiger chrysaeus*	resident	uncommon [units unknown]	A3	Least Concern
White-browed Bush-robin *Tarsiger indicus*	resident	uncommon [units	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
		unknown]		
Rufous-breasted Bush-robin *Tarsiger hyperythrus*	resident	uncommon [units unknown]	A3	Least Concern
Blue-capped Redstart *Phoenicurus caeruleocephala*	resident	frequent [units unknown]	A3	Least Concern
White-throated Redstart *Phoenicurus schisticeps*	resident	uncommon [units unknown]	A3	Least Concern
White-bellied Redstart *Hodgsonius phaenicuroides*	breeding	uncommon [units unknown]	A3	Least Concern
White-tailed Robin *Cinclidium leucurum*	resident	uncommon [units unknown]	A3	Least Concern
Grandala *Grandala coelicolor*	unknown	frequent [units unknown]	A3	Least Concern
Slaty-backed Forktail *Enicurus schistaceus*	resident	frequent [units unknown]	A3	Least Concern
Blue-capped Rock-thrush *Monticola cinclorhynchus*	breeding	uncommon [units unknown]	A3	Least Concern
Rusty-tailed Flycatcher *Muscicapa ruficauda*	breeding	uncommon [units unknown]	A3	Least Concern
Ferruginous Flycatcher *Muscicapa ferruginea*	breeding	rare [units unknown]	A3	Least Concern
Rufous-gorgeted Flycatcher *Ficedula strophiata*	resident	common [units unknown]	A3	Least Concern
White-gorgeted Flycatcher *Ficedula monileger*	resident	rare [units unknown]	A3	Least Concern
Ultramarine Flycatcher *Ficedula superciliaris*	breeding	common [units unknown]	A3	Least Concern
Slaty-blue Flycatcher *Ficedula tricolor*	resident	common [units unknown]	A3	Least Concern
Small Niltava *Niltava macgrigoriae*	breeding	frequent [units unknown]	A3	Least Concern
Rufous-bellied Niltava *Niltava sundara*	resident	common [units unknown]	A3	Least Concern
Orange-bellied Leafbird *Chloropsis hardwickii*	resident	uncommon [units unknown]	A3	Least Concern
Yellow-bellied Flowerpecker *Dicaeum melanoxanthum*	resident	uncommon [units unknown]	A3	Least Concern
Black-throated Sunbird *Aethopyga saturata*	resident	uncommon [units unknown]	A3	Least Concern
Fire-tailed Sunbird *Aethopyga ignicauda*	resident	frequent [units unknown]	A3	Least Concern
Black-winged Snowfinch *Montifringilla adamsi*	resident	present [units unknown]	A3	Least Concern
White-rumped Snowfinch *Montifringilla taczanowskii*	unknown	present [units unknown]	A3	Least Concern
Plain-backed Snowfinch *Montifringilla blanfordi*	unknown	present [units unknown]	A3	Least Concern
Rufous-breasted Accentor *Prunella strophiata*	resident	frequent [units unknown]	A3	Least Concern
Brown Accentor *Prunella fulvescens*	unknown	frequent [units unknown]	A3	Least Concern
Rosy Pipit *Anthus roseatus*	breeding	frequent [units unknown]	A3	Least Concern
Yellow-breasted Greenfinch *Carduelis spinoides*	resident	common [units unknown]	A3	Least Concern
Plain Mountain-finch *Leucosticte nemoricola*	resident	common [units unknown]	A3	Least Concern
Spectacled Finch *Callacanthis burtoni*	unknown	uncommon [units unknown]	A2	Least Concern
Dark-breasted Rosefinch *Carpodacus nipalensis*	resident	frequent [units unknown]	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
Beautiful Rosefinch *Carpodacus pulcherrimus*	resident	common [units unknown]	A3	Least Concern
Pink-browed Rosefinch *Carpodacus rodochroa*	resident	frequent [units unknown]	A3	Least Concern
Vinaceous Rosefinch *Carpodacus vinaceus*	unknown	rare [units unknown]	A3	Least Concern
Dark-rumped Rosefinch *Carpodacus edwardsii*	unknown	unknown [units unknown]	A3	Least Concern
Spot-winged Rosefinch *Carpodacus rodopeplus*	resident	frequent [units unknown]	A3	Least Concern
White-browed Rosefinch *Carpodacus thura*	resident	frequent [units unknown]	A3	Least Concern
Great Rosefinch *Carpodacus rubicilla*	resident	uncommon [units unknown]	A3	Least Concern
Red-fronted Rosefinch *Carpodacus puniceus*	unknown	uncommon [units unknown]	A3	Least Concern
Crimson-browed Finch *Pinicola subhimachala*	unknown	uncommon [units unknown]	A3	Least Concern
Scarlet Finch *Haematospiza sipahi*	resident	uncommon [units unknown]	A3	Least Concern
Brown Bullfinch *Pyrrhula nipalensis*	resident	uncommon [units unknown]	A3	Least Concern
Red-headed Bullfinch *Pyrrhula erythrocephala*	resident	frequent [units unknown]	A3	Least Concern
Collared Grosbeak *Mycerobas affinis*	resident	frequent [units unknown]	A3	Least Concern
Spot-winged Grosbeak *Mycerobas melanozanthos*	resident	rare [units unknown]	A3	Least Concern
White-winged Grosbeak *Mycerobas carnipes*	resident	frequent [units unknown]	A3	Least Concern
Gold-naped Finch *Pyrrhoplectes epauletta*	resident	rare [units unknown]	A3	Least Concern

Source: BirdLife International (2013) Important Bird Areas factsheet: Annapurna Conservation Area. Downloaded from http://www.birdlife.org on 08/08/2013

Table 2: List of Bird Species found in Farmlands in Lumbini area

Farmlands in Lumbini area
Central coordinates 83° 17.00' East 27° 29.00' North
Area 141,367 ha

Species	Season	Population estimate	IBA Criteria	IUCN Category
Indian Peafowl *Pavo cristatus*	unknown	present [units unknown]	A3	Least Concern
Painted Stork *Mycteria leucocephala*	non-breeding	rare [units unknown]	A1	Near Threatened
Lesser Adjutant *Leptoptilos javanicus*	unknown	frequent [units unknown]	A1, A4i	Vulnerable
Black-headed Ibis *Threskiornis melanocephalus*	non-breeding	rare [units unknown]	A1	Near Threatened
Red-naped Ibis *Pseudibis papillosa*	unknown	present [units unknown]	A3	Least Concern
Pallas's Fish-eagle *Haliaeetus leucoryphus*	passage	unknown [units unknown]	A1	Vulnerable
White-rumped Vulture *Gyps bengalensis*	resident	uncommon [units unknown]	A1, A3	Critically Endangered
Slender-billed Vulture *Gyps tenuirostris*	resident	uncommon [units unknown]	A1, A3	Critically Endangered
Red-headed Vulture *Sarcogyps calvus*	unknown	present [units	A3	Critically

Species	Season	Population estimate	IBA Criteria	IUCN Category
		unknown]		Endangered
Cinereous Vulture *Aegypius monachus*	passage	rare [units unknown]	A1	Near Threatened
White-eyed Buzzard *Butastur teesa*	unknown	present [units unknown]	A3	Least Concern
Indian Spotted Eagle *Aquila hastata*	resident	rare [units unknown]	A1	Vulnerable
Sarus Crane *Grus antigone*	resident	common [units unknown]	A1, A4i	Vulnerable
Yellow-footed Green-pigeon *Treron phoenicopterus*	unknown	present [units unknown]	A3	Least Concern
Plum-headed Parakeet *Psittacula cyanocephala*	unknown	present [units unknown]	A3	Least Concern
Indian Grey Hornbill *Ocyceros birostris*	unknown	present [units unknown]	A3	Least Concern
Lineated Barbet *Megalaima lineata*	unknown	present [units unknown]	A3	Least Concern
Yellow-crowned Woodpecker *Dendrocopos mahrattensis*	unknown	present [units unknown]	A3	Least Concern
Black-rumped Flameback *Dinopium benghalense*	unknown	present [units unknown]	A3	Least Concern
Common Woodshrike *Tephrodornis pondicerianus*	unknown	present [units unknown]	A3	Least Concern
Small Minivet *Pericrocotus cinnamomeus*	unknown	present [units unknown]	A3	Least Concern
White-bellied Drongo *Dicrurus caerulescens*	unknown	present [units unknown]	A3	Least Concern
White-browed Fantail *Rhipidura aureola*	unknown	present [units unknown]	A3	Least Concern
Rufous-winged Lark *Mirafra assamica*	unknown	present [units unknown]	A3	Least Concern
Indian Short-toed Lark *Calandrella raytal*	unknown	present [units unknown]	A3	Least Concern
Ashy-crowned Sparrow-lark *Eremopterix griseus*	unknown	present [units unknown]	A3	Least Concern
Bristled Grassbird *Chaetornis striata*	breeding	rare [units unknown]	A1	Vulnerable
Large Grey Babbler *Turdoides malcolmi*	unknown	present [units unknown]	A3	Least Concern
Jungle Babbler *Turdoides striata*	unknown	present [units unknown]	A3	Least Concern
Bank Myna *Acridotheres ginginianus*	unknown	present [units unknown]	A3	Least Concern
Chestnut-tailed Starling *Sturnus malabaricus*	unknown	present [units unknown]	A3	Least Concern
Brahminy Starling *Sturnus pagodarum*	unknown	present [units unknown]	A3	Least Concern
Indian Robin *Saxicoloides fulicatus*	unknown	present [units unknown]	A3	Least Concern
White-throated Bushchat *Saxicola insignis*	passage	rare [units unknown]	A1	Vulnerable
Yellow-breasted Bunting *Emberiza aureola*	winter	unknown [units unknown]	A1	Vulnerable

Source: BirdLife International (2013) Important Bird Areas factsheet: Farmlands in Lumbini Area. Downloaded from http://www.birdlife.org on 08/08/2013

Table 3: List of Bird Species found in Shivapuri-Nagarjun National Park
Shivapuri-Nagarjun National Park
Central coordinates 85° 20.00' East 27° 48.00' North
Area 15,900 ha

Species	Season	Population estimate	IBA Criteria	IUCN Category
Hill Partridge *Arborophila torqueola*	resident	uncommon [units unknown]	A3	Least Concern
Speckled Wood-pigeon *Columba hodgsonii*	unknown	present [units unknown]	A3	Least Concern
Golden-throated Barbet *Megalaima franklinii*	resident	uncommon [units unknown]	A3	Least Concern
Darjeeling Woodpecker *Dendrocopos darjellensis*	resident	uncommon [units unknown]	A3	Least Concern
Maroon Oriole *Oriolus traillii*	resident	uncommon [units unknown]	A3	Least Concern
Grey Treepie *Dendrocitta formosae*	resident	common [units unknown]	A3	Least Concern
Green-backed *Tit Parus monticolus*	resident	common [units unknown]	A3	Least Concern
Yellow-browed Tit *Sylviparus modestus*	resident	common [units unknown]	A3	Least Concern
Black-throated Tit *Aegithalos concinnus*	resident	common [units unknown]	A3	Least Concern
Himalayan Bulbul *Pycnonotus leucogenys*	resident	common [units unknown]	A3	Least Concern
Mountain Bulbul *Hypsipetes mcclellandii*	resident	common [units unknown]	A3	Least Concern
Asian Black Bulbul *Hypsipetes leucocephalus*	resident	common [units unknown]	A3	Least Concern
Hume's Bush-warbler *Cettia brunnescens*	resident	uncommon [units unknown]	A3	Least Concern
Buff-barred Warbler *Phylloscopus pulcher*	resident	common [units unknown]	A3	Least Concern
Grey-hooded Warbler *Phylloscopus xanthoschistos*	resident	common [units unknown]	A3	Least Concern
Black-faced Warbler *Abroscopus schisticeps*	resident	frequent [units unknown]	A3	Least Concern
Rusty-cheeked Scimitar-babbler *Pomatorhinus erythrogenys*	resident	common [units unknown]	A3	Least Concern
Black-chinned Babbler *Stachyris pyrrhops*	resident	common [units unknown]	A3	Least Concern
Spiny Babbler *Turdoides nipalensis*	resident	frequent [units unknown]	A2	Least Concern
White-throated Laughingthrush *Garrulax albogularis*	resident	common [units unknown]	A3	Least Concern
Striated Laughingthrush *Garrulax striatus*	resident	common [units unknown]	A3	Least Concern
Rufous-chinned Laughingthrush *Garrulax rufogularis*	resident	uncommon [units unknown]	A3	Least Concern
Grey-sided Laughingthrush *Garrulax caerulatus*	resident	rare [units unknown]	A3	Least Concern
Streaked Laughingthrush *Garrulax lineatus*	resident	uncommon [units unknown]	A3	Least Concern
Red-billed Leiothrix *Leiothrix lutea*	resident	uncommon [units unknown]	A3	Least Concern
Green Shrike-babbler *Pteruthius xanthochlorus*	resident	uncommon [units unknown]	A3	Least Concern
Hoary-throated Barwing *Actinodura nipalensis*	resident	frequent [units unknown]	A2	Least Concern
Chestnut-tailed Minla *Minla strigula*	resident	common [units	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
		unknown]		
Red-tailed Minla *Minla ignotincta*	resident	frequent [units unknown]	A3	Least Concern
White-browed Fulvetta *Alcippe vinipectus*	resident	common [units unknown]	A3	Least Concern
Nepal Fulvetta *Alcippe nipalensis*	resident	frequent [units unknown]	A3	Least Concern
Rufous Sibia *Heterophasia capistrata*	resident	common [units unknown]	A3	Least Concern
Stripe-throated Yuhina *Yuhina gularis*	resident	common [units unknown]	A3	Least Concern
White-tailed Nuthatch *Sitta himalayensis*	resident	common [units unknown]	A3	Least Concern
Tickell's Thrush *Turdus unicolor*	breeding	uncommon [units unknown]	A3	Least Concern
Grey-winged Blackbird *Turdus boulboul*	resident	uncommon [units unknown]	A3	Least Concern
Blue-capped Rock-thrush *Monticola cinclorhynchus*	breeding	uncommon [units unknown]	A3	Least Concern
Ultramarine Flycatcher *Ficedula superciliaris*	breeding	uncommon [units unknown]	A3	Least Concern
Small Niltava *Niltava macgrigoriae*	resident	uncommon [units unknown]	A3	Least Concern
Rufous-bellied Niltava *Niltava sundara*	resident	uncommon [units unknown]	A3	Least Concern
Brown Bullfinch *Pyrrhula nipalensis*	resident	uncommon [units unknown]	A3	Least Concern

Source: BirdLife International (2013) Important Bird Areas factsheet: Shivapuri-Nagarjun National Park. Downloaded from http://www.birdlife.org on 08/12/2013

Table 4: List of Bird Species found in Bharandabhar Forest and Wetlands

Bharandabhar Forest and Wetlands
Central Coordinates 84^{o} 10.00' East 27^{o} 40.00' North
Area 12,300 ha
Protected Area Contained by the Site: Beeshazar and Associated Lakes (Ramsar Site)

Species	Season	Population estimate	IBA Criteria	IUCN Category
Indian Peafowl *Pavo cristatus*	unknown	present [units unknown]	A3	Least Concern
Ferruginous Duck *Aythya nyroca*	winter	rare [units unknown]	A1	Near Threatened
Painted Stork *Mycteria leucocephala*	breeding	rare [units unknown]	A1	Near Threatened
Black-necked Stork *Ephippiorhynchus asiaticus*	non-breeding	rare [units unknown]	A1	Near Threatened
Lesser Adjutant *Leptoptilos javanicus*	resident	frequent [units unknown]	A1, A4i	Vulnerable
Red-naped Ibis *Pseudibis papillosa*	unknown	present [units unknown]	A3	Least Concern
Oriental Darter *Anhinga melanogaster*	resident	present [units unknown]	A1, A4i	Near Threatened
Pallas's Fish-eagle *Haliaeetus leucoryphus*	winter	rare [units unknown]	A1	Vulnerable
Lesser Fish-eagle *Ichthyophaga humilis*	non-breeding	rare [units unknown]	A1	Near Threatened
Grey-headed Fish-eagle *Ichthyophaga ichthyaetus*	resident	frequent [units unknown]	A1	Near Threatened
White-rumped Vulture *Gyps bengalensis*	resident	unknown [units	A1, A3	Critically

Species	Season	Population estimate	IBA Criteria	IUCN Category
		unknown]		Endangered
Slender-billed Vulture *Gyps tenuirostris*	resident	unknown [units unknown]	A1, A3	Critically Endangered
Red-headed Vulture *Sarcogyps calvus*	non-breeding	unknown [units unknown]	A1	Critically Endangered
Cinereous Vulture *Aegypius monachus*	winter	rare [units unknown]	A1	Near Threatened
White-eyed Buzzard *Butastur teesa*	unknown	present [units unknown]	A3	Least Concern
Indian Spotted Eagle *Aquila hastata*	unknown	unknown [units unknown]	A1	Vulnerable
Greater Spotted Eagle *Aquila clanga*	winter	rare [units unknown]	A1	Vulnerable
Lesser Florican *Sypheotides indicus*	unknown	present [units unknown]	A3	Endangered
Black-bellied Tern *Sterna acuticauda*	non-breeding	rare [units unknown]	A1	Endangered
Yellow-footed Green-pigeon *Treron phoenicopterus*	unknown	present [units unknown]	A3	Least Concern
Plum-headed Parakeet *Psittacula cyanocephala*	unknown	present [units unknown]	A3	Least Concern
Sirkeer Malkoha *Phaenicophaeus leschenaultii*	unknown	present [units unknown]	A3	Least Concern
Indian Grey Hornbill *Ocyceros birostris*	unknown	present [units unknown]	A3	Least Concern
Great Hornbill *Buceros bicornis*	resident	rare [units unknown]	A1	Near Threatened
Brown-headed *Barbet Megalaima zeylanica*	unknown	present [units unknown]	A3	Least Concern
Lineated Barbet *Megalaima lineata*	unknown	present [units unknown]	A3	Least Concern
Yellow-crowned Woodpecker *Dendrocopos mahrattensis*	unknown	present [units unknown]	A3	Least Concern
Black-rumped Flameback *Dinopium benghalense*	unknown	present [units unknown]	A3	Least Concern
Ashy Woodswallow *Artamus fuscus*	unknown	present [units unknown]	A3	Least Concern
Common Woodshrike *Tephrodornis pondicerianus*	unknown	present [units unknown]	A3	Least Concern
Black-headed Cuckooshrike *Coracina melanoptera*	unknown	present [units unknown]	A3	Least Concern
Small Minivet *Pericrocotus cinnamomeus*	unknown	present [units unknown]	A3	Least Concern
White-bellied Drongo *Dicrurus caerulescens*	unknown	present [units unknown]	A3	Least Concern
White-browed Fantail *Rhipidura aureola*	unknown	present [units unknown]	A3	Least Concern
Rufous-winged Lark *Mirafra assamica*	unknown	present [units unknown]	A3	Least Concern
Indian Short-toed Lark *Calandrella raytal*	unknown	present [units unknown]	A3	Least Concern
Ashy-crowned Sparrow-lark *Eremopterix griseus*	unknown	present [units unknown]	A3	Least Concern
Jungle Prinia *Prinia sylvatica*	unknown	present [units unknown]	A3	Least Concern
Ashy Prinia *Prinia socialis*	unknown	present [units unknown]	A3	Least Concern
Tawny-bellied Babbler *Dumetia hyperythra*	unknown	present [units unknown]	A3	Least Concern
Jungle Babbler *Turdoides striata*	unknown	present [units unknown]	A3	Least Concern

Species	Season	Population estimate	IBA Criteria	IUCN Category
Bank Myna *Acridotheres ginginianus*	unknown	present [units unknown]	A3	Least Concern
Chestnut-tailed Starling *Sturnus malabaricus*	unknown	present [units unknown]	A3	Least Concern
Brahminy Starling *Sturnus pagodarum*	unknown	present [units unknown]	A3	Least Concern

Source: BirdLife International (2013) Important Bird Areas factsheet: Bharandabhar Forest and Wetlands. Downloaded from http://www.birdlife.org on 08/08/2013

Table 5: List of Important Protected Species in Annapurna Conservation Area

Common names	Scientific names	NPWC Act	NRDB(1995)	IUCN	CITES
Mammals					
Red panda	*Ailurus fulgens*	P	E	VU	I
Snow leopard	*Uncia uncia*	P	E	EN	I
Jungle cat	*Felis chaus*		S	LC	II
Leopard cat	*Prionailurus bengalensis*	P	V	LC	II
Golden cat	*Catopuma temminckii*		V	NT	I
Clouded leopard	*Pardofelis nebulosa*	P	V	VU	I
Marbled cat	*Pardofelis marmorata*		V	VU	I
Himalayan lynx	*Lynx lynx isabellinus*	P	E	LC	II
Forest leopard	*Panthera pardus*		S	NT	I
Dhole	*Cuon alpinus*		V	EN	II
Grey wolf	*Canis lupus*	P	V	LC	I
Red fox	*Vulpes vulpes*		S	LC	III
Tibetan sand fox	*Vulpes ferrilata*		S	LC	
Asiatic black bear	*Ursus thibetanus*		V	VU	I
Himalayan brown bear	*Ursus arctos*	P	V	LC	I
Indian flying fox	*Pteropus giganteus*			LC	II
Common otter	*Lutra lutra*		S	NT	I
Smooth-coated otter	*Lutrogale perspicillata*		S	VU	II
Spotted lingsang	*Prionodon pardicolor*	P		LC	I
Tibetan argali	*Ovis ammon hodgsoni*	P	C	NT	I
Tibetan gazelle	*Procapra picticaudata*			NT	
Tibetan wild ass	*Equus kiang kiang*			LC	II
Himalayan musk deer	*Moschus chrysogaster*	P	E	EN	I
Himalayan goral	*Naemorhedus goral*		S	NT	I
Mainland serow	*Narmorhedus sumatraensis*		S	NT	I
Chinese pangolin	*Manis pentadactyla*	P	S	EN	II
Assamese monkey	*Macaca assamensis*	P		NT	II
Rhesus monkey	*Macaca mulatta*		S	LC	II
Herpatofauna					
Indian bull frog	*Hoplobatrachus tigerinus*			LC	II
Mustang frog	*Paa rostandi*		S	VU	
Annapurna ground skink	*Asymblepharus capitaneus*		S		
Golden monitor	*Varanus flavescens*	P	S	LC	I
Burmese rock python	*Python bivittatus*	P	V	VU	I
Rat snake	*Ptyas mocosus mocosus*		S		II
King cobra	*Ophiophagus hannah*		V	VU	I

Source: (NTNC, 2008), (IUCN, 2013), Wikipedia, Birdlife International and CITES Appendix from 5th August 2013.
Legend: C= critical, E= endangered, S= susceptible, V= Vulnerable, P= protected, LC (IUCN)= least concern, EN= endangered, VU= vulnerable, CITES (I, II, III)= Appendices

Table 6: List of Important Protected Species in Annapurna Conservation Area

Nepali Name	Scientific Name	CITES Appendix	IUCN Red List	Forest Regulation 1995
Kutki	*Neopicrorhiza scrophularifollora*		listed	Protected
Talispatra	*Abies spectabilis*	-	NT	Protected
Panchaunle	*Dactylorhiza hatagirea*	-	-	Protected
Yarsagumba	*Cordyceps sinensis*	-	-	Protected
Unyu	*Cythia spinulosa*	II	-	-
Jatamansi	*Nardostachys grandiflora*		listed	Protected

Source: *(NTNC, 2008), (IUCN, 2013)*

Table 7: Protected Plant Species and Forest Products (Pursuant to Section 70 (kha) of the Forest Act 1993)

S.N	Scientific Name	Local Name	Family	IUCN Status	CITES Appendices
1	*Dactylorhiza hatagirea*	Panch Ounle	Orchidaceae		II
2	*Juglans regia* (only bark)	Okhar	Juglandaceae	NT	
3	*Picrorhiza scrophulariflora**	Kutki	Scrophulariaceae		
	Plants banned for export except processed in the country and permission issued from DOF along with the recommendation of DPR or HPPCL				
4	*Abies spectabilis*	Talis patra	Piniaceae		
5	*Cinnamomum glaucescens*	Sugandakokila	Lauraceae		
6	Lichens spp.	Jhyau			
7	*Nardostachys grandiflora*	Jatamansi	Valerianaceae		
8	*Rauvolfia serpentine*	Sarpganda	Apocynaceae	V	
		Harbaruwa		E	II
9	*Taxus baccata* subsp. *Wallichiana*	Loth salla	Valerianaceae		
10	*Valerianna jatamansi*	Sugandabala	Valerianaceae		II
	Forest product banned for export except processed in the country through boiling and extraction method permission issued from DOF along with the recommendation of DPR or HPPCL				
11	Asphaltum (rock exudate)	Silajit			
	Ban on export except processed in the country through steaming and packaging, and permission issued from DOF along with the recommendation of DPR or HPPCL				
12	*Cordyceps sinensis*	Yarsa gomba	Clavicipitaceae		
	Timber trees banned for felling, transportation and export for commercial purposes				
13	*Acacia catechu*	Khayer	Leguminosae		
14	*Bombax ceiba*	Simal	Bombacaceae		
15	*Dalbergia latifolia*	Satissal	Fabaceae		
16	*Juglans regia* (only of national forest)	Okhar	Juglandaceae		
17	*Michelia champaka*	Champ	Magnoliaceae		
	Michelia kisopa				
18	*Pterocarpus marsupium*	Bijaya Sal	Fabaceae		
19	*Shorea robusta*	Sal	Dipterocarpaceae		

Source: HMG, 2001. Nepal Gazette. Section 51 and No. 36, and Section 53 & No. 31), HMG press, Kathmandu (31 December 2001 (2058/9/16), and 17 November 2003 (2060/8/1). Cited by (Uprety, 2003)

Notes: This prohibition will not apply to trees to be felled as per the Operational Forest Management Plant, and of areas implementation of the national priority projects. DOF= Department of Forests; DPR= Department of Plant Resource, and HPPCL= Herbs Production and Processing Company Limited.

* Species to be specified and recommended fpr export by DPR, and availability to be considered by DOF before issuing license for export.

Table 8: Protected Wildlife under NPWC Act 1973 including their status

Scientific Name	Local Name	Common Name	IUCN Status	CITES Appendices
Mammals				
Ailurus fulgens	Habrey	Red Panda	V	III
Antilope cervicapra	Krishnasar	Black buck	NT	III
Bos gaurus	Gor budson	Gaur bison	V	I
Bos mutus	Yok nak	Wild Yak	E	I
Bubalus arnee	Arna	Wild water buffalo	E	III
Canis lupus	Bwanso	Grey wolf	V	I
Caprolagus hispidus	Hispid Kharayo	Hispid Hare	EN	I
Cervus duvauceli	Barasinghe	Swamp deer	VU	I
Elephas maximus	Hatti	Asiatic Elephant	EN	I
Felis lynx		Lynx	E	II
Hyaena hyaena	Hundar	Striped hyaena	NT	
Macaca assamensis	Asamese rato bander	Asamese monkey		
Manis crassicaudata	Salak	Indian pangolin		II
Manis pentadactyla	Salak	Chinese pangolin		II
Moschus chrysogaster	Kasturi mirga	Himalayan forest musk deer	EN	I
Ovis ammon	Nayan	Great Tibetan Sheep		I
Panthera tigris	Bagh	Bengal tiger	EN	I
Panthera uncial	Hiun chitwa	Snow Leopard	EN	I
Pantholops hodgsoni	Chiru	Tibetan Antelope		I
Pardofelis nebulosa	Dwanse chitwa	Clouded Leopard	VU	I
Platanista gangetica	Suns	Gangetic dolphin	EN	I
Prionailurus bengalensis	Chari bagh	Leopard cat		I
Prionodon pardicolor	Silu	Spotted Lisang		I
Rhinoceros unicornis	Gainda	Asian one-horned rhinoceros	VU	II
Sus salvanius	Sano (Pudke) bandel	Pigmy hog	CR	I
Tetracerus quadricornis	Chauka	Fore-horned antelope	VU	III
Ursus arctos	Himali rato bhalu	Brown bear		I
Birds				
Buceros bicornis	Thulo dhanesh	Great-horned hornbill	NT	I
Catreus wallishii	Cheer	Cheer pheasant	EN	I
Ciconia ciconia	Seto sarus	White stork		
Ciconia nigra	Kalo sarus	Black stork		II
Eupodotis bengalensis	Khar mujur	Bengal florican	EN	I
Grus grus (G. antigone)	Sarus	Common crane		I
Lophophorous impejanus	Danfe	Impeyan pheasant		I
Sypheotides indica	Sano Khar Mujur	Lessor florican	EN	II
Tragopan satyra	Monal	Crimson horned pheasant		III
Reptiles				
Gavialis gangeticus	Ghadial gohi	Gharial	EN	I
Python molurus	Azingar	Asiatic rock python	VU	
Varanus flavescens	Sun gohori	Golden monitor lizard		I

Source: MFCS/GEF/UNDP. 2002
CR=Critically Endangered, EN=Endangered, VU=Vulnerable, C=Common, NT=Near Threatened

Table 9: Nepal's Flora Listed in the CITES Appendices

	Scientific Name	English Name	Local Name	Family
Appendix I				
1	*Saussrea lappa*		Kuth	Compositae
Appendix II				
2	*Ceropedia pubescens*	Milkweeds		Asclepiadaceae
3	*Cyatheaceae*	Tree ferns	Rukh Unyu	Cyatheaceae
4	*Cycadaceae*	Cycas	Jokar	
5	*Dioscorea deltoidea*	Disocorea	Ban tarul, Bhyakur	Dioscoreaceae
6	*Orchicaceae*	Orchids	Sungava	
7	*Podophyllim hexandrum*	May apple		Berberidaceae
8	*Rauvolfia serpentina**	Rauwolfia root	Sarpagandha	Apocynaceae
9	*Taxus wallichiana**	Himalayan yew	Lauth salla	Taxaceae
Appendix III				
10	*Cycas pectinata*	Cycas	Jokar	Cycadaceae
11	*Gnetum montanum*	Gnetum		Gnetaceae
12	*Meconopsis regia*	Himalayan yellow poppy		Papaveraceae
13	*Podocarpus neriifolius*	Podocarpus		Podocarpaceae
14	*Talauma hodgsonii*	Magnolia		Magnoliaceae
15	*Tetracentron sinense*	Tetracentron		Tetreacentraceae

* Legally protected in Nepal by publishing in Nepal Gazette under the Forests Act, 1993 and its Rules, 1995
Source: (MFSC/GEF/UNDP, 2002)

Table 10: Nepal's Fauna Listed in CITES Appendices

Mammals (Total 58)					
Appendix I (Total 29)		**Appendix II (Total 7)**		**Appendix III (Total 22)**	
1	*Ailurus fulgens* (Red Panda)	1	*Cuon alpinus* (Wild dog)	1	*Antilope cervicapra* (Black buck)
2	*Bos gaurus* (Gaur bison)	2	*Equus hemionus* (Wild ass)	2	*Arctictis binturong* (Bear cat)
3	*Bos grunnies* (Yak)	3	*Manis* species (Pangolin)	3	*Bubalus arne* (Wild buffalo)
4	*Canis lupus* (Wolf)	4	*Primates* species (Monkey)	4	*Canis aureus* (Jackal)
5	*Capra falconeri* (Markhor)	5	*Pteropus* species (Flying fox)	5	*Herpestes edwardsii* (Common mongoose)
6	*Caprolagus hispidus* (Hispid hare)	6	*Ratufa* species (Squirrel)	6	*Herpestes fuscus* (Brown mongoose)
7	*Cervus duvauceli* (Swamp deer)	7	*Tupaia glis* (Common tree shrew)	7	*Herpestes urva* (Crab-eating mongoose)
8	*Elephas maximus* (Elephant)			8	*Marmota himlayana* (Himalayan marmot)
9	*Delis bengalensis* (Leopard cat)			9	*Martes flavigula* (Yellow-throated marten)
10	*Felis marmorata* (Marble cat)			10	*Martes foina intermedia* (Stone marten)
11	*Felis temmincki* (Golden cat)			11	*Mellivora capensis* (Haoney badger)
12	*Lutra lutra* (Otter)			12	*Mustela altaica* (Pale weasel)
13	*Melursus ursinus* (Sloth bear)			13	*Mustela kathiah* (Yellow-bellied Weasel)
14	*Moschus chrysigaster* (Musk deer)			14	*Mustela sibirica* (Himalayan weasel)
15	*Naemorhedus goral* (Ghoral)			15	*Paguma larvata* (Himalayan palm)
16	*Naemorhedus sumatraensis* (Himalayan serow)			16	*Paradosurus hermaphrod* (Common palm civet)
17	*Neofelis nebulosa* (Clouded leopard)			17	*Paradoxurus jerdoni* (Brown palm civet)
18	*Ovis ammon hodgsonii* (Argali)			18	*Tetracerus quadricornis* (Four-horned antelope)
19	*Panthera tigris* (tiger)			19	*Viverra zibetha* (Large Indian

					civet)
20	*Panthera pardus* (Common Leopard)			20	*Viverricula indca* (Small Indian civet)
21	*Uncia uncia* (Snow leopard)			21	*Vulpes bengalensis* (Indian fox)
22	*Pantholops hodgsoni* (Chiru)			22	*Vulpes montana* (Mountain fox)
23	*Platanista gangetica* (Gangetic Dolphin)				
24	*Presbytis entellus* (Langur)				
25	*Prionodon pardicolor* (Linsang)				
26	*Rhinoceros unicornis* (Greater One-horned Rhinoceros)				
27	*Selenarctos thibetanus* (Himalayan black bear)				
28	*Sus salvanius* (Pygmy hog)				
29	*Ursus arctos* (Brown bear)				
Birds (Total 40)					
Appendix I (Total 16)		**Appendix II (Total 9)**		**Appendix III (Total 15)**	
1	*Aceros nepalensis* (Rufous-necked hornbill)	1	*Anthracoceros* species (Pied hornbill)	1	*Anas acuta* (Northern pintail)
2	*Aquila heliaca* (Imperial eagle)	2	*Ciconia nigra* (Black stork)	2	*Anas cypeata* (Northern shoveler)
3	*Ardeotis nigricepas* (Great Indian bustard)	3	*Falconiformes* species (Falcon)	3	*Anas crecca* (Common tern)
4	*Buceros bicornis* (Giant hornbill)	4	*Gruidae* species (Crane)	4	*Anas penelope* (Eurasian wigeon)
5	*Catreus wallichii* (Cheer pheasant)	5	*Ithaginis cruentus* (Blood pheasant)	5	*Anas querquedula* Garganey)
6	*Eupodotis bengalensis* (Bengal florican)	6	*Otididae*species (Lesser florican)	6	*Aythya nyroca* (White-eyed pochard)
7	*Falco jugger* (Lagger falcon)	7	*Pitta nympha* (Indian pitta)	7	*Bubulcus ibis* (Cattel egret)
8	*Falco pelegrinoides* (Barbary falcon)	8	*Platelea leucorodia* (Eurasian spoonbill)	8	*Casmerodius albus* (Great egret)
9	*Falco peregrinus* (Red-capped falcon)	9	*Sarkidiornis melanotos* (Comb duck {Nakta})	9	*Columba livia* (Rock pigeon)
10	*Grus nigricollis* (Black-necked crane)			10	*Dendrocygna bicolor* (Fulvous whistling duck)
11	*Haliaeetus albicilla* (White-tailed eagle)			11	*Egretta gsrtzetta* (Little egret)
12	*Lophophorous impejanus* (Himalayan monal)			12	*Gracula religiosa* (Talking mynah)
13	*Psittacula karmeri* (Rose ringed parakeet)			13	*Streptopelia senegalensis* (Laughing dove)
14	*Rhodonessa caryophyllaceae* (Pink-headed duck)			14	*Threskiornis aethiopicus* (Black-headed ibis)
15	*Tetraogallus tibeatanus* (Tibetan snowcock)			15	*Tragopan satyra* (Crimson-horned pheasant)
16	*Tragopan melanocephalus* (Western horned pheasant)				
Reptiles (Total 13)					
	Appendix I (Total 7)	**Appendix II (Total 4)**		**Appendix III (Total 2)**	
1	*Crocodulus palustris* (Mugger crocodile)	1	*Elachistodon westermanni* (Indian egg-eating snake)	1	*Viperra russelli* (Russle's viper)
2	*Gravialis gangeticus* (Gharial)	2	*Naja naja* (Cobra)	2	*Xenochrophis piscator* (Checkerd keelback)
3	*Python molurus molurus* (Indian	3	*Ophiophagus hannah* (King		

	python)		cobra)		
4	*Testudinidae* species (Land tortoise)	4	*Ptyas mucosus* (Dhaman or common rat snake)		
5	*Trionyx gangeticus* (Ganges softshell)				
6	*Trionyx hurum* (Peacock softshell)				
7	*Varanus flavescens* (Golden monitor lizard)				
Amphibians (Total 1)					
		Appendix II			
		1	*Rana tigerina*(Indian bull frog)		
Insects (Total 2)					
			Appendix II		
		1	*Troides aeacus aeacus* (Golden birdwing)		
		2	*Troides helena* subsp. *Serberus* (Common birdwing)		

Source: (Uprety, 2003)

Table 11: Non-endemic Threatened Plants included in the IUCN Category

SN	Scientific Name	Family	IUCN Category
1	*Allium przewalskianum*	Amaryllidaceae	V
2	*Choerospondias axillaries*	Anacardiaceae	R
3	*Pistacia chinensis subsp. Integerrina*	Anacardiaceae	R
4	*Alstonia neriifolia*	Apocynaceae	R
5	*Alstonia scholaris*	Apocynaceae	R
6	*Beaumontia grandiflora*	Apocynaceae	V
7	*Rauvolfia serpentine*	Apocynaceae	E
8	*Arisaema untile*	Araceae	I
9	*Helwingia himalaica*	Araliaceae	I
10	*Hoya amottiana*	Asclepiadaceae	K
11	*Tylophora belsotemma*	Asclepiadaceae	Ex?
12	*Podophyllum hexandrum*	Berberidaceae	V
13	*Alnus nitida*	Betulaceae	R
14	*Oroxylum indicum*	Bignoniaceae	V
15	*Maharanga bicolour*	Boraginaceae	K
16	*Maharanga emodi*	Boraginaceae	K
17	*Crateva unllocularis*	Capparaceae	R
18	*Megacarpaea polyandra*	Cruciferae	V
19	*Cycas pectinata*	Cycadaceae	E
20	*Dioscorea deltoidea*	Dioscoreaceae	T
21	*Dioscorea prazeri*	Dioscoreaceae	T
22	*Elaeocarpus sphaericus*	Elaeocarpaceae	V
23	*Lithocarpus fenestrate*	Fagaceae	K
24	*Swertia chirayita*	Gnetaceae	E
25	*Gnetum montanum*	Gnetaceae	E
26	*Acacia catechu*	Fabaceae	T
27	*Butea monsperma*	Fabaceae	E
28	*Dalbergia latifolia*	Fabaceae	V
29	*Gloriosa superb*	Liliaceae	R
30	*Lillium wallichianum*	Liliaceae	R
31	*Paris polyphylla*	Liliaceae	V
32	*Magnolia globosa*	Magnoliaceae	R
33	*Michelia champaca*	Magnoliaceae	E
34	*Michelia kisopa*	Magnoliaceae	E
35	*Talauma hodgsonii*	Magnoliaceae	E
36	*Olea ferruginea*	Ileaceae	R
37	*Paeonia emodi*	Paeoniaceae	R

38	*Calamus acanthospathus*	Palmae	E
39	*Calamus latifolius*	Palmae	E
40	*Calamus leptospadix*	Palmae	E
41	*Wallichia densiflora*	Palmae	R
42	*Passiflora napalensis*	Passifloraceae	E
43	*Larix griffithiana*	Piniaceae	R
44	*Larix himalaica*	Piniaceae	K
45	*Ceratostigma ulicinum*	Plumbaginaceae	R
46	*Podocarpus neriifolius*	Podocarpaceae	E
47	*Hydrobryum griffithii*	Podostemaceae	R
48	*Rheum nobile*	Polugonaceae	R
49	*Helicia nilagirica*	Proteaceae	R
50	*Aconitum ferox*	Ranunculaceae	T
51	*Aconitum gammiei*	Ranunculaceae	R
52	*Aconitum heterophyllum*	Ranunculaceae	R
53	*Aconitum laciniatum*	Ranunculaceae	T
54	*Aconitum spicatum*	Ranunculaceae	T
55	*Prunus carmesina*	Rosaceae	R
56	*Bergenia ciliate*	Saxifragaceae	T
57	*Picrorhiza scrophulariaefolia*	Scrophulariaceae	R
58	*Tetracentron sinense*	Tetracentraceae	R
59	*Ulmus wallichiana*	Ulmaceae	R
60	*Nardostachys grandiflora*	Valerianaceae	V

Source: (MFSC/GEF/UNDP, 2002)

Table 12: Nepal's Threatened Animals in the IUCN List, 1994

Order/Family		**Scientific Name**	**Common Name**	**Status**
Class: Mammalia	1	*Canis lupus*	Grey Wolf	V
	2	*Cuon alpines*	Asiatic Wild	V
	3	*Vulpes benghalensis*	Bengal Fox	I
Felidae	4	*Catopuma temmincki (Felis temmincki)*	Asiatic Golden Cat	I
	5	*Neofelis nebulosa*	Clouded Leopard	I
	6	*Panthera tigris tigris*	Tiger	E
	7	*Prionaliurus marmorata, (Felis marmorata)*	Marbled Cat	K
	8	*Prionaliurus viverrinus, Felis viverrinus, Felis viverrina)*	Fishing Cat	
	9	*Uncia uncia (Panthera uncia)*	Snow Leopard	E
Mustelidae	10	*Aonyx cinerea*	Oriental Small-clawed Otter	K
	11	*Autra perspicillata*	Smooth-coated Otter	K
Ursidae	12	*Ailurus fulgens*	Lesser Panda (Red Panda)	V
	13	*Melurus ursinus (Ursus ursinus)*	Sloth Bear	V
	14	*Selenarctos thibetanus (Ursus thibetanus)*	Asiatic Black Bear	V
Cetacea/Latanestidae	15	*Platanista gangetica*	Ganges River Dolphin	V
Proboscidea/Elephantidae	16	*Elephas maximus*	Asian Elephant	E
Perissodactayla/Rhinocerotidae	17	*Rhinoceros unicornis*	Greater One-horned-Rhinoceros	E
Artiodactyla/Suidae	18	*Sus salvanius*	Pygmy Hog	E
Cervidae	19	*Cervus duvauceli duvauceli*	Swamp Deer	I
Bovidae	20	*Antelope cervicapra*	Blackbuck	V
	21	*Bos gaurus (B.frontalis)*	Gaur	V
	22	*Bos mutus (B.grunnies)*	Wild Yak	E
	23	*Bubalus arnee (B.bubalus)*	Wild Water Buffalo	E
	24	*Capricornis sumatraensis (Naemorhedus sumatraensis)*	Mainland Serrow	T
	25	*Hemitragus jemlahicus*	Himalayan Thar	K
	26	*Tetracerus quadricornis*	Four-horned Antelope	V

Lagomorpha/ Ochotonidae	27	*Ochotona nubrica*	Nubra Pika	I
Leporidae	28	*Caprolagus hispidus*	Hispid Hare	E
Class: Aves				
Pelacaniformes/Pelacanidae	1	*Pelecanus phillippensis*	Spot-billed Pelican	I
Ciciniformes/	2	*Leptoptilos dubius*	Greater Adjutant Stork	V
	3	*Leptoptilos javanicus*		
	4	*Aythya baeri*	Baee's Pochard	V
	5	*Aegypius monachus*	Cinerous Vulture	V
	6	*Aquila heliacal*	Imperial Eagle	R
	7	*Haliaeetus albicvilla*	White-tailed Eagle	V
	8	*Haliaeetus leucocryphus*	Pallas's Sea Eagle	R
	9	*Falco naumanni*	Lesser Florican	E
	10	*Catreus wallichi*	Cheer Pheasant	E
	11	*Francolinus gularis*	WSwamp Francolin	V
	12	*Tragopan melanocephalus*	Western Tragopan	E
	13	*Eupodotis bengalensis (Houbaropsis bengalensis)*	Bengal florican	E
		Eudotis indica (Sypheotides indica)	Lesser Florican	E
	15	*Gallinago nemoricola*	Wood Snipe	I
	16	*Alcedo Hercules*	Blyth's Kingfisher	E
	17	*Aceros nipalensis*	Rofous-necked Hornbill	R
	18	*Chaetornis striatus*	Bristled Grassbird	K
	19	*Chysomma altirostris (Moupinia altirostris)*	Jerdon's Babbler	V
	20	*Paradoxornis flavirostris*	Black-breasted Parrotbill	I
	21	*Saxicola insignis*	White-throated Bushchat	K
	22	*Spelaeornis caudatus*	Rufous-throated Wren-babbler	K
Class: Reptillia				
Testudines/	1	*Geoclemys hamiltonii (Domania hamiltonii)*	Black Pond Turtle	I
	2	*Kachuga kachuga*	Red-crowned Roofed Turtle	I
	3	*Melanochelys tricarinato (Geochelone or Nicoria tricarinata)*	Three-keeled Land Tortoise	I
	4	*Indotestudo elongata (Geochelone elongata)*	Elongated Tortoise	K
Crocodyla/ Crocodylidae	5	*Crocodylus palustris*	Mugger	V
Gavialidae	6	*Gavialis gangeticus*	Gharial	E
Sauria/Varanidae	7	*Varanus flavescens*	Yellow Monitor Lizard	I
Serpentes/Boidae	8	*Python molurus*	Indian Python	V
Colubridae	9	*Elachistodon westermanni*	Indian Egg-eating Snake	R
Class: Insecta Odanata/ Epipophlebiidae	1	*Epipophlebia laidlawi*	Relict Himalayan Dragonfly	V
Lepidoptera/ Papilionidae	2	*Teinopalpus imperialis*	Kaiser-I-Hind	R

Source: (MFSC/GEF/UNDP, 2002)
IUCN Definitions
Endangered (E) = Taxa in danger of extinction and whose survival is unlikely if causal factors continue operating.
Vulnerable (V) = Taxa believed likely to move into the endangered category in near future in the casual factors continue operating.
Rare (R) = Taxa with small world populations that are not at present endangered or vulnerable, but are at risk.
Intermediate (I) = Taxa known to be endangered or vulnerable or rare but there is not enough information to say which of three categories is appropriate.
Insufficiently Known (K) = Taxa that are suspected but not definitely known to belong to any of the above categories, because of lack of information.

Figure 1: Suitability for growing Barley

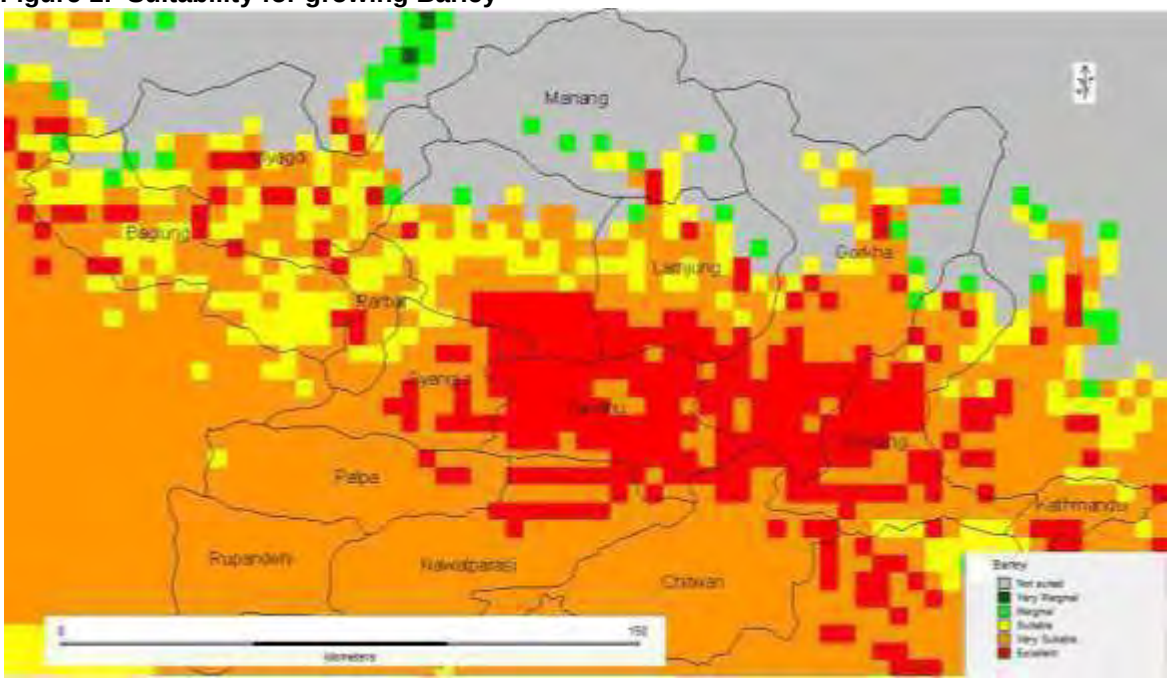


Figure 2: Suitability for growing Buckwheat

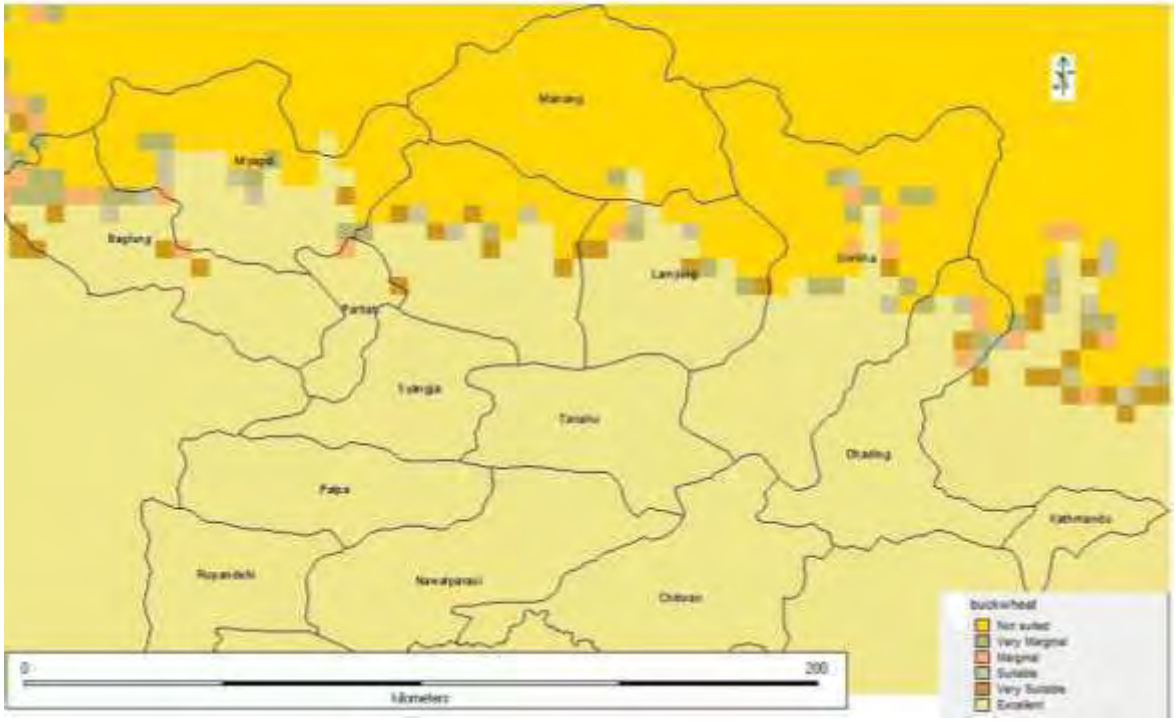


Figure 3: Suitability for growing Maize

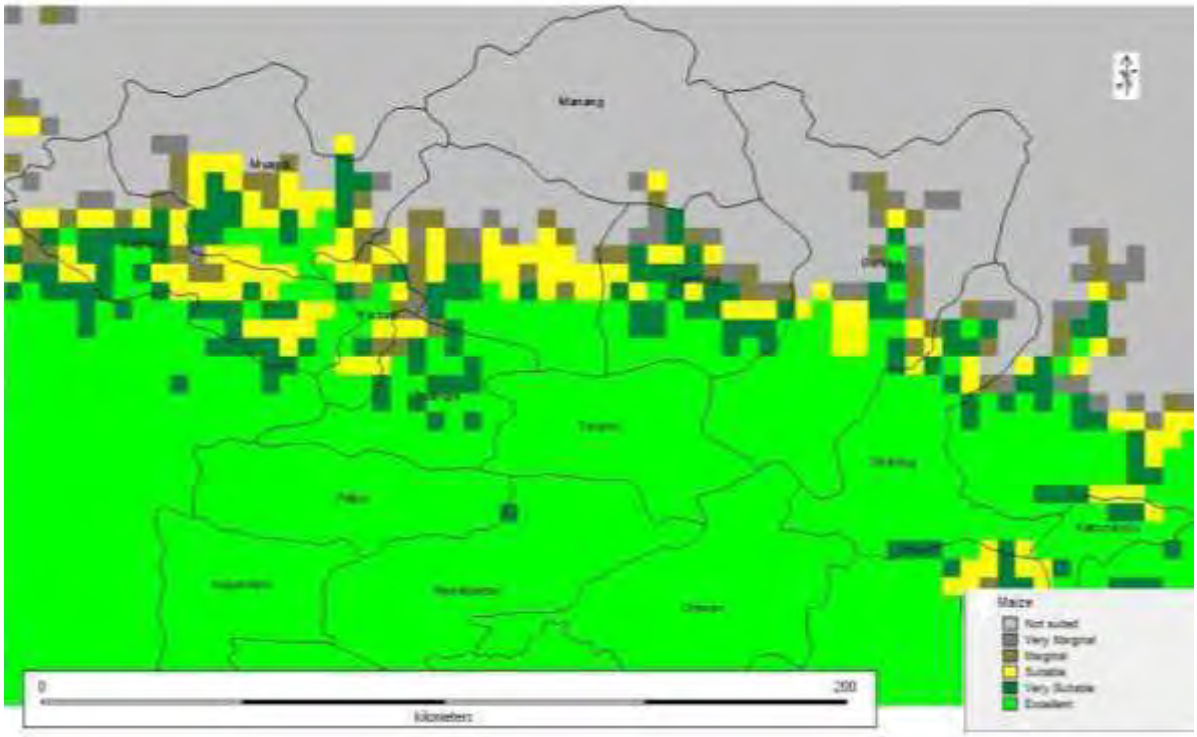


Figure 4: Suitability for growing Millet

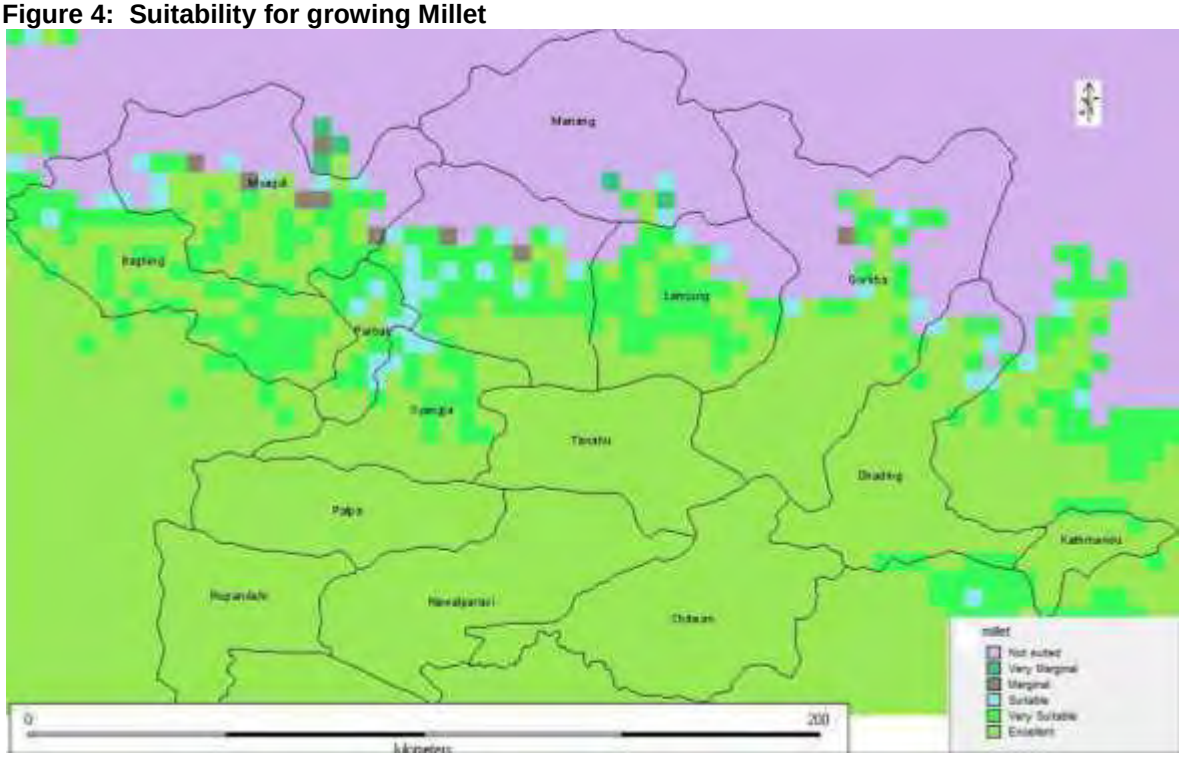


Figure 5: Suitability for growing Potatoe

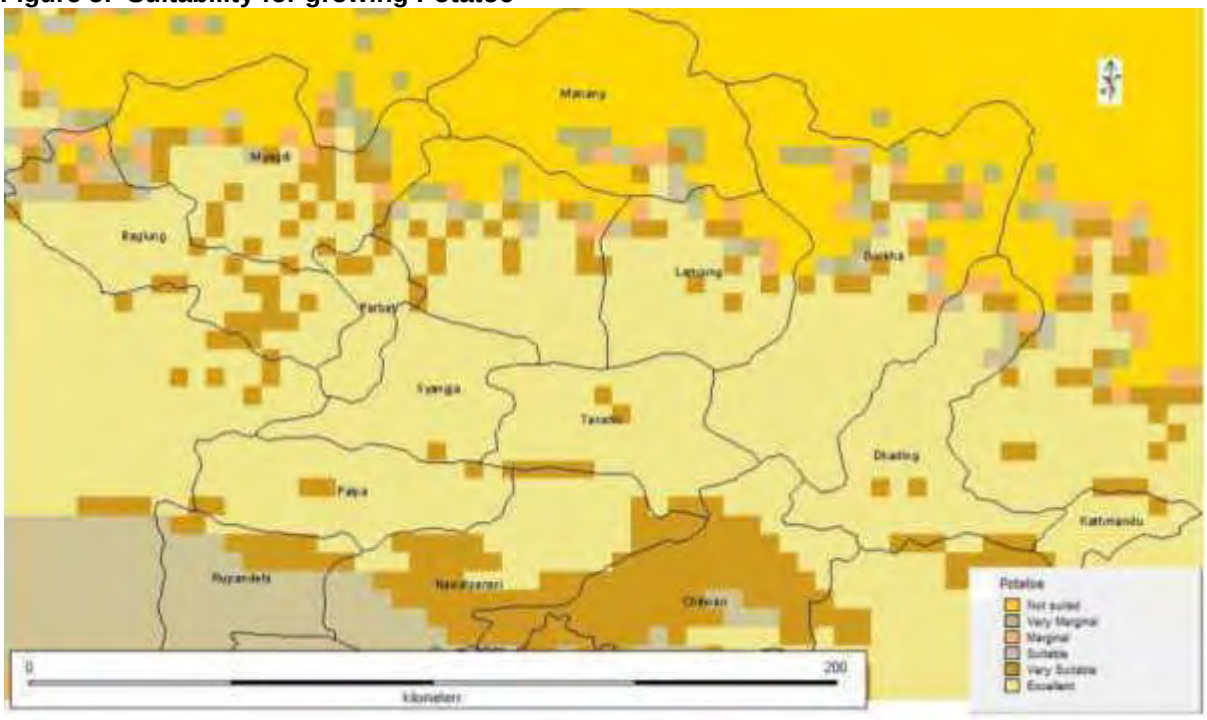


Figure 6: Suitability for growing Paddy

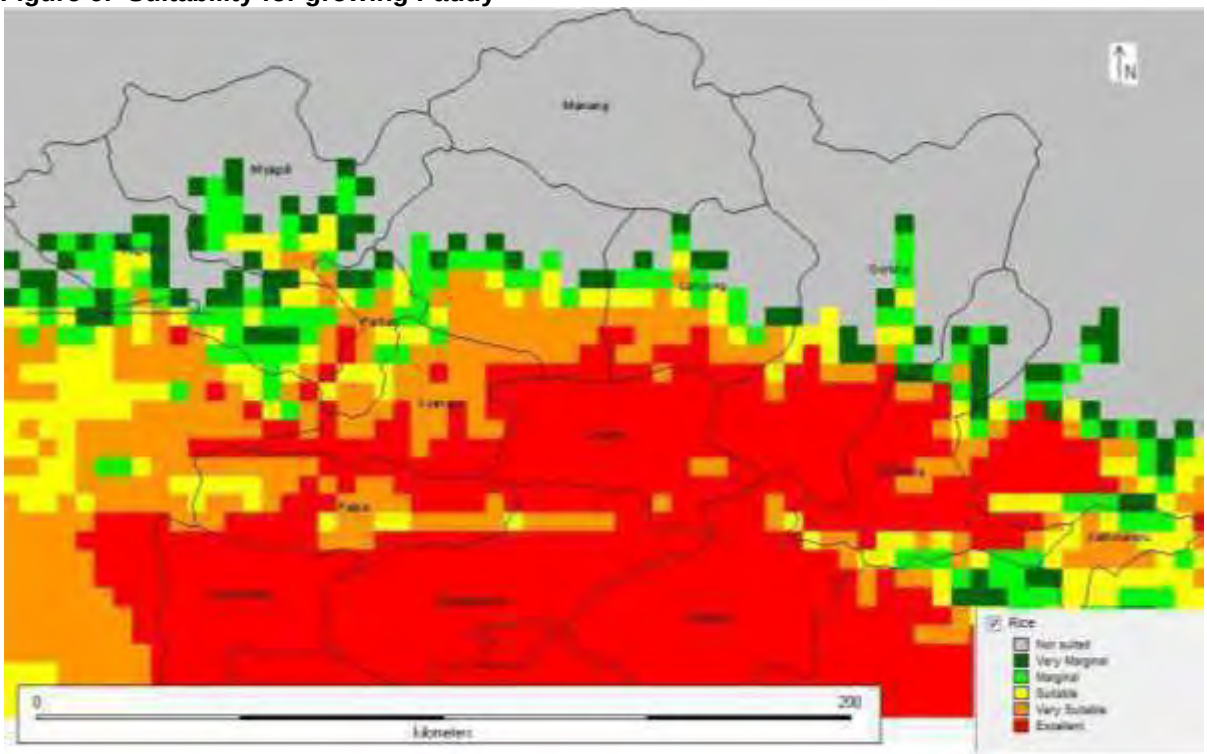
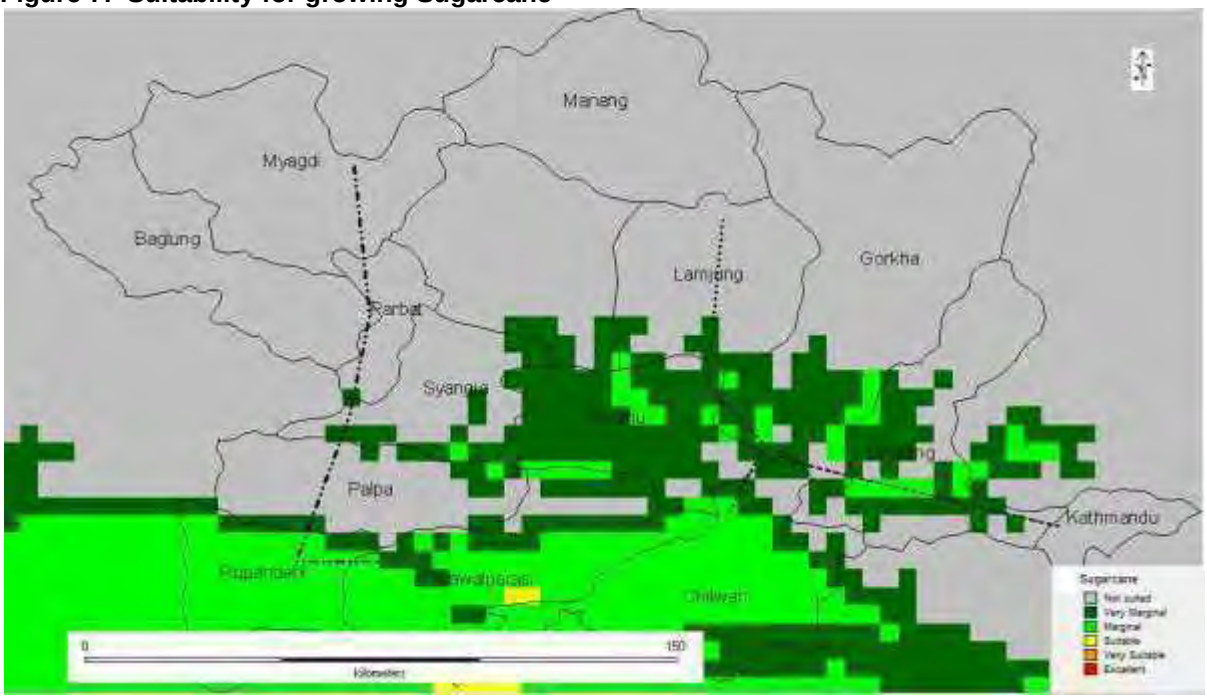


Figure 7: Suitability for growing Sugarcane

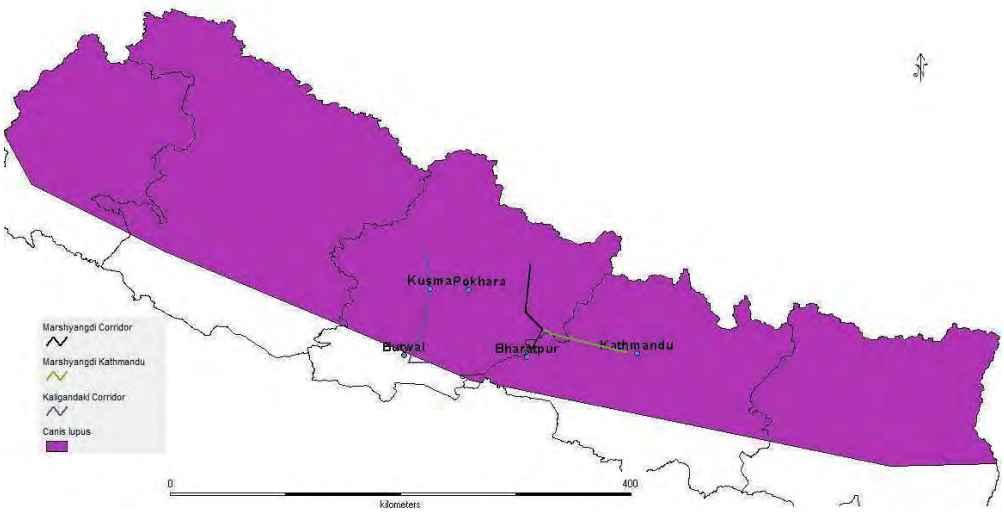


Source: FAO

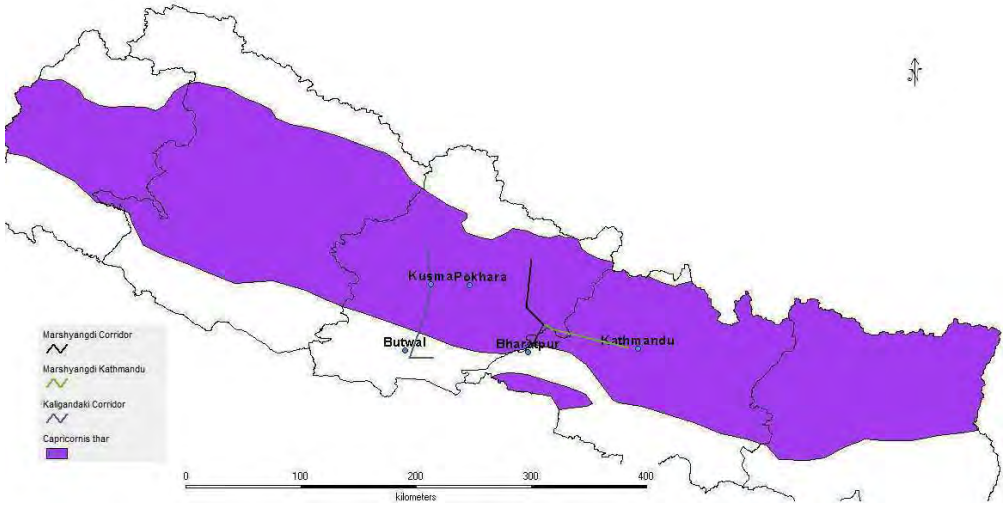
Appendix 2: Potential Habitat Distribution of Important Species

Mammals

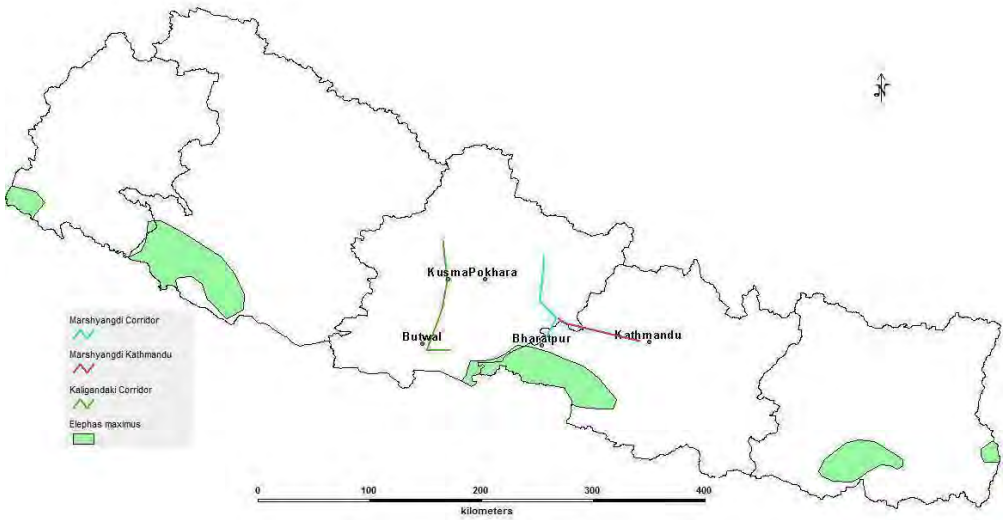
Canis lupus (Grey Wolf)



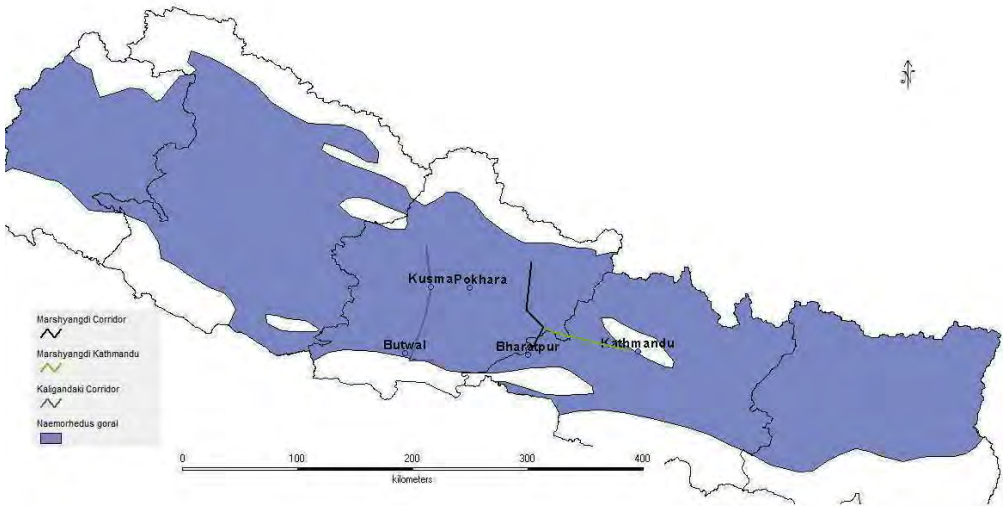
Capricornis thar



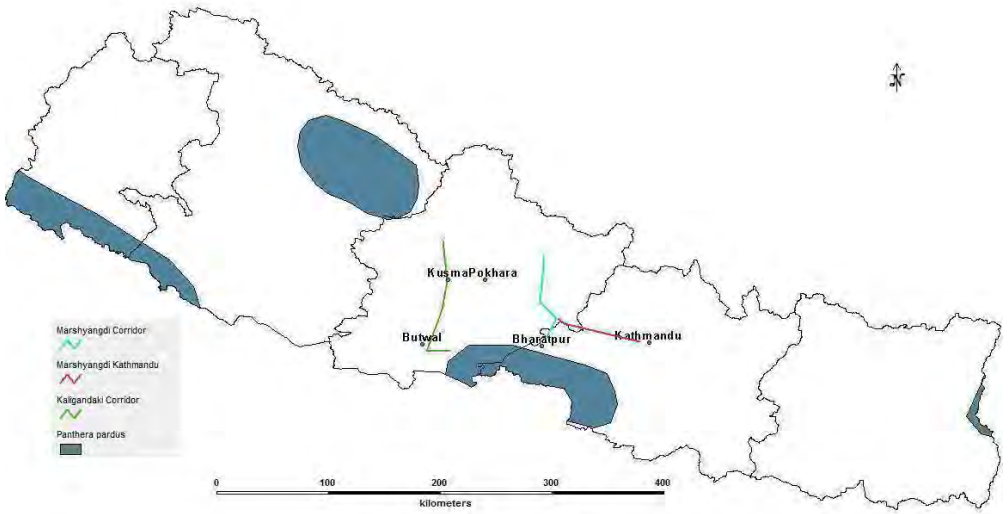
Elephas maximus (Asian Elephant)



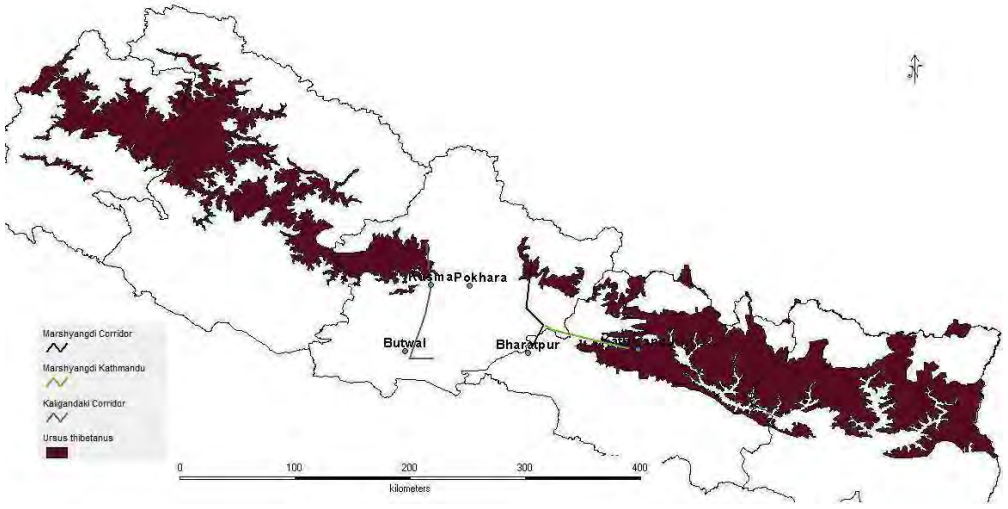
Naemorhedus goral (Himalayan goral)



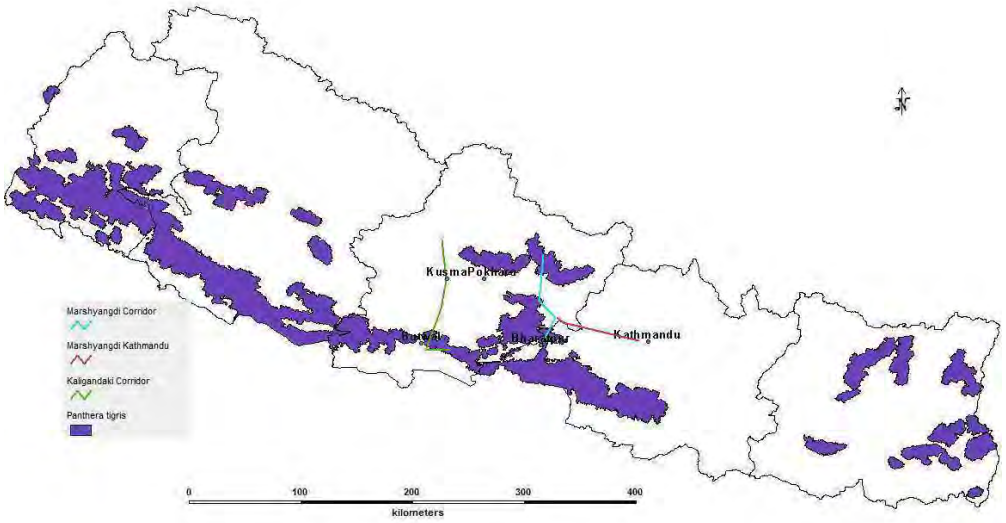
Panthera pardus (Common Leopard)



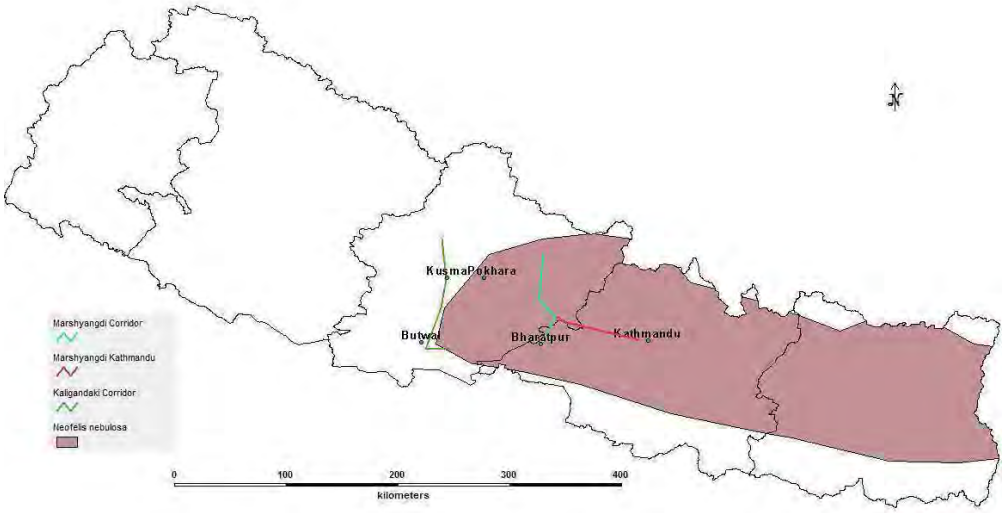
Ursus thibetanus (Asiatic Black Bear)



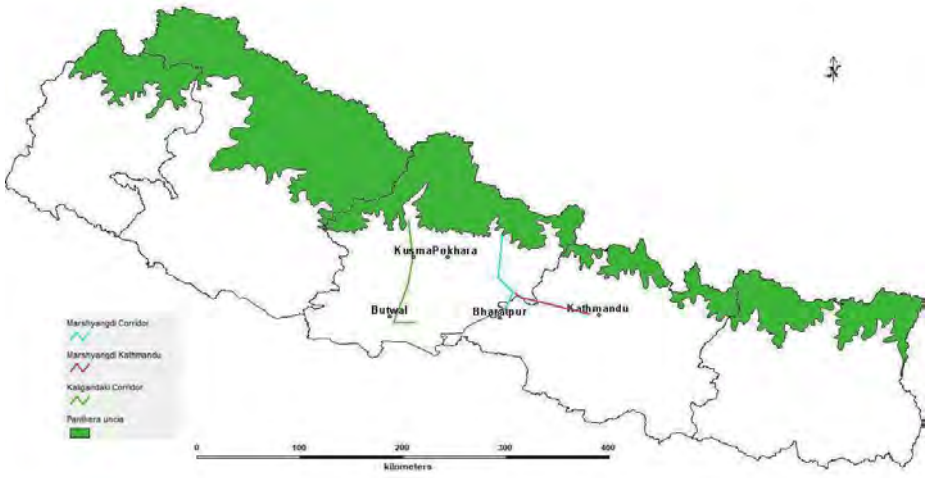
Panthera tigris (Bengal tiger)



Neofelis nebulosa (Clouded leopard)

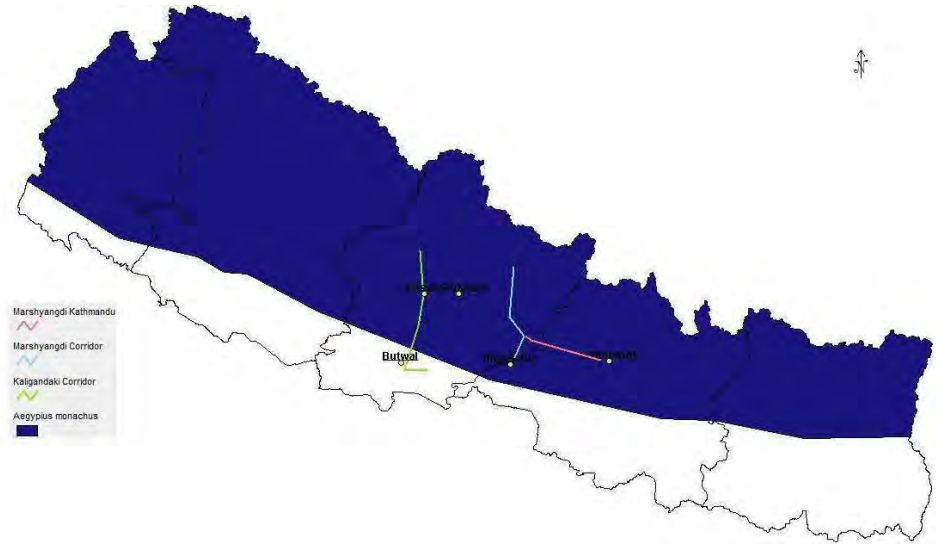


Panthera uncia (Snow Leopard)



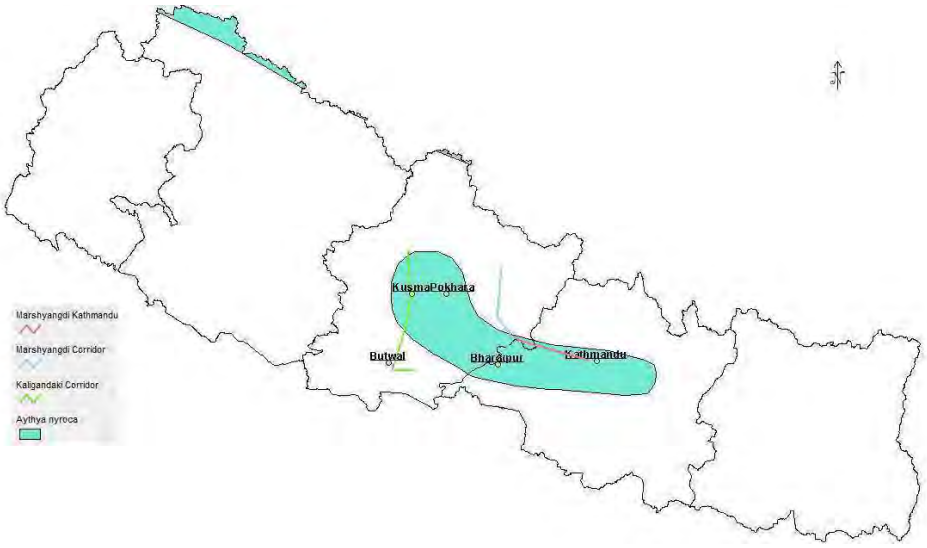
Birds

Aegypius monachus (Cinerous Vulture)

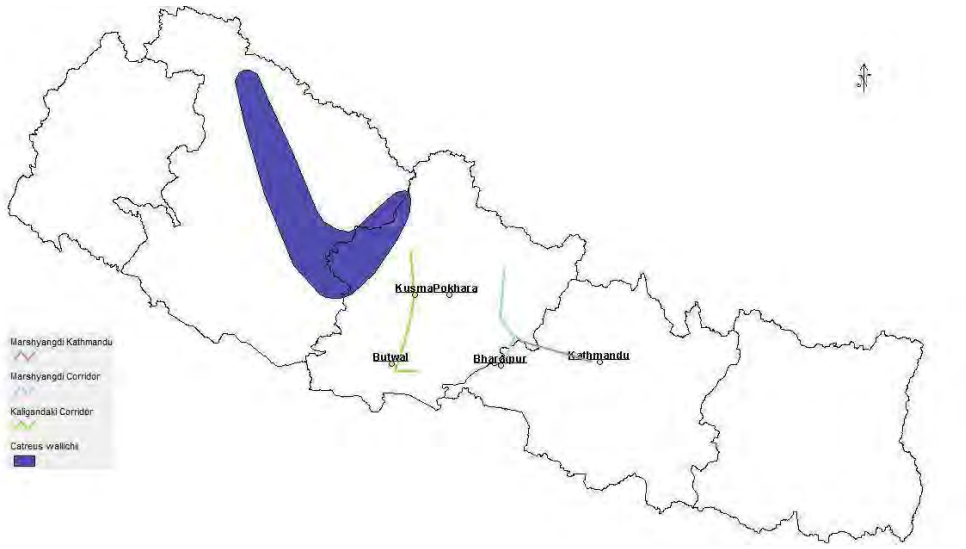


Aquila heliacal

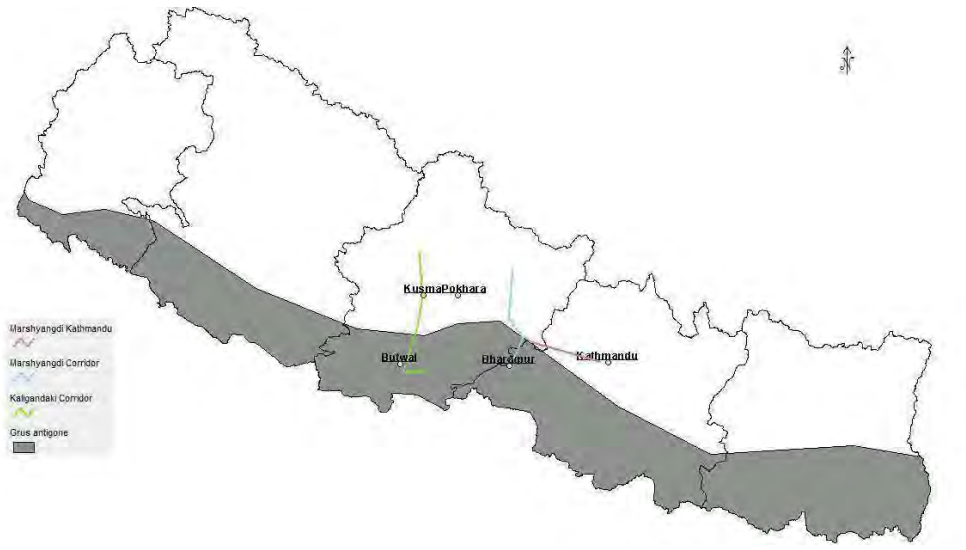
Aythya nyroca



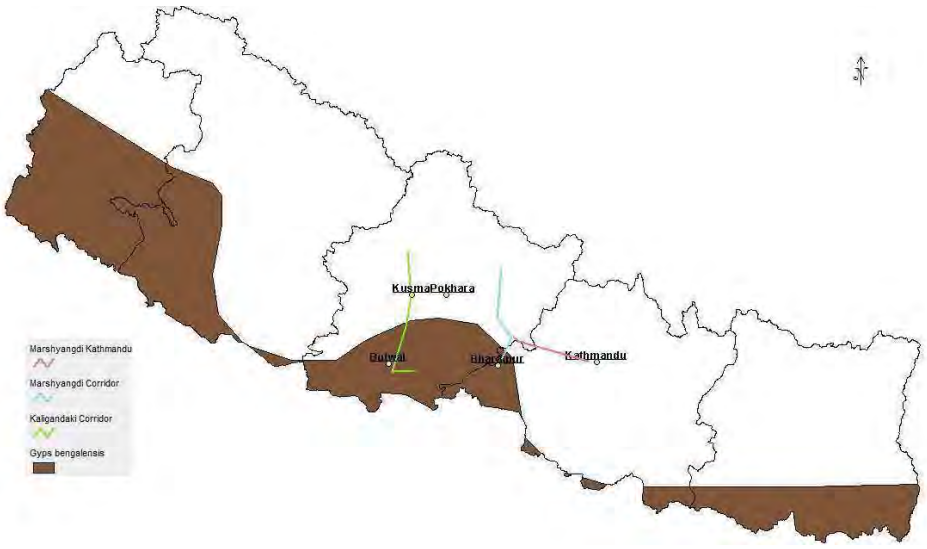
Catreus wallichii (Cheer pheasant)



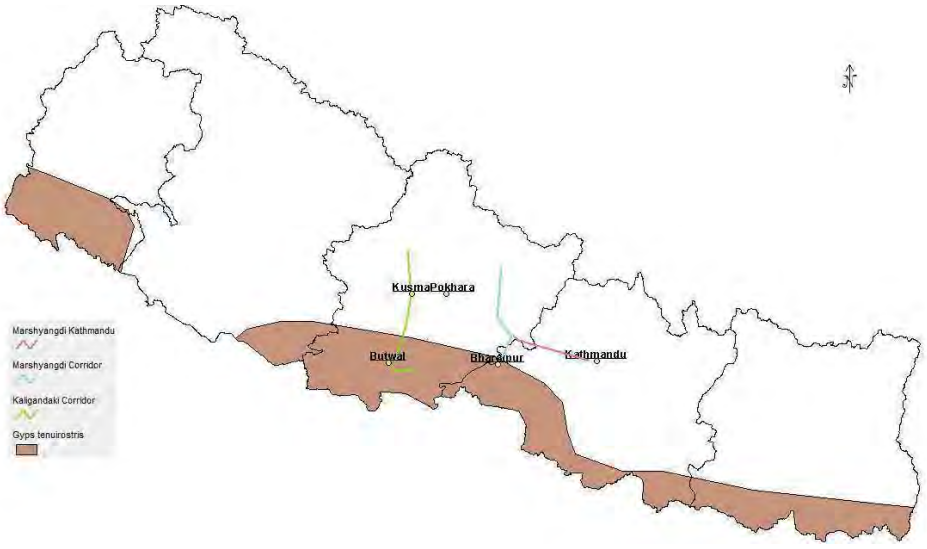
Grus antigone (Sarus Crane)



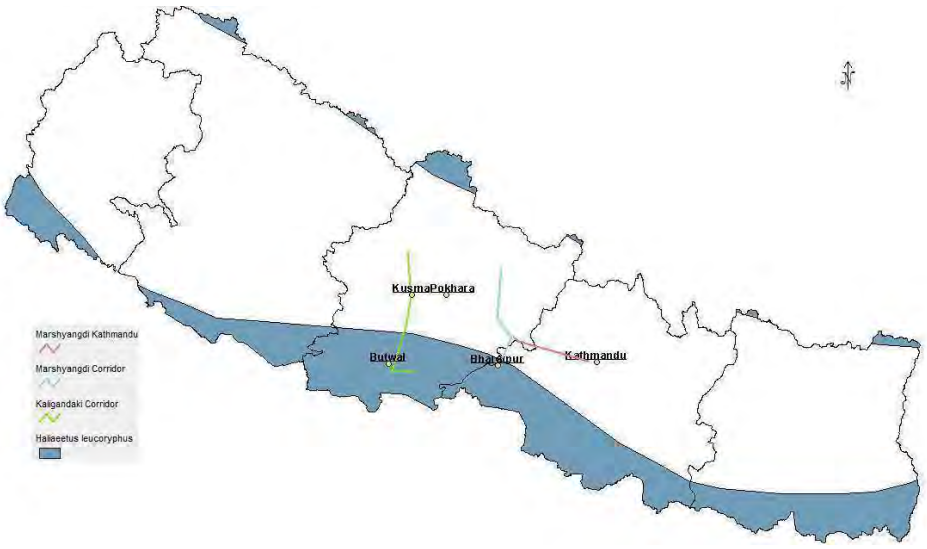
Gyps bengalensis (White-rumped Vulture)



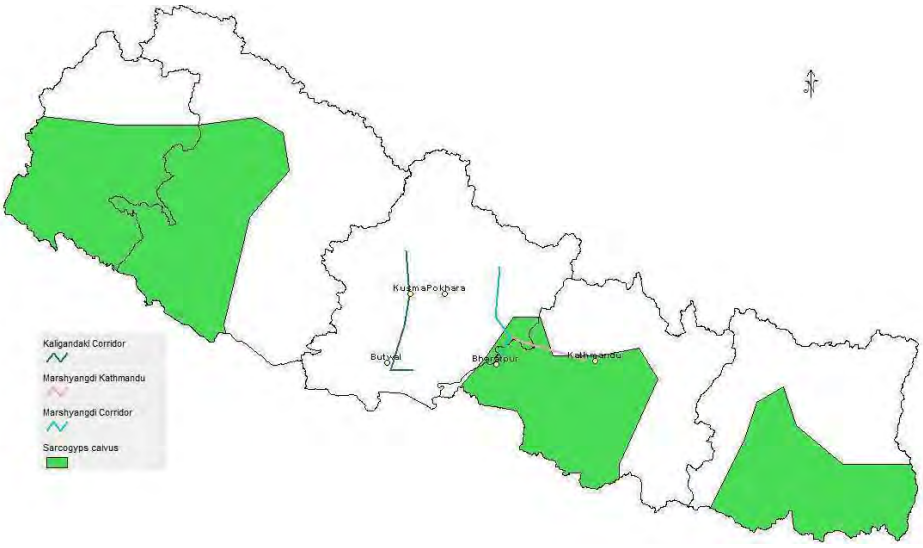
Gyps tenuirostris (Slender-billed Vulture)



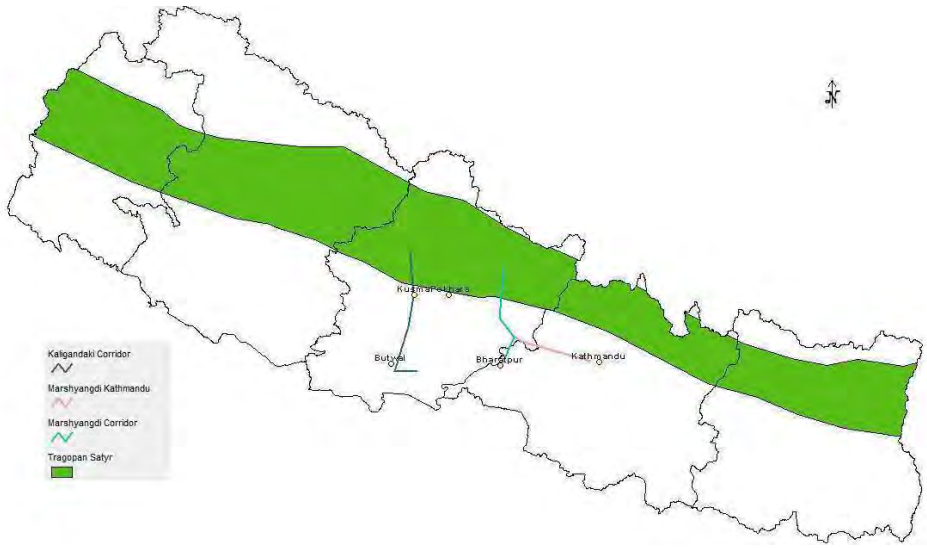
Haliaeetus leucoryphus (Pallas's Fish-eagle)



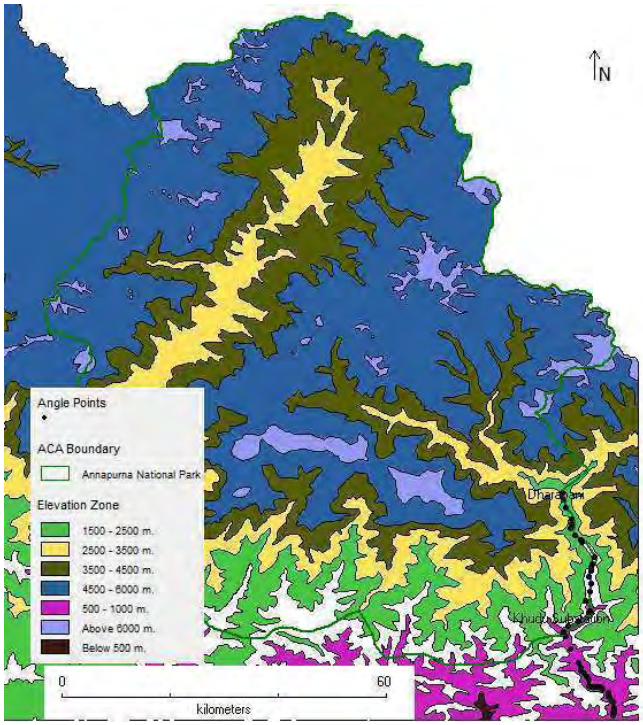
Sarcogyps calvus (Red-headed Vulture)



Tragopan satyra (Crimson horned pheasant)



Elevation Zone



Source: (ICIMOD, 2008), (IUCN, 2010), (Birdlife International, 2010)

Appendix 3: Ongoing and New Donor-Funded Activities with Indirect Offsets to the Project

Project / Description	Time Line	Funding ($) / Source	Relevance to Conservation Area (and Climate Change)
Hariyo Ban Project This program aims to: i) reduce threats to biodiversity in target landscape(s); ii) build the structures, capacity and operations necessary for an effective sustainable landscapes management, especially reducing emissions from deforestation and forest degradation (REDD+) readiness; and iii) increase the ability of target human and ecological communities to adapt to the adverse impacts of climate change.	August 2011 to 2016[1]	TBC (approx. US$30 million) / USAID[2]	Reduce threats to biodiversity and vulnerabilities of climate change in Nepal. The project works in Terai Arc Landscape and Chitwan Annapurna Landscape also includes Annapurna Conservation Area
Reducing Climate change vulnerability of poor The New programme will support the development of climate adaptation evidence and pilot approaches to improve adaptive capacity of communities. The programme will focus on vulnerable groups, safeguarding their livelihoods and creating employment, whilst reducing the vulnerability of people.	2009-2014	10 m £ / DFID	Building climate resilience and promoting low carbon development pathways
Establishment of Regional Flood Information System in the Hindu Kush- Himalaya The project, with ICIMOD, is intended to minimize loss of lives and livelihoods by providing timely warning information and thus reducing flood vulnerability in the HKU region, in particular in the Ganges – Brahmaputra – Meghna and Indus river basins through sharing meteorological and flood data and information amongst six regional partner countries, Bangladesh, Bhutan, China, India, Nepal and Pakistan.	2009 – 2013[3] (3 years)	$US 2.9 million / Finland	Enhanced technical capacity of partner countries would improve flood forecasting, disaster preparedness and water related hazards that are expected to occur as a result of climate change. Sharing of timely and reliable flood warning systems would improve the lead time for taking risk reduction measures in the region.
Hazard Risk Management Program: Nepal To mainstream disaster reduction in poverty reduction strategies and supporting national capacity to deal with natural disaster risk.	2014-2016	US $83.8 million / IFRC, USAID, UNDP[4]	***Building Resilience*** The Global Facility for Disaster Reduction and Recovery (GFDRR) mainstreams disaster reduction in poverty reduction

[1] http://carenepal.org/opportunities/18_TOR%20Biophysical%20Condition%20of%20Critical%20Watersheds%20updated%20on%2022%20March%20201....doc
[2] http://www.theredddesk.org/sites/default/files/english_brochure.pdf
[3] http://www.finland.org.np/public/default.aspx?contentid=194229&contentlan=2&culture=en-US
[4] https://www.gfdrr.org/sites/gfdrr.org/files/publication/GFDRR_Work_Plan_Endorsed_2013.pdf

Project / Description	Time Line	Funding ($) / Source	Relevance to Conservation Area (and Climate Change)
			strategies and supporting national capacity to deal with climate-change natural disaster risk.
Multistakeholder Forestry Programme-Nepal The Multistakeholder Forestry Programme aims to contribute to inclusive economic growth, poverty reduction and tackle climate change	2010-2021	20 million£ / DFID	Promoting growth Enhanced assets of rural communities through more equitable, efficient and sustainable use of forest resources and better forest sector governance leading low carbon development pathways and creating green jobs.
Enhancement of Sustainable Production of Lokta Handmade Paper in Nepal The project aims to the production of "Lokta" paper and its production as sustainable economic activities, reducing the social and environmental challenges associated with the production of paper and paper products, as well as to increase the earning of the marginalized farmers and small scale entrepreneurs.	2009 - 2013	US$ 1.8 Million / EU	***Building Resilience*** Sustainable exploitation of natural resources, preventing further deforestation, finally reducing emission of the GHGs (CO2) emission during the production processes of hand made paper and its products.
Forest Resource Assessment in Nepal (national forest inventory) The project is designed to obtain forest information at national scale concerning Non-Timber Forest Products, Trees Outside Forests, carbon content, forest biodiversity, human and biotic pressure and the soil characteristics among others as elements of the forest characteristics	2009 -2014 (5 years)	US$ 6.8 million / Finland	The project flags out the opportunities that exist for generating financial resources through carbon trading supporting Clean Development Mechanism (CDM) projects, supporting "Reducing Emissions from Deforestation and Forest Degradation" (REDD) mechanism, different climate change adaption and mitigation mechanisms and through payment of environmental services. The project outputs can be valuable tools to monitor climate change.

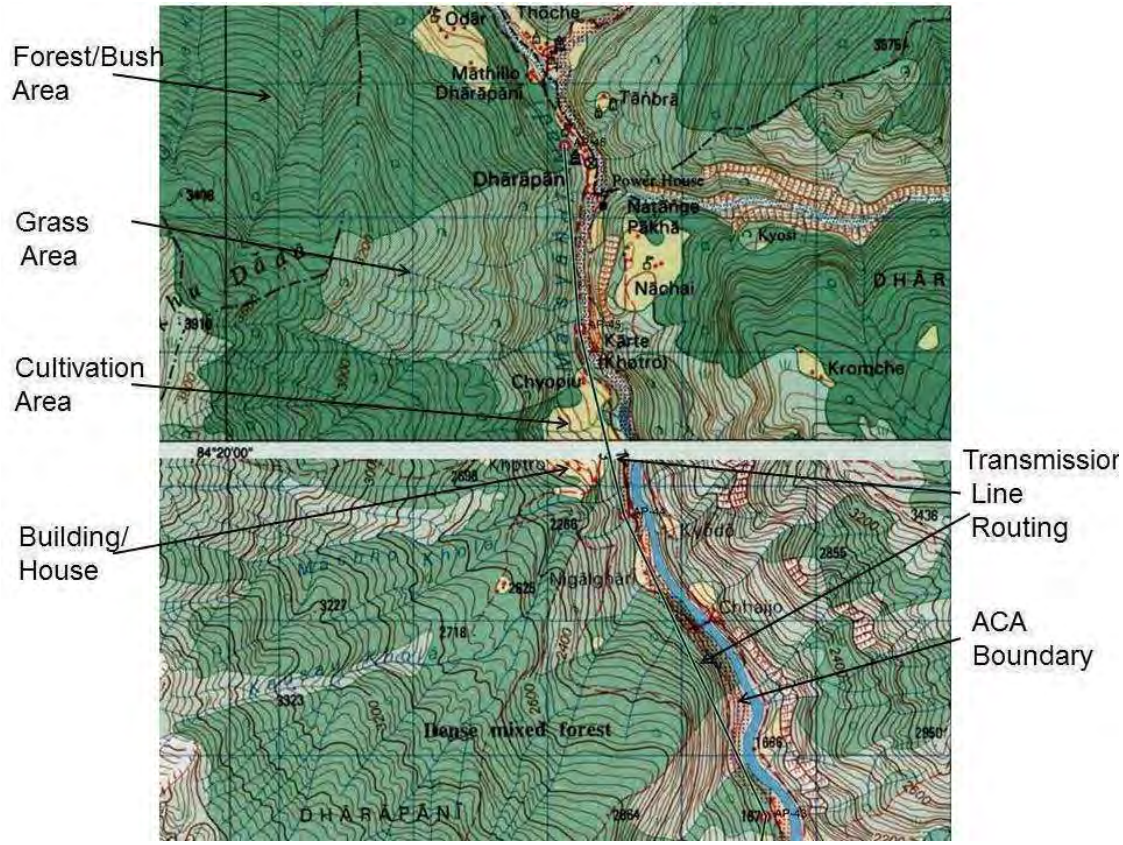
Project / Description	Time Line	Funding ($) / Source	Relevance to Conservation Area (and Climate Change)
Advise to Energy Efficiency (Nepal Energy Efficiency Programme)[5] A Technical cooperation programme for eight years with the objective to broaden public and policy understanding to use energy efficiently to balance the energy demand and supply and hence contribute to a sustainable energy management and climate protection.	2009 bis 2017	US$ 5.4 Million / Germany[6]	The projects use of energy efficiently helps conserves environment and climate.
Biogas Two biogas operations are being supported to increase access to modern energy sources in the rural and peri-urban areas of Nepal	2006-2015	US$7.0 million TF Grant / World Bank	***Promoting Growth*** Biogas reduces global emissions of carbon dioxide, a greenhouse gas.
High Mountain Agribusiness and Livelihood Improvement (HIMALI) Project (ADB Grant 0248) The project will assist farmers and downstream enterprises to strengthen linkages, taking advantage of the gradual improvement in infrastructure, to realize the existing demand for mountain products.	2011 – 2017	US $20,000 / ADB – ADF Grant	***Sustainable economic development*** The project will support agribusiness and value-chain development in 10 districts, including the Manang and Mustang District which covers part of the Annapurna Conservation Area

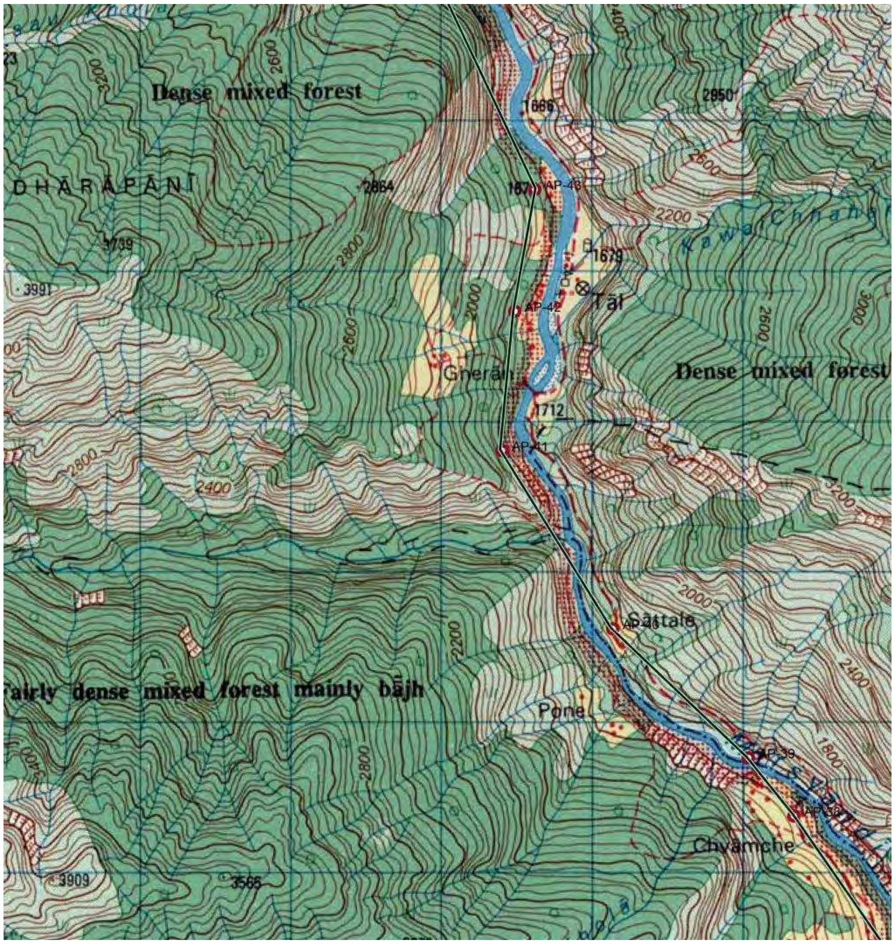
Source: Nepal. 2010. ***Nepal: Strategic Program for Climate Resilience***. Proposal prepared under the Pilot Program for Climate Resilience. Projects are from Annex 2: Summary of Climate Change and Associated Projects Supported by Developments Partners.
The ADB HIMALI project information is from ADB project database.

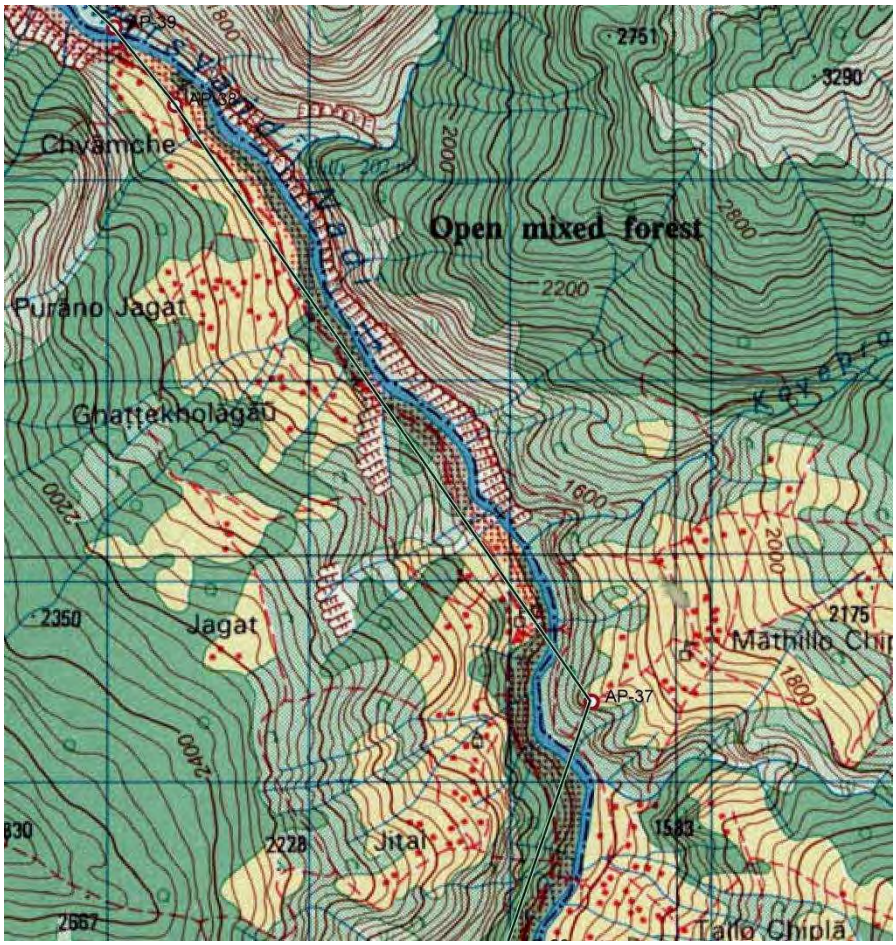
[5] http://wecs-neep.gov.np/article-about
[6] http://www.aiddata.org/content/Project?id=50068358

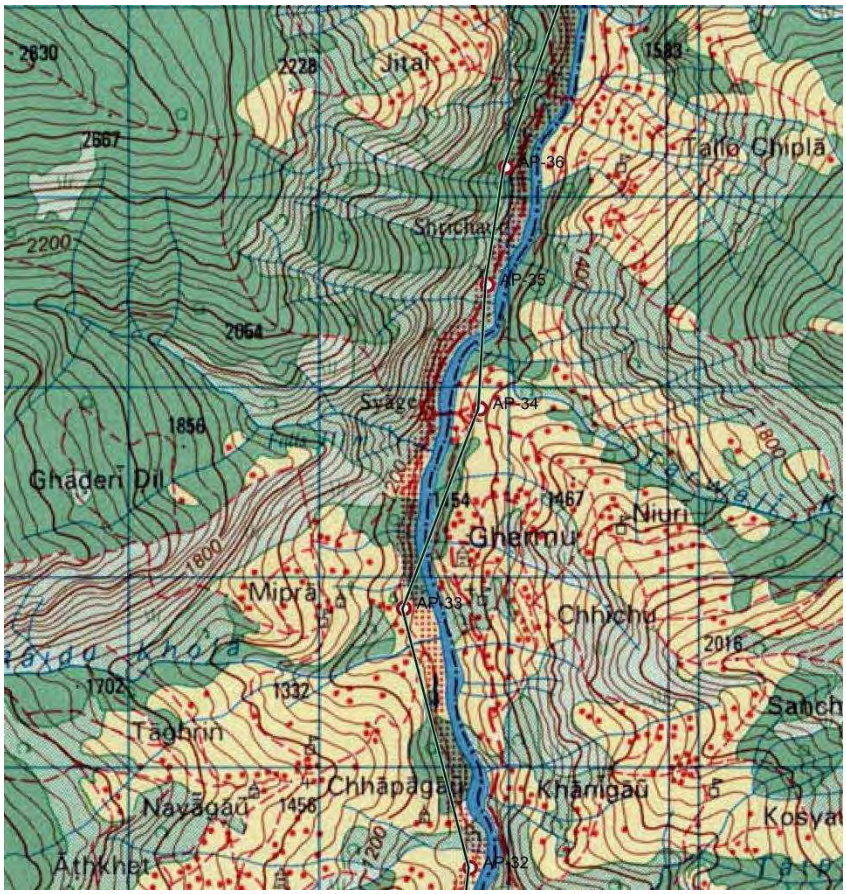
Appendix 4: Routing Map of Marsyangdi Corridor and Kaligandaki Corridor through ACA and December 2013 Field Visit Site Photos (Routing Map Source: NEA Survey Report)

Marsyangdi Corridor from Dharapani to Khudi VDC (East side of ACA)




Dense mixed forest
DHARAPANI
2864
3739
3991
1686
2950
AP-43
1679
Tal
AP-42
Gheran
Dense mixed forest
1712
AP-41
Sattale
Fairly dense mixed forest mainly bajh
Pone
AP-39
Chyamche
3909
3566


AP-39
AP-38
AP-37
Chyâmche
Open mixed forest
Purâno Jagat
Ghattekholâgâũ
Jagat
Jital
Mathillo Chi
Tallo Chiplâ
2751
3290
2350
2175
2228
1583
2667
2000
2200
2400
1800
2800


2830
2228
Jital
1583
2667
Tallo Chiplā
AP-36
Shirichaur
2200
AP-35
2064
Syāge
AP-34
1856
Ghāderī Dil
1800
1454
1467
Niuri
Ghemmu
Miprā
AP-33
Chhichu
2016
1702
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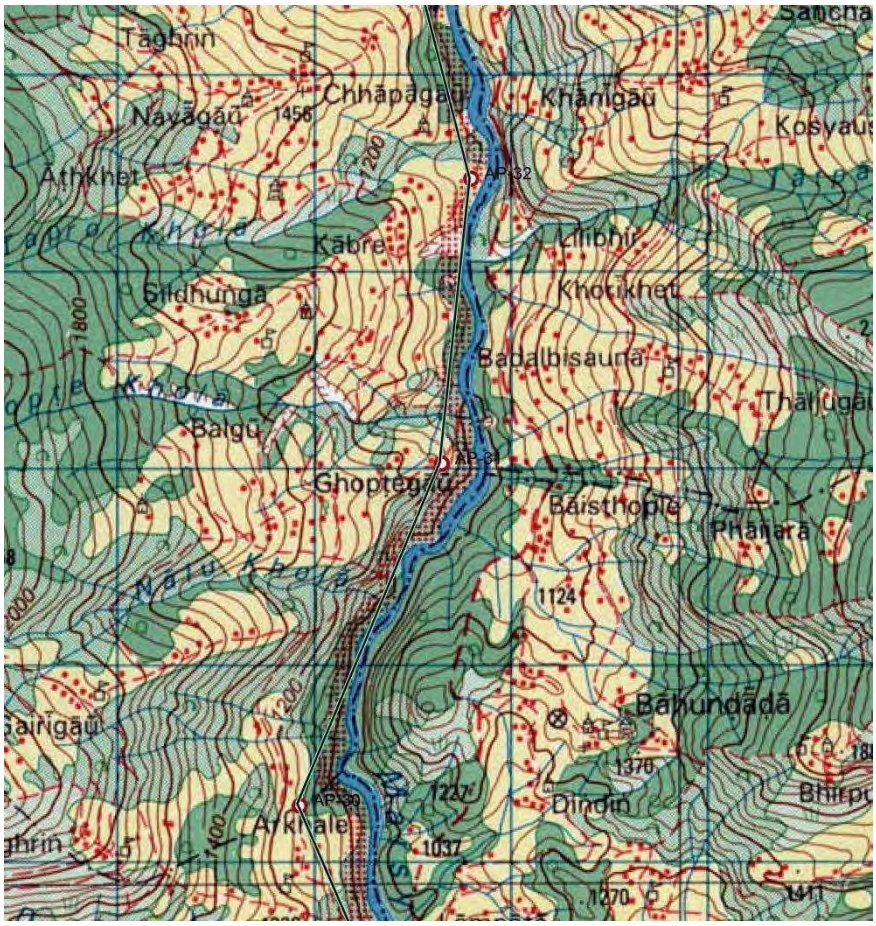
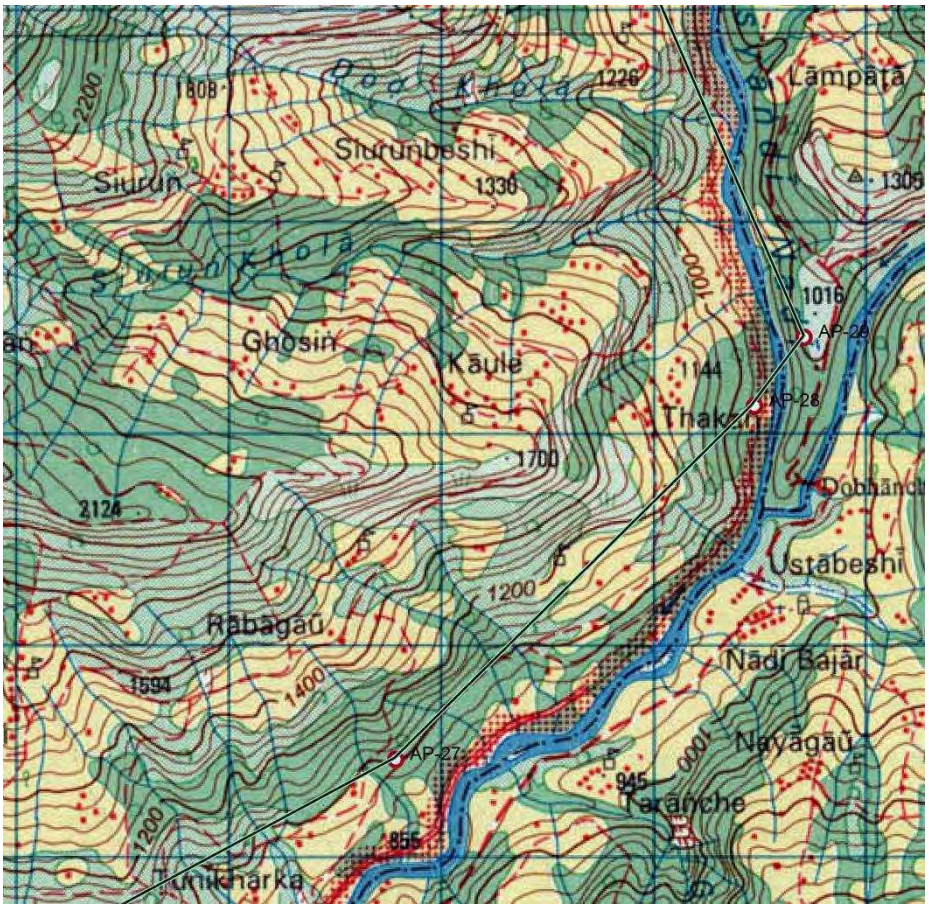
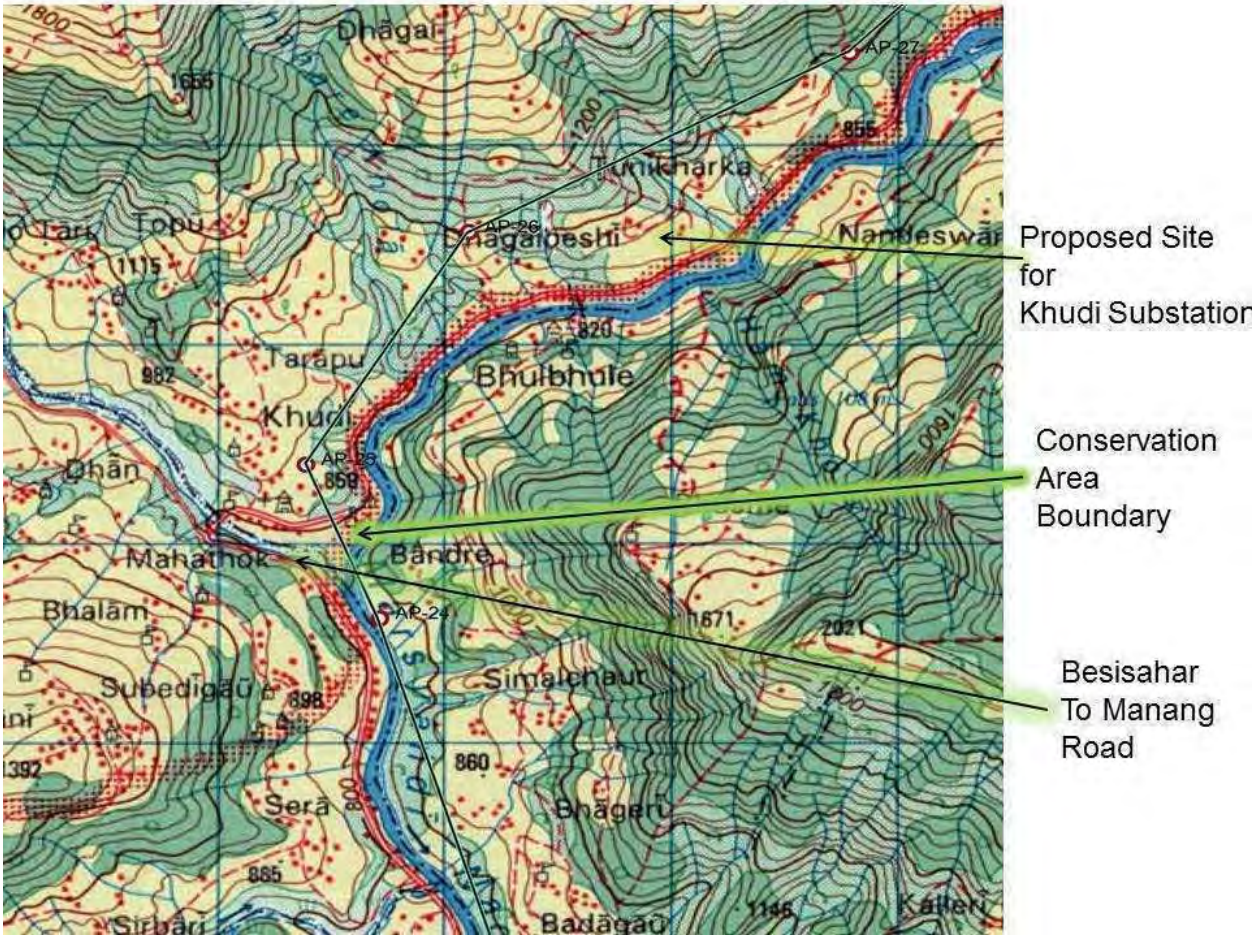
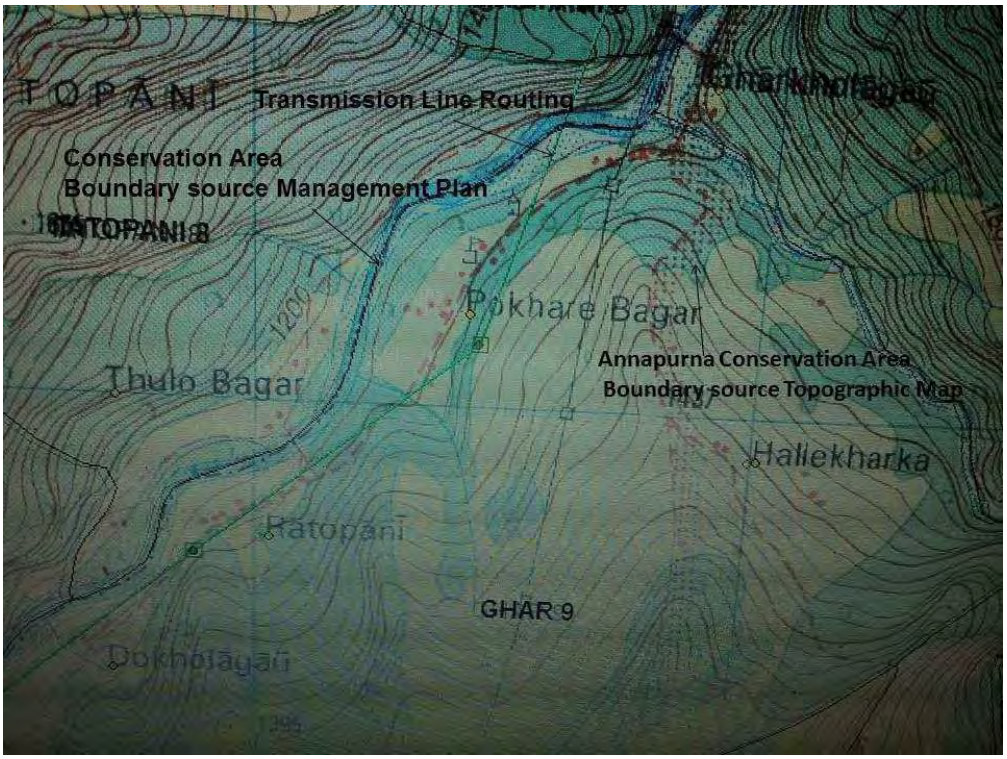
Sanch
Tāghrin
Chhāpāgāu
Khānigāu
Nayāgāu
1456
Kosya
Āthkhet
AP-32

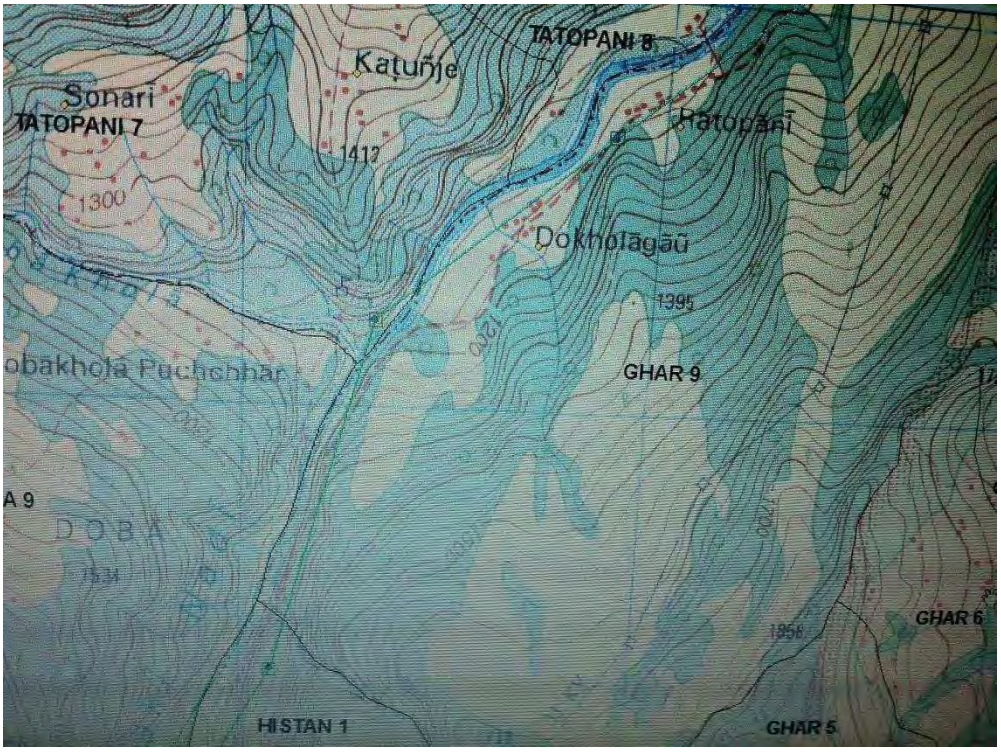

Tāghrin
Navāgāū
1456
Chhāpāgāū
Khānigāū
Āthkhet
AP-32
Kābre
Lilibhir
Sildhungā
Khotikhet
Badalbisaunā
Balgū
AP-31
Ghoptegāū
Bāisthoplē
Phāñarā
1124
Bāhundādā
1370
Dindin
AP-30
Arkhale
1037
1270


Lāmpāṭā
1226
1305
Siurunbeshi
1330
Siurun
1808
2200
1000
1016
AP-29
AP-28
Ghosin
Kāule
1144
Thak
1700
2124
Dobhāndi
Ustābeshi
1200
Rābagāũ
Nādī Bajār
1594
1400
AP-27
Nayāgāũ
945
1000
Tarānche
1200
855
Unikharka



Kaligandaki Corridor at Ghar VDC (west side of ACA)


TOPANI
Transmission Line Routing
Conservation Area
Boundary source Management Plan
TATOPANI 8
Pokhare Bagar
Annapurna Conservation Area
Boundary source Topographic Map
Thulo Bagar
Hallekharka
Ratopani
GHAR 9
Dokholagau


TATOPANI 8
Katuñje
Sonari
TATOPANI 7
Ratopani
1417
1300
Dokholagau
1395
obakhola Puchchhar
GHAR 9
A 9
DOBA
GHAR 6
HISTAN 1
GHAR 5

Pictures from Site Visit

Figure 1: Marki Chowk Substation Site

Figure 2: Marki Chowk Substation Site

Figure 3: Udipur Substation Marsyangdi Corridor

Figure 4: Routing Close to Proposed Udipur Substation Site in Marsyangdi Corridor

Figure 5: Construction of Upper Marsyangdi A near Khudi Substation site. Photo taken on Besisahar-Manang road which is inside the ACA.

Figure 6: Khudi Substation Site in Marsyangdi Corridor – Site is just inside the ACA

Figure 7: Dana Substation Site Kaligandaki Corridor. ACA is visible in background of photo.

Figure 8: Kaligandaki Corridor - Early Stage Construction Activities for Mistri Khola Hydro. Site is about 2 kilometers north of Tatopani Hot Springs. Land on left side of river is in the ACA (see next photo).

Figure 9: Mistri Khola Hydro Power Construction Kaligandai Corridor

Figure 10: Kushma Substation Site Kaligandaki Corridor

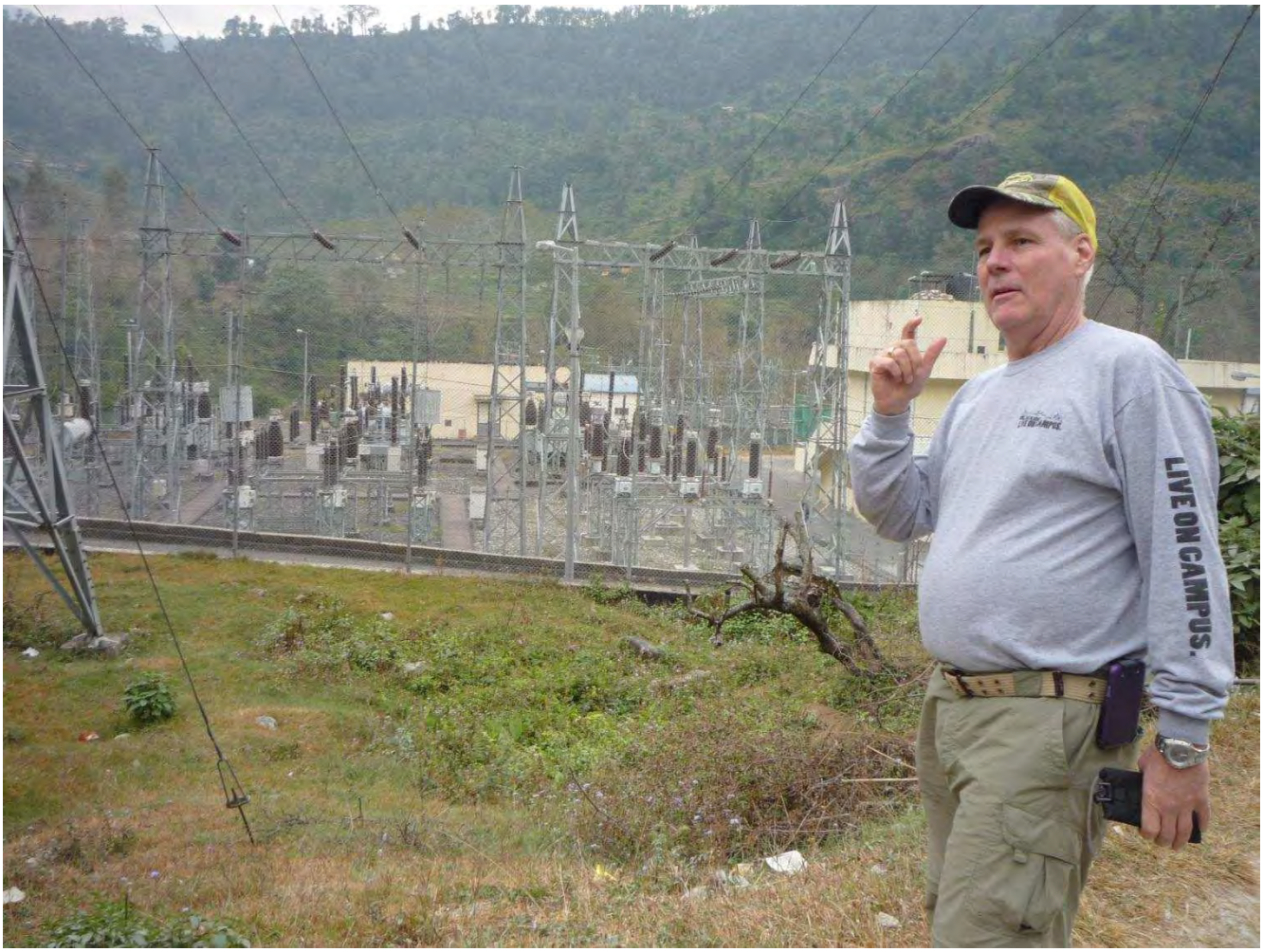


Figure 11: 132/33 kV Substation Facility on Modi River. Modi hydroelectricity plant (HEP) powerhouse is underground in background of photo. This substation is similar in scale to those proposed for the project.

Figure 12: Common Run of River Hydro Plant – Diversion structure of Modi HEP

Figure 13: Proposed Site for 132/33 kV Samundratar Substation

Figure 14: Routing for Samundratar Trishuli 132kV Transmission Line

Figure 15: Trishuli Routing at Ghermu VDC

Figure 16: Trishuli 3B Hub Site

Figure 17: Trishuli Routing near Betrawati