Role of forest on climate change adaptation

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वन तथा भू - संरक्षण मन्त्रालय

रेड - फरेष्ट्री तथा जलवायु परिवर्तन इकाई

बबरमहल, काठमाडौं, नेपाल

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Ministry of Forests and Soil Conservation
REDD – Forestry and Climate Change Cell
Babarmahal, Kathmandu

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Abbreviations

BISEP-ST	Biodiversity Sector Assistance Programme for Siwalik and Terai
BPP	Biological Profile Project
BS	Bikam Sambat (Bikram era)
CBD	Convention on Biological Diversity
CF	Community Forest
CNP	Chitwan National Park
DFO	District Forest Office/r
DFRS	Department of Forest Research and Survey
DNPWC	Department of National Parks and Wildlife Conservation
DoF	Department of Forest
DPR	Department of Plant Resources
DPTC	Disaster Prevention Training Center
DSCO	District Soil Conservation Office/r
DSCWM	Department of Soil Conservation and Watershed Management
FAO	Food and Agriculture Organization
FRIS	Forest Resource Information System
FUG	Forest Users Group
ha	Hectare
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Intergovernmental Panel for Climate Change
ISDR	International Strategy for Disaster Reduction
LRMP	Land Resource Mapping Project
mm	Millimeter
NAPA	National Adaptation Programme of Action to Climate Change
NBS	Nepal Biodiversity Strategy
NFA	Nepal Foresters' Association
NGO	Non Governmental Organization
NPWCA	National Parks and Wildlife Conservation Act
NTFP	Non-Timber Forest Product
PRSP	Poverty Reduction Strategy Paper
R & D	Research and Development
REDD	Reducing Emission from Deforestation and Forest Degradation
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

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Chapter 1: Introduction

Forests form a vital resource for practically all economies of the world. Apart from timber and wood products, it offers a variety of valuable goods and services including implications for global climate regulations. Due to its altitudinal variation ranging from a 60 meters (NBS, 2002) to the highest vegetation line, Nepal harbors critical forest ecosystems. Different types of forests, forest based goods and services as well as biodiversity are main components of these ecosystems.

1.1 Forests

In Nepal, according to Forest Act 1993, forest is defined as all the area, which is fully or partially covered by trees. Under this definition, Department of Forest Research and Survey (DFRS) has done inventory of forest area using the satellite images from 1994 to 1997. According to the inventory report, forest area is 4.27 million hectares (29%), shrub land area is 1.56 million hectares (10.6%), together with trees and shrubs covered land, total forest area is 5.83 million hectares or 39.6% (DFRS, 1999).

1.1.1 Ecological Forest Types

Ecological forest types in Nepal are very diverse with different species of flora. Stainton (1972) has classified with 35 forest types. These forest types are further categorized into ten major groups, which are:

i. **Tropical Forest** (below 1,000m): This forest type is predominantly composed of *Shorea robusta* in the southern parts of Nepal. *Acacia catechu / Dalbergia sissoo* forests replace *Shorea robusta* forests along streams and rivers.

ii. **Sub-tropical Broadleaved Forest** (1,000-2,000m): *Schima wallichii / Castanopsis indica* forests are found in central and eastern Nepal.

iii. **Sub-tropical Pine Forest** (1,000-2,200m): *Pinus roxburghii* forests occur particularly on the south-facing slopes of the Mid-hills and Siwalik.

iv. **Lower Temperate Broadleaved Forest** This forest type occurs between 2,000-2,700m in the west and 1,700- 2,400m in the east. *Alnus nitida, Castanopsis tribuloides/C. hystrix, Lithocarpus pachyphylla,* and several species of *Quercus.*

v. **Lower Temperate Mixed Broadleaved Forest** (1,700-2,200m): This type of forest is confined to north and west facing slopes, which especially include the Lauraceae family.

vi. **Upper Temperate Broadleaved Forest** (2,200-3,000m): *Quercus semecarpifolia* forests are widespread in central and eastern Nepal on south-facing slopes.

vii. **Upper Temperate Mixed Broadleaved Forest** (2,500-3,500m): This forest type occurs in central and eastern Nepal, mainly on north and west-facing slopes. *Acer* and *Rhododendron* are prominent species.

viii. **Temperate Coniferous Forest** (2,000-3,000m): *Pinus wallichiana, Cedrus deodara, Cupressus torulosa, Tsuga dumosa* and *Abies pindrow* forests 2haracterize the temperate conifer forest type.

ix. **Sub-alpine Forest** (3,000-4,100m): *Abies spectabilis, Betula utilis*, and *Rhododendron* forests occur in subalpine zones, the latter in very wet sites.

x. **Alpine Scrub** (above 4,100m): Juniper-Rhododendron associations include *Juniperus recurva, J. indica, J. communis, Rhododendron anthopogon*, and *R. lepidotum* associated with *Ephedra gerardiana*, and *Hippophae tibetana* in inner valleys.

(Source: NBS, 2002)

1.1.2 Legal Forest Types

In Nepal, there are six forest types defined by Forest Act, 1993 and other official documents, which include:

- Government Managed Forests
- Community Forests
- Leasehold Forests
- Religious Forests
- Private Forests
- Collaborative Forests[1]

Today, there are more than 16,283 community forest users group managing 15,15,593 hectares of forests (DoF, 2011a). Similarly, there are 34,826 hectares of leasehold forests managed by 56,018 households (DoF, 2011b) and there are also 29,798 hectares of collaborative forests managed by local communities.

Table 1: Information on Community Based Forest Management in Nepal

S. N.	Mode of management	Total Areas (ha)	Number of FUG	Households Involved
1	Community forest	1515593	16283	1956371
2	Leasehold forest	34826	6041	56018
3	Collaborative forest	29798	13 CFM plan	
4	Buffer zone forest	507667	4088	120210

Source: DoF, 2011

1.2 Land-Use Change

There is decline in forest area and change in between 1991/1992 and 2001/2002. The figure used by REDD Readiness Preparation Proposal; Nepal is given in table 2 below. The table shows that all types of forests in all ecological regions are decreased from 5.828 million hectares to 4.268 million hectares. This means decrease in 1.560 million hectares with the change of minus 2.7 percent per year. The table shows that forest land has been converted to other land use categories, especially shrub land and agriculture land. The change from forest to shrub-land indicates forest degradation over the 10 year time period has been covered by

[1] This category was added by government from the directive in 2001

the study. It is estimated that about 84,000 hectare of forest land becomes deforested annually. The annual deforestation rate in the Terai is estimated to be 2.7 %.

Table 2: Land-Use Change 1991-2001 ('000 ha)

Land Use	Year	Ecological Region				Change	Annual Change %
		Himal	Hills	Terai	All		
Cultivated	1991/1992	208	1,722	1,039	2,969	123	0.4%
	2001/2002	211	1,798	1,082	3,091		
Non Cultivated	1991/1992	495	436	56	987	44	0.4%
	2001/2002	517	449	65	1,031		
Forested	1991/1992	233	4,436	1,159	5,828	-1,560	-2.7%
	2001/2002	228	2,891	1,149	4,268		
Shrub	1991/1992	138	512	39	689	872	12.7%
	2001/2002	168	1,254	138	1,560		
Grassland	1991/1992	133	1,589	35	1,757	9	0.1%
	2001/2002	138	1,592	36	1,766		
Other	1991/1992	797	1,668	25	2,490	513	2.1%
	2001/2002	946	2,025	31	3,002		
Total	1991/1992	2,004	10,363	2351	14,718	0	0
	2001/2002	2,208	10,009	2,501	14,718		

Source: Adapted from CBS, 2008, Environment Statistics of Nepal

1.3 Biodiversity in Nepal

Nepal's biodiversity is a reflection of its unique geographical position and climatic variations. There are over 6500 species of flowering plants, over 1500 fungi species, over 350 lichen species. Out of those about 370 species of flowering plants are considered endemic to Nepal. Faunal diversity in Nepal is also vast, the country harbors 175 mammal species, 836 bird species, 147 reptile and amphibian species, 180 species of fish, 640 species of butterfly and above 6000 species of moth (Maskey, 1996). Of these, 26 species of mammals, nine birds and three reptiles are either endangered or vulnerable or threatened. Those species include Tiger, Rhinoceros, Elephant, Musk deer, Snow leopard, Swamp deer, wild buffalo, Bengal florican, Lesser florican, Red panda, clouded leopard, Gangatic dolphin, Gharial, etc. (Maskey, 1996).

A total of 118 ecosystems have been identified in different physiographic zones of Nepal. Out of these ecosystems, 80 ecosystems are represented in present protected area system in Nepal (BPP, 1996). These ecosystems in Nepal and their representation in protected area system are shown in the table below.

Table 3: Dobermez's Ecosystems in Nepal

Zone	Number found in Nepal	Represented by Protected Area
Terai	10	10
Siwalik	13	5
Midhills	52	33
Highlands	38	30
Others	5	2
Total	***118***	***80***

(NBS, 2002)

The biodiversity in Nepal is supported by forest, rangeland, wetland and mountain ecosystems. To protect these ecosystems, the Government of Nepal has established four kinds of protected areas, and these are national parks, wildlife reserve, conservation area and buffer zone. The National Parks and Wildlife Conservation Act (NPWCA), 1973 and its associated regulations are the principal legal instruments that govern the management of protected areas in Nepal. The Act provides complete protection to 27 species of mammals, nine species of birds, and three species of reptiles.

The government has also brought forward Buffer-Zone Management Regulations, 1996 which gave local communities rights to manage the forests around the protected area to fulfill their needs and at the same time maintaining the buffer-zone forests as security belt to conserve core protected area involving local communities.

Chapter 2: Objectives, Scope and Methodology of the Study

2.1 Objectives of the Study

- Identify how forest ecosystems support enhancement of adaptive capacity of local communities.
- Analyze win-win roles of forests for climate change mitigation and adaptation (using multi-criteria analysis).
- Analyze policy gaps in Nepal to bring forests in the forefront of climate change adaptation while enhancing mitigation performance.
- Recommend policy framework to integrate adaptation roles of forest to mitigation function (how REDD+ and NAPA go together).

2.2 Scope of the Work

Task 1: Identify adaptation potential of forests in terms of biophysical parameters

Task 2: Prioritization and comparing adaptation/mitigation roles of forests

Task 3: Policy analysis and developing policy framework for integrating adaptation and mitigation roles of forests

2.3 Study Methodology

2.3.1 Literature Review

Review of International Literature

Study of international literatures on forest adaptation produced by different international organizations like FAO, UNEP, UNFCCC, etc. was carried out. On this basis, forest services mentioned in the TOR were identified.

Review of National Literature

The main document reviewed for overall direction of the study is NAPA Nepal 2010, which has identified 20 forest and biodiversity related activities in forest water conservation, wildlife stress, vulnerable species conservation, NTFP management, forest fires, reduction of invasive species, etc. Similarly, documents produced at national level were studied, some major documents include different study reports of REDD Cell, MFSC like drivers of deforestation and degradation, text linking to REDD strategy formulation, etc. Other documents linked with conservation of biodiversity such as National Biodiversity Strategy (NBS) 2002, NBS Implementation Plan 2006, etc. were also consulted. The NAPA Report of Nepal and NAPA reports of other countries like Eretria, Cambodia and NAPA report of other countries and other forests and adaptation reports were also referred. Additionally, this study identifies the list of ecosystem services mentioned in the TOR. Some of the very important national literature includes:

i. National Adaptation Programme of Action to Climate Change Nepal, 2010 (NAPA Report
ii. National Climate Change Policy, BS 2067

2.3.2 Discussion with Experts in Kathmandu

The study team consulted experts working in different fields, mainly rooted in climate change causing problems such as those related with increasing pathogens and forest fires, stress to wildlife, reduction in water availability, and so on. Therefore, experts involved in consultation were officers working in different government and non-government organizations like the Department of National Park and Wildlife Conservation, Department of Forests, Department of Forest Research and Resource Survey, and Department of Plant Resources.

2.3.3 Selection of Field Sites

As mentioned in the TOR, three study sites were selected, one each in the Terai, mid-hill, and high mountain as mentioned below.

A. Terai

For study in Terai setting, Chitwan district was selected for study of invasion by alien species, study of wildlife stress estimated in context to role of forest management, problems in wetland management for wild animals, and other forest related problems. For this study, Chitwan National Park and District Forest Office, Chitwan were contacted.

B. Mid-hill

As mentioned in the TOR, due to the lack of budget and time, district nearer of Kathmandu valley was selected for study of potential adaptation issues. District Forest Office and District Soil Conservation Office, Kavrepalanchwok were contacted for the forestry and watershed related problems that have been arising potentially from climate change.

C. High Mountain

Rasuwa district was selected of high hill districts for the study. Officials of Langtang National Park, District Forest Office, District Soil Conservation Office, and other government and non-government offices were contacted for sharing their views on issues of wildlife stress, and problems associated with water scarcity and forest pathogens.

2.3.4 Plan for Field Visits

While in Kathmandu, the study team planned visiting key offices related with the study. It had communicated the persons working in the government and NGOs to whom the study team intended to meet in advance. In addition, specific potential sites were identified and analyzed field situations through discussion with the local communities.

Checklists were prepared for discussion on thematic areas such as shift of plants towards uphill, spread of pathogens, invasion of alien species, and stress on wildlife from change in seasonal food availability, shortage of water, and reduction of water availability from forest area to local people. In addition, a checklist (see annex 2) was also made to determine how forest ecosystems are promoting adaptive capacity of local communities living around the forests.

2.3.5 Actual Field Visits

Actual field visits were conducted in identified districts and sites. Interactions were carried out at the district headquarter and relevant offices. The site visit program was further refined and narrowed down after consultation with officials discussed in the district headquarters. In the district, thematic issues were discussed with corresponding district office such as wildlife issues with staff of Nation Park, forest pathogens issue with staff of DFO, water issues with staff of DSCO and other relevant experts (see annex 3).

The proposed sites were visited and details documented and measured, including the use of photographs when necessary. On the basis of the observation and record, specific issues were discussed with the local people living around the area which is selected for specific study. Among the local people, discussions were also focused with relevant key persons such as discussion in water shortage with women, early ripening of flowers and fruits with senior citizens, traders of same products and herds (men/women). Focus group discussions were conducted by using prepared checklist and opportunities were provided to put their opinion especially to women, indigenous people and *Dalits*, when they occurred in the group.

Picture 1: Group Discussion with Local People

Picture 2: Group Discussion with Stakeholders

The knowledge gained by study team members in other past field visits like *Kaski, Parbat, Dolpa, Sankhuwasava*, etc. were also used to analyze climate change issues. In addition, technical knowledge and experiences of study team members are also used to identify climate change activities on the basis of technical knowledge.

2.3.6 Discussion on Field Outcome with REDD Cell

Field outcomes and issues were briefed and discussed in the REDD Cell. On the basis of the discussion, outline of the study was finalized.

2.3.7 Multi-criteria Analysis of Identified Activity

Various criteria were used for prioritization of identified activities, which are important from ecological and social perspectives, and include forestry criteria, cross-cut criteria and inter-sectoral criteria. These criteria incorporate biodiversity conservation, social criteria like people's participation, employment or income as well as contribution from the identified activities to agriculture, livestock, health, water and disaster.

2.3.8 Policy Analysis

On the basis of various observations in field, communities expression, experts opinion and based on study team's field observations, policy analysis were made in order to identify new policy requirements in forestry sector in relation to adaptation. One of the issues, which have been raised by NAPA, 2010 is a policy shift from conventional biomass production approach to forest management for water.

2.3.9 Preparing Draft Report

On the basis of the proposed outline, the draft report has been prepared.

2.3.10 Discussion on Draft Report

As per the TOR of study, the draft report would first be discussed at REDD Cell, which eventually would be presented for feed-back in the stakeholders workshop (see annex 3).

Chapter 3: Potential Climate Change Impacts in Forest and Forest Dependent People

3.1 Potential Impacts and Vulnerability in the International Context

Industrial and energy generation activities are necessary for human development. These activities produce various green house gases and their compositions have been increasing in the Earth's atmosphere. This is bringing about changes in net solar radiation received by the Earth, atmospheric circulation and hydrological cycle resulting global warming and erratic rainfall patterns. These effects are leading changes in the land surface, water bodies, forests and ice sheets.

Temperature increase and variability in rainfall, snowfall, heat, drought, etc. are resulting changes in forests and biodiversity. These climatic deviations are related to climate change and thus increasing vulnerability in the survival of trees, herbs, small and big animals and insects.

3.1.1 Impact of Climate Change in Forestry and Biodiversity Sectors

Some of the impact of climate change in forest and biodiversity in global level are presented below.

Case I: Forest Fire in Australia

Picture 3: Forest Fire in Australia

In February 2009, for two week the temperature was more than 40^{O}C. Maximum temperature recorded during these days was 46 ^{O}C. Wind was blowing with high speed up to 110 kilo meter per hour. The wind was dry. No humidity. It came from the desert but felt like it came straight from a furnace. There was one week forest fire in Victoria State, Australia in early February, 2009. The fire killed more than 200 lives. It made several people homeless; this is recorded as maximum damage from a forest fire in the history of Australia. Hot conditions by raising temperatures up to 46 degree Centigrade and high speed wind blowing contributed in spreading fire. After this accident, Australian government is taking legal measures to prohibit on controlled fire outside in open.

Case II: Polar bear vulnerability

Picture 4: Polar Bear

Polar bears (Ursus maritimus) are estimated to be 20,000 to 25,000 worldwide. They are depended especially on seals for their survival. Seals in sea ice are their main food; it is easy for them to hunt in sea ice than in water due to less seals mobility. Continuous access to sea ice allows bears to hunt throughout the year. Due to the global warming, break-up of the sea ice on the Hudson Bay of Canada, already occurred about 3 weeks earlier than in 1970. As the result polar bears in the area coming ashore earlier with reduce body fat (15% decline in body condition). As the result, the bear population in Hudson Bay has decreased from 1200 in 1987 o fewer than 950 in 2004. (Faschlin et al, 2007, p. 231)

Case III: Impact on Coral Reefs

Coral reefs are habitat for about a quarter of marine species and are the most diverse among marine ecosystems. Those will be affected by rise in atmospheric carbon dioxide concentration resulting decline in calcification and coral Skelton weakening (Faschlin et al, 2007, Pp. 235). Recent risk analysis of coral reef in Asia suggest that between 24% - 30% of the reefs in Asia are likely to be lost during the next 10 years and 30 years, respectively (Cruz et al, 2007).

Picture 5: Coral Reef

3.1.2 Vulnerability and Adaptive Capacity Development

Forest and biodiversity are as vulnerable from climate change as any other sectors and therefore, there is strong need to assess and enhance the adaptive capacity of the forest and biodiversity. For this purpose, the IPCC concept of vulnerability is taken into consideration and mentioned below.

Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC 2001, p.995). Vulnerability can thus be defined as a function of exposure, sensitivity, and adaptive capacity, or:

Vulnerability = *f* (exposure, sensitivity, adaptive capacity)
(Yusuf and Fransisco, 2009)

In the IPCC report, exposure is defined as "the nature and degree to which a system is exposed to significant climatic variations"; sensitivity is defined as "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli"; and adaptive capacity is defined as "the ability of a system to adjust to climate change (including climate variability and extremes) , to moderate the potential damage from it, to take advantage of its opportunities, or to cope with its consequences". Therefore, vulnerability is depended upon adaptive capacity.

Adaptive capacity is further defined as the degree to which adjustments in practices, processes, or structures can moderate or offset potential damage or take advantage of opportunities (from climate change). It can be written in equation form as follows:

Adaptive Capacity = *f* (socio-economic factors, technology, infrastructure)

From rise in temperature, and variability in rainfall, snowfall and other climate change related incidents, there will be impact on forests, biodiversity and local people who are depending upon these resources for firewood, fodder, non-timber forest products, water, etc. will be severally impacted. Change in forests and biodiversity may be aggravated by other human induced activities such as deforestation and encroachment for different human needs.

3.1.3 Observed Changes in the Forest Sector

Attributing to single characteristics brought by climate change is difficult, but climate change has added on different adverse conditions in forestry sector such as forest fire, pest attack, degradation of species, etc. Some of the discernable examples seen as impact of climate change in international contexts include as below:

- Changes in the timing of biological events have been observed. For example, earlier flowering of some species and increase in growing season period for some plants across the Europe by about 11 days from the years 1959 to 1993. Earlier start of breeding season of some bird species in Europe, North America and Latin America. Also, mismatch in the timing of breeding of bird species, for example Great Tit (*Parus major*) including their food (insect species), has been observed. This decoupling or mismatch could lead to bird hatching when food supplies may be scare (Bernier and Schoene, 2009).
- Many species have shown changes in morphology, physiology and behavior that are associated with changes in climatic variables. For example, painted turtle grew larger in warmer years and reached sexual maturity faster during warm sets of years.
- Pole ward shifting of species due to warming, for example, the ranges of some butterfly species in Europe and North America have been found to shift pole ward and higher elevation as temperature has increased (Bernier and Schoene, 2009).
- Drought has increased tree mortality and resulted degradation and reduced distribution of entire forest ecosystem such as Atlas cedar (*Cedrus atlantica*) forest (Bernier and Schoene, 2009).
- In the tropics, complex interdependence of forest organisms and their narrow climatic niches make biodiversity conservation more complicated.
- Increased outbreak of pests and diseases, for example spruce budworm outbreaks frequently follow droughts and or dry summer in parts of their range. Outbreak of mountain pine beetle (*Dendroctonus ponderosae*) in more than 13 million hectares of Canada (Bernier and Schoene, 2009).
- Forest fires in Australia, USA and Canada endangered lives of the communities living up to several kilometers apart. Increasing intensity and spread of forest fires in Asia were observed in the past 20 years (Cruz et al, 2007).
- Climatic changes bring deviation from existing practices and uncertainty, which are difficult to tackle.

3.1.4 Potential Climate Change Impacts

- Changes in phenology are expected to occur for many species. Changes are seen in date of bud break, hatching and migration. This will continue for more species.
- Movement of habitats to pole wards or upwards. However, present and future land-use change and associated migration prevents natural adaptation via geographical shifts (Fischlin et al, 2007).
- Slow to show evidences in long lived species.
- Species with limited climatic ranges are typically most vulnerable to extinction. Approximately 20% -30% of plants and animal species assessed so far are likely to be at

increasingly high risk of extinction as global mean temperature exceeds warming of 2-3 degree Celsius (Fischlin et al, 2007). In North Asia, forests growth and northward shift in the extent of boreal forest is likely (Cruz et al, 2007).

- Species which are already at risk are in state of extinction. Inland aquatic ecosystems as most vulnerable to climate change and have indicated limits of climate adaptation due to the dependence on water availability (Fischlin et al, 2007).
- Climate change is likely to provide favorable condition for the growth and distribution of invasive alien species because of their adaptability to disturbance.
- Geographically restricted ecosystems are potentially more vulnerable due to less flexibility for species distribution.
- Livelihood of indigenous people who depend on biodiversity will be adversely affected.
- Globally, commercial forestry productivity rises modestly with climate change in the short and medium term (Easterling et al, 2007).

3.1.5 Vulnerabilities and Adaptation Actions

Major observed vulnerabilities and possible adaptation actions in international context include:

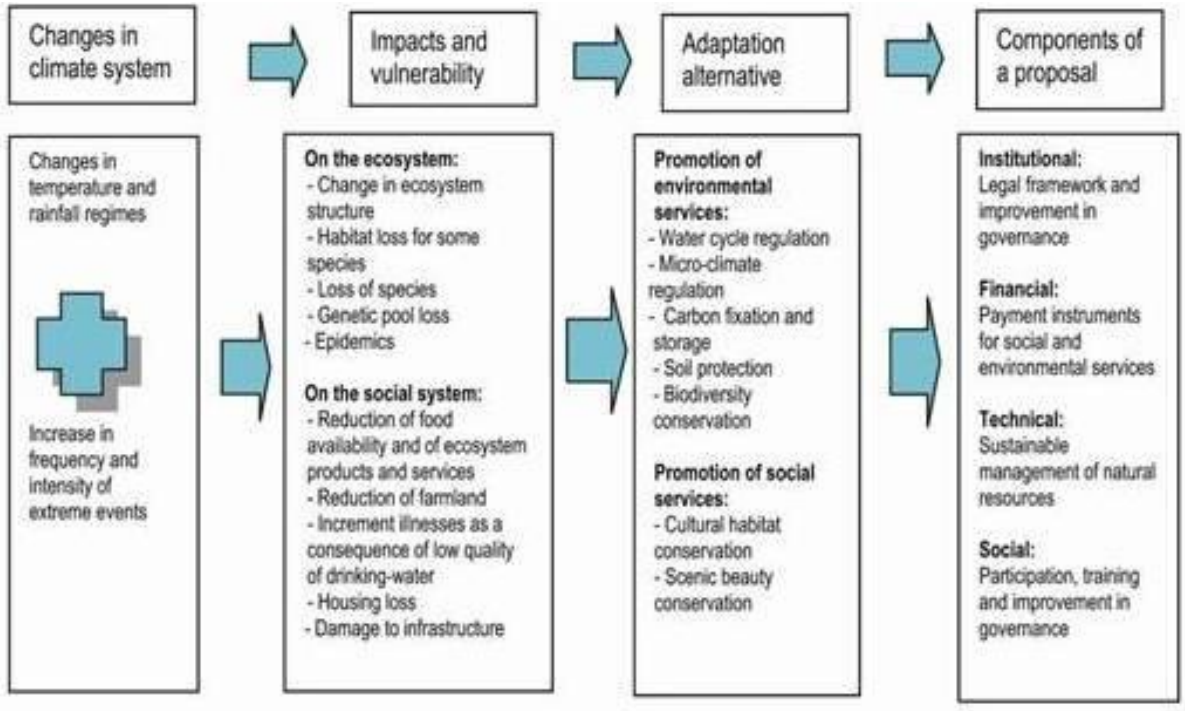
Table 4: Vulnerabilities and Adaptation Actions

Effect of Climate Change	**Warm winter and erratic rain**	**Prolonged drought**	**Special effect on biodiversity**
Vulnerability	• Increased chance of prevailing insects and diseases. • Increased competitions of invasive alien species. • Change in plant behavior like early flowering and fruiting. • Soil erosion and landslides in fringe forests.	• Increased chance of forest fire. • Reduced minimum flow of water in dry season when needed most. • Reduced availability of small plant products such as herbs. • Decreased forest ecosystem services such as water.	• Threatened to protected ecosystems. • Changes in wildlife habitat. • Changes in wildlife behavior. • Movement of vegetation.
Adaptation actions	• Monitoring of forest health. • Selection of resistant variety. • Understand changing context. • Management of forests for protection of soil. • Initiate landscape level conservation	• Incorporating fire management in forest management plans. • Introduction of fire control actions. • Establish better legislation to control fire. • Emphasis on management of	• Landscape level ecosystem and corridor management. • Increasing understandings on changes in habitat. • Create favorable conditions by intervention such

	to provide more flexibility for the species to adapt to adverse climatic condition by ensuring horizontal as well as vertical connectivity to enable movement of species due to climate change.	herbs. • Forest management to conserve water.	as water availability. • Ex-situ conservation of threatened species.

The relationship between climate change, vulnerability, adaptation alternatives and proposals for actions are elaborated in the figure below.

Figure 1: Relationship between Adaptation to Climate Change and the Environmental and Social Services of Forest Ecosystem



Source: Adopted from Robeldo and Forner, 2005

3.1.6 Proposed General Actions

In relation to climate change, forest management cannot be confined to traditional forest management of harvesting only timber. In context with effects of climate change, there can be three scenarios, first is no intervention or no change, second is reactive adaptation or the intervention is taken only after seeing negative effect, and third is proactive or planned adaptation. In planned adaptation, forestry goals and practices are redefined in context to the potential effect of climate change. Thus, planned adaptation will reduce vulnerability and increase resilience.

3.1.7 What Should be Done?

Some measures to overcome the effects of climate change and enable better adaptation of local populations are listed below.

Policy

- Study barriers in adaptation, for example laws and policy on forest fire.
- Better policies and better knowledge to adapt with impacts brought by climate change.
- Integrating CC Adaptation into sustainable forest management with climate change focus in forests and biodiversity adaptation of climate change, because fires, landslides, water resources are major issues related with forest management (Nkem et al, 2007).

Planning

- Initiate landscape level management and creation of biodiversity corridors to ensure vertical as well as horizontal connectivity of the protected area so as to facilitate species movement both vertically and horizontally in the changing climatic context.
- Bring synergies from adaptation and mitigation to benefit local people.
- More knowledge development in discerning role of trees in anchoring soils, etc. (Spittle house and Stewart, 2003).
- Mass media coverage of the climate change issues, papers in adaptation, etc. are also important activities.

Implementation

- Monitoring of forest health and hygiene and determine vulnerability of forest ecosystems and community depended in it.
- Manage forest to reduce vulnerability and enhance recovery.
- Increase awareness and education within forestry stakeholders about adaptation.

Activities like promotion of community forestry has increased local adaptive capacity to cope with the climate change and diversification of forest based activities. In case of multiple species introduction, if one species is affected, there is alternative species. This will enhance adaptive capacity of the communities whose livelihood depends on non-timber forest products. However, there are many problems to cope with the climate change, mainly due to poverty and instability.

3.2 Potential Impacts and Vulnerability in the National Context

In the international context, climate change has substantial impacts on the forestry sector. There is some information existing in Nepal related to vulnerability caused by climate change. However, there is no long term and scientific studies conducted to identify climate change impact vulnerability and coping practice. All forestry sector climate change impact and adaptation studies are based on perception of local communities, district officials or experts and NGOs as well as experts in the study team. This methodology is also applied during the preparation of NAPA report. Same methodology is applied by specific case studies done by NGOs and students. Issues identified for climate change vulnerability in Terai, hill and high altitude is given below.

3.2.1 Meteorological Data Related to Forestry

Precipitation and temperature are two main parameters, which are directly related with the survival of biological diversity. In northern high altitude areas, there is generally low precipitation and low temperature. For example, In Manang average precipitation is 428mm/year. In the area mean temperature is increasing in pre-monsoon and post monsoon season. Similarly, maximum temperature is also increasing in both seasons. Minimum temperature is also increasing in pre-monsoon season. However, in winter, minimum temperature is decreasing (Practical Action, 2009). So, extremes are being more hazardous to the plants and animal.

Siwaliks and Terai region of Nepal receive less total rainfall. But, in terms of 24 hours extreme, the area receives highest rainfall (Practical Action, 2009). Makawanpur Gadhi 24 hour's maximum is 391 mm in 2004, where average total rainfall is 2337 mm/year. In Rampur, 24 hours maximum is 296 mm in 2003, where average total rainfall is 2009 m/year. This is adding vulnerability in the Siwaliks which is already vulnerable from geological perspectives.

3.2.2 Forestry Sector Impacts in National Context

The forestry sector, as explained above, includes different category of forest and protected areas. This also includes forests, which are critical watershed (source of infiltration, storage, flow regulation, etc.) like Shivapuri forests of Kathmandu and Churia forests spreading in the southern geographical belt. Although, there is no data which show direct impact of climate change in those forests, there are many evidences of climate change such plants being exposed to higher temperature in lower altitude and shift upward due to global warming. In late 2008 and early 2009, the area faced severe drought due to lack of winter rain. This resulted in massive forest fire during late spring. The forest fires destroyed thousands of tones of forest biomass emitting carbon to the atmosphere and more critically destroyed many critical flora and fauna. It is difficult to estimate the exact loss in the species in such events. The forest fire incidence also killed 43 persons in the year BS 2065. Among the forest fire, notorious one was in Ramechhap which even killed 33 security persons who were deployed to extinguish fire (National Forest Fire Management Strategy, 2009). In the context of climate change, there is possibility that the winter rain will decrease and thus increasing the frequency and magnitude of such forest fire events in future.

Protected areas of Nepal harbor many critical forest ecosystems, watersheds and biodiversity, which are also impacted by climate change. The fire in Kachanjunga Conservation Area was most evident where there was not only ground fire, but crown fire also occurred, which lasted several days.

Due to climate change, vertical migrations of plant species are reported from international context. Thus, if there is unfavourable condition for the vertical migration, there is high possibility for the plant species to be in critical condition or even extinction, e.g. Birch and Taxus. Although there is no data, anecdotal evidences in Dolpa district has shown degradation of Birch (*Betula utilis*) forest, which could be due to increased temperature in the

current habitat and at the same time there is no favorable upward place with required soil. Besides, shifting of trees line is relatively slow because in natural way dispersal of plants through natural dispersal of seeds is very slow process. Similarly, many foresters and community forest user groups in high altitude districts like Dolpa, Jumla, Mugu, Humla have told that the high altitude herbs like Jatamansi and Kutki are found much less than which used to be before. But, there is no evidence that this is only due to climate change and not due to indiscriminate harvesting. The study on snow leopard habitat also indicates that increased temperature will lead to shrinkage of snow leopard habitat.

Climate change has increased vulnerability on forests and biodiversity of Nepal due to rise in temperature, decrease in snow fall, untimely rain (in 2009 monsoon was late), increased dryness, these all are impacting flowering and fruiting season and also ultimately resulting difficult situation for survival of plant species in forests.

Due to less snowfall, untimely rain, increased dryness, plants changed their behavior of flowering, fruiting which is closely related with survival of fauna or wildlife. Plants are the ultimate food for the wild animals and their life cycle is related with availability of food and climate such as wildlife hibernation during winter when there is adverse climate and less food available. If seasonal availability of food is changed, then natural life cycles of animals such as reproduction, migration and hibernation do not match with their existing physiology. This mismatch results big vulnerability in wildlife. These are natural or biological process, which takes time for changing, thus climate change is also impacting biodiversity in more vulnerable position. Therefore, climate change is creating forests, watershed and biodiversity more and more vulnerable. General climate change vulnerability condition for Nepal is presented below.

Table 5: General Vulnerability for Nepal

Terai		
Impact on ecosystem	***Impact on wildlife***	***Impact on plants***
• Siltation from forest materials • Flooding • Increased dryness in forest • Reduction in water bodies, less quantity of water	• Reduced local bird • Reduced migratory bird • Reduced wild animals • Change in habitat of wildlife • Change in food availability	• Diseases and insects in trees and plants • Reduction of tree species • Reduction of herbs and NTFP • Early flowering and fruiting • Increase in invasive species
Mid-hills		
Impact on ecosystem	***Impact on wildlife***	***Impact on plants***
• Increased dryness in forest • Reduction in water bodies, less quantity of water • Increased landslides	• Reduced local bird • Reduced migratory bird • Reduced wild animals • Change in habitat of wildlife • Change in food availability	• Diseases and insects in trees and plants • Reduction of tree species • Reduction of herbs and NTFP • Early flowering and fruiting • Increase in invasive species

High Altitude		
Impact on ecosystem	***Impact on wildlife***	***Impact on plants***
• Landslides • Less snow but more water in precipitation	• Overlapping range of low altitude animals like leopard.	• Biodiversity loss • Habitat change • Upward shifting of tree line • Disease in plants

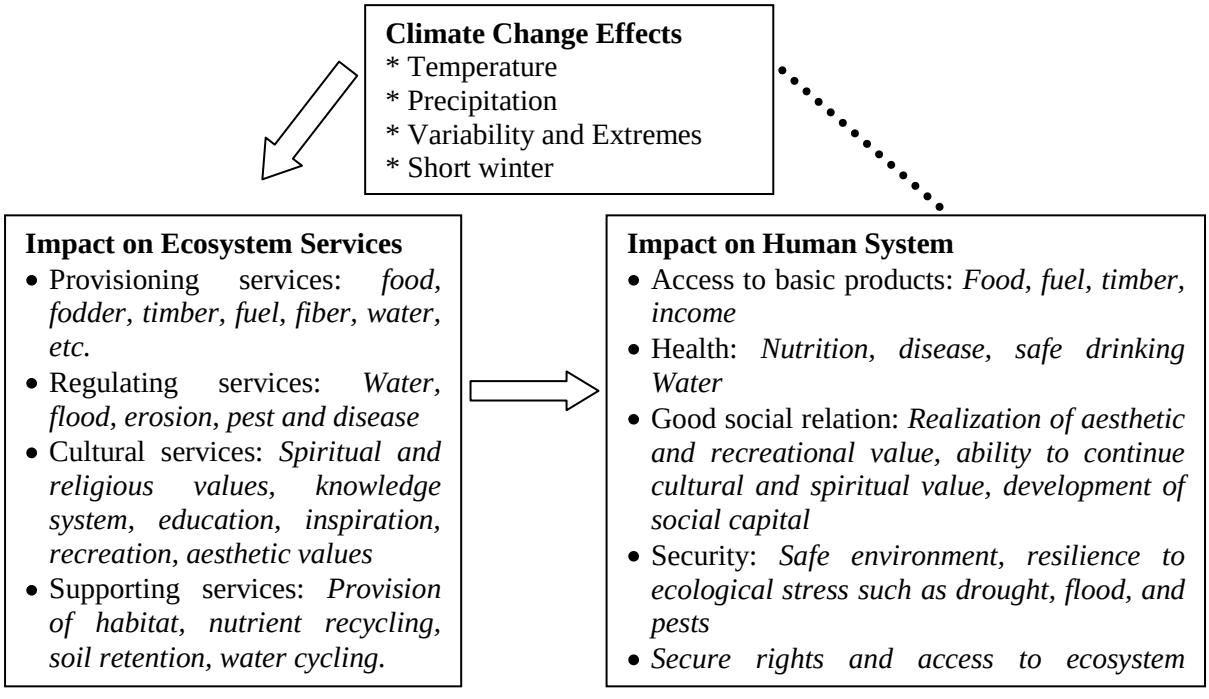
3.2.3 Impact of Climate Change on Local Human Systems

Indigenous people and local communities in rural Nepal are vulnerable to effect of climate change due to ecological fragility and economic marginality. They still depend upon water, food, fuel, fodder for daily livelihood. Forest ecosystem has critical role in production of these goods and services, which are highly affected by climate change and climate variability.

In addition, climate change is also related with different diseases in forest and agricultural crops and humans. Climate change effects like forest fires can reduce availability of forest products like timber, firewood, NTFP, leaf litter, fertilizers. Fire also reduces availability of wild foods and degrades watershed conditions.

In addition, extreme events like drought and flood also affect their source of livelihood like water, agricultural and forest production, milk and meat. According to the Ministry of Home Affairs in the year 2010, altogether 226 persons were killed from flood and land slides, so is the situation every year. Even in European countries where coping capacity is high, from heat waves in 2003, agricultural production was reduced by 13 billion Euros with largest loss of 4 billion Euros in France (Parry et al, 2007). All climate change related impact in rural Nepal is also supporting out-migration of indigenous peoples and rural communities making rural ecosystem more vulnerable due to reduced availability of human resources. The figure below shows relationship between climate change, ecosystem services and human system.

Figure 2: Relationship between Climate Change, Ecosystem Services and Human System



Indigenous people and poor rural communities in Nepal still live in the life style which is closed to nature. They live in the house which is built from local materials like wood and thatch. They depend in the food which is grown in the village farm or gathered from nearby forests. Meat and fish, as source of protein, also come from local natural systems like grass land and streams. They use firewood to cook the food and making house warm. Nearby water hole is the source of drinking water. Involving in collection or trade of non-timber forest products is their employment. Therefore, for their daily livelihood, indigenous people and local communities depend upon the natural systems, which are very vulnerable to the effect of climate change.

3.2.4 Key Impacts of Climate Change in Ecosystem

Nepal Biodiversity Strategy, 2002 has identified five ecosystems in Nepal, which are Forests, Rangelands, Wetlands, Mountain and Agro-ecosystems. There are various impacts seen on those different ecosystems, which are explained below.

Impact on Forest Ecosystems

- ***Increased dryness and fire*:** As explained before, one of the strong impacts of climate change experience in Nepal is drought during the spring season. Although, forest fire is started by human, dryness of forest floor and winds are great contributing factors to spread fires and increase damages of all forest products such as timber, fuel wood, NTFP, wildlife, plants and small micro-organisms.
- ***Physical disturbance from erratic rain, landslides and erosion*:** Heavy rains results landslips and landslides. Once there is land disturbance, additional rain cause erosion in the forest ecosystems. These physicals disturbance also cause damage to overall forest ecosystems.
- ***Altered natural life cycles*:** Short winters due to increase in temperature results, reduced dormant period for plants. As the result, there has been early sprouting, flowering and fruiting. This makes impacts to species which depends upon flower and fruits of the particular species.
- ***Encroachment by alien species*:** Due to rise in temperature, drought and other unknown climatic factors, certain alien species are spreading rapidly in forests such as Mikania species in Terai forests, Lantana and blue ageratum (Nilo ganne jhar) in hill forests.
- ***Disease and pests:*** Due to extension rainfall after conventional monsoon period, rise in temperature, and other unknown factors various pest and diseases are seen increasing in forest ecosystems.
- ***Degradation of species diversity*:** Degradation of forest ecosystems from physical disturbance, erosion, and rise in temperature, short dormant season, forest fire, encroachment by alien species, insects and pests cause damage to existing species diversity in forest ecosystems.

Impacts on Rangeland Ecosystems

- ***More grass due to rise in temperature*:** Due to rise in temperature, the high altitude area which will be devoid of grasses due to less temperature in winter also has lush of green

grasses, as the result wild life which normally comedown in low altitude is also observed thriving in high altitude grasslands even in winter.

- ***Less grass due to drought*:** On the other hand due to drought, the area which normally support grasses are seen devoid of grasses as the result livestock, wild lives and local communities depending on those resources are facing problems.
- ***Reduced availability of NTFP*:** Due to drought and rise in temperature, in high altitude grass land, local communities have experienced availability of less herbs and NTFP in grass lands.
- ***Damage by fire*:** Similarly, due to drought and fire, high altitude grass land are also going through fires which damages physical resources in the land as well as reduce species diversity

Impact on Wetland Ecosystems

- ***Degradation of species*:** Due to drought, water level is reduced in wetlands especially in Terai and some hill districts like Kaski. Many species of aquatic plants and fishes are destroyed in the wetlands. In Rupatal area of Kaski, it is claimed that number of plant species like white lotus, *navo dhan, Karaute dhan, kadhe* fish, etc are reduced from the area.
- ***Encroachment by alien species*:** Exotic specie such as water hyacinth is spread well beyond its conventional territory.
- ***Degradation of livelihood resources*:** Degradation of wetland species like plants and fishes also reduce availability of direct products to neighboring indigenous peoples and local communities which will reduce their employment and income.

Agriculture Ecosystems

- ***Reduced production*:** Erratic rainfall and drought both are reducing agricultural yield, especially paddy (NAPA, 2010). Similarly decline in rainfall from November to April also reduce agricultural production.
- ***Loss of local crop diversity*:** In context of producing drought varieties, there has been loss of local land race and species.

Mountain Ecosystems

- ***Risk of glacial lake outburst flood*:** There are 20 glacial lakes which are in the risk of bursting and six of which have been identified as critical.
- ***Damage due to landslide and flood*:** In last ten years more than 4000 persons died and properties worth $ 5.34 billion are lost, which include loss of land and crops, livestock etc (NAPA, 2010).
- ***Spread of diseases*:** With rise in temperature, mosquitoes are also common in mountains, which are spreading diseases such as malaria, kala-azar, and Japanese encephalitis. In addition, there is also increased incidence and risk of other vector born tropical diseases such as typhoid.

3.2.5 Vulnerability Assessment in Forestry Sector

A study (Shrestha et al, 1999) carried out on the basis of 49 stations for period 1977 to 1994 indicate consistent and continuous warming in the period at an annual rate of 0.06 degree Celsius per year. Similarly, a study conducted by Practical Action on the basis of 45 stations or the period 1996 to 2005 indicate consistent increase in maximum temperature at annual rate 0.04 Celsius per year. (Ministry of Environment: 2010). Similarly, rainfall pattern is changing in Nepal. As the result, forests and biodiversity is being more and more vulnerable in high altitude, mid-hills and Terai. A study done by ICIMOD for Eastern Himalayas also shows similar figures, but less increase in per year temperature which has mentioned increase in temperature 0.01 degree C, 0.02 degree C and 0.04 degree C in the altitudinal range of less than 1000 meter, 1000-4000 meter and greater than 4000 meter, respectively (ICIMOD, 2009). According to the report, the most vulnerable segment also includes Terai-Dun tract from southeast Nepal to eastern Bhutan. And Koshi Tappu Wildlife Reserve is the most vulnerable to climate change. In addition, the area has also pressure for land and other natural resources, habitat fragmentation, species destruction through poaching and no potential for habitat extension.

High Altitude

Vulnerability of Snowline Trees

Due to impact of rise in temperature, upward elevations became warm and some trees are seen growing in higher altitude, literature claim that growing vegetation may extend by 500 meter (Practical Action, undated from website). In order to move the plants uphill, it needs favorable soil depth, and required properties of soil and water. In field visits in Rasuwa and other high altitude area, local communities told that snowline trees like Birch *(Betula utilis)* and Taxus *(Taxus baccata),* Cedar*(Cedrus deodara)* became highly vulnerable as there are new trees competing and for existing trees to move up there is no favorable soil above the area where these species were growing. So, the trees such as Birch and Taxus are increasingly vulnerable in high altitude.

Vulnerability in Fringe Forests

Forests which are close to roads, streams, villages, agricultural lands are vulnerable due to human interferences. As results, many landslides can be seen in these fringe forests. These vulnerability increases with high intensity and short duration rainfall, which make the upper layer of soil heavier and results landslips, especially in areas where there is no large root systems of trees enforcing horizontal soil layers of different level. Therefore, climate variability triggers vulnerability of the fringe forests resulting landslides and erosion. This can have further impact on water quality, deposit debris in low agricultural lands and damage to infrastructures like bridge and roads.

Vulnerability on High Altitude Medicinal Plants and People

As reported in Darchula district, medicinal plant like Yarshagumba *(Cordeyseps sinensis)* is less seen. Similar experiences are reported from the communities and District Forest Office in Dolpa. Officials and communities say that availability of Jatamansi (*Nordostachys*

grandiflora), Kutki (*Neopicrorhiza scorphularifolia*) and Sughadhawal (*Valerina wallichii*) has decreased. In Dunai, in an interaction conducted by Shey Phoksundo National Park, community forest's buffer zone users reported that there is no Jatamansi to harvest for five Years. Due to climatic stress such as less water, and change in weather patterns herbs in high altitude became vulnerable and found less and less. Same is reported from Darchula and Mustang districts during the transect field trips.

In Rasuwa district, unpalatable unidentified thorny grasses have been found in large quantity in high altitude, where these were not predominantly found before. Increase in such grass is reducing forage available to livestock.

Vulnerability on High Altitude Birds and Migratory Birds

Due to erratic rainfall and less surface water, wetlands, and water sources are decreasing in and around high altitude forests. This decrease in water is also affecting trees, shrubs, and herbs, water plants in ponds and lakes, and fishes. All of these are important part of food and habitat for the local and migratory birds like Danphe pheasant (*Lophophorus impijanus*). As the result, communities told that migratory birds like domicile crane (*Anthropodis virgo*) and other birds like pheasants are seen less. So, vulnerability on high altitude birds and migratory birds are also increasing.

Vulnerability on High Altitude Animals

There has been also shifting of high altitude animal like Pika (*Ochotona* spp.). Experts' claim that the species which has been residing mostly in 2800 meter, is now found to be shifted up to 3200 meter high. Similarly, common leopard is observed at higher altitude, normally, it has not been seen in the past.

Picture 6: Pika- A Rodent Found at High Altitude

Vulnerability of Local Community

Due to less availability of herbs in forests, forest dependent indigenous communities, poor, women are being more vulnerable. As the income of local communities living around the forests are much related with the availability of herbs in the forests and income of the local communities depended on the availability of herbs in forests and grassland, climate variability also made forest depended herbal collectors and local traders highly vulnerable.

Picture 7: A High Altitude Local Collecting Mushroom

Less availability of herbs also impact local indigenous communities, poor people and women who regularly collect herbs and non-timber forest products in high altitude. Vulnerability of herbs not only makes the local biodiversity vulnerable, but poor, women and indigenous

people are also at risk due to slash in earnings which are used to buy foods for their livelihood.

Vulnerability in Mid-hills

Vulnerability in Tree Species due to Dryness

As experienced by local communities, vulnerability has increased in tree species which in particular need moisture such as Banjh (*Quercus lanata*), Kharsu (*Quercus semicarpifolia*), Katus (*Castenopsis indica*), Champ (*Michelia champaca*), Utis (*Alnus nepalensis*). Upward shifting was also experienced in trees like Utis.

Vulnerability in Tree Species due to Diseases

Local communities have experienced that stem borer (benikira) and aijeru (fungus) are increasing in Khandbari.

Every year, fodder trees (mainly Dudhilo) in farmlands of Dhungkhark, Kavrepalanchwok district have been infested by defoliator resulting ultimate death of trees. Another insect named Guheykira also infested in Banjh and Painyu trees. Farmers did not have to feed straw to their cattle15-16 years back as fodder and forages were available plentiful. Now, they have to use straw almost 50% of the total feed.

From time to time, Sal trees and Utis trees have been infested of caterpillar during Chaitra, Baisakh and even Jestha when trees experienced new foliage in Falgun creating shortage of fodder to the cattle.

Late flushing is common on many broadleaved tree species (mainly Chilaune and Phalant) in Bhagawan Thumki CF of Kavrepalanchwok district. This has affected in obtaining untimely and inferior quality of leaves (small size) as feed to the cattle. The effect could also be seen in agriculture delaying the collection of dry leaves for making compost. Also, coiling of leaves has been noticed on species such as Chilaune and Phalant since last 3-4 years.

Vulnerability in Tree Species due to Forest Fire

Similarly, due to prolong dryness, vulnerability of forests fires is increasing and showing many incidences of small fire. The frequency of forest fire has been increased in Patne CF of Dhungkhark-7, Kavrepalanchwok district after BS 2052/053. Broadleaves are very much prone to fire and cannot thrive in stress conditions, whereas pine regenerates easily between 2-3 years after the damage. This might be one of the grounds that pine trees dominate the forest in many CF in Dhungkhark.

Vulnerability of Medicinal Plants

Due to erratic rainfall and reduction in moisture, herbal fruits like Amala (*Phylanthus emblica*), Ritha (*Sapindus mukrossi*), Timur (*Zanthoxylum armatum*), Bel (*Aegle marmelos*) are found less and less every year. Likewise, Bhase, Satu and Sugandhakokila are also found less. Similarly, non-timber forest products like Nigalo (small bamboo), bamboo, mushroom, etc. have become less.

Vulnerability of Wetland, Water Source and Water Bodies

As told by local communities, 25-30 % water has already decreased in and around forests. Due to less water, chance of forest fire is increasing which will not only kill trees but also destroy all ecosystems in the area. Similarly, areas of wetland are also reduced and water is decreasing in lakes and ponds in and around the forests. This is resulting increased vulnerability in wetlands, water sources and water bodies.

People in Dhungkhark-7, Kavrepalanchwok district experienced that one water source at Surung in forest block 5 of Patne CF has been dried for 2 years. Similarly, water flow in other sources reduced by almost 50% some 15-20 years. Similarly, there has been scarcity of water at zero kilometers along the Araniko highway in Kavrepalanchwok district. Golmadevi CF is the watershed and main source of water to the local people residing there. Until the year 2057, around 1000 liters of water could be collected in an hour, but now hardly 15 liters of water is available.

Vulnerability of Birds

Due to water stress condition, the number of local bird species such as dhukur (dove), bhyakur (bablar), haleso (ducks), vulture, eagle and bat is decreasing. Migratory birds like malchari, crane are also decreasing. Whereas, hill dhukur (*Stereptopelia chinensis*), terai dhukur (tame dhukur: *Stereptopelia orientalis*) are appearing here and there.

Early flowering and early fruiting is also making birds vulnerable due to change in food availability.

Vulnerability of Wild Animals

Due to the water related problems deer, monkey, porcupine, pangolin are decreasing. Red monkeys earlier found in Churia range are now seen in Mahabharat range. Similarly, due to change in food availability, wild animals are more vulnerable.

Vulnerability of Local Ecosystems

Due to the unknown favorable conditions brought by climate change, alien and invasive species such as *Lantana camera* and invasive species such as Banmara (*Eupatorium* spp.) is increasing. This is making all pants in the locality vulnerable.

Forage grasses like Khar, Makhlari, Tite, Tharthari that had been abundantly available 20-25 years ago in Patne Community Forest of Dhungkhark, ward no. 7 of Kavrepalanchwok district are not readily seen now days and there is likely extinction of fodder tree species such as Khasru and Banjh due to ever increasing number of Gobre salla (*Pinus wallichiana*) trees and overshadowing effect caused by it on other tree species and ground vegetation. Gobre salla seems to be growing favorably in more exposed and dry conditions as compared to the locally available broadleaved species. Pine species finding favorable environment to its establishment and growth might be considered as having climatic effect despite unreasoned biotic influences.

In nature, space underneath of pines can be found thorny bushes like Chutro, Katrekanda Jhyaukanda, Kandejhar, which have no fodder values creating scarcity of fodder and forage to the cattle. As a result, people have to travel almost 2 hours to reach to Kharkatne danda or Simsar near Phulchowoki of Lalitpur district to fetch fodder and forages of their choice.

Community people claim that seto banmara was not present 10 years ago in Golmadevi CF in Kavrepalanchwok district, but now this has become an invasive species.

In western Nepal like Kaski district, new variety of *Agiratum* with blue flower is encroaching in fringe forests and grass land. The species is also unpalatable to the animals.

Vulnerability of Local Communities

Less availability of water is increasing vulnerability of local communities specially women. Because, they have to walk further due to erratic rainfall, they are being more vulnerable. Similarly, due to less availability of herbs in forests, forest dependent indigenous communities, poor, women are being more vulnerable.

Vulnerability in Terai

Vulnerability in Trees due to Dryness

Trees found along the river and stream bank such as Khair (*Acacia catechu*), Sissoo (*Dalbvergia sissoo*), Simal (*Bombax ceiba*) are seen decreasing due to change in water conditions in the streams. Trees like Satisal (*Dalbergia latifolia*) and Bijasal (*Pterocarpus marsupium*) are not seen in the forests.

Vulnerability in Trees due to Disease

Diseases are seen even in wild Sissoo trees.

Vulnerability in Trees due to Forest Fire

Forests are becoming drier. There is more incidence of fire in Terai forests and vulnerability in relation to fire is also increasing.

Vulnerability in Herbs

Due to changes in temperature and water related characteristic, herbs like Kurilo (*Asparagus recemosus*), Pipala (*Piper longum*), Dalchini (*Cinamomum zeylanicum*), Kaulo (*Cinamomum grandiliferum*) are decreasing in the forests and making them more vulnerable.

Picture 8: A Stream in Terai

Vulnerability of Water Source and Wetlands

Due less rainfall, water is decreased in water sources in forests. Similarly, small ponds and lake are being dry such as Kalkij, Salgaudhi and Ranital in Kanchanpur.

Vulnerability of Birds

Due to water related problems, peacock, ghaghan, pani hans, and maina are decreasing in forests. Birds like Kilhat and migratory birds like Malchari are being more vulnerable and decreasing in and around forests. Similarly, due to early flowering, fruiting, time of food availability have changed, this is also making birds more vulnerable.

Vulnerability of Animals

Availability of food for herbivores like deer is decreasing due less grass. Similarly, vulnerability is increased due to water stress. Due to less deer, prey animals like tiger are also decreasing and being more vulnerable. Due to change in availability of food, behaviors of wild dogs have changed in Suklaphanta Wildlife Reserve, Kanchanpur.

Picture 9: Gharials- Sunbathing on the bank of Narayani River

Water stress may also result vulnerability in aquatic animals.

Vulnerability of Local Ecosystem

Invasive species such as *Lantana camera, Eupatorium* spp., *Mikania micrantha, etc* are increasing. This is making all plants in the locality vulnerable. An extreme example is found in Chitwan National Park where *Mikania macrantha* are spreading extensively affecting original vegetation of shrubs and trees, which are important food for many wild animals.

Picture 10: Mikania Invasion in Chitwan

Vulnerability of Local Community

Local communities who are living near to the forests are very poor, in other words as they are very poor, they happened to live near to the forests. Livelihoods of local communities are being more vulnerable due to the stress of decreased water. Forest water is the only source which is made available even to the people living in remote areas; it is like blood circulated in entire human body. When water is decreased in the forests, women and children have to go farther, because there is less water in forest streams or ponds. Similarly, due to less availability of herbs, incomes of the local communities are reduced. Thus, they are increasingly being vulnerable.

Chapter 4: Possible Forestry Sector Adaptation Activities

On the basis of field visits, interactions with stakeholders and national literature review, numbers of forestry sector climate change adaptation activities are identified. These activities are also in line with NAPA 2010, which are described below.

4.1 Forest Fire Control

Due to climate change or climate variability, rainfall has decreased, especially in the winter. For example, decrease in rainfall due to climate variability in Kathmandu Valley can be compared as below.

Table 6: Rainfall Variation in Kathmandu Valley

Months	Nov	Dec	Jan	Feb	March
Long term mean precipitation in mm	8	4	9.5	11.9	15.6
Observed point data	Nov 2007	Dec 2007	Jan 2008	Feb 2008	Mar 2008
Sankhu, Kathmandu	2	0	0	0	0

Source: Data procured from Department of Hydrology and Metrology, February 2010

Broadleaves are very much prone to fire and cannot thrive in stress condition, whereas pine regenerates easily between 2-3 years after the damage. Dale, V.H., *et al* (2001) in their article "Climate Change and Forest Disturbances" described that droughty sites typically support species that survive well under dry conditions with uncertain rainfall. He added sites that have frequent fires contain Gymnosperm species with uncertain rainfall. One long winter drought is enough to make impact on increase in dryness in forest floor. Thus, long drought is making forest floors highly susceptible to fire. Therefore, as evident in recent time, one of the main reasons which are increasing vulnerability to forests and biodiversity is fire. In order to adapt this problem, there should be capacity building programme for forest managers, awareness building programme for communities, actual prevention programme like construction of fire line (even though fire line is not effective in controlling forest fire in slopes, especially fire spreading downwards as per users), early detection of fire and warning system developed (siren) to make the locals aware of fire hazard within short time, developing a separate fire fighting squad with equipments and protective clothing and locally produced tools in the village, prescribed burning of roadside fuel loadings, particularly dried leaves in erosion prone areas, creation of controlled burning, simulation exercise for forest managers, villagers/users and actual fire fighting activities when it occurs. In addition, policy should be reformed for effective and easy implementation like giving responsibility of extinguishing fire to fire igniters.

The policy intervention can be legally allocating duty of fire extinguishing to fire makers. For example, origin of most of the forest fire in Nepal is human made and spreading in forest from agriculture land. Forest fires are occasionally spread in settlement areas causing enormous damage to the property and even fatality. During the unset of spring, farmers clears slash in the field by burning, but they leave the fire often unattended. The months, Chitra and Baisakh, are relatively dry and windier. Rain with thunder storms are other common climatic

characteristics of these two months. When wind blows during slash burning, then the fire is spread to forests. Climate change is increasing this problem due to less rain or no rain in winter as well as in the spring. So, when fire makers extinguish fire, the source of fire is minimized. Thus, fire extinguishing duty should be legally given to fire making person.

This adaptation activity can be implemented jointly with the Department of Forests and also with community forest users groups, if the project implemented is community forest. In addition, there can also be partnership with ISDR Regional South Asia Wild land Fire Management Network (Coordinated by Sunder Sharma of DPTC, former employee DSCWM).

Table 7: Contribution to Forestry and Other Sector from Adaptation Activity

Forestry	Other Sector
Conservation of biodiversity (plants, animal) in the potential fire control, depletion of carbon sink, conservation of soil properties (e.g. permeability, infiltration capacity, water storage in soil), conservation of conventional food for forest dependent people, etc. This also produces mitigation co-benefits by reducing carbon emission and enhancing carbon sink at the same time.	Reduction in forest fire will also reduce change in village disaster by transmission of forest fire to village. Fire control will also support livelihood of forest dependent indigenous people and local communities by making traditional food available to them. This will also make conventional herbs and NTFP available to indigenous people and local communities and support income generation or employment .Fire protection will also maintain physical properties of soil needed to maintain infiltration and water holding capacity, thereby contribute in water storage and help to increase minimum flow of water in dry season supporting drinking water, sanitation (human health), irrigation in agricultural fields.

4.2 Programmes for Forest Pest and Pathogen Control

Pathogens like fungus and pests were minimal in natural forests of Nepal in the past, but now communities feel that gradual disappearing of trees like Sissoo, Bijasal, Satisal is also the effect of forest pathogens outbreak. This can be related with climate change because temperature is increasing and numbers of cold days are decreasing. Pathogens become more active during temperature rise. In addition, due to reduced number of cold days, period of hibernation of pests is also reduced. The literature review also shows climate change generally will lead to reductions in tree health and will improve conditions for some highly damaging insects and pathogens. Therefore, the programme of actions to cope with forest pathogens is quite related with climate change adaptation. However, understanding exactly how forest diseases will be affected by climate change is extremely challenging, and is further complicated by lack of knowledge, data and monitoring of forest diseases.

An environmental factor affecting the establishment and growth of trees is unpredictable since we do not have field studies as such. However, Johnston, M. *et al* (2009) predicts that given the lack of detailed understanding of climate change impacts on forest insects and disease, a general strategy is to understand and adhere to the principles of Sustainable Forest Management, since these principles have been established by the Canadian Council of Forest

Ministers and dealt with maintaining forest ecosystem biodiversity, health and productivity. This principle may hold well in Nepalese context as well.

Impact

Forestry	**Other Sector**
Biodiversity conservation, support in better biomass growth or mitigation	This will protect income of forest manager by protecting value of forest products

4.3 Integrated Forest Management for Water

In context of climate change, water is being less and less available to the communities in the villages, so it is being precious. Forests are the only sources of water, which can supply water in the villages in Nepal, except a few kilometers along the river from the river water. Forests play a major role in climate mitigation strategies through carbon sequestration and the provision of products substituting fossil energy and materials. Furthermore, forests contribute significantly to regional climate regulation and to continuous water supply in large and small scale water cycles. These regulating services of forests including their alleviating functions can be essential for adaptation strategies to climate change effects.

Well positioned forests substantially improve catchment water quality outcomes. Thus, management of forests for water and minimizing waste of water in forests are also important from climate change perspectives, because till now forests are mainly managed for timber, fire wood and fodder.

Landslides and flash floods caused by the increase in the events of intensive rains had destroyed irrigation channels and affected water discharge in the streams. Streambeds had risen because of deposition of debris, which had covered up stream water, making it inaccessible for irrigation.

In context of climate change, where water is being less at the time of spring or when it is needed most, forest management modalities should also focus on increasing infiltration, storage; reduce evapo-transpiration which is other important adaptation measures.

Specific adaptation activities may include:

- Establishment of mixed species forests- systems those are resilient to extreme climate events such as storms, drought and even heavy rainfall.
- Management of vegetation which results more infiltration.
- Management of vegetations which result less evapo-transpiration.
- Increase input through subsurface flow through conservation pond (reservoirs) and contour ditches.
- Protection of water source from landslides, erosion and other disturbances through bio-engineering techniques.
- Protection of forest water canals from excessive loss.
- Protection of stream bank cutting inside forest.

- Management of wetlands ameliorates both water quantity and water quality thereby benefiting the local biodiversity.
- Implement conservation awareness programmes at different levels.

Impact

Forestry	**Other Sector**
Mitigation by promoting biomass production, biodiversity conservation, protection of forest watershed from environmental degradation	This will support conservation and storage of water. Thus impact on drinking water, sanitation, irrigation, agriculture, even the hydropower if based in forest watershed by reducing evapo-transpiration. Thus this will also help improve income or livelihood of forest dependent people. This is the forestry adaptation activities which can have maximum impact in other sectors

4.4 Wildlife Management in Relation to Climate Stress

Due to the climate change, dryness has been increased, water is reduced in sources, and even small sources are dried up in forests. Due to such climatic stress, wild lives have to move towards the place where there is water. Therefore, conservation plans have to consider problem of water scarcity while implementing biodiversity conservation programmes.

As the climate changes, farming, forestry, water management and many other land uses are likely to change with it. These activities are all important for wildlife, and the way they adapt may offer both opportunities and threats to biodiversity. This has to be done especially in relation to animals, local birds and migratory birds for whom water or wetland is the key for survival.

Another category of climate change impact on wildlife is the changes to competitive advantages between species and the spread and impacts of invasive species and diseases that are likely to lead to markedly different communities of plants and animals than those we know now. Mikania (*Mikania micrantha*), as one of the world's worst invasive species, is also spreading in Chitwan National Park (CNP) within 10-15 years. Mikania has already invaded significant proportion of grasslands and riverine forests of CNP and its buffer zone which could lead to serious ecological and economic consequences.

Extreme weather conditions like floods, drought can kill wildlife through inundation, temperature imbalances and starvation.

Although there are evidences in the global context, current sources of information in the country do not show the reality of climate change effect on wildlife and thus cannot be predicted the nature of impact in the coming days confidently.

Activities:

Only small areas of the country are protected and managed as habitat for wildlife. These have to be set in a wider landscape management concept and sustainably so that it helps in

restoring biodiversity and facilitates wildlife movement freely in suitable habitats. Bear in mind, this does not facilitate transformation or extension of invasive alien species.

Maintain or improve structural diversity of wetland forests ensuring both water quantity and water quality, and maintain prey species to support populations of water birds and mammals.

Yet our landscape is full of physical barriers (roads, canals, farmlands, settlements) to animals' movement, there is considerable doubt that species are able to move to their new locations. Therefore, we should still hold the programme of translocation of species of vulnerability.

Impact

Forestry	**Other Sector**
Biodiversity conservation	Depends upon specific activity what is done to protect wild animals

4.5 R & D for Adaptation

ICIMOD (2009) study has identified clear gaps in research information in three broad areas which are:

- There is much to learn about the potential magnitude and rate of climate change at the regional and local levels, and subsequent impacts on the full range of biodiversity endpoints and ecosystems.
- Second, there is no consolidated handbook of proven biodiversity conservation techniques, or climate adaptation techniques, targeted at this region.
- Third, detailed analyses need to be developed for each of the priority climate change threats to biodiversity and other natural resources.

For identification, planning and implementation of adaptation activities, minimum information is necessary. Such information is lacking in Nepal, so there should be some R and D activities to generate required information which include R and D in different topic, some area of study are as below.

For Small Plants and Animal

Due to their long term life cycle, it is very difficult to study impact of climate change in trees. R and D to know stress of climate change in biodiversity is possible in small plants and animals due to their short life cycles. These characteristics are unknown but urgent in case of small size biodiversity (plants and animals) conservation in context to climate change. Thus, in order to adapt with climate change stress such as increase in temperature, increase in dryness, decrease in rainfall, untimely rain, increase in rain instead of snow, impact of climate change in small flora and fauna should be studied.

For Large Mammals

Movement of large mammals is also important. It has been reported from high altitude districts that due to rise in temperature, leopards are moving towards up to the habitat of

snow leopard. In the past, it is accepted that snow leopard lives up in high altitude and leopard lives down. But, now leopards are also observed in the area of snow leopard by staff of Department of National Parks and Wildlife Conservation. As these are both territorial big cats, new management interventions may be necessary so that both kinds of cats do not conflict among themselves.

Food Availability and Change in Wildlife Behavior

Due to late rain or change in time of rainfall, time of sprouting, flowering, fruiting has been changing. Flowers, fruits, seeds are important food for birds and animals which are related with their important physiological activities such as reproduction, hibernation, migration. Therefore, we should know impact of mismatch of natural food availability in the survival of key biodiversity in Nepal.

Change in Management with Respect to Early Flowering and Fruiting

No study has been conducted on impact of climate change in biodiversity, however local communities living in the same area for several years have experienced changes such as early sprouting, flowering and fruiting (Gurung and Bhandari, 2009).

Management of particular trees such as loping, pruning, branch cutting is related to sprouting, flowering and fruiting. Normally, such activities are not conducted while flowering and fruiting on tree species. In conventional forestry, branch cutting, pruning are done in Magh, but if the trees sprouts during this time, those forestry operations have to be synchronized with such new issue appeared from climate change. Therefore, further studies are needed in these concerns.

Impact

Forestry	**Other Sector**
Depend upon specific research	Depend upon specific research activity

4.6 Management in Landscape Level

In context to climate change, plants and animal have to migrate to favorable places depending upon their need of temperature, water, snow, food etc. So, in large landscape, they have enough opportunity to move in the direction which is favorable to them. On the contrary, if the protected area is only a few square kilometer or small, then they have limited chance to cope the factors brought forward by climate change. In fact for past some years landscape level management is initiated in Nepal. These concepts need more emphasis from the perspectives of climate change.

In the present context of climate change, scientists have predicted the shift of vegetation from lower altitude to higher altitude. In the absence of favorable condition for the vegetation to move upward, there is high risk for the species to be extinct. Therefore, to facilitate in vegetation shifting, the landscape level conservation should work towards building vertical connectivity of the national parks. There should be connection between conservation areas of Terai, mid-hill and High Mountains.

Impact

Forestry	Other Sector
Biodiversity conservation by establishing corridors and connectivity	Promotion of tourism through biodiversity conservation

4.7 Collection and Maintenance of Biodiversity Database

Actually, there is no database availability of critical biodiversity in the country. According to Convention in Biological Diversity as a conference of the party, Nepal is obliged to prepare and update those databases. But, due to the unavailability of resources, so far such activity to map biodiversity and maintaining database is not started. So, in context to climate change such database should be prepared, especially for endangered wildlife living in high altitude such as snow leopard, brown bear (high altitude bear), red panda and other critical animals in the country.

Impact

Forestry	Other Sector
Biodiversity conservation	Educational

4.8 Management of Wetlands

Wetlands are source of water for many people living around. These are sources of biodiversity such as various local water birds, migratory water birds, fishes, and other important lives. These are also sources of food, especially for the poorest of the poor living near to these sites. Wetlands are also source of fodder and firewood.

In context of climate change, many communities have reported that water is decreasing in the wetlands, ponds and reservoirs and small ponds are even dried up. These are increasingly threatened. Therefore, as part of adaptation measures, conservation of wetlands, pond and water sources should be implemented for biodiversity conservation and making water available to the local communities.

Impact

Forestry	Other Sector
Biodiversity conservation. Carbon enhancement. Protection of the wetland area itself from degradation.	Support livelihood of forest dependent indigenous peoples and local community by making tradition of food available in the area. Support income generation by making NTFP and herbs available in the area. Enhance water availability there by supporting agriculture, human health

4.9 Management of Herbs for Poverty Reduction

Poverty reduction has been the prime objective of past several development plans of Nepal from Eighth Five Year Plan. Tenth Plan had heavily targeted in poverty reduction and also known as Poverty Reduction Strategy Paper or PRSP. However, there is no success as expected by the country. People have also expected to support poverty reduction from herbs

and non-timber forest products. It is also prime area which possesses big potential for poverty reduction.

Main herbs in high altitude such as Panchaule, Kutki, Jatamasi, Atis, etc. are found less and less. These are low volume and high value products. In addition, as told by local communities in fields, these are found less and less due to change in rainfall pattern or snow fall patter or reduction in snow fall. Unavailability of these species is linked with climate change.

Sustainable management of those species have two major additional objectives, these are biodiversity conservation of the species itself and increase income of the communities who are living around these resources. So, in this project, climate change, biodiversity conservation and poverty reduction, three prime objectives can be blended in a single project.

Impact

Forestry	**Other Sector**
Sustainable management of the forest area, protection of land, biodiversity conservation.	Support livelihood of forest dependent indigenous peoples and local community through income generation from NTFP and herbs available in the area. Support production of tradition food available in the area.

4.10 Control of Invasive Species

Mikania is an invasive species. In most of the forest in Terai including Chitawan National Park, unwanted invasive species are increasing. The species is a climber and presently, it is encroaching most of the forests in the Terai, which are important habitats of wildlife. It has succulent thick stems and can have vegetative propagation from any part of the plant. Experts do not know why such species are increasing. Many think that it is something to do with the increase in temperature, increase in warm days and changes coming from climate change.

Impact

Forestry	**Other Sector**
Biodiversity conservation, production of biomass	Support tourism and income generation activities of indigenous peoples and local communities.

4.11 Awareness and Capacity Building of Stakeholders

The general public in Nepal does not have good understanding of the implications of climate change and potential benefits of climate change response measures (Chapagai and Adhikari, 2007). Those who have certain knowledge do not dare to state impacts, vulnerability and mitigation confidently. Therefore, awareness raising and capacity building of all concerned stakeholders like government line agencies (central and district level), NGO and communities, local people are also essential. So, there must be strong awareness raising and capacity building project in various topics related to climate change, such as global warming, rainfall, snow fall and how these affects climate change. The project should also have strong publicity or media related activities.

Impact

Forestry	Other Sector
Sustainable management of the forest area, protection of land, biodiversity conservation.	Support livelihood of forest dependent indigenous peoples and local community through income generation from NTFP and herbs available in the area. Support production of tradition food available in the area.

4.12 Supportive Functions of Forests to Improve Adaptive Capacity of People

As explained above, different forestry activities improve adaptive capacity of local communities. Sustainable forest management will improve availability of forest products like firewood, timber to the indigenous peoples and local communities who are living around the forests. Forestry activity such as forest fire management will improve availability of fodder for animals and leaf litter as fertilizers. Similarly, this practice will increase availability of traditional food items and non timber forest products. Forest management activities focused in water will also improve watersheds conditions and enhance dry season water flow which is necessary for drinking, sanitation, irrigation, agriculture etc. Wetlands and other biodiversity conservation related activities will promote ecotourism and will improve local employment. Management of herbs and NTFP will increase productions and thereby support indigenous peoples and local communities for their daily life sustenance. Therefore, forest management practices and forest adaptation practices both will support to increase adaptive capacity of local people in relation to the problems which they have been facing as impact of climate change.

Chapter 5: Criteria for prioritization of Forestry Adaptation Activities

5.1 Forestry Criteria

i. **Reduction of adverse impact in forestry:** This also includes criteria such as relationship with climate attribute, severity of impact to community, programme for climate change affected refugee.
ii. **Biodiversity conservation:** Conservation of vulnerable species, controlling invasive and alien species, ecosystem conservation, wetland conservation and identical criteria, ecological services, landscape conservation and identical criteria.
iii. **Support to mitigation:** This include generation of additional carbon in forest area or reduction in emission due to identified programme.
iv. **Support to eco-tourism**
v. **Synergy with forestry and other policies:** This also includes multilateral agreement, values in other strategies of the country and identical criteria.

5.2 Cross-cut Criteria

i. **Poverty reduction to increase resilience:** Contribute in employment and income generation. This includes support to forest dependent community, remote area focus, indigenous people, minority, gender issues, equity etc.
ii. **People's participation:** Role of community in project planning, decision making, capacity building, simplicity, good governance, awareness raising and identical criteria.

5.3 Other Thematic Area

i. **Support to agriculture:** This include support to agricultural practice by providing fertilizers or conservation of land or making water available to the crops.
ii. **Support to livestock:** This means support to livestock by increasing fodder.
iii. **Support to health:** This include support to sustenance of human health.
iv. **Support to water:** This include supporting increase in water for human consumption
v. **Support to disaster reduction**: this include support to Disaster Reduction such as flood and fire, etc.

Table 8: Scoring for Prioritization of Activities Using Identified Criteria

	Forestry Criteria					Cross Cut		Other theme					
Identified Adaptation Activity	**Reduct-ion of impact**	**B.D Conservat-ion**	**Mitigat-ion**	**Eco-tour-ism**	**Synergy**	**Poverty Reduct-ion**	**Peoples Participat-ion**	**Agric-ulture**	**Livestock**	**health**	**Water**	**Disaster**	**Total**
Extreme weather resisted mixed forest ecosystem	5	2	4	2	2	2	2	2	2	2	3	3	**28**
Community based forest fire control in mid hills	5	3	5	2	4	4	4	4	4	3	2	4	**44**
Forest pathogen control in terai forests	5	3	2	0	1	1	0	0	1	0	0	0	**13**
Control of alien and invasive species	5	4	3	3	3	1	0	0	0	0	0	0	**19**
Wildlife management in relation to climate stress	5	5	1	3	1	0	0	0 0	0 0	0	3	1	**19**
Vulnerable species conservation	5	5	0	0	0	1	1	0	0	0	1	0	**15**
Rangeland conservation in high altitude	5	4	2	2	4	0	1	2	2	0	1	0	**33**
Landscape level management	5	4	2	2	4	0	1	2	2	0	1	2	**25**
Wetland biodiversity conservation	5	5	1	3	3	4	4	3	2	2	3	3	**38**
Conservation of reverine forest	5	2	4	2	3	1	2	3	3	0	3	3	**31**

Management of high altitude herbs and NTFP	5	4	2	2	4	5	5	0	3	4	2	1	**36**
Management of TOF in public and private land	5	4	3	1	2	2	3	2	2	0	0	0	**24**
Conservation forestry/shelterbelts	5	1	4	1	2	1	1	2	2	0	3	3	**25**
Integrated forest management with focus in water	5	3	3	3	3	2	1	3	3	3	3	3	**35**
Integrated watershed management with focus on Churia	5	3	3	1	1	3	3	5	4	1	3	4	**36**
Sub watershed management in high altitude	5	3	3	3	2	2	0	2	3	2	2	1	**28**
Forest watershed protection through bio-engineering	5	2	3	1	2	2	2	3	3	2	3	3	**31**
Management of vegetation with increase infiltration	5	1	3	2	2	1	2	3	2	3	2	2	**28**
Management of vegetation with reduced evapo-transpiration	5	1	3	1	2	2	2	3	2	2	3	3	**29**
Conservation ponds in forests	5	3	1	1	3	3	3	4	3	2	3	0	**31**
Forest watershed protection through bio-engineering	5	2	3	2	2	1	2	3	2	2	3	3	**30**

Payment of environmental Services	5	3	3	2	2	2	3	3	2	2	2	2	**31**
Collection and maintenance of biodiversity database	5	5	1	4	3	2	0	0	0	0	0	0	**20**
Policy reform													
Climate awareness and capacity building of stakeholders													
Research and Development in relation climate issues													
* Effect of climate change in small flora and fauna													
* Large fauna													
* Change in animal behavior													
* Change in forest management with respect to early flowering													

Key for Scoring of Activities:

5 = fully supports criterion (maximum score)
4 = supports criterion significantly
3 = generally supports criterion
2 = marginally supports criterion
1 = does not directly support criterion (indirectly related)
0 = No notable impact on criterion

Chapter 6: Review of Policies

6.1 Review of Climate Change Policy

The Climate Change Policy of the Government of Nepal was endorsed by the cabinet on January 17, 2011. The policy mentions that climate change has brought about various effects like extreme events, including long duration drought and severe floods, change in timing of seasons, etc., which are impacting poor communities and mountain countries.

The policy has mentioned that the climate change effects are impacting forest and biodiversity and forest dependent people through floods, droughts, forest fire, reduced availability of forest products necessary for daily life sustenance. The policy has also emphasized that the impact will be more on poor, which also means forest dependent communities, indigenous people and marginalized communities. The policy has further added that study is not done in impact of climate change in geographical area, thematic area and its quantity and severity.

In the needs identified by the policy, it has mentioned spending at least 80 percent of total budget in local level and making natural resource management "climate change friendly" (as mentioned in the rationale).

The targeted needs mentioned include the following points:

- Establishment of Climate Change Centre for research and monitoring
- Initiate community based adaptation programs based in National Adaptation Plan
- Formulation of a Carbon Trade Strategy

With regard to strategy, it has highlighted the importance of:

- Preparation of integrated program to cope with climate change, land degradation, and biodiversity conservation

The policy mentions, including others, points for climate friendly natural resource management, which are further elaborated as:

- Conservation and management of forest for alternative livelihood of forest dependent communities
- Initiate sustainable forest management to address climate change issues.
- Using some portion of income from forest to combat with fire and other problems

Gaps

The present climate change policy of the government in relation to the role of forests is rather broad and general, and does not address specific issues. Sector specific sub-policies would be helpful for the sectoral line agencies to focus their efforts on climate change. For example, in context of adaptation, it could include the following issues:

- How forest in high altitude should be managed to address the issue of degradation of NTFP and watershed.

- How forest in the hills should be managed to address issues of long term drought (water), and forest fire.
- How wetland area in Terai should be managed for biodiversity conservation and livelihood.
- Initiate collection and maintenance of biodiversity database for potentially impacted flora and fauna.

6.2 National Biodiversity Strategy

National Biodiversity Strategy, 2002 published by Ministry of Forests and Soil Conservation has 17 cross-sectoral strategies and 28 sectoral strategies relating to biodiversity conservation in Nepal.

In context to climate change, especially, climate change adaptation, the issues which should be addressed in relation to biodiversity conservation will, *inter alia*, including the following strategies:

- Maintain database of species existing, native and migratory birds, and their key habitat parameters such as food, water and other characteristics.
- Assessment of climate stress in biodiversity based on perception of experts and local people.
- Study of impact on animals and birds due to reduction of water.
- Study of impact on high altitude animals due to rise in temperature.
- Training to staff of DNPWWC, DPR and other organizations for conducting effect of drought and rise in temperature in plants and animals.
- Development of human resources for conducting research in biodiversity in relation to climate change.

6.3 Forest Act, 2049

The Forest Act identifies different types of forests and their management modalities. In context of climate change adaptation, it needs defining relationship between climate change and forest management right from definitions of words used "परिभाषा". The law should have annex of potential effect of climate change in forestry either in the Act or in Regulations.

In the chapter 3 relating to management of government forests, identification of potential effect of climate change in forests and their adaptation activities should be mentioned. The issues mentioned should be tackled by forest management plan. This should be put in Chapter 4 (Protected forests), Chapter 5 (Community Forests). In community forests chapter in addition, impact of climate change in forest dependent indigenous people and local communities should be mentioned in relation to the products which they use for their livelihood. Likewise, the issue should be incorporated by forest operational plan.

The provisions will sensitize corresponding stakeholders to climate change adaptation in forestry, and will make a basis for data base. These activities will also mainstream climate change adaptation in forestry and will also open up chances to use climate adaptation funds.

6.4 Interim Plan (2064-2067)

In forestry chapter of Interim Plan (2064-67), there are 60 bullet points in "Policy and Working Policy" sub-chapter of forestry. The plan has also recommended 300 action research areas to improve livelihood of communities depending in forests. But, there are no distinct points focused on climate change adaptation. In the context of climate change effects in forestry, this point, along with others, needs to be emphasized. Listed below are some of the important gaps:

- Initiating sustainable forest management with a focus on storage of water in forested watersheds.
- Study water yield from 10 major forest blocks in the high altitude zone, mid-hills and Churia region.
- Study of effect of high stand density community forest in water use by the forest and water production for communities downstream.
- Study of impact of climate change in wild foods used by local communities.
- Study of impact of climate change in two protected area in high altitude.
- Study of impacts of climate change in critical plant species of Nepal.
- Study of change in sprouting, flowering and fruiting of key tree species important for biodiversity conservation.

6.5 Approach Paper (2010-2013)

The Forestry Sector Chapter of the Approach Paper also does not clearly specify measures for climate change adaptation in the ***Objectives, Strategies, and Working Policies***. But in the expected outcome, it has mentioned the development and implementation of at least 1000 community forest user groups' adaptation plans.

Gaps

In strategy, it should mention developing climate change resilient capacity of forestry sector. Similarly, in working policy it should mention various points relating to forestry sector adaptation which include:

- Preparing a holistic grass root level adaptation plan.
- Coordinating grass root level adaptation plan in the initiation of forestry sector, as the Forest Department is one of the main government organizations that has a strong relationship with user groups and offices / contacts at the grass roots level.
- Provide training to forestry sector government employees to enhance knowledge in implementing activities related to forestry sector.
- In addition, it is also necessary to mention issues mentioned in gaps in interim plan.

6.6 Policy Recommendations Relating to the Different Sectors / Themes

Livelihood Theme

- Give emphasis on the management of NTFP and herbs for optimizing rural income as climate change impacts are endangering the livelihood of local communities.

- Conduct studies of the impact of climate change on wild foods used by local communities.

Water Theme

- Give emphasis in forest management in high and mid-hill regions with focus on water storage to address issues of long term drought (water), and forest fire.
- Initiate sustainable forest management with focus on maintaining a dense forest cover, high quality of tree stand, high diversity of species, and enhanced percolation and ground water augmentation in forested watersheds.
- Study water yield from 10 major forest blocks in the high altitude, hills and Churia regions.
- Study the effects of high stand density community forest in water use by the forest (evapo-transpiration rates) and water production for communities downstream.

Forests

- Put definitions of climate change impacts into the Forest Act itself.
- Keep annex of potential effect of climate change on forests within the Forest Act.
- Management plan should identify potential effect of climate change on the forests for which the plan is made.
- For community based forest management plan like CFUG plan, impact of climate change on the forest-dependent indigenous people and local communities should be mentioned.

Biodiversity Theme

- Assessment of climate stress on biodiversity based on the perception of experts and local people.
- Study of impact on animals and birds due to reduction of water.
- Study of impact on high altitude animals due to rise in temperature.
- Initiate collection and maintenance of a biodiversity database for potentially impacted flora and fauna, such as, native and migratory birds, and their key habitat parameters such as food, water and other characteristics.
- Training to staff of DNPWWC, DPR and other organizations for conducting research on the effects of drought and rise in temperature on plants and animals.
- Development of human resources for conducting research on biodiversity in relation to climate change.
- Study of impact of climate change in two protected area in high altitude
- Study of impacts of climate change on critical plant species of Nepal.
- Study of change in sprouting, flowering and fruiting of key tree species important for biodiversity conservation.

Cross-Sectoral

- Give emphasis on management of wetlands in the Terai for biodiversity conservation and livelihood security.

- Prepare a holistic grass root level adaptation plan that deals with water, food, forest and livelihood of rural communities in different regions.
- Coordinating grass root level adaptation plan with the initiation of the forestry sector, as the Forest Department is one of the main government organizations that has a strong relationship with user groups and offices / contacts at the grass roots level.
- Provide training to forestry sector government employees to enhance knowledge in implementing climate adaptive activities related to the forestry sector.

6.7 Policy Frameworks to Integrate Adaptation and Mitigation:

Generally, sustainable forest management activities are viewed as mitigation activities. So, in order to integrate adaptation roles of forests to mitigation, following policy frameworks should be adopted:

- While preparing strategic or periodic management plan, forestry sector vulnerability should also be analyzed. Plans and programmes are also identified and proposed from adaptation perspectives.
- Similarly, while preparing community based forest management plan like CFUG plan, impact of climate change on the forest-dependent indigenous people and local communities should be identified and plans and programmes are identified and proposed.
- Some problems are crucial from both adaptation and mitigation perspectives which will enhance biomass in the forests as well as support to reduce adaptation problems like encroachment by alien species or damage by insects and pests, etc. Such common problems to mitigation and adaptation should be identified and these are implemented with special focus.

Chapter 7: Conclusion of the Study

Twelve criteria are used for prioritizing the climate change adaptation activities using pre-determined score from 0 to 5. The followings are identified as the most promising activities, meaning that these are highly related to climate change adaptation problems, forestry sector needs, poverty reduction/livelihood as well as support to other sectors such as agriculture, livestock and water. Activities which scored more than 33 are identified and prioritized as below:

- Community based forest fire control in mid-hills
- Management of high altitude non timber forest products/ herbs
- Wetland biodiversity conservation in Terai
- Integrated watershed management with focus in Churia
- Integrated forest management with focus in water
- Range land conservation in high altitude

7.1 Importance of the Identified Adaptation Activities

7.1.1 Community Based Forest Fire Control in Mid-hills

Forest fire control activity can provide high benefits to the communities through protecting wild food, which they have been getting from forests, e.g. rhizome, fern, mushroom, other NTFP as well as herbs. This will also assure availability of leaf litter as fertilizer for agriculture. This will ensure better availability of livestock forage from the forest, and protection of forest will support infiltration capacity of soil and enhance water recharge ultimately improving watershed conditions. This will also reduce chance of disaster to settlement fire and protection of forest slopes from land slide. With all these reasons, it is also likely that there will be high support and participation from the indigenous people and local communities living near to the forests.

Forest fire protection will also support biodiversity conservation in the area. This will also provide co-benefits of mitigation by supporting carbon emission which would have otherwise gone to atmosphere. The activity is also highly stressed by forest fire management policy of the Ministry of Forests and Soil Conservation. Therefore, forest fire control in mid-hills is very important both from non-forestry and forestry prospective.

7.1.2 High Altitude NTFP / Herbs Management

High altitude NTFP/Herb management will support livelihood and employment of indigenous and local people in the area. This will also play crucial role in human health in the region where traditional knowledge and conventional medicinal practices still existed at par, and modern medicines are not easily available. This will support water storage and management in forest areas under consideration. Possibly, this activity supports improvement of watershed conditions and management of the area will create better conditions of forage for livestock. The activity will also play positive role in eco-tourism of the area. Identified activity areas are

in line with the national policies such as herbs and NTFP policy; trade promotion policy which promotes experts of herbs based products. This also conserves biodiversity in the area as well as support mitigation by producing additional biomass in the area under management. Therefore, management of high altitude NTFP is also important from livelihood, health, biodiversity and mitigation perspectives.

7.1.3 Wetland Conservation in Terai

Terai wetlands are source of food for the poor people who have been depending upon those areas. This is also source of drinking water and irrigation water. The area is also source of varieties of fishes and aquatic plants which are source of income. Proper management of wetland will also reduce disaster by smooth flow of additional water. From the forestry perspectives also conservation of wetland in Terai is important for biodiversity, accumulation of biomass around the water bodies, ecotourism. The conservation and sustainable management of such policy is also supported by wetland policy of Ministry of Forests and Soil Conservation.

7.1.4 Integrated Watershed Management for Churia

Integrated watershed management of Churia is important to protect the area from extreme events of rainfall resulting erosion in the area as well as depositing silts in the agriculture land along the stream channels negatively impacting it and downstream agricultural field. If managed in proper way it can store optimum water contributing improvement in dry season flow. Churia is also source for livelihood through collection and gathering of NTFP, herbs, bamboo. Therefore, if properly managed, this can reduce climate change / variability related problems for the people in downstream.

From forestry perspectives also, protection of Churia also result biodiversity conservation, mitigation through carbon enhancement. It also contributes positively for eco-tourism. The programme is also highlighted by ministry through Presidential Churia Conservation program.

7.1.5 Integrated Forest Management with Focus on Water

Integrated forest management for water also improves water recharge capacity through improved infiltration and reduced evapo-transpiration from plants. This will also improve storage of water and there by contributing to life substance during drought as well as support to agriculture. Sustainable forest management can also support livestock through production of grass and forage. From forestry perspectives also it is important to storage of biomass as well as production of timber, firewood and other forestry products.

7.1.6 High Altitude Rangeland Conservation

High altitude range land is important for the livestock which is main source for the indigenous and local communities living in the area. Better management of the high altitude range land also positively contributes water storage and control negative plants encroaching

to livestock forage. These pastures are also source of NTFP and herbs for life sustenance. From forestry perspectives also the area can produce biomass and support mitigation as well as support biodiversity existing in the area.

7.2 Conclusion

The adaptation activities identified here are important on the basis of need according to the policies mentioned above or gaps identified in the policies. These activities are in line with policy needed in relation to climate change adaptation.

From the adaptation activities prioritized here, it is clear that these activities not only support forestry and biodiversity in Nepal, but also support livelihood, local employment, promotes water availability in dry season, support agriculture and livestock as well as protects lands. Therefore, forestry sector adaptation activities are very important for all sectors in Nepal; this can support to ameliorate drought condition if carefully adaptation activities identified are implemented.

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Annex 1: Terms Used in Context of Forest and Biodiversity Adaptations *(Source: IPCC, 2007)*

Adaptation:

Adaptation means adjustment in natural or *human systems* in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- **Anticipatory adaptation** – Adaptation that takes place before impacts of *climate change* are observed. Also referred to as proactive adaptation.
- **Autonomous adaptation** – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*. Also referred to as spontaneous adaptation.
- **Planned adaptation** – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Adaptive capacity (in relation to climate change impacts):

It means ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Climate change:

Climate change refers to any change in *climate* over time, whether due to natural variability or as a result of human activity. This usage differs from that in the *United Nations Framework Convention on Climate Change (UNFCCC)*, which defines "climate change" as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global *atmosphere* and which is in addition to natural climate variability observed over comparable time periods".

Climate variability:

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the *climate* on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (internal variability*)*, or to variations in natural or *anthropogenic* external forcing (external variability).

Coping range:

The range of climate where the outcomes are beneficial or negative but tolerable; damages or losses beyond the coping range are no longer tolerable and a society is said to be vulnerable.

Ecosystem:

The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, *biomes* at the continental scale or small, well-circumscribed systems such as a small pond.

Sensitivity:

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by *climate variability* or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to *sea-level rise*).

Uncertainty:

An expression of the degree to which a value (e.g., the future state of the *climate system*) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain *projections* of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).

Vulnerability:

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its *sensitivity*, and its adaptive capacity.

Vulnerability baseline:

Vulnerability includes a description of current vulnerabilities to climate variability and events. See also *baseline*.

Annex 2: Check list for Adaptation Study

1. Which is nearby main forest or source of biodiversity? Describe forest or other sources of biodiversity (like wetland, grassland, etc). Ask area, forest type, uses, products (fodder, firewood, timber) or services (water, ecotourism) of the area. What poor communities get from these area or forests?

2. What are the changes observed in last 20 years in the area we talked about?
    a. Change in production and/or services

    b. Change in availability, status of trees like *Betula, Taxus*

    c. Change in herbs and important small plants

    d. Changes seen in existence, status of wild animals

    e. Changes seen in existence, status of forest birds

    f. Diseases experienced by plants and wild animal, birds

    g. Change in forest soil or experienced status of erosion

    h. Change in watershed or experienced status of forest landslide

    i. Quantity, quality, and variation in water in forests

    j. Frequency and severity of Forest fire

3. Are those changes natural or anthropogenic?

4. Are those changes positive or negative?

5. Who have been affected from the changes?

6. How the problem can be addressed through forest management?

7. What are the problems in coping these negative changes?

8. Out of the issues mentioned by the interviewee, ask which are also important from the perspectives of co-benefits (mitigation, biodiversity conservation, poverty reduction). For this purpose interviewer has to remember the activities proposed for adaptation under the check list question 6.

9. Which activities you prioritize first, second and so on and what is the reason of ranking prioritization.

10. Relating to the proposed adaptation activities and priority framework what should be recommended in policy framework. Remember that just conducting activities or implementing activities which we have been doing do not need to recommend for policy framework.

After interview, study team member should make gist of interview in four column, these are:
1. Impact of climate change
2. Potential Adaptation or coping mechanism through forest management
3. Gaps in coping
4. Remarks

For example if forest fire is the problems then

Impact of climate change	Potential adaptation activities	Gaps	Remarks
Forest fire	Making fire line, clearing forest floor, raising awareness, preparing fire management plan	Technical problem in making fire line, preparing fire management plan	

Target Groups for the Study

- **Central Level:** Key or knowledgeable persons in the department under Ministry of Forests. Also outside if existed. Project Officials, NGOs and other useful persons. **Please name, some.**
- **District Level:** Head and knowledgeable person of District Forestry line agencies, such as DFO, DSCO, NP and WR. The persons recommended by them who know Natural Resources Related Adaptation Activities. NGO
- **Local Level:** Get suggestion from District line agencies to interact with User Group officials and NGO, Local communities
- **Note for the person collecting information in Forest and Biodiversity Theme**

In order to get information in more clear way from local communities during the transect walk, person interacting with communities are requested to keep various issues in mind related with various check list, which include:

Related with 2a

There can be increase in production due to change in climate, increased temperature resulting increased photosynthesis may increase production. At the same time climate related stress may decrease production.

Related with 2b

Plants growing in partial snow or high latitude plants may be more vulnerable due to climate change. Thus plants such as Butula utilis, Taxus and other plants growing in partial snow in some season can be affected severely due to retreat of snow.

Related with 2c

There also can be small plants and herbs which became more vulnerable due to climate change. There also can be invasive species in new conditions increasing vulnerability of other plants. If some plants are found less, it is necessary to ask why this happened and we should make sure that it is due to climate change and not due to over exploitation.

Related with 2d

Similarly, existence of animals can be reduced due to change is habitat and stress in food and water. Here also we should make sure that it is due to climate change and not due to over exploitation or poaching. Habitat overlap of common leopard and snow leopard is reported from western region. Change in phonological characteristics in vegetation such as new leaf coming, flowering, fruiting period may affect on wildlife. Change in season in these plant growths will mis-match between floristic composition or food which is necessary for life sustenance and breeding of wild animals.

Related with 2e

Likewise there can be change in population of birds. Migratory bird may be more vulnerable to drought and other climatic stress. Here also we should make sure that it is due to climate change and not due to exploitation or poaching.

Related with 2f

In the context of climate change, due to increase in warm days there can be increase in fungus and pathogens which are affecting forests and biodiversity.

Related with 2g

Due to climate change draught and untimely rain can change physical properties of soil. This may also occur due to fire which is result of draught due to climate change.

Related with 2h

It is also necessary to understand what damages have done due to landslide like damaging agriculture land or house etc. Also ask who are loser, like: rich or poor, men or women, indigenous communities or other minorities etc.

Related with 2i

Also get idea in change in per unit volume of water received from forests. Change in water quality such as turbidity, reduction in dry season is also important. Who are mostly affected in the community should also be asked.

Related with 2j

Also ask number of events and when, area affected, season of occurrence. Get idea on damage done by fire in terms of human lives, wildlife, birds, trees and plants, forest soil, etc.

Related with 3

If the respondent feel that some of those changes due to human made reasons, they we should drop those issues from discussion. Continue discussion for the cause due to natural or climate reasons.

Related with 4

The question should be asked only if the result of changes in terms of positive and negative is not clear in previous answers.

Related with 5

Ask the question if who are affected is not clear in previous answer. Under this question if further details are necessary, such as level of impact and scale, these can be asked. The impact can also be on the communities who live far such as impact of water scarcity in down stream irrigation.

Related with 6

Local people might have done something like to control forest fire they might have done controlled burning, preparing fire line, fire fighting training, leaf litter collection and safe disposal. They might have selected another tree or plant species to adopt with drought, fire etc.

They might have constructed community pond, reservoirs (water tanks). They might have changed their forest management practices. We should know these from local communities.

Related with 7

This question is very important to identify adaptation activities. The problems can be from technical, social unity, lack institutions, technical, governance, coordination, and most importantly due to lack of funding.

Further note:

It is also necessary to note characteristics of community or respondent such as poor, women groups, indigenous people etc.

It is important to note that whether changes are experienced or perceived change (existing) or future possible changes (potential).

Forest tenure related: if there is no community forests, increased socioeconomic vulnerability that may limit the adaptive capacity.

Discussion should focus on enhancing the adaptive capacity of both people and forests to climate change.

Annex 3: List of Officials/Experts Consulted

Department of Forest, Babarmahal

S.N.	Name of participant	Designation
1	Harihar Sigdel	Director General, Department of Forests
2	Bishwo Nath Oli	Regional Director, Mid-West
3	Resham Bahadur Dangi	Deputy Director General, Department of Forests
4	Yam Bahadur Thapa	Deputy Director General, Department of Forests
5	Prakash Pyakurel	Monitoring and Evaluation Officer, DoF
6	Munni Gautam	Community Forestry Officer, DoF
7	Ramanandan Shah	Forest Production Officer, DoF

Department of Soil Conservation and Watershed Management, Babarmahal

S.N.	Name of participant	Designation
1	Bharat Kumar Pudasaini	Director General, DSCWM
2	Gopal Prasad Upadhyay	Soil Conservation Officer, DSCWM
3	Gangaram Sendhai	Soil Conservation Officer, DSCWM

Department of National Parks and Wildlife Conservaion, Babarmahal

S.N.	Name of participant	Designation
1	Krishna Acharya	Director General, DNPWC
2	Fanindra Kharel	Conservation Officer, DNPWC

Langtang National Park, Rasuwa

S.N.	Name of participant	Designation
1	Ram Chandra Kandel	Warden, Langtang National Park, Dhunhe

Chitawan National Park

S.N.	Name of participant	Designation
1	Jagannath Singh	Warden, Chitawan National Park
2	Ganesh Pant	Assistant Warden, Chitawan National Park
3	Amir Maharjan	Assistant Warden, Chitawan National Park
4	Bed Bahadur Khadka	Ranger, Chitawan National Park

District Forest Office, Chitawan

S.N.	Name of participant	Designation
1	Jeeban Thakur	DFO, Chitawan

Bageshori CFUG, Kabilash VDC-9, Chitawan

S.N.	Name of participant	Designation
1	Aaita Bahadur Lama, chair	Bageswori CFUG
2	Ser Bahadur Tamang, Secretary	Bageswori CFUG
3	Parnati Baral, vice chair	Bageswori CFUG
4	Lila Man Tamang, treasurer	Bageswori CFUG
5	Guna Raj Lama, member	Bageswori CFUG
6	Hukum Singh Gurung, member	Bageswori CFUG
7	Resham Lal Lama	Bageswori CFUG
8	Lokman Lama	Bageswori CFUG
9	Tej Bahadur Lama	Bageswori CFUG
10	Jagat Lama	Bageswori CFUG
11	Gor Bahadur Lama	Bageswori CFUG

District Forest Office, Kavrepalanchwok

S.N.	Name of participant	Designation
1	Durga Raj Acharya	Acting District Forest Officer
2	Ganesh Chand Devkota	Assistant Forest Officer
3	Chinkaji Shrestha	Assistant Forest Officer
4	Shankar Jha	Ranger
5	Krishna Bahadur Thapa	Ranger
6	Krishna Dahal	Forester
7	Hem Bahadur Basnet	Forest Guard

District Soil Conservation Office, Kavrepalanchwok

S.N.	Name of participant	Designation
1	Khruschev Shrestha	District Soil Conservation Officer

Bageswari Community Forest Users Group, Kabilas VDC, Chitawan

S.N.	Name of participant	Designation
1	Aaita Bahadur Rana	Chairman
2	Sher Bahadur Tamang	Secretary
3	Lila Man Tamang	Member
4	Gun Raj Lama	Member
5	Jagat Lama	Member
6	Parbati Baral	Member
7	Tej Bahadur Lama	Member
8	Gore Bahadur Lama	Member
9	Roshan Lal Lama	Member
10	Lok Bahadur Baral	Member

Patne Community Forest Users Group, Dhungkhark-7, Kavrepalanchwok

S.N.	Name of participant	Designation
1	Ram Bahadur Timilsina	Chairman
2	Mim Prasad Timilsina	Secretary
3	Hari Prasad Timilsina	Member
4	Lok Bahadur Timilsina	Member
5	Hari Prasad Timilsina	Member
6	Devi Bahadur Timilsina	User
7	Mim Prasad Gautam	User
8	Ganga Prasad Timilsina	User
9	Lal Prasad Timilsina	User

Community Forest Users Group, Golmadevi CF, Panchkhal-6, Kavrepalanchwok

S.N.	Name of participant	Designation
1	Indra Bahadur Shrestha	Chairman
2	Bel Bahadur Lama	Vice Chairman
3	Narayan Tamang	Member
4	Hari Prasad Gautam	Advisor
5	Narayan Prasad Adhikari	Advisor
6	Babu Dorje Lama	User
7	Indra Man Tamang	User
8	Ruk Bahadur Lama	User

Community Forest Users Group, Bhagawanthumki CF, Janagal-3, Kavrepalanchwok

S.N.	Name of participant	Designation
1	Chitra Bahadur KC	Ex-Chairman/Member

Consultation Meeting, Training Hall, Babar Mahal

S.N.	Name of participant	Institution	Designation
1	Rishiram Tripathi	REDD Cell	Chief
2	Keshav Khanal	REDD Cell	Under Secretary
3	Rabindra Maharjan	REDD Cell	Under Secretary
4	Ram Asheshwar Mandal	REDD Cell	Forest Officer
5	Rajan Shrestha	REDD Cell	Forest Officer
6	Baburam Pokhrel	DFO, Rautahat	AFO
7	Rajendra Kafle	DoF	FMO
8	Pashupati Koirala	DoF	Planning Officer
9	Laxman Gautam	DoF	Under Secretary
10	Devi Chandra Pokhrel	BISEP-ST	Programme Officer
11	Keshav Gautam	DFRS	Research Officer
12	Saraswoti Sapkota	DNPWC	Asst. Ecologist
13	Bishnu Devkota	Kathmandu Forestry College	Lecturer
14	Kamala Thapa Magar	NEFIN,CC & REDD Project	Project Officer
15	Kumud Shrestha	Nepal Foresters Association	Vice President
16	Amardev Yadav	RAN	Chairperson
17	Birkha Bahadur Shahi	FECOFUN	Secretary
18	Bishnu Bahadur Nepali	DANAR	Vice Chairperson
19	Brayan Bushley	University of Hawai	PhD candidate
20	Sankar Paodel	Rupantaran Nepal	PES Coordinator
21	Sudeep Raj Adhikari	NORMS	Consultant Staff
22	Sulav Gautam	NORMS	
23	Gopi Poudel	NORMS	Director
24	Kiran Timilsina	Green Governance, Nepal	Chairperson
25	Shambhu Dangal	ERI	Director
26	Basanta Lamsal	ERI	Consultant
27	Bishnu Poudyal	ERI	Director
28	Mahendra Raj Suwal	IFFRC	Managing Director
29	Rabin Suwal	IFFRC	Environmentalist