Government of Nepal
Ministry of Population and Environment

Synthesis of the Stocktaking Report for the National Adaptation Plan (NAP) Formulation Process in Nepal

National Adaptation Plan
Formulation Process
May 2017

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Foreword

The Government of Nepal (GoN) is committed to responding to climate change risks and impacts through integrated policies and affirmative action. The GoN, as a party to the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement has initiated the National Adaptation Plan (NAP) formulation process since September 2015. The NAP formulation process is led by the Ministry of Population and Environment (MoPE). MoPE has established seven thematic working groups (TWGs) and two cross-cutting working groups (CWGs), which cover major climate change sensitive sectors, in the NAP formulation process.

The NAP formulation process was established to build on the country's rich experiences in addressing adaptation through the National Adaptation Programme of Action (NAPA), and through it, to address medium- and long-term adaptation. The process aims to assist Nepal to reduce its vulnerability to the impacts of climate change by building adaptive capacity and resilience, and by facilitating the integration of climate change adaptation into development planning.

The overall objective of this synthesis report is to summarise the information presented in the NAP thematic and cross-cutting sectoral stocktaking reports. The technical synthesis report summarises the stocktaking reports that have been prepared for the nine thematic and cross cutting sectors. It presents relevant information on the impacts of climate change on thematic and cross cutting areas, and on vulnerability and adaptive capacity, and assesses sectoral gaps and needs for the NAP process.

The report provides a glimpse of the most relevant data presented in the stocktaking report. It also offers a range of options for dealing with each element of NAP process and is based on the guiding principles of NAP process.

On behalf of MoPE, I express my sincere thanks to Dr. Ram Prasad Lamsal (Joint secretary), Mr. Naresh Sharma (NAP Coordinator), the NAP team, experts from Practical Action and the International Centre for Integrated Mountain Development (ICIMOD) involved in preparing the document, and members of the thematic and cross-cutting working groups involved for guiding the process. I also appreciate the financial and technical support of Action on Climate Today (ACT)—a UK AID funded initiative managed by Oxford Policy Management Limited (OPML) and Practical Action, and the Support to Rural Livelihoods and Climate Change Adaptation in the Himalaya (Himalica) project led by International Centre for Integrated Mountain and Development (ICIMOD).

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Acronyms

ACT	Action on Climate Today
ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
AMIS	Agriculture Management Information System
AMSL	Above Mean Sea Level
ASHA	Adaptation for Small Holders in Hilly Areas
BCN	Bird Conservation Nepal
CBS	Central Bureau of Statistics
CCBC	Climate Change Budget Code
CFUGs	Community Forest User Groups
CHAL	Chitwan-Annapurna Landscape
COP	Conference of the Parties
CPEIR	Climate Public Expenditure and Institutional Review
CRM	Climate Risk Management
CWGs	Cross-Cutting Working Groups
DFID	Department for International Development
DFRS	Department of Forest Research and Survey
DHM	Department of Hydrology and Meteorology
DNPWC	Department of National Parks and Wildlife Conservation
DPNet	Disaster Preparedness Network
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DWIDM	Department of Water Induced Disaster Management
DWSS	Department of Water Supply and Sewerage
EbA	Ecosystem-based Adaptation
EFLG	Environment Friendly Local Governance
EIA	Environment Impact Assessment
EU	European Union
EWS	Early Warning System
FAO	Food and Agriculture Organisation
FIAN	Food First Information and Action Network
GCAP	Global Call to Action Against Poverty
GCM	General Circulation Model
GDP	Gross Domestic Product
GESI	Gender and Social Inclusion
GEF	Global Environment Facility
GHT	Great Himalayan Trail
GLOF	Glacial Lake Outburst Flood
GoN	Government of Nepal
HDI	Human Development Index
IBRD	International Bank for Reconstruction and Development
ICIMOD	International Centre for Integrated Mountain and Development
ICT	Information and Communications Technology
IDS-Nepal	Integrated Development Society (IDS)-Nepal
IFAD	International Fund for Agriculture Development
IPCC	Intergovernmental Panel on Climate Change
ISET-N	Institute for Social and Environmental Transition-Nepal
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
LAPA	Local Adaptation Plans for Action
LDCs	Least Developed Countries
LDOF	Landslide Dam Outburst Flood
LEG	LDC Expert Group
LPG	Liquefied Petroleum Gas
MCCICC	Multi-stakeholder Climate Change Initiatives Coordination Committee
MDGs	Millennium Development Goals

MoA	Ministry of Agriculture
MoAD	Ministry of Agriculture Development
MoCTCA	Ministry of Culture, Tourism and Civil Aviation
MoE	Ministry of Education
MoF	Ministry of Finance
MoFALD	Ministry of Federal Affairs and Local Development
MoFSC	Ministry of Forests and Soil Conservation
MoHA	Ministry of Home Affairs
MoHP	Ministry of Health and Population
MoPE	Ministry of Population and Environment
MoPIT	Ministry of Physical Infrastructure and Transport
MoSTE	Ministry of Science, Technology and Environment
MoUD	Ministry of Urban Development
MoWSS	Ministry of Water Supply and Sanitation
MoWCSW	Ministry of Women, Children and Social Welfare
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NAST	National Academy of Science and Technology
NATHM	Nepal Academy of Tourism and Hotel Management
NBSAP	National Biodiversity Strategy and Action Plan
NCCKMC	Nepal Climate Change Knowledge Management Centre
NCCSP	Nepal Climate Change Support Programme
NCVST	National Climate Vulnerability Study Team
NDC	Nationally Determined Contribution
NDR	Nepal Disaster Report
NDRF	National Disaster Response Framework
NEA	Nepal Electricity Authority
NGO	Non Governmental Organisation
NHSS	Nepal Health Sector Strategy
NLSS	Nepal Living Standard Survey
NPC	National Planning Commission
NSDRM	National Strategy for Disaster Risk Management
NTB	Nepal Tourism Board
NTFPs	Non-Timber Forest Products
OECD	Organisation for Economic Co-operation and Development
OPML	Oxford Policy Management Limited
PAC	Practical Action Consulting
RCC	Reinforced Cement Concrete
RCM	Regional Circulation Models
RECOFTC	Regional Community Forestry Training Centre
RIC	REDD Implementation Centre
RRT	Rapid Response Team
SDGs	Sustainable Development Goals
SNC	Second National Communication
SPCR	Strategic Programme on Climate Resilience
SRES	Special Report on Emissions Scenarios
SWM	Sustainable Waste Management
TAL	Terai Arc Landscape
TNCH	Tourism, Natural and Cultural Heritage
TWGs	Thematic Working Groups
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WASH	Water, Sanitation and Hygiene
WECS	Water and Energy Commission Secretariat
WFP	World Food Programme
WHO	World Health Organisation
WTTC	World Travel and Tourism Council

Chapter 1 Introduction

1.1. Country Background

Nepal is a landlocked country. It is located at the southern slope of the Himalaya and has a total area of 147,181 square kilometres (km^2). It is bordered by India on three sides and by the Tibet Autonomous Region of the Peoples' Republic of China to the north. The country has topographic altitudinal extremes of less than 100 metre (m) to above 8,000m within a short span of less than 150 kilometres (km) (DFRS, 2015). It falls under a sub-tropical monsoon climate zone. The climate (temperature and rainfall) varies from north to south and east to west. The southeast monsoon from June to September, and the westerly rain from December to February contribute to local variations in climate. The average annual rainfall of the country is 1,530 millimetres (mm). Annual rainfall generally increases with elevation up to 3,000m and then declines with elevation and latitude, and from east to west. The country is broadly divided into five physiographic regions (Table 1)

The new Constitution of Nepal, adopted on 20 September 2015 foresees the division of the country into seven provinces. These provinces will be formed by grouping the existing districts of Nepal. On March 10th, 2017, the Government of Nepal has adopted 744 local level bodies fulfilling the requirement of the new constitution (Local Bodies Restructuring Commission). All old municipalities and villages (which were more than 3900 in number) are regrouped in a total of 744 new Municipalities and Villages. The old 75 district development committees (DDC) have also been replaced by new 75 District Coordination Committees (DCCs), which will have much less power than DDC (CBS, 2017).

Social, political and economic activities in the last 20 years have changed both population structure and distribution dramatically. Populations in the hills and mountains are decreasing, while population is increasing in the Terai. Rural-urban migration is also increasing fast (Rimal et al, 2015). There are both positive and negative implications of migration. One positive implication for Nepal is that the flow of remittances has increased in recent years and is supporting rural economies and the livelihoods of many families. However, Nepal is gradually losing its skilled human resources to migration. This loss of human resources has negatively impacted the agricultural and service sectors, made evident by the gradual decline in gross domestic product (GDP) from these sectors (MoF, 2012).

Table 1. Nepal's Physiographic Regions

Physiographic region	Area coverage
High Himalaya	Almost always covered with snow, to the north: represent 24% of the area
High Mountains	South of the high Himalaya: represent 20% of the area
Middle Mountains	Represent 30% of the area
Siwalik (Chure)	Represent 12% of the area
Terai (low lying plain areas)	The northern extension of the Indo-Gangetic plain, to the south: Represent 14% of the area

Source: MoFSC, 2014

Yet, the economy of Nepal is very much dependent on the use of natural resources, including agricultural land, wetlands, rangelands, forests and protected areas. Agriculture is the main occupation for a vast majority of the population. Agriculture (including forestry and fishery) remains the principal economic activity, employing about employing 63% of the total population (GoN, 2016) and contributing to 31.2% of the total GDP (MoF, 2016). In recent years, Nepal's economy has been gradually moving towards non-land and non-agriculture sectors. The major sources of foreign currency are remittance and the tourism industry. The 2011 Nepal Living Standard Survey (NLSS, III) showed that, in Nepal, 28% of all household income comes from agriculture, 37% from non-farm enterprises, 17% from remittances and 16% from individual housing consumption (CBS, 2011).

1.2. State and Impact of Climate Change

Nepal's climate is extremely complex and varied. This is in part due to its topography, the extraordinary variation in elevation from the plains to the Himalayan high mountains, and the influence of the Himalayan mountain range and the South Asian monsoon (IDS et al, 2014). Reflecting this, the lowland regions of Nepal have a warm and humid sub-tropical climate, while the high mountainous regions are cold, with temperatures remaining well below zero in winter (Practical Action, 2009).

Nepal is among the lowest greenhouse gas emitters in the world, with a global contribution of less than 0.03%. But it is considered a global warming hotspot because of the direct impact on local resources (Shrestha et al, 2000). The annual compound growth rate of CO2 equivalent emissions for Nepal is 2% per annum, which is lower than that for many other developing countries (MoE, 2011).

Despite the lower emissions, Nepal has experienced consistent and continuous warming and extreme variability in rainfall. The National Adaptation Programme of Action (NAPA) (GoN, 2010), based on a detailed analysis over a period of 30 years (1976 – 2005) reported a trend of observed warming for Nepal of approximately 0.4°C–0.6°C per decade, with spatial differences across the country.

Regarding rainfall trends, the situation is more unclear. NAPA has reported that precipitation data does not show any general trends nationwide. However, there are a number of regional precipitation trends, and NAPA reports that annual precipitation data shows a general decline in pre-monsoon precipitation in far- and mid-western Nepal, and a few pockets with declining rainfall in the western, central and eastern regions. Other studies (Baidya et al, 2007; Practical Action, 2009) report a change in precipitation during different seasons, with some regions showing increases and others showing decreases. Baidya et al (2008) identified an increasing trend in the number of extreme precipitation days at a majority of the stations (particularly stations below 1,500m) and highlighted the implications for landslides, flash floods and inundation (GoN, 2010).

Future projections of climate change also show an alarming trend. A 2009 Nepal Climate Vulnerability Study Team (NCVST) study, using general circulation models (GCM) and regional circulation models (RCM), projects that Nepal's mean annual temperature will increase by 1.4°C by 2030, 2.8°C by 2060 and 4.7°C by 2090. An Organisation for Economic Co-operation and Development (OECD) study using GCM with the Special Report on Emissions Scenarios (SRES) B2 scenario, shows mean annual temperature will increase by an average of 1.3°C by 2030, 1.7°C by 2050 and 3°C by 2100, compared to the 2000 baseline (GoN, 2010). The OECD projections on precipitation show that in terms of winter precipitation, the models project almost no change in precipitation in western Nepal while projecting a 5–10% increase in precipitation in eastern Nepal. During the summer months, however, projections depict an increase in precipitation for the whole country in the range of 15–20% (GoN, 2010). NCVST (2009) projects both increase and decrease in mean annual precipitation with no clear trends. In terms of spatial distribution, the NCVST study projects an increase in monsoon rainfall in eastern and central Nepal as compared to western Nepal. Further, the projections indicate an increase in monsoon and post-monsoon rainfall as well as an increase in the intensity of rainfall, and a decrease in winter precipitation (GoN, 2010).

Climate impacts are becoming increasingly visible and affect economic and productive sectors in Nepal. The evidence shows that climate related impacts have negatively affected Nepal in a number of ways, including an increase in glacial lake outburst flood (GLOF) disasters, the destruction of hydropower and irrigation infrastructure, biodiversity loss and limited access to domestic water usage (Regmi, 2014). Water-induced disasters claim more than 300 lives every year. From 1971 to 2007, more than 50,000 people were reported injured, and about 27,000 deaths recorded as a result of water-induced disasters. Besides human loss, disasters have destroyed houses, cattle sheds, farmland and infrastructure. Between 1971 and 2011, landslides destroyed 18,414 houses and partially damaged 13,773 houses. Likewise, floods destroyed 94,700 houses and damaged 87,261 houses (MoHA, 2011).

Nepal will face many challenges, such as decline in agricultural productivity, loss of agro biodiversity and worsening food insecurity over the coming decades due to climate-related variability (Malla, 2008). In the water resources sector, erratic rainfall during the monsoon poses threats of increased flooding, landslides and erosion, and reduced groundwater reserves due to excessive surface runoff (Bartlett et al, 2010). The availability of water and increased hazards is impacting energy production and supply system. In the health sector, vector and water-borne diseases are increasing in the country, along with a strong identified relationship between these diseases and changing temperature and precipitation trends (GoN, 2010).

Rising temperatures, glacial retreat and changes in water availability are leading to changes in natural biodiversity, and influencing the distribution and population density of flora and fauna. In addition, in terms of increases in temperature, an upward movement of forest species and forest types from lower altitudes has been observed. This has led to a decline in the number of useful medicinal plants and forest species from higher altitudes (Joshi et al, 2012). Impact on forest and biodiversity is also going to affect the tourism sector. Extreme weather and climatic conditions, including hazards, are going to directly impact the flow of tourists and the overall sustainability of the tourism sector (Shrestha and Shrestha, 2012).

Climate change has an impact on both the rural and the urban populations of Nepal. In Nepal, about 42% of the total population now live in urban areas (municipalities). Urban population grew by 3.38% annually during the 2001-2011 period. n urban areas, the low socio-economic status of certain sections of the population, coupled with a fragile system of governance, has resulted in poor quality infrastructure and unplanned settlements. Extreme weather events have also had significant impact on both urban and rural communications, services and settlement infrastructure (Regmi et al, 2015).

Climate change will continue to impact land and natural resource-based livelihoods such as agriculture, forests and fisheries (GoN, 2010). Prolonged dry seasons will result in drastic reductions in the availability of grasses and other sources of food, as well as drinking water for livestock, forcing women to travel farther and longer for the collection of fodder and drinking water (Mainaly and Tan, 2012). Climate change also impacts non-land and non-natural resource-based livelihoods such as and tourism, and will likely exert pressure on people's livelihoods.

Gender, caste, ethnicity and other social markers also play a role in shaping and defining climate vulnerability (Boyd, 2011). About 70% of women are employed in agriculture, contributing to 60.5% of the agriculture economy. However, their work is often not formally recognized, and they have limited land rights and access to and control over resources, thus creating a set of specific vulnerabilities. Changing temperature and rainfall patterns disproportionately impact landless, forest-dependent poor, and women and socially disadvantaged people and groups (Mainaly and Tan, 2012).

A more comprehensive analysis of climate change impact on the major socio-economic sectors of Nepal is described in Chapter 3 to 11.

1.3. Policy Initiatives and Institutional Arrangement in Response to Climate Change

Policy Initiatives

Nepal aspires to become an inclusive, equitable and prosperous middle-income country by 2030 (reference to development vision 2030). Sustainable development will continue to be Nepal's priority agenda during the socio-economic transformation in the spirit of the new Constitution (2015) to develop a peaceful, prosperous and equitable society. However, climate change poses threats to this development aspiration. Realizing this threat, and obliged by international climate change negotiations and policies, Nepal has undertaken a number of policy initiatives and established institutional mechanisms to mainstream climate change into development processes and adapt to its impacts. Table 2 below summarizes the key policy initiatives of the Government of Nepal in response to climate change.

Knowledge generation and management revolving around climate change are also reflected in other sectoral policies. The Forest Policy 2015 has set as a priority the carrying out of studies for identifying specific impacts of climate change on ecosystems and forest resources (MoFSC, 2015). The Nepal REDD+ Strategy or Plan Strategy envisions establishing and maintaining a robust forest management information system with strong monitoring, reporting and verification mechanisms. It further aims to establish credible national measurements, monitoring, reporting and verification system.

The Agriculture Development Strategy 2015 also includes research and knowledge generation on climate change. It prioritises research on stress-tolerant varieties and breeds of crops, livestock and fish, and the development of climate-resilient agriculture, which is at the same time higher in yield. Nepal's National Development Plan also includes Government's priorities on climate change knowledge management (MoAD, 2014). The Nepal Health Research Council (NHRC) has also included climate change in its research priorities. Its policy intends to promote multidisciplinary research on crosscutting issues such as gender, vector-borne diseases, climate change, influenza, nutrition, road traffic accidents, domestic violence and disabilities (NHRC, 2011).

Table 2. Climate Change Policy Initiatives

Policy Initiatives	Focus
National Adaptation Programme of Action (NAPA), 2010	The NAPA identified nine urgent and immediate climate change adaptation priority programmes related to six thematic sectors (agriculture, forest biodiversity, water resources, health, infrastructure, and disaster). The first comprehensive government response to climate change, the NAPA also specified a coordination mechanism and implementation modality for climate change adaptation programmes in Nepal.
Climate Change Policy, 2011	The goal of the policy is to improve livelihoods by mitigating and adapting to the adverse impacts of climate change, adopting a low-carbon emissions socio-economic development path, and supporting and collaborating in the spirit of the country's commitments to national and international agreements related to climate change. It has time-bound targets to address climate risks and vulnerability in the country.
National Framework for Local Adaptation Plans for Action (LAPA), 2011	The LAPA framework was developed by the Government of Nepal as an operational instrument to implement NAPA prioritized adaptation actions. Its goal is to integrate climate adaptation and resilience into local and national planning, and to incorporate the four guiding principles of being bottom-up, inclusive, responsive and flexible. The aim of the LAPA is to integrate climate adaptation activities into local and national development planning processes, and to make development more climate-resilient.

Climate Resilient Planning Tool, 2011	The National Planning Commission (NPC) developed a climate resilience framework to guide the country in implementing development plans. It recommends methods, tools and approaches for guiding climate-resilient planning.
Nepal Development Vision 2030 (concept paper), 2011	The concept paper developed by the NPC recognises the need for formulating climate-resilient plans, following a low carbon economic development pathway, and equipping policy-makers and practitioners with knowledge, tools, enabling policies and sustained funding to implement climate-resilient plans in order to build a climate-resilient society and economy.
Climate Change Health Adaptation Strategies and Action Plans for Nepal (2016-2020)	The strategies and action plans have the objectives of raising public awareness and generating evidences on the effects of climate change on health, managing risks of extreme climatic events and protecting human health from adverse effects of climate change.
Thirteenth Periodic Plan (2014-16)	The 13th periodic plan of the Government of Nepal adopts the green development approach to mitigate the impacts of climate change.
Fourteenth Plan (2016-2018)	The 14th plan has the goal of implementing development programmes by adapting to climate change. It also has a strategy to mobilize national and international sources of climate finance in the national budget and increase investment.

Institutional Structure

Government of Nepal has established institutions and coordination mechanisms to tackle climate change in the country. The government established the Climate Change Council in 2009. The council, headed by the Prime Minister, provides coordination, guidance and direction for the formulation and implementation of climate change-related policies. Also, in 2009, donors signed a donor compact for the harmonization of support around nationally prioritized climate change initiatives. The NAPA process in 2010 established a Multi-stakeholder Climate Change Initiatives Coordination Committee (MCCICC) under the chair of the Secretary of Ministry of Population and Environment (MoPE), as a platform for consultation and dialogue among key stakeholders to implement climate change actions in Nepal. In 2011, the GoN constituted the Climate Change Coordination Committee under the chairmanship of Honorable Minister for Population and Environment. During the preparation of the NAPA, the Nepal Academy of Science and Technology (NAST), with support from the MoPE, established the Nepal Climate Change Knowledge Management Centre to generate and share climate change knowledge and good practices.

According to the business allocation rules (2015) of the Government of Nepal, MoPE is mandated to formulate, implement, monitor and evaluate policies, plans and programmes related to environment, hydrology and meteorology, pollution control, alternative energy, climate change and adaptation, and liaise and coordinate with national and international environmental agencies. The MoPE has a dedicated Climate Change Management Division. The Department of Environment is mandated to promote climate change adaptation activities. A number of sectoral ministries have appointed climate change focal points to integrate climate change concerns into their respective plans and programmes.

In 2009, REDD+ specific institutions were created to support REDD+ related activities. The REDD Coordinating and Monitoring Committee (the apex inter-ministerial body) established under the chair of the Minister for Forests and Soil Conservation ensures multi-sectoral coordination and cooperation for the planning and implementation of REDD activities, and provides advice to the NPC, the MoPE and stakeholders. The Ministry of Forest and Soil Conservation (MoFSC) has also established a REDD Implementation Centre (RIC). The RIC is the lead institution, in charge of undertaking REDD related activities in Nepal. There are also other ministries

who have developed institutional mechanisms to mainstream climate change.

Implementation of Policies and Plans

The NAPA provided a basis for developing and implementing adaptation projects with support from bilateral and multilateral donors. Support has also been received from specialized climate change funds under the United Nations Framework Convention on Climate Change (UNFCCC). The government has implemented a number of climate change adaptation and climate-resilient projects to build adaptive and resilient capacity, and address specific climate change impacts.

Nepal received roughly USD 538.24 million in international funds which supported adaptation activities from 2009 to 2014 (Dixit et al, 2016). The amount committed by various donors for Nepal's climate finance was USD 652.4 million from 1997 to 2014. In 2011, the government undertook a Climate Public Expenditure and Institutional Review (CPEIR) to increase understanding on climate financing mechanisms. Based on its findings, a climate change budget code (CCBC) has been developed to track climate-change related expenditure at the national and sub-national levels on a regular basis. The allocation of climate responsive budget in the national budget is given in Table 3. It shows that climate finance has been increasing over the years.

Table 3: Climate Responsive Budget in Nepal's National Budget

Fiscal Year	Climate Responsive Budget (% of total budget)	
	Highly Relevant	Relevant
2012/13	4.45	2.29
2013/14	5.36	4.98
2014/15	5.66	5.07
2015/16	5.66	13.79
2016/17	5.90	13.32

Source: Ministry of Finance

Government and non-government agencies are implementing climate change initiatives in different parts of Nepal. The MoPE is implementing the Nepal Climate Change Support Programme (NCCSP), with funding support from the UK Department for International Development (DFID) and the European Union (EU) in 14 districts of mid- and far-west Nepal. This project is under implementation with particular focus on the preparation and implementation of LAPAs. There are other projects such as the Community-based Flood Risk and GLOF Risk Reduction Programme, which has received funding from the Least Developed Countries (LDCs) Fund through the United Nations Development Programme (UNDP), as the Global Environment Facility (GEF) implementing agency.

In addition, the MoPE is implementing a project titled "enhancing capacity, knowledge and technology support to build climate resilience of vulnerable developing countries" with support from Special Climate Change Fund through the People's Republic of China and UNEP. The MoFSC is implementing Adaptation for Small Holders in Hilly Areas (ASHA) with support from the International Fund for Agriculture Development (IFAD). With support from the Least Developed Countries (LDC) Fund and the Food and Agriculture Organization (FAO), the Ministry of Agricultural Development (MoAD) is implementing projects to respond to the impacts of climate change and variability for sustainable livelihoods in the agriculture sector in Nepal. There are many more projects and programmes implemented directly by non-government organizations including community based organizations.

1.4. Initiation of the National Adaptation Plan (NAP) Formulation Process

The MoPE, in its capacity as focal point to the UNFCCC, the Kyoto Protocol and Paris Agreement, is leading and facilitating the implementation of climate change activities in Nepal.

Nepal prepared the NAPA along with other LDCs as part of the mandate of the seventh conference of the parties (COP) of the UNFCCC aimed at addressing the most urgent and immediate adaptation needs. Considering the need for further continuing and expediting adaptation actions to help climate vulnerable people and natural resources to adapt and build resilience to climate change impacts, the parties to the UNFCCC in COP16 decided to

initiate a process to facilitate LDCs to formulate and implement national adaptation plans (NAPs). The NAPs would build upon the experience of LDCs in preparing and implementing NAPAs, as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs.

Nepal has initiated the NAP formulation process on the basis of subsequent COP decisions and based on 'initial guidelines (Decision 5/CP.17)' and the technical guidelines developed by the LDC Expert Group (LEG). The NAP has two key objectives: (i) reducing vulnerability to the impacts of climate change by building adaptive capacity and resilience; and (ii) facilitating the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The MoPE launched the NAP formulation process on 18 September 2015. Based on previous experiences and lessons learned from NAPA and LAPA processes, the MoPE has adopted the Thematic/Cross-cutting Working Group (T/CWG) approach and the following nine working groups have been formed to expedite the NAP formulation process (Table 4). While the MoPE leads and ensures overall coordination, nine sectoral ministries are engaged in coordinating the NAP formulation process for respective themes and cross-cutting areas.

Nepal's NAP formulation process, as per 'initial guidelines (Decision 5/CP.17)' and the Least Developed Countries Expert Group (LEG) NAP technical guidelines, will focus on four major elements which include: 1) laying groundwork; 2) preparatory work; 3) implementation strategy; and 4) reporting, monitoring and review. The first element includes stocktaking for identifying available information on climate change impacts, vulnerability and adaptation, and assessing gaps and needs for creating an enabling environment for the NAP process. This report falls under the first element and presents a summary of the information provided in the NAP thematic and cross cutting sectoral stocktaking reports.

Table 4: NAP Working Groups and Coordinating Ministries

SN	Working Group	Coordinating Ministry
Thematic Working Group		
1	Agriculture and food security (nutrition)	Agricultural Development
2	Climate induced disasters	Home Affairs
3	Forests and biodiversity	Forests and Soil Conservation
4	Public Health (WASH)	Health
5	Tourism, natural and cultural heritage	Culture, Tourism and Civil Aviation
6	Urban settlements and infrastructure	Urban Development
7	Water resources and energy	Energy
Cross-cutting Working Groups		
8	Gender and Marginalized Groups (social inclusion)	Women, Children and Social Welfare
9	Livelihood and governance	Federal Affairs and Local Development

Chapter 2

Methodology Used in the Stocktaking Process

The report was prepared through an iterative process of evidence generation, involving consultations with multiple actors at the national and local levels. The methodology for the preparation of this report involved intense literature review and consultations with experts and relevant organizations. A review was undertaken of policies for various sectors, including water and energy, agriculture and food security (nutrition), forests and biodiversity, urban settlements and infrastructure, climate induced disasters, public health (WASH), Gender and marginalised groups (social inclusion), tourism natural and cultural heritage, and livelihood and governance.

2.1. Objectives of the Report

The overall objective of this synthesis report is to summarize the information presented in the NAP thematic and cross cutting sectoral stocktaking reports. It presents relevant information on the impacts of climate change on thematic and cross cutting areas, and vulnerability and adaptive capacity, and assesses sectoral gaps and needs for the NAP process. Specifically, this report has focused on:

- Collecting and analysing information on the impact of climate change in thematic and cross cutting sectors;
- Understanding potential risk and vulnerability within the sectors;
- Reviewing policy and legal frameworks along with institutions, plans and programmes addressing climate change impacts; and
- Assessing gaps and the need to address climate change effects and impacts.

2.2. Methodological Approach and Methods

2.2.1. Collecting and Analysing the State and Impact of Climate Change in Sectors

Literature Review

The review process included intensive mining of existing database, published and unpublished papers and institutional reports. Secondary data sources for this research include literature reviews and data compiled by international agencies such as the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), United Nations agencies, research and academic institutions, regional entities, and government and non-government agencies. Climate change specific information includes published data and reports on climate change trends and scenarios, and sector specific impacts of climate change. Data on climate change trends and scenarios were derived from reports and publications of the Department of Hydrology and Meteorology (DHM), the NAPA, the Second National Communication (SNC), economic impact assessments of key sectors, and other relevant documents. Information on sector specific climate change impacts was collected through government reports, policy documents and journal articles. A majority of the information on socio-economic capabilities was derived from data from Central Bureau of Statistics (CBS) sector specific reports, such as agriculture surveys, forest inventories, water and energy outlook, etc.

Analysis of the literature review helped with understanding the present situation and explored into issues of current climate variability and climate extremes, including their socio-economic and ecological costs. This is crucial to understanding the current adaptation deficit. This information was also used to understand the impacts of climate change on people whose livelihoods depend on natural resources. It was also useful in identifying data and knowledge gaps in the NAP thematic and cross cutting sectors.

Policy and Institutional Review

First, the team reviewed national and international policy documents in order to situate the NAP within relevant policy and institutional frameworks. These included Nepal's national, sectoral policy documents, development partners' country strategies and other secondary resources. The team reviewed climate change documents such as the climate change policy, LAPA, NAPA, the Nationally Determined Contribution (NDC), the REDD+ roadmap, and national policies aimed at addressing natural disasters. The review also included an analysis of published material from programmes and projects on climate change operating in Nepal.

The policy and institutional review helped in understanding government policies, development and sectoral plans, and assessing whether these are resilient to current and emerging climate change, or whether the plans need amending to enhance climate resilience. The analysis helped in understanding the synergies and trade-offs between climate change adaptation and development policies in order to establish the right policy context and environment to mainstream climate change adaptation into development plans.

2.2.2. Consultation with Thematic and Cross-cutting Working Groups

Thematic and cross-cutting working group meetings and key stakeholder interactions were held throughout the process and informed the stocktaking reports. The thematic and cross-cutting working groups involved key representatives from government institutions, non-governmental organizations, academic institutions and the private sector. The stakeholders actively participated in the consultative process and provided valuable inputs to strengthen the stocktaking reports. The discussions were useful for improving understanding of the implications of climate change on sectors and populations dependent on natural resources. Policy and institutional responses to environmental hazards and the adverse impact of climate change in each sector were also discussed. The stakeholders also provided suggestions on data and knowledge gaps.

2.2.3. Consultation with Experts and Relevant Stakeholders

Experts and relevant stakeholders and institutions were consulted during the stocktaking process to seek qualitative information about climate change adaptation. Several individuals representing government institutions, non-governmental organizations, the private sector and academic institutions were involved in the discussions and interaction meetings. Discussions with experts and organizations were useful in understanding how the climate is changing and how this is impacting major national socio-economic sectors. In addition, these interviews provided relevant information for identifying potential opportunities and gaps in terms of information and knowledge on climate change, as well as on how they could be addressed within the NAP formulation process.

2.3. Scope of the Report and Limitation

The technical synthesis report summarizes the stocktaking reports that have been prepared for the nine thematic and cross cutting sectors of the NAP process. This synthesis provides a glimpse of the most relevant data presented in the stocktaking reports and hence may not cover in detail the areas and issues. This report is based on published science and unpublished grey literature. The report relies on immediately available resources and documents already available in the public domain. The synthesis report covers aspects of climate change trends and impact on each sector, the current level of preparedness and existing gaps. The report is a 'living document' and will be further enriched as the NAP process unfolds. Detailed information and analysis are presented for each of the nine sectors.

Chapter 3

Agriculture and Food Security (Nutrition)

Context

Livelihoods and food security in Nepal depend heavily on agriculture and remittances (Selvaraju, 2014). The agriculture sector involves more than 66% of Nepal's population and produces over one-third of Nepal's Gross Domestic Product (CBS, 2014). This sector also employs more than 70% of the female population (ICIMOD et al, 2014). Despite the considerable contribution it makes to national food security and the economy, the potential of the agriculture sector has still not fully tapped due to several climatic and socio-economic factors. Currently, almost 50% households in the country are food insecure (MoHP, 2012), and Nepal is facing a huge agriculture trade deficit. Agriculture sector export in 2010/2011 was USD 248 million whereas the import was USD 621 million (MoAD, 2014). Economic growth over the last decade has been (on average) around 4% per annum (IDS et al, 2014).

Nepal's agriculture is mostly smallholder production where average landholding is less than one hectare (ha) per household. For those households with a farm size less than 0.5ha, the average farm size is 0.25 ha and therefore often insufficient to generate sufficient income. Nepal has about 0.082 arable land per capita per hectare (MoAD 2014). Three and half million people, 13% of the population, are considered to be moderately to severely food insecure with respect to food grains (MoAC, 2012).

The agriculture and food security sector is most sensitive to climate change. All aspects of food security are potentially affected by climate change, including food access, utilization and price stability (Porter et al 2014). Rainfall and other climatic factors are critical to crop yields and livestock production. More than 50% of Nepali agriculture is dependent on natural rainfall (MoAC, 2012). Historically, the sector has been affected by floods, droughts and erratic rainfall (Sherchand et al, 2007). Paudel and Kotani (2012) mentioned that an increase in the variance of both temperature and rainfall has adverse effects on crop production in general. Climate change also affects food security when the supply of food items from downstream areas is limited, particularly after hazards such as heavy rainfall induced landslides blocking roads (Hussain et al, 2016).

Climate Change Trend and Disaster

Climate data is extremely region-specific in Nepal, given the different ecological environments. The degree of climate variability varies across different regions. Nepal's NAPA document stated that over a period of 30 years (1976 – 2005) the observed warming trend in Nepal is of approximately 0.4°C–0.6°C per decade, with spatial differences across the country (GoN, 2010). Warming in winter is also more pronounced compared to lower altitudes. Extreme variability is observed in precipitation pattern. Floods and landslides are particularly regular phenomena in Nepal because of the country's undulating topography. Pest and disease outbreaks in plants and animals are another major concern (UNDP, 2009). Impacts of hazards on the agriculture sector are increasing, with dramatic increase since 1990s (FAO, 2014).

Increasing temperature and extreme variability in rainfall have major implications for the agriculture sector. Rainfall and other climatic factors are critical to crop yields, and there are strong annual variations in production and growth rates due to these factors

(Sthapit and Shrestha, 2008; WFP, 2009; GoN and WFP, 2011). About 70% of the performance of crop production is explained by climatic variability linked with temporal weather conditions (Sherchand et al, 2007). The sector is also affected by extremes, including droughts and other extreme weather events (heat stress, hot winds, cold waves, hailstones and snowfall), as well as floods. The observed variability in climate has led to rain deficit, drought and floods in different parts of Nepal with significant (more than 10% and up to 30%) decline in production as a result (IDS et al, 2014). In addition, people have observed some shifts in climatic zones and early maturation of crops due to temperature increase, which has a positive impact on yields and enables double cropping options in some areas (Malla, 2008). Some crops (rice, wheat and barley) are more likely to have an increase in yield as rainfall and temperature increase, whilst others (maize and millet) may decline, according to Joshi (2011).

As a result of extreme climatic conditions, the agriculture sector is already suffering from production losses. A number of studies have looked at relationships that link agriculture production to climate (Sherchand et al, 2007; Malla, 2008; Sharma and Dahal, 2011; Bastakoti et al, 2011). More than 10% of production decline is caused by climate induced hazards and lack of adaptation practices. In 2006, drought caused losses of 11% of rice yield and 7% of wheat yield in Nepal. About 90% of crop loss in Nepal is caused by weather or meteorological events. Of all hydro-meteorological hazards, drought has the most severe impact on crops. Between 1971 and 2007, nearly 850,000 ha of crops were lost to weather- and climate-related events: droughts accounted for 38.9% of lost agricultural crops, and floods for 23.2% (UNDP, 2009).

The overall analysis shows that the direct economic cost of current climate variability in the agriculture sector is very high. It is estimated to be equivalent to 1.5% to 2% of the country's GDP on average (approximately USD 270 million in 2013 prices) (IDS et al, 2014). The direct economic cost of the 2006 and 2009 droughts can be estimated by valuing the lost agricultural output of the two years. They equate to 1.9% and 0.4% of the current GDP, respectively. A recent Government of Nepal report (MoF 2014) estimates a 2–4% drop in current GDP per year due to climate change, with the need for USD 2.4 billion to be invested in adaptation by 2030. In the agriculture sector, losses to droughts for paddy alone amounted to USD 753 million from 2001 to 2010, with USD 75 million being lost annually (UNDP, 2013).

Exposure to the Adverse Impacts of Climate Change

Agriculture systems and associated resources in Nepal are mostly rain-fed and exposed to climate extreme events such as floods, droughts, landslides, hailstorms, thunderstorms, cold waves and heat waves. Agriculture is predominantly small-scale and much of it is heavily dependent on the monsoon. As a result, rainfall and other climatic factors are critical to crop yields, and there are strong annual variations in production and growth rates due to these factors. More than 69% of the agricultural land is not irrigated and is hence particularly exposed to extreme weather variability and climate change impact. These attributes identify the high inter-annual variability for rain-fed agriculture, especially associated with important development stages, e.g., the pre-monsoon rains and winter rainfall for wheat (IDS et al, 2014). Some studies have linked higher maize production to increased water availability during development (pre-monsoon), but have also found that high rainfall is detrimental during maturity and harvesting (Nayava and Gurung, 2010).

More than 65% of the people whose livelihood is agriculture-dependent are frequently exposed to a variety of climate extremes. Data shows that many people and children in Nepal are still going hungry and are malnourished, with two thirds of Nepalese not having enough to eat at some point in the year (Feed the Future, 2014). These impacts have Gender and Social Inclusion (GESI) implications. About 70% of women are employed in agriculture, contributing to 60.5% of the agriculture economy (ICIMOD et al, 2014). The increased risk in agriculture is attributable to increased temperature, frequent and intense incidence of floods and

landslides, and erratic rainfall patterns that affect the availability of water both for consumption and irrigation. This has increased drudgery for women (Mainaly and Tan, 2012). The losses from climate induced disasters recorded by the Ministry of Home Affairs (MoHA) indicate damages to agriculture assets and infrastructure such as irrigation canals and storage facilities due to flooding and landslides (MoHA, 2015).

There are also strong distributional differences in the patterns of exposure across the country. The highest risks of river flooding are in the Terai, whereas the highest risks of landslides and GLOFs are in the hills and mountains. People in the mid- and far-western regions of Nepal were hugely impacted by extreme weather and climate events such as the droughts of 2006 and 2009. Given the context of low stock levels prior to the 2009 poor harvest (down 20% compared to 2008) the result was a serious deterioration in food availability, particularly in the most hard hit and isolated regions of the mid- to far-western hills and mountains (WFP, 2009).

Climate Change Vulnerability

The agriculture sector is very vulnerable to climate change due to its high degree of sensitivity and low adaptive capacity (Selvaraju, 2014). The sensitivity of the agriculture and food security thematic sector rests on a number of factors which include socio-economic differences, ownership status, geographical location, geomorphology, productivity and distribution, age, and food stability. For examples, the sensitivity of rain-fed agriculture to climate change is high. The rainfed system, due to its dependence on the changing monsoon pattern and timing, is susceptible to declining crop productivity (IDS et al, 2014). Food systems and food production systems for key grain crops, particularly rice and other cereal crop farming systems, are highly susceptible due to changing dates of sowing and transplanting. Devkota et al (2013) found that seeding rice before and after the optimal seeding dates reduces crop yield and yield stability significantly because of spikelet sterility induced by both high and low temperatures. The total value of crops exposed to climate sensitivity, as of 2012, amounts to around USD 1.5 billion (UNDP, 2013).

Geographical location also increases human population sensitivity to climate change. Farmers in the Terai are sensitive due to the negative impacts of climate change on yields of major cereals. Major hazards in the Terai include flood, drought, hot and cold waves, frost and dew. The frequency of occurrence of these hazards is increasing, and farmers view this as not only damaging crops and natural resources but also affecting vulnerable groups such as women, children and the elderly. The sensitivity of Nepal's hill population to droughts and landslide is greater than that of the population living in the Terai (Practical Action, 2009). Likewise, the sensitivity of farmers in the mid- and far-western regions to drought is different from those populations living in the eastern regions. Sensitivity to climate change is impacted by both climatic factors and socio-structural issues. For example, the poor and women farmers in the mid- and far-western regions are more sensitive to climate change because of socio-structural disparity and a lack of agriculture support (Regmi et al, 2015; Boyd, 2011).

At the national level, it was found that the impact of climate change and the actions needed to confront climate change are slowly being embedded into the policy and governance system. The Agriculture Development Strategy 2015 includes research and knowledge generation on climate change. In 2013/2014, the MoAD allocated NPR1.8 billion (USD 17.5 million), for research and knowledge generation which is approximately 32% of the total annual budget for the Ministry (IDS et al, 2014). The Nepal Agriculture Research Council has carried out research to assess carbon dioxide increase and see how crops respond to temperature changes. It has also developed climate stress varieties to cope with droughts and floods. It has developed submergence resistance rice (Swarna Sub 1 and Sub 2, Shamba mansuli) to address the problem of flooding and its impact on paddy cultivation. Furthermore, it has released stress-tolerant wheat varieties (Bijay and Gautam) and an alternative variety (Tarahara-1) for wet and dry conditions. It has recommended direct seeding rice variety (Shukkha dhan) as a suitable drought-tolerant variety for dry areas (NAST and OPML, 2016).

Farmers now have access to technologies suitable or adaptable to climate change impact in the agriculture sector. These include water-efficient technologies for dry conditions, water management practices to maximize water storage during the monsoon and water usage during winter, improved cropping system and soil and nutrient management, and improved early warning system for minimizing flood hazards. Recently, the Department of Environment, the Ministry of Agriculture and Development, has identified and promoted Agriculture Management Information System (AMIS), early warning system, climate-smart agricultural technologies and the concept of climate-smart villages in different parts of Nepal. Farmers also have rich traditional knowledge on efficient water resource management such as farmer managed irrigation systems. These local-level adaptation strategies are now being used to help farmers cope with adverse climate change effects (Regmi and Pandit, 2016).

However, the agriculture sector is not fully developed in terms of economic transformation. Productivity and competitiveness are low, adoption of improved technology is limited. Although most of the cultivated areas are utilized for cereal production, there is growing food deficit and malnutrition is high (MoAD, 2014). The Government of Nepal's investment in agriculture has been low at about 23% of GDP in recent decades. There is huge agriculture labour shortages in the mid-hills of Nepal. Nepal's youth and some of its most productive labour force have looked for jobs elsewhere. About 300,000 migrants left Nepal in 2010 and this has been a growing trend for the past 10 years (MoAD, 2014). Other reasons for low adaptive capacity in the agriculture sector are triggered by persistent poverty, socio-economic disparity, inadequate access to improved technologies, weak governance system leading to poor planning and budget delivery (IDS et al, 2014).

Table 5: Key Indicators Related to Agricultural and Food Security

Indicator	1995/1996	2010/2011
Agriculture GDP	USD 3.4 billion	USD 5.2 billion
Productivity of Agricultural Labour (USD/person)	USD 466/person	USD 700/person
Agricultural Land per Household (ha/hh)	1.1	0.7
Percentage of holdings operating less than 0.5 ha	40.1%	51.6%
Productivity of Agricultural Land (USD/ha)	USD 1,118/ha	USD 1,700/ha
Agricultural Land Use (cereal as percentage of cultivated land)	80%	80%
Seed turnover	8%	8%
Employment in Agriculture	66%	60%
Agricultural exports	USD 32 million	USD 248 million
Agricultural imports	USD 157 million	USD 621 million
Poverty (2010/11)	42%	25%
Percentage of households reporting inadequacy of food consumption	50.9%	15.7%
Stunting of children (less than five years)	60%	42%
Irrigation cover (percentage of cultivated area)	39.6%	54%
Infrastructure (Rural Road Network km and Strategic Road Network km)	SRN=10,000km	RRN=40,000km SRN=20,000km
ICT read	Less than 10% connected	46% connected

Source: MoAD, 2014, pp 22-23

Key Gaps

A major gap in the agriculture sector is poor access to information, knowledge and services. Although the government has developed climate resilient varieties to cope with droughts and floods, and a few technologies have been introduced, these are not tailored to local needs and priorities. Another challenge is absence of access to climate information and services. There is inadequate capacity as well as information and knowledge on the scale and magnitude of climate change impact in the agriculture sector. Farmers are facing problems in terms of taking decisions mostly related to dates for sowing, planting and weeding, and related to fertilizer and pest management, and harvesting (Malla, 2008). There is also a inadequate evidence and knowledge base to guide smallholder farmers through the exact means by which they can respond to current climate variability and future change (NCVST, 2009). Irrigation facilities are inadequate and access to water for agriculture is poor in the hills and mountains due to poor infrastructure. These leave farmers less equipped to adapt and highly vulnerable to climate change.

Another challenge is the poor governance mechanism that is restricting poor and vulnerable farming households from accessing and benefiting from government services. At present, the agriculture sector planning and budgeting process has not fully integrated climate change risks and opportunities in a comprehensive and sustained manner (Malla, 2008). Implementation of policies and plans within the sector remains largely uncertain due to the inadequate strategy on how to implement them, and governance issues (Pant and Gautam, 2013). There is also absence of effective extension system, inadequate human resources, little if any capacity to design and deliver adaptation services and support services that can provide farmers the right advice and help them overcome the impact of climate change (NAST and OPML, 2016).

Future projections show that the long-term effects of slow-onset climate change will also have serious impacts on agriculture and food security, requiring substantive adaptation of agricultural systems over time. This requires strategic and long-term adaptation strategies and an action plan to deal with climate change adversities and enhance the resilience of mountain agriculture systems. Sustainable Development Goals 1, 2, 3 and 12 emphasize on ending poverty and hunger, ensuring good health and well-being, and ensuring responsible consumption and production. In response to several national and international priorities, the NAP within the agriculture sector should have a visionary and robust strategy that can help the government fully mainstream climate change in policies, plans, budgetary structure and governance.

Chapter 4 Climate Induced Disasters

Context

Due to mountainous topography and diverse climatic and ecological conditions, Nepal is exposed and highly sensitive to any variability or change in existing climate systems. Nepal's first national communication report to the UNFCCC (MoPE, 2004), the NAPA (MoE, 2010) and its national policy documents on climate change and DRR have highlighted sectoral and overall exposure to climate related hazards The country is also prone to disaster events due to fragile geology and steep topography. A total of 22,372 disaster events have been recorded during the period of 1971-2015. Hence, annually Nepal is exposed to about 500 events of disaster (MoHA, 2016). Evidence shows that 49 out of Nepal's 75 districts are prone to floods and/or landslides, 23 to wildfires, and one to windstorms (MoHA, 2009a). In 2016, the Global Climate Risk Index ranked Nepal the 17th most climate vulnerable country (Kreft et al, 2016).

Water-induced hazards are a major cause of disaster in Nepal. Current climate variability and extreme events lead to major impacts and economic costs. Floods associated with monsoon rains top the list of disasters, and lead to loss of life and major property and infrastructure damages. Current climate variability and extreme events also lead to major impacts on agriculture (rainfed agriculture, soil erosion, droughts) and low season river flows reducing hydroelectricity generation (IDS et al, 2014). The highest vulnerability to floods is in the lower plains of the Terai, while high vulnerability to landslides is in the hills and high mountains (GoN, 2010).

Economic losses from weather- and climate-related disasters have increased, but with large spatial and inter-annual variability. Annual direct costs of current climate variability in Nepal, on average, are estimated to be equivalent to 1.5–2% of current GDP/year (approximately USD 270 million–USD 360 million/year in 2013 prices). However, there is wide variability across years and in exceptional years, the costs of floods can rise to be equivalent to 5% of GDP (IDS et al, 2014).

Together, the emerging dynamics of climate change induced disasters could significantly increase the impact on local level food and livelihood systems. The implications of these dynamics for policymaking for adaptation are immense. Understanding the interactions between disaster risk reduction and other livelihood systems on the one hand, and climate trends and scenarios on the other, has implications for the designing of both short- and long-term effective strategies for adapting to the impacts of climate change (Dixit, 2011).

Climate Change Trend and Disaster

Analysis shows an increase in temperature and more erratic precipitation (Shrestha et al, 1999; Shrestha et al, 2000; Practical Action, 2009; DHM, 2015). Over the years, the precipitation trend has also varied according to altitude and slope while remaining heterogeneous within climatic zones, river basins and across Nepal (DHM, 2015). As a result of climate change, extreme weather events, particularly cloudbursts, thunder and dry-spells, and the losses and damages they cause, have been increasing (MoHA and DPNet, 2013; MoHA and DPNet, 2015, MoHA 2009a). In the NAP process, climatic hazards have been grouped as:

- Climate extreme events: extreme hot temperature and heat waves, extreme cold temperature and cold waves, wind storms, extreme rainfall, hailstorms, thunder, droughts, long gaps in between two successive rainfall events during

monsoon (or different forms of erratic rainfall)
- Climate induced hazards: floods (including flash floods, GLOFs, torrential floods and inundation due to excessive rainfall), landslides, fire (forest fire in particular), disease and pest outbreaks, avalanches
- Sector specific climate related hazards: disease and pests, invasive and alien species intrusion, land and ecosystem degradation, sediment loading, crop failure

Climate-related disasters in Nepal are caused by rapid-onset events and slow-onset events. Climate-dependent hazards that arise suddenly, or whose occurrence cannot be predicted far in advance, trigger rapid-onset disasters. They include windstorms, landslides, avalanches and floods. The warning time before these hazards strike ranges from a few seconds or minutes (in the case of landslides), to a few days (in the case of storms and floods). The slow-onset disasters occurring in the country are droughts, whose results, in the form of water and food shortages and livelihoods lost, can take months or sometimes years to become evident. Rising temperatures, forest fires, regional sedimentation and accelerated melting of snow and glaciers also result in slow-onset disasters (Dixit, 2011).

A changing climate leads to changes in the frequency, intensity, spatial extent, duration and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events (IPCC, 2012). Climate induced hazards that cause significant losses and damages have been increasing in recent decades. There are direct and indirect losses which are tangible and intangible. For example, economic losses of assets are tangible direct losses while loss of lives are intangible direct losses. Similarly, the interruption of social and economic activities is a tangible indirect loss and decrease in trust in socioeconomic systems is an intangible indirect loss. This kind of breakdown in not available and is also hard to quantify in many instances.

Major climate induced hazards have occurred in Nepal between 1990 and 2010 causing major damages to the lives and livelihoods of people. The 1998 Rohini River and other Terai floods in Nepal affected 279 families in Nawalparasi District, washing away about 24ha of land and damaging property worth over NPR 680,000 (USD 6600 of 2009 exchange rate). Due to the 2008 Koshi embankment breach, some 65,000 people in Nepal and about three million in India's Bihar were displaced. Twelve people went missing in Nepal. The data also shows that the 2008 floods in far-west Nepal impacted Banke, Bardiya, Kailali and Kanchanpur, and the hill districts of Dang, Dadeldhura, Doti and Salyan. According to an estimate by the Nepal Red Cross Society (NRCS), 158,663 people in 23,660 households in Kailali District and 30,733 people in 5,961 households in Kanchanpur District were affected (NCVST, 2009).

There is an increasing trend of disasters occurring from flood hazards. Floods that have occurred in major rivers in recent years show that they have broken the record for the biggest floods over the past 50 years in many cases. Floods in the Mahakali (2013), the Babai (2014), the Rapti (2014 and 2015) and the Karnali (2015) are some examples. The Karnali River flooded at its largest from 14 to 15 August 2015 in what was a one-in-450-year flood (some studies have claimed it was a one-in-1,000-year flood) (ISET-N, 2015). According to the Ministry of Home Affairs (MoHA) updates, 39,812 families were affected in 2014 compared to 2,697 families in 2013. Similarly, the economic loss was greater in the year 2014 [NPR 16,753.7 million (USD 163 million)] than in the year 2013 [NPR 2,057.0 million (USD 20 million)]. However, the total number of disaster events was more in the year 2013 (58 disasters) than in the year 2014 (42 disasters).

Cloudbursts and GLOFs and associated floods are other emerging hazards that cause major loss and damages. In 1993, as the result of mid-mountain cloudbursts and floods, altogether 1,460 people died or were reported missing, 73,606 families were seriously affected, 39,043 houses were completely or partially destroyed, and about 43,330 ha of cultivated land was washed away or covered in debris. Likewise, in 1998, a glacial lake outburst event, the breach of Tam Pokhari, killed two people, destroyed more than six trail bridges and washed

away arable land. The loss was estimated at NPR 150 (USD 1.5 million) (NCVST, 2009).

Drought is becoming a serious issue which has direct impact on the health of people. The winters of 2007/2008 and 2006/2007 were also unusually dry. In a period of 36 years, from 1971 to 2007, more than 150 droughts events were reported in Nepal affecting more than 330,000 ha of agricultural land, mainly in the Terai and western hills and mountains (NSET, 2009). Extreme drought has also triggered forest fires. The dataset shows that fire is one of the most recurrent hazards in Nepal. Number of incidences was recorded 7,187 times (MoHA, 2016). Forest fires in 2009 caused 43 deaths, injured 12, affected about 516 families and killed 375 livestock while also damaging 74 houses and 22 cattle sheds, causing an estimated loss of NPR 14 million (USD 140,000). The 2009 cholera epidemic in the mid-western hills resulted in major human casualties and illness. Reports by the NRCS in 2009 showed that altogether more than 20,000 families had been affected and that 240 people had died (NCVST, 2009)

Climate Change Exposure and Vulnerability

Exposure and vulnerability are key determinants of disaster risk and impact. The severity of the impacts of climate extremes depends strongly on the level of exposure and vulnerability to these extremes. Increasing exposure of people and economic assets is a major cause of long-term increases in economic losses from weather and climate-related disasters (Cutter et al, 2012).

Climate extreme events can have very different impacts on different populations depending on their vulnerability. Exposure and vulnerability to climate induced hazards and impacts are differentiated by socio-economic factors such as gender, livelihood strategies and cultural practices, and bio-physical factors such as landscapes and ecosystems (IPCC, 2012). The occurrence of disastrous events and disasters entails a wide range of far reaching impacts.

Human populations, economic sectors and services are exposed to one or more hazards. Markets, settlements and services are growing in unplanned urban centres in risk prone areas where the impacts of climate change are most likely to aggravate vulnerability and disaster risks in the near and distant future. Geographic distribution and seasonality of hazards are important in terms of understanding exposure. Heat waves (during dry summers) and cold waves (during dry winters) are persistent in the Terai. High mountain herders and mountaineers are exposed to avalanches and other weather phenomena at high altitudes like the 2014 Nepal snowstorm disaster caused by the Hudhud effect[1].

Extreme events will have greater impacts on sectors with closer links to climate, such as water, agriculture and food security, forestry, health and tourism. The forest and biodiversity sector is exposed to fire hazards. Fire involves three elements: high temperature, dry air and burning material. Higher temperature and dry air are climate events that contribute to increasing fire hazard potential. Besides, there is a clear linkage between weather phenomena, status and fire progression (Billmire et al, 2014). Past and future changes in exposure and vulnerability to climate extremes in the water sector are driven by both changes in the volume, timing and quality of available water, and changes in the property, lives and systems that use the water resource, or that are exposed to water related hazards (Agarwala et al, 2003).

Agriculture is also an economic sector exposed and vulnerable to climate extremes. The economies of many developing countries rely heavily on agriculture, dominated by small-scale and subsistence farming, and livelihoods in this sector are especially exposed to climate extremes. Since more than 65% of the population is dependent on agriculture, the impact of disaster has huge implications to food security and the livelihood of people (MoAD, 2014).

[1] The 2014 Nepal snowstorm disaster occurred in central Nepal during the month of October and resulted in the deaths of at least 43 people of various nationalities, including at least 21 trekkers. Injuries and fatalities resulted from unusually severe snowstorms and avalanches on and around the mountains of Annapurna and Dhaulagiri. The incident was said to be Nepal's worst trekking disaster.

Settlement patterns, urbanization, and changes in socioeconomic conditions have all influenced observed trends in exposure and vulnerability to climate extremes. Settlements concentrate the exposure of humans, their assets, and their activities. The most vulnerable populations include urban poor in informal settlements, refugees, internally displaced people, and those living in marginal areas (Handmer et al, 2012).

Closer integration of disaster risk management and climate change adaptation, along with the incorporation of both into local, sub-national, national and international development policies and practices could provide benefits at all scales. The Government of Nepal formulated a number of policies, frameworks, and guidelines related to Disaster Risk Management (DRC) and Climate Risk Management (CRM). Nepal is a signatory to many regional and international agreements such as the Sendai Framework of Action related to disaster. The Government of Nepal has prepared the Natural Disaster Relief Act (1982), the National Strategy for Disaster Risk Management (NSDRM), the National Disaster Response Framework (NDRF-2013) and the Water Induced Disaster Management Policy (2006). Periodic plans particularly from the 10th Plan onwards have put an effort into mainstreaming disaster risk reduction into development planning. Although it is yet to be reflected into action on the ground, successive plans have continued to include DRR in the planning.

Governance structures are pivotal to addressing disaster risk and informing responses as they help shape efficiency, effectiveness, equity and legitimacy. An institutional set up aimed at enhancing resilience to disasters is in place. Provisions of the Natural Calamity Relief Act (1982) mandate relief and recovery action, and roles and responsibilities are allocated to disaster response with the arrangement of an institutional mechanism down to the district level and a provision to form institutions further down based on need. Nepal has adopted community centered approaches to disaster preparedness. Local disaster risk management guidelines are in place and the Ministry of Federal Affairs and Local Development (MoFALD) is promoting local government bodies to mainstream and integrate DRR into local development planning. Nepal has pioneered participatory resource management approaches such as community forestry. These are some good examples that could be carried forward to mitigate the impacts of climate change (Carter et al, 2011).

Post-disaster recovery and reconstruction provide an opportunity for reducing weather- and climate-related disaster risk and for improving adaptive capacity. A number of national priority programmes and projects include donor funded projects which, for particular purposes, have worked on enhancing capacity to prepare for and respond to disasters. There are efforts in practice to mitigate disaster risks. River training activities are implemented in many rivers (DWIDP, 2015). Nepal pioneered community-based early warning systems (EWS) and there are also studies on gendering flood EWS (Shrestha et al, 2014). The flood EWS that have been set up involve multiple stakeholders and link public private collaboration on saving lives, assets and livelihoods. However, these are scattered and are yet to come into mainstream development priority. Development practice, policy and outcomes are critical to shaping disaster risk, which may increase as a result of shortcomings in development

However, existing capacity to cope with and adapt to climate induced hazards is very low. The human and economic losses faced every year clearly show how the country is unable to respond effectively. Preparedness for and response to disasters is ineffective due to poor infrastructure and services. There is also a lack of sufficient equipment and human resource to rescue and rehabilitate affected segments of the population. The remoteness and harshness of the geographical terrain also make certain responses ineffective. In addition, the extreme poverty many live in in the country also constraints recovery mechanisms among households and communities.

Inequalities influence local coping and adaptive capacity, and pose disaster risk management and adaptation challenges from the local to national

levels. These inequalities reflect socioeconomic, demographic and health-related differences, and differences in governance, access to livelihoods, entitlements and other factors. Studies show that efforts to address climate and disaster risk have been challenging because exclusion and inequalities exist (Boyd, 2011)

Key Gaps

Data on disasters and disaster risk reduction are inadequate at the local level, which can constrain improvements in local vulnerability reduction. There are a few examples of national disaster risk management systems and associated risk management measures explicitly integrating knowledge of and uncertainties in projected changes in exposure, vulnerability and climate extremes. The frequency, intensity and magnitude of disasters have been poorly recorded. As only larger scale disaster events are in the count, impacts of slow onset hazards and climatic shifts posing gradual stresses to agriculture and other productive sectors leading them to complete failure over time are often unaccounted for in these assessments. The adverse impacts of climate change (descending from both rapid- and slow-onset hazards) on ecosystem resources, such as water springs and biodiversity losses due to the combined impacts of different climatic and non-climatic hazards, are difficult to assign monetary value to and assess based on the same (IBRD/World Bank and the United Nations, 2010). This means that we need tailor-made methodologies and approaches to account for loss and damage.

There are key policy gaps in terms of addressing natural disasters and disasters induced by climate change. Development plans have not fully accommodated DRR for three reasons. First, there is a inadequate awareness and information among planners and policy makers in the public and private sectors about the benefits of investing in DRR activities. There is also a need to demonstrate or showcase evidences of investment on DRR and risk sensitive planning and development. Second, there is a lack of technology, methodologies and skills in integrating DRR into development projects and programmes in practice. Third, the country also lacks an implementation, and monitoring and evaluation mechanism for integrating DRR.

There are institutional and financial challenges related to addressing climate induced disasters. Those institutional coordination mechanisms that have been put in place have not been effective due to a number of reasons including political instability. The government's allocation of financial resources in climate induced disaster management is limited and unpredictable. This shows that the government has yet to prioritize climate induced disaster management as an important issue.

The existing approach needs a significant shift—from traditional relief or passive response to active preventive measures and resilience capacity building. There is inadequate awareness, capacity and commitment to access and disseminate climate information services such as weather forecasts to deal with climate risks and uncertainties. The available institutional capacity is inadequate when it comes to accessing and disseminating reliable climate information services considering the needs of different people (who are differently vulnerable), and development sectors including private sectors. The existing challenges within the sector can be met by developing a strategic longer term plan and necessary policy, and adequate institutional, financial and skilled human resources.

Chapter 5

Forests and Biodiversity

Context

Nepal is home to a uniquely rich diversity of flora and fauna due to its distinctive geography and variability in physiographic and climatic conditions (MoFSC, 2014). With only 0.1% share in the global map, it harbours about 3.2% of the world's flora and 1.1% of the fauna, including 350 floral and 160 faunal species that are found nowhere else in the world. There are 118 ecosystems, 75 vegetation types and 35 forest types in the country (MoFSC, 2014). Similarly, forests, which occupy 44.74 % of the country's land area, serve as the prime natural resource in the country (DFRS, 2015).

The forestry sector is considered an integral part of rural livelihoods. About 76% of Nepal's population depends on forests for their livelihoods (Amatya, 2013), with some 64% still using fuelwood as a major source of domestic energy (CBS, 2014). While the agriculture and forestry sector contributes to around 1% of global GDP, its contribution to the national GDP was estimated at 15% (MoFSC/FAO, 2009). In addition, the forestry sector contributes to the national economy significantly by providing an average annual revenue of NPR 550 million (USD 5.4 million) (Subedi et al, 2014). Moreover, the sale of different forest products and services, including timber, non-timber forest products (NTFPs) and nature-based tourism, has become a significant source of revenue for the government (Subedi et al, 2014). The forestry sector has the potential to generate employment for about 100,000 person days per year (MSFP, 2015). Moreover, forests in Nepal have a total carbon stock of 1,054.97 million tonnes (DFRS, 2015), the trading of which could further offer additional economic contributions.

However, being physically exposed assets, the growth and sustenance of forests and biodiversity are broadly dependent on climatic and edaphic factors (Chitale et al, 2014; MoFSC, 2011). Future changes in climate are likely to exacerbate the observed impacts of current threats on natural resources, ecosystems, ecosystem services and biodiversity. Climate extreme events and hazards will degrade, damage and convert forest areas, and these changes in forest distribution and composition will adversely affect ecosystem services and biodiversity. It is therefore important to strategically plan and implement adaptation and mitigation measures to tackle climate change issues in order to protect the country's rich natural resources.

Climate Change Trend and Disaster

The forests and biodiversity of Nepal are threatened by numerous factors. Loss, degradation and alteration of natural habitats, such as conversion of forests, grasslands and wetlands into agricultural or urban lands; overexploitation of natural resources; invasion by alien species; and pollution of water bodies remain the predominant threats to the productivity of natural ecosystems (Karki, 2015). In addition to these, climate change is emerging as a serious threat to forests and biodiversity.

Prevailing climatic conditions influence the status and quality of biodiversity and ecosystems, and any change on it directly affects their functions (Kumar, 2012). While Nepal is experiencing changes in climate, the impact of both slow and rapid onset climatic phenomena on natural resources and the environment is evident (Joshi et al, 2012). Based on observations and anecdotal evidences from local communities, the flowering and fruiting time of many species and the length of the growing season have reportedly changed resulting in significant implications for species growth and production (GoN, 2010).

Sector specific hazards, such as fires, diseases and pests, and intrusion of alien invasive species, have negative impacts on forests and biodiversity (Joshi et al, 2012; Dahal, 2006). Forest fires occur annually in all the major physiographic regions of Nepal (GoN, 2010). However, there is limited scientific data that documents the impacts of forest fires, especially in relation to biodiversity loss and carbon emissions.

Our understanding of the impacts of climate change on Nepal's biodiversity is inadequate. However, a number of studies conducted in this sector have indicated some likely impacts:

- The geographical range of many species will move upward in elevation from their current locations with varying effects on different species. Some species will migrate through fragmented landscapes, while others may not be able to do so (GoN, 2010).
- Many species that are already vulnerable are likely to become extinct. Species with limited climatic ranges and/or with limited geographical opportunities (eg, mountain top species), species with restricted habitat requirements, and/or small populations are typically the most vulnerable (GoN, 2010).
- Changes in the frequency, intensity, extent and locations of climatically and non-climatically induced disturbances will affect how and at what rates existing ecosystems will be replaced by new plant and animal assemblages. High himal and high mountain ecosystems are likely to be worst affected by climate change. Among natural habitats, remnant native grasslands are highly vulnerable to the impacts of climate change (BCN and DNPWC, 2011).
- The impacts of climate change are likely to increase in the future, which will not only affect biodiversity but also the livelihoods of millions of local and indigenous people who depend on forests and biodiversity. The disruption of ecosystem services due to climate change is expected to especially affect the poorest and most vulnerable communities of the country (GoN, 2010, UNEP, 2010).

Exposure to the Adverse Impacts of Climate Change

'Exposed' elements within the forests and biodiversity thematic sector include biophysical and socio-economic elements such as forests, water bodies, ecosystems, watersheds, flora and fauna, different ecosystem services, and forest dependent populations including poor, marginalized and indigenous communities (Easterling et al, 2007).

Changes in temperature and precipitation expose forests mainly through an alteration of species composition and invasion by alien species. It has direct implications on forest health and thereby its productivity (Spitlehouse and Stewart, 2003; GoN, 2010). Mikania, an alien invasive species first noticed in Chitwan National Park and its buffer zone after the Rapti River floods in 2003, has invaded the local forests (Rai and Scaborough, 2012) and deteriorated forest health and production (Rai and Scaborough, 2012). Similarly, invasion by water hyacinth (Eichhornia crassipes) poses a major threat to tropical and subtropical wetlands (MoFSC, 2014). It is likely that climate change will accelerate the invasion by such alien species in different ecosystems.

Among forest species, NTFPs are directly exposed to changes in temperature and precipitation. Decline in the productivity of some economically viable NTFPs, such as panch aunle (Dactylorhiza hatageria), silajit (Rock exudates), amala (Imblica officianalis), ritha (Sapindus mukurosii), timur (Zanthoxylum armatum), and bel (Agle marmelos) have been observed as a result of climate change (GoN, 2010). A decrease in the availability of NTFPs will impact the communities dependent on these resources for their livelihoods.

Wildlife habitat, especially rangelands in the Himalayan region, and wetlands are highly exposed due to increasing frequency of disasters and water scarcity which contribute to the depletion of rangelands and loss of wetlands (GoN, 2010). Moreover, the trend of replacing mixed natural forests with monocultures poses an additional risk

of exposure to climate change that then affects the stability of such forests.

Communities dependent on forests and biodiversity are at high risk of exposure to climate change. More than 66% of Nepal's population is dependent on agriculture for their livelihood, but they occupy small parcels of land that can barely produce enough food for their families (CBS, 2014). They are heavily reliant on local natural resources such as forests and water resources to supplement their dietary intake, thus they will suffer the most when the forests and biodiversity sector is exposed to climate change (ASHA, 2014). About 1.1 million people, including women, poor, and the marginalized, are highly exposed to climate change as they are classified as the most vulnerable in the country (GoN, 2010).

Climate Change Vulnerability

Degradation of natural resources and widespread poverty is the outcome of a complex interplay of socio-economic conditions and natural phenomenon such as erosion, floods, droughts and storms. However, such phenomenon is further triggered by climate variables including temperature and precipitation. Rise in temperature and increasing drought incidents have catalysed the sensitivity of dry landscapes, including the Chure and high hills, to forest fire (GoN, 2010). Similarly, increasing deforestation rates, especially in the Terai, predispose forests and ecosystems to further sensitivity (DFRS, 2015).

Climate extremes have altered plant flowering and fruiting behaviour causing food deficiency for wild animals and insects. Freshwater ecosystems in the mid-hills and the Terai are sensitive through changes in physical habitat and water quality (Bryant, 2009). It was observed that the distribution and productivity of aquatic species (rivers, wetlands) and communities dependent on fishing in the Terai are sensitive to changes in temperature extremes and variability in rainfall (GoN, 2010). Similarly, treeline shift has been observed in high altitude areas (Gaire et al, 2014).

Compared to forests fauna are highly sensitive to temperature changes and extreme variability in rainfall. The loss and/or alteration of their habitats as a result of climate change greatly affects their survival (Uprety and Bishwokarma, 2016). The increasing rate of snow-melt in the Himalaya has increased the vulnerability of high altitude fauna, including snow leopards (GoN, 2010).

The adaptive capacity of the forests and biodiversity sector is determined by the richness of natural resources, existing policies and response mechanisms, and the capability of both ecosystems and the human population to respond to climate change impacts (Dahal, 2006). Nepal has successfully demonstrated community based forest and biodiversity conservation and management. More than 1.9 million ha of forest area is being managed by about 26,000 local forest user groups (DoF, 2017). Similarly, scientific forest management is employed in the Terai in different forest management regimes, especially collaborative forests which are further expanding both within the region and also to other ecological zones. The Government of Nepal has allocated NPR 630 million (USD 6.2 million) to continue and expand sustainable forest management for the fiscal year 2073/74 (2016/17) (Jayasawal and Bishwokarma, 2016). Moreover, the government has developed different policy instruments which will contribute to reducing vulnerabilities and enhancing adaptive capacity in the forests and biodiversity sector (Table 6).

There are strong and extended institutional arrangements in place to look after the forests and biodiversity sector in Nepal. The MoFSC has its institutional arms at the national, regional, district, and local levels which contribute not only to law enforcement, but also to providing technical inputs within the sector. There is a functional institutional structure in place, the REDD Implementation Centre, that effectively addresses climate change impacts and develops mechanisms for enhancing opportunities from market based incentives. Similarly, forest user groups at the community level contribute to resources conservation, management and utilization. Favourable policies and strong

Table 6: Major Policy Instruments in the Forests and Biodiversity Sector

Strategies and plans	Policies	Law and Acts
Forestry Sector Strategy, 2015	Forest Policy, 2071 (2015)	Forest Act, 2049 (1993)
National Low Carbon Economic Development Strategy, 2014 (Draft)	Climate Change Policy, 2067 (2011)	Forest Regulations, 2051 (1995)
National Biodiversity Strategy and Action Plan, 2014-2020 (NBSAP)	National Land use Policy, 2069 (2013)	Environment Protection Act, 2053 (1997)
Nature Conservation National Strategic Framework for Sustainable Development (2015-2030)	Rangeland Policy, 2068 (2012)	Environment Protection Regulation, 2054 (1998)
Forest Fire Management Strategy, 2067	National Wetlands Policy, 2012	Soil and Watershed Conservation Act, 2039 (1982)
REDD+ Strategy, 2015 (draft)		National Parks and Wildlife Conservation Act 2029 (1973)
Terai Arc Landscape (TAL) Strategy and Action Plan (2015-2024)		National Park and Wildlife Conservation Regulations (1973)
Chitwan-Annapurna Landscape (CHAL) Nepal Strategy and Action Plan 2016-2025		

institutional mechanisms are resulting in positive impacts on forests. The recent forest inventory (DFRS, 2015) has shown an increase in forest cover in the mid-hills.

However, some constraints prevail on the adaptive capacity of the forests and biodiversity sector. Pre-existing socio-structural constraints such as access to source and power, and governance issues in the forestry sector present limitations concerning the maximization of benefits and opportunities for poor and marginalized households (Acharya et al, 2011). Information and technological barriers such as technical know-how necessary for scientific forest management and knowledge on responding to extreme events including drought and fire also have limited adaptive capacity in the sector. The role of scientific research needs to be recognized in the future and the answer to how the 'adaptation' of forest ecosystems can potentially contribute to carbon sequestration in the context of REDD+ must be sought. Furthermore, to undertake adaptation measures, there is the need to investigate real and specific climate change threats to each forest type in Nepal.

The 14th Development Plan for the forestry sector has identified several issues, such as impact on low lying areas due to inadequate conservation of mountain ecosystem, implication of poor management of Chure in the livelihoods of people dependent on natural resources, poor access of communities who are a distant forest user, degradation and deforestation issues, and need to address the challenges posed by climate change and climate induced disasters (NPC, 2016).

Key Gaps

Forest and biodiversity sectoral policies have been designed at different governance levels, but there are gaps impeding their effective implementation. These gaps are particularly related to strategies that address emerging global challenges including climate change and proper benefit sharing mechanisms at different levels. Sectoral policies have different mitigation and adaptation options despite sharing some common issues. Identifying and integrating these common issues could contribute to enhancing forest and ecosystem health, along with reducing problems such as invasion by alien species or damage by insects and pests. Opportunities to achieve results on enhancing adaptive capacity are being missed in policies and programmes mainly due to inadequate cross-sectoral synergy at the planning and implementation levels.

Some institutional gaps exist in the forestry and biodiversity sector, including inadequate holistic and integrated approaches, focus on top-down approach, inadequate monitoring, limited stakeholders, and weak intersectoral and interagency coordination. These gaps delay decision making, thereby leading to poor implementation of policies. There are also issues within the internal governance of forest user groups such as the inclusion of poor and marginalized groups in decision making and equitable benefit sharing which are further constraining the capacity of poor and vulnerable households to adapt to climate change (Regmi et al, 2016).

Despite being a resourceful sector, its potential to enhance adaptive capacity has been diminished by inadequate technical know-how and limited updated information. For instance, existing technical human resources in the MoFSC are responsible for providing technical assistance on scientific forest management across the country, but communities are unable to access such knowledge and skills mainly due to the labsence of adequate human resources (Jayasawal and Bishwokarma, 2016).

There is limited research on assessing vulnerability, exposure and climate change impact on forests and biodiversity since it demands long-term engagement (GoN, 2010). Both government and non-government agencies, including academic institutions, have not invested adequately on such research to generate and disseminate reliable data and knowledge. This has implications for the development and implementation of proper strategies to enhance resilience. It is therefore essential for institutions to facilitate an exchange of practices from 'lab-to-land and land-to-lab' (ICIMOD, 2016).

Addressing climate change issues related to forests and biodiversity become more challenging without specific policies, guidelines and tools relevant for the sector Informed decision making also requires good quality, regularly updated and context-specific data achieved through in situ research. Nepal must improve its capacity to effectively design, plan, implement and monitor changes in the status of forest and biodiversity health and ecosystem services. It is also necessary to have a long-term vision and plan for addressing future challenges related to climate change in this sector.

Chapter 6

Gender and Marginalised Group (Social Inclusion)

Context

Nepal is multi-ethnic, multi-cultural and multi-lingual country. One of the most important issues the country has to deal with is gender equality and social inclusion (GESI). This is because marginalised is reproduced in the country through structural inequality, patriarchal socio-cultural norms, and limited representation and participation of women and marginalized groups in decision making spheres (NPC, 2015; Gurung, 2009). According to the Human Development Report, Nepal's gender inequality index is 0.489 and it stands 144th out of 188 countries (UNDP, 2016). Women's scant access to decision-making roles, ownership of property, land rights, access to information and education put them at a further disadvantage (GoN /CBS, 2010–11). The lifespan of women is shorter by two and half years (Gurung, 2009). Compared to men, women work longer hours (12–16 hours a day) (Gurung, 2009; GoN/CBS, 2010–11). Similarly, the gross national income per capita of men is USD 2,690, while that of women is USD 1,956 (UNDP, 2016). Caste, ethnicity, regional identity and geographical location are also strong determinants of poverty and unequal development outcomes (Gurung, 2009). Institutionally, social inclusion issues are not given the same attention as gender as most line ministries have designated 'gender focal points', but not GESI focal points (ADB, 2010).

Fragile topography, a dominant subsistence economy, fast-paced cultural and socioeconomic changes and weak institutional capacity for anticipatory governance make Nepal particularly vulnerable to the adverse impact of climate change. Women and marginalised groups are more vulnerable because of their dependence on climate sensitive sectors such as forests and agriculture. Moreover, their vulnerability is associated with limited ownership of productive assets and decision-making power, and is further aggravated because of men's out-migration (Thieme and Mueller-Boeker, 2011). Limited rights and capabilities, particularly in relation to making financial decisions, difficulty in accessing support from relevant agencies, and increased responsibility as a result of labour shortage have further increased women's burdens in the absence of men (Adhikari and Hobley, 2011), and women-headed households face a particular set of challenges with respect to food and nutritional security, vulnerability to hazards and poverty (Verma et al, 2011).

Recognizing this reality and differences, the Government of Nepal aims to promote inclusive development by ensuring participation, access to opportunities and sharing of benefits across all individuals and groups. The goal of climate adaptation and equitable development can only be achieved if a fair share of benefits is distributed among all fraction of society, irrespective of their caste, class, ethnicity, gender, age and disability status.

Climate Change Trends and Disaster

Gender needs to be seen relationally, in its intersection with other social identity markers. This means understanding and analysing interconnections between social categories such as class, age, (dis) ability, ethnicity, caste etc. is necessary. Gender determines what social spaces and opportunities available or unavailable to us, thereby influencing our vulnerability as well as our ability to prepare, respond and recover in the wake of an environmental hazard. Climatic changes are observed in Nepal.

Evidences show an increase in temperature and greater variability in terms of precipitation (Baidhya et al, 2008). The warming is evident in the mountainous region of Nepal (Shrestha et al, 2000). In most Nepali communities, women have the primary responsibility of collecting water and firewood. As climate change exacerbates scarcity of water and firewood, women and girls may have to travel farther to collect these resources, increasing threats to their safety, decreasing productivity in other areas like farming, and reducing time available for schooling and other productive activities (Chapagain and Gentle, 2015; Macchi et al, 2015). In some areas, the drying up of springs has forced people to out migrate to areas with more water availability (Chapagain and Gentle, 2015). This has direct linkages on their health (eg, uterus prolapse) and well-being. A research estimated that more than 600,000 women in Nepal are suffering from uterus prolapse (ICIMOD, Verma et al, 2011). During food deficit periods, women consume less food in order to feed others and this has serious consequences on their health and nutritional requirement (GoN, 2010). The emergence of new weeds and pests has increased women's workload, as they are responsible for weeding and farm operations.

Shifts in the monsoon season, longer dry periods and decreased snowfall push Dalit (untouchable caste) girls and women to grow drought resistant buckwheat and work as daily wage labourers on the lands of high caste Lama landlords, while Dalit men are forced to seek patronage protection to engage in cross-broader trade (Onta and Resurreccion, 2011). Outbreaks of pests and diseases in crops and livestock are increasing, with devastating crop and biodiversity loss posing a direct threat to the livelihoods of poor and marginalized people (Leduc, 2009).

Exposure to the Adverse Impacts of Climate Change

The bio-physical and social conditions of Nepal represent a fragile ecosystem with a poor economy and weak institutional arrangements respectively. The population is composed of about 125 caste and ethnic groups with as many as 123 mother languages spoken (GoN /CBS, 2010–11).

Key livelihood dependent sectors are agriculture, forest, biodiversity, tourism and hydropower. Water resources are more exposed due to unpredictable weather patterns and extreme weather events. Similarly, communities whose livelihoods depend on forest-based products are exposed to the impacts of climate change due to pests, disease attacks, changes in rainfall pattern and rising temperatures leading to forest fires and forest degradation. Extreme climate events can wash away essential infrastructure like roads, bridges, houses, schools and public buildings that directly impact the lives of poor and marginalized people living in isolated and remote areas.

Differentiated vulnerabilities are exacerbated through disaster processes (Enarson and Morrow, 1998; Cannon, 2002), Women are also often more vulnerable to the impacts of disaster as they have less access to early warning systems and climate information, and lack the skills necessary to survive extreme events (Shrestha et al, 2014; MOSTE, 2014). Similarly, poor and marginalized groups are more vulnerable to natural disasters because of the spatial locations of their settlements (Verma et al, 2011), which leave them more exposed, and delay rescue and support operations during and after a disaster.

Floods and droughts adversely affect agricultural production and productivity resulting in income shortages. The increasing need for livelihood diversification triggers outmigration (predominantly men, with 12% women migrant workers). The primary responsibility for agricultural and household work falls on women (Leduc 2009; ICIMOD, 2011), resulting in increased drudgery, but also increased decision-making power, as women become key natural resource managers at the household level (Verma et al, 2011).

Floods destroy crop production and directly affect sanitation and the food supply chain. In the aftermath of flooding, cases of water-borne diseases are significantly higher. Apart from facing a personal security issue, women are endowed with the responsibility of providing resources for themselves

and their families (Alam, 2015). Recognizing the differentiated roles that women and men play as natural resource managers and food providers, there is the necessity of engaging women and men in early warning systems and disaster preparedness programmes that must reach the most disadvantage segments of society (Shrestha et al, 2014).

Climate Change Vulnerability

The social and cultural characteristics of people shape their vulnerability and capacity to adapt to the impacts of climate change. For example, children, pregnant women and those with compromised health are more sensitive to contaminated water sources. Similarly, women- headed households and those with limited access to modern agricultural input, infrastructure and education are more sensitive to impacts of extreme events on food security. It is therefore important to identify specific vulnerabilities, risk and impacts of climate change on women and marginalized groups in order to help designing gender and social inclusion responsive adaptation plans and strategies for specific thematic sectors.

Climate change impacts men and women differently due to the differences in their traditional roles and socio-cultural constructions. Moreover, women's higher dependence on climate-sensitive sectors, makes them more vulnerable to the adverse impacts of climate change (Verma et al, 2011). Despite having interest and the necessary skills to establish micro enterprises, women face challenges as formal and informal credit institutions are geared to funding property owners. Major credit institutions seek tangible collateral for loan and women have no or very low access to inherited property leaving them sidelined. Moreover, women have limited decision-making power, despite the fact that a major proportion of their income is often dedicated to the family's basic needs (Mainaly and Tan, 2011).

Having realized the importance of gender for development, Nepal initiated the integration of gender into various forms of policy reforms, especially after participating in the "World Conference on Women" held in Beijing in 1995. A separate ministry has been established to look after the welfare of women and children [the Ministry of Women, Children and Social Welfare (MWCSW)]. In addition, there are a number of policy instruments at the national and international levels, and several projects and programmes working to address gender inequality and social exclusion and contributing to ensuring that the poorest and most vulnerable communities are able to adapt to the negative effects of climate change.

Existing approaches to vulnerability assessment are technocentric and deterministic, and do not adequately recognize the nuances of differentiated vulnerability between men and women and their intersection with other social markers (eg, caste, ethnicity, disability etc (Verma et al, 2011). Data on vulnerability and adaptive capacity are predominantly collected at the household level. However it is the socio-economic construction of a patriarchal society that affects the accessibility of resources, thus creating a dissonance between vulnerability and the adaptive capacities of men and women. This requires different approaches and data, where power dynamics and various types of deprivation are taken in due consideration, thus ensuring equal entitlements and access to risk mitigation and adaptive strategies.

The Government of Nepal has already recognized gender mainstreaming and social inclusion as important issues in all of its periodic development plans, with an emphasis on special measures backed by proportional representation, positive discrimination and gender budgeting (Table 6). The Constitution of Nepal, 2015, guarantees a right-based approach regarding gender equality and social inclusion. Article 18 of the Constitution stipulates a non-discrimination principle that reinforces the equality of all citizens before the law (GoN, 2015). In ensuring this constitutional right, the Civil Service Act (second amendment, 2007) legalized the principle of positive discrimination by ensuring reservation for certain sections of the community in the civil service. The Business Allocation Rule, 2015 assigns the MWCSW the task of conducting the functions of social welfare. The Caste Based

Discrimination and Untouchability (Offence and Punishment) Act, 2011, is the main law aimed at criminalizing and punishing the act of discrimination on the basis of caste, race, descent etc, in the name of custom, tradition, religion, culture, ritual or any other name.

- Eliminate harmful practices
- Increase the proportion of seats held by women in the national parliament to 40%
- Increase women's share in public service decision making positions to at least 28%

Table 7: Gender Responsive Budget in Nepal's National Budget

Fiscal Year	Gender Responsive Budget (%of total budget)	
	Directly Relevant	Indirectly Relevant
2012/13	21.51	44.13
2013/14	21.75	43.94
2014/15	21.93	45.04
2015/16	22.27	47.98
2016/17	23.10	48.45

Source: MoF, 2016

The periodic plans also have dedicated plans, programmes and policies for Muslims and marginalized groups, including Dalits and Adhivasis/ Janajatis. There are targeted programmes such as the Gender Equality Index and the Gender Empowerment Index as well. Women's participation in the state machinery, women's participation in targeted programmes, gender responsive budgeting, the expansion of women development programmes, targeted women's groups in women development programmes etc, are also given due attention.

Nepal has also implemented international commitments. As a part of the implementation of the Beijing Platform for Action, the Government of Nepal formulated the National Action Plan on Gender Equality and Women Empowerment, 2061 (2004/05). The government has given the highest priority to implementing sustainable development goal (SDG) priorities. SDG 5 is about gender equality and the empowerment of women and girls. The proposed specific targets for SDG 5 for Nepal include the following:

- Eliminate gender disparity in all levels of education by 2030, particularly in tertiary level education (which currently stands at 0.71) and literacy rates of women and men aged 15–24 years (which currently stands at 0.85)
- Eliminate wage discrimination in similar work
- Eliminate physical and sexual violence

However, there are challenges to achieving these SDG goals. In the context of gender inequality and social exclusion, the impacts of climate change are faced more disproportionately by women, the poor and the marginalized. Simultaneously, the disproportionate impacts of climate change aggravate existing gender inequality and social exclusion (ICIMOD, 2011). This demonstrates the vicious circle of climate change (biophysical), poverty, and gender inequality and social exclusion.

The existence of multiple forms of discrimination and marginalization in Nepali society limits women's ability to utilize resources in their own right. Limited access to and control over natural resources like land, forest and water, limited engagement in decision-making processes, limited access to knowledge and information, and limited access to social protection and safety nets, backed by an unequal division of labour put women, the poor and the marginalized population in the frontline of climate change vulnerability (ICIMOD, 2011).

Key Gaps

The efforts of the Government of Nepal to mainstream climate change in development planning and policy frameworks is inadequate. It is equally important to understand existing challenges and opportunities that hinder and enable the successful implementation of adaptation plans and priorities.

Along with constitutional and legal provisions, enabling policies, programmes and institutional structures should be in place to address gender and climate change issues in Nepal. These encourage development efforts.

There is a absence of sex-disaggregated data in most sectors to measure the differential impacts of climate change between men and women, and the most marginalized segments of society. There is also inadequate documentation and sharing of existing climate resilient adaptation practices that are GESI responsive on specific thematic sectors. The knowledge and information gap in climate change and gender is evident. However, it is even more so in socially excluded groups. This presents a challenge to addressing the issues of socially excluded groups in the adaptation process. In comparison to the gender issue, addressing the social inclusion issue is relatively new and unattended.

More coordinated and integrated efforts are required for formulating adaptation plans and strategies at different levels (national and district). Gaps are also evident in institutional and functional linkages between gender focal points and climate change focal points in ministries. This in turn obstructs the building of constructive synergies between them. Monitoring frameworks to examine the combined outcome of investments in the gender and climate change sectors are also required.

Finally, since social inclusion issues are not given as much space as gender, the problem needs to be addressed structurally. This can be done by re-designating gender focal points in line ministries as GESI focal points.

Chapter 7

Livelihood and Governance

Context

Socio-economic, demographic and environmental issues, and slow economic growth make Nepal's development challenging. Nepal is ranked 144th in the Human Development Index (HDI) out of 188 countries (UNDP, 2016). The livelihood of a majority of the population (66% of the total population) is largely dependent upon agriculture (MOAD, 2014), much of which is characterized by subsistence agriculture. About 25.2% of the population lives below the national poverty line (ADB, 2016). The country's low human development capacity coupled with climate change impacts is likely to exacerbate poverty by increasing vulnerability and inequality.

Climate change, climate variability and extreme events interact with numerous aspects of people's livelihoods, with direct impact on natural, physical, financial, human and socio-cultural assets (IPCC, 2014). Climatic and other stressors affect agriculture and non-agriculture based livelihoods at different scales: spatial (eg, village, national) or temporal (eg, annual, multi-annual). Some livelihoods are directly climate sensitive, such as rainfed smallholder agriculture, seasonal employment in agriculture (eg, tea, coffee), fishing, pastoralism and tourism. Climate change also affects households dependent on informal livelihoods or wage labour in poor urban settlements, directly through unsafe settlement structures or indirectly through rises in food prices or migration (Olsson et al, 2014).

Climate change will exacerbate multidimensional poverty in most developing countries, including high mountain states like Nepal and countries with indigenous peoples. Poverty and persistent inequality are the most salient of the conditions that shape climate related vulnerability (Ribot, 2010, p50). The poor, the socially and economically disadvantaged, and the marginalized living in fragile, mountainous and rural areas with low income and inadequate access to services are disproportionately affected by the impacts of climate change and extreme events (GoN, 2010).

Governance is another merging area that strives to understand the role of institutional arrangements in adapting to climate change. The laws and policies of institutions including the state, private and civil sectors, and agencies from the local to the national and the international levels all determine the livelihood strategy and ultimately the adaptive capacity of the people, particularly the poor (Dulal et al, 2010). The challenges for vulnerability reduction and adaptation actions are particularly high in regions that have shown severe difficulties in governance (IPCC, 2014). There are also issues related to promoting adaptation and the governance of climate financing in Nepal. Although there are issues at the global level, fixing operational modalities at the national and local levels is relatively urgent and important (Regmi and Bhandari, 2013).

Climate Change Trend and Disaster

Analysis of observational data have showed that the climate of Nepal is already changing (NCVST, 2009; Practical Action, 2009; Sthapit and Shrestha, 2008). A general increasing trend in temperature has been observed (0.05°C/year in maximum temperature and 0.03 °C/year in minimum temperature) with a steep increase over recent decades, rising at a much faster rate than the global average. Changes in precipitation have also been observed, including heavy rainfall extremes. However, the trend is more complex and there are wide variations across the seasons and the regions of the country. The complex climate of the country coupled with ensuing changes is leading to a high level of climate variability and

increasing extreme events, including floods and droughts (NCVST, 2009).

The poor, women and mostly natural resource dependent communities are bearing the burden of the increasing trend of damage to shelter and infrastructure, malnutrition and diseases, displacement of communities, loss of productivity in agriculture, etc. (Sharma, 2009; Chaudhari, 2014). The frequency and magnitude of water induced disasters, notably floods and landslides have risen, thus resulting in increased loss of lives and livelihood assets. The estimated total annual cost of water induced disasters is equivalent to 1.5% of the GDP (IDS et al, 2014).

Small-scale farming, which sustains the livelihoods of a majority of the population, is dependent on natural rainfall. It is affected by climatic extremes including floods and droughts, as well as other weather extremes. Soil erosion is another hazard that is leading to reductions in crop yield and productivity in the hill and mountain regions of Nepal, thus making a majority of farming households in these regions vulnerable to climate change (FIAN, 2013).

Hazards such as floods, outbreaks of pest and diseases, and landslide have direct impact on the livelihoods of poor and marginal farmers. Flood inundation is a major climate-related hazard in the country, affecting property, agriculture, infrastructure (settlements, roads, bridges, and communication and transmission networks), business and commerce, and causing loss of human life. Landslides, which are often related to extreme rainfall or flood events, also have a significant impact on communities and infrastructure. There are also additional risks from GLOFs, which have an impact on communities and infrastructure (MoSTE, 2014). Increasing temperature and erratic rainfall are leading to an increase in the incidence of forest fires, thereby reducing the mean residual energy available in forests for use by local communities (NCVST 2009). Outbreaks of pests in crops and diseases in livestock are increasing whereas invasive species are causing crop loss and biodiversity loss posing direct threats to the livelihoods of dependent communities (Regmi and Adhikary, 2007). The drying up of springs in the mountainous region is forcing members of established communities to travel farther and longer to fetch water. This is a cause for forced migration or displacement in some areas of the country (Chapagain and Gentle, 2015).

Exposure to the Adverse Impacts of Climate Change

Poor, marginalized and landless farmers practising subsistence agriculture are more exposed to the adverse impact of climate change such as floods, cold waves and heat waves. About 90% of crop loss in Nepal is caused by weather or meteorological events (UNDP, 2009). Besides agriculture, the anticipated losses resulting from increased intensities of weather related hazards, epidemics and diseases are likely to add to the sufferings of the population with overall damage to the national infrastructure (Sharma, 2009). People are exposed to increasing health problems, such as the growing risk of vector borne diseases in terms of the increased duration of transmission windows, spatial spread, etc, and other health problems (GoN, 2010).

Traditional natural resource based livelihoods such as agricultural land, forest and water are exposed to increasing climate change impacts (Regmi and Pandit, 2016). In the mid-2000s nearly 10% of agricultural land was left fallow due to rain deficit in Nepal (Regmi, 2007). It was reported that the depletion of water bodies exposes women, the poor and rural households to the adverse effects of climate change because of the additional stresses caused by inaccessibility and the low availability of water (Mainaly and Tan, 2012). Studies also show that the livelihoods of farmers who are already vulnerable and food insecure are further deteriorated because of crop failure and loss of livestock (Devkota and Gyawali, 2015).

Increases in the frequency and magnitude of disasters have huge implications on the livelihoods of people living in fragile and disaster prone areas. Extreme weather events that have induced floods and droughts from 2006 to 2009 significantly affected food production in Nepal (WFP, 2009), resulting in

food insecurity in the mid- and far-western regions. In 2005, the early monsoon and rain deficit in the eastern Terai (plains) reduced crop production by 12.5%, while in the same year western Nepal suffered floods resulting in the reduction of crop production by 30% (Regmi, 2007).

In addition, forest and biodiversity resources including communities dependent on these resources for their livelihoods are exposed to climate extreme events. Increased incidences of fires in recent years have affected more than 50,000 people and caused losses extending over large areas of productive forest land (GoN, 2010). Prolonged dry seasons resulted in a drastic reduction in the availability of grass and other sources of fodder, as well as in drinking water for livestock, forcing people, particularly women, to travel farther and longer to collect fodder and water or to lead animals to water sources. For example, a shortage of grass production in the Terai has been created by 'drought' conditions and loss of forests from floods (Bishokarma and Sharma, 2013).

Climate Change Vulnerability

Poor communities mostly rely on ecosystem services for their subsistence livelihoods and often have limited capacity to adapt to change, which makes them more vulnerable to climate change and other forms of changes (ICIMOD, 2010). Socially and geographically disadvantaged people exposed to persistent inequalities at the intersection of various dimensions of discrimination based on gender, age, race, class, caste, indigeneity, and (dis)ability are particularly negatively affected by climate change and climate-related hazards (Onta and Bernadette, 2011; IPCC, 2014).

Vulnerability to climate change is context-specific and differs for each segment of society. Gender, caste and ethnicity also play a role in shaping and defining climate vulnerability (Regmi et al, 2016). In the far-western region of Nepal, the cultural hegemony of the upper castes has limited the access of Dalit castes to credit and the distribution of aid (from both the government and NGOs) (Boyd, 2011).

The livelihoods of marginal farmers are more sensitive as their lands are located in marginal locations which are mostly affected by floods. Weather events and climate erode farming livelihoods as a result of declining crop yields and degrading land. These pieces of land are fragmented into several parts where affording small irrigation systems is very difficult (FIAN, 2013). Due to a reduction in the availability of water for irrigation, there are increased costs of buying chemical fertilizers, pesticides and improved seeds, extraction of ground water for irrigation, use of agricultural equipment as well as the cost of agricultural labour. Also, new diseases and pests in agriculture amid a loss of biodiversity and natural resources is creating livelihood and food crises (Gentle and Maraseni, 2012).

Farm labour is climatically sensitive as well. The increase in extreme events has reduced farmers' working hours and thus reduced agricultural production (Bishokarma and Sharma, 2013). Damages to the rain fed agriculture base of rural Nepal has contributed to an increase in the number of emigrants form agrarian families. Case study in few villages show that poor people are moving to cities or to India as temporary workers while middle class and rich people are migrating to middle income and high income countries respectively (Chapagain and Gentle, 2015).

In response to the impacts of climate change, the government and communities in Nepal have started adopting several coping and adaptation strategies for building adaptive capacity at various levels. The adaptive capacity of households depends on their access to livelihood assets, including finance, safe shelters, and alternative sources of water, and backup health care and food supplies (Gentle and Maraseni, 2012). Financial and social remittances can support off-farm livelihood diversification, which can in turn compensate for income losses in the farm sector due to environmental hazards (GoN, 2010). It was reported that remittances have contributed to building the adaptive capacity of some rural households due to the availability of financial resources to be mobilized during events such as disaster and losses (Gentle and Maraseni, 2012).

Weather events and climate compound the stressors, benefiting some people and enhancing their wellbeing while others experience severe shocks and may slide into chronic poverty. For example, in Nepal's Humla district, gender roles and caste relations influence livelihood trajectories in the face of multiple stressors including shifts in the monsoon season (climatic), limited road linkages (socioeconomic) and high elevation (environmental). Women from low castes have adapted by seeking more day labour employment, whereas men from low castes have ventured into trading on the Nepal-China border, previously an exclusively upper caste livelihood (Olsson et al, 2014).

Local responses to climate variability, shocks and change have always been part of livelihoods (Morton, 2007). Communities have since long practiced autonomous adaptation strategies, such as the diversification of livelihoods, adjustment in the farming system, efficient use of natural resources, storage of food, market responses, saving/credit societies and systems of mutual support (Regmi and Pandit, 2016; Gentle and Maraseni, 2012). These local practices have been found to have positive effects on poverty reduction in certain contexts, or at least prevent further deterioration due to weather events and climate (Regmi and Pandit, 2016).

Furthermore, communities have traditionally practiced voluntary local self-governance through systems such as caste and ethnicity. These traditional local governance systems which are informal and outside government systems are practised for land management, forest management, agriculture management, labour management and socio-economic management among others (Bhattachan, 1997). These systems and networks are effective in helping each other and enhancing social safety nets and responding to environmental issues such as climate change.

However, the adaptive capacity of a majority of the population is low and they are thus vulnerable to climate change impact. Limited access to resources, lack of diversification options for subsistence livelihoods, and lack of health and education are some critical factors limiting the adaptive capacity of communities when it comes to climate change (Regmi et al, 2016). Vulnerability increases when capacities and opportunities to adapt to climate change and adjust to climate change responses are limited. People who are socially, economically, culturally, politically, institutionally or otherwise marginalized in society are especially vulnerable to climate change. This heightened vulnerability is a product of intersecting social processes ('multidimensional vulnerability') that result in inequalities in socioeconomic status and income, as well as in exposure (Maraseni, 2012).

The vulnerability of a given population and its livelihood is also exacerbated by weak institutions and poor governance. The Government of Nepal has made a commitment to climate change adaptation in terms of policy documents, but more action is required in terms of practice (Regmi and Bhandari, 2013). Another challenge of mainstreaming climate change is poor institutional governance within community based institutions which deprive poor and vulnerable households from benefiting from adaptation interventions (Regmi et al, 2016). This entails that future adaptation planning focus strategically on addressing issues of livelihood and governance.

Key Gaps

The country's complex geographical setting makes climate projection difficult. There is absence of consistent climate data and climate change scenarios, and examining climate risk in livelihood sectors with confidence is challenging. The country has inadequate capacity to forecast potential threats of large scale disasters and has little preparedness to respond to and cope with such disastrous events. The observed and projected climate change impacts are not systematically integrated into poverty reduction programmes. The data on poverty is scattered and the country had not adopted a multidimensional poverty index yet.

Nepal's socio-economic and cultural setting and practices make the designing of adaptation options more challenging. Nepal has multi-ethnic, multi-

lingual, multi-religious and multi-cultural social groups, and diverse regional characteristics. The Nepali people have multidimensional livelihood assets and strategies. These multi-dimensionalities also include micro level practices. As Nepal has micro-climatic variations, the impacts of climate change are felt at the micro level. It is very difficult to project climate change scenarios at that micro level and their impacts on the diverse livelihoods of the people.

There is limited information and knowledge on how diversity of livelihoods and vulnerability (incidence, impacts and adaptation) interact with each other. Nepal's NAPA has analysed district wise climate change incidences and vulnerability but it has not included the geographical and social dimensions of livelihoods and climate change vulnerabilities, or adaptation strategies. There is insignificant information on the diverse impacts of climate change on different sections of the society. For example, there is no systematic information about non-land/ non-natural resource based livelihoods. Some information shows that climate change impacts tourism, migration, industry etc. Nevertheless, this information doesn't tell how the impacts unfold in these sectors.

Climate change is impacting livelihoods, but the nexus between climate change and governance is unclear. The country will benefit from strengthening its governance and the management of its public expenditures. Multiple studies have identified the absence of a robust governance framework for climate change. Furthermore, the formal governance structure and institutional bodies should learn from existing traditional structures which are efficient in agricultural and natural resource management, and try to integrate those lessons learnt so that people will have a better sense of belonging as well as ownership, thus contributing to the enhancement of overall adaptive capacity.

In addition, there is a dearth of clarity within national policies and strategies on the governance structure and mechanisms required for mainstreaming climate change within development policies and plans. The climate change policy is silent on possible mobilization of finance, the governance arrangements of financial transfers at local level and the expected scale of financing required. There is also difficulties on track spending on climate change, though the government has initiated a mechanism to track the allocation of funds for climate relevant activities through the climate change budget code.

The existing gaps suggest that a long-term, strategic and transformational approach to livelihood and governance is needed to overcome the challenges posed by climate change in addition to the existing problems of poverty and inequality. In the changing context of state restructuring in Nepal, there are opportunities within the NAP process for designing effective governance mechanisms that can facilitate climate change adaptation and livelihood activities at the local level.

Chapter 8 Public Health (WASH)

Context

Human health is intimately related to climate. Weather and climate have a wide range of health impacts and play a role in the ecology of many infectious diseases (Patz et al, 2000). Health is sensitive to shifts in weather patterns and to other climate-related impacts. Climate change is likely to exacerbate already existing health problems, and bring additional impacts on health and mortality (IPCC, 2014).

Heat waves, floods, storms, fires and droughts already cause death, physical and psychological disease and injury. Scant availability and bad quality of water damage personal hygiene and health. Lack of clean drinking water could increase the frequency and spread of diarrheal diseases, and increasing droughts will exacerbate malnutrition and associated disorders. There is also the possibility of pollen-related allergies (Boyd et al, 2009). Overall, the positive benefits of a warmer temperature are expected to be significantly outweighed by negative impacts, especially in developing countries.

Public health is a development priority for Nepal and, along with access to clean water and sanitation, an essential condition for a prosperous sustainable future, as well as a basic right enshrined in the constitution. Several of the global SDGs set health and WASH-related goals. In particular, SDG 3 sets the goal of reducing preventable deaths to <1% of new-borns and children and to reduce the prevalence of tropical and water borne diseases. SDG 6 prioritizes the quality and sustainability of water resources and sanitation for all. Nepal has made considerable achievements to improve the health status of its citizens. The infant mortality has dropped to 23 percent/1,000 live births. Likewise under five child morality has dropped to 38 (per thousand live births) and underweight child is only 28.8 (GoN, 2016).

While important steps have been taken, climate challenges must be taken fully into account. As recognized by the Climate Change Health Adaptation Strategies and Action Plans of the Ministry of Health (MoH 2015), if climate change continues as projected across the Representative Concentration Pathways scenarios, increases in health risk are expected. Specifically, the major identified risks and impacts are: (1) Greater risk of injury, disease and death due to more intense heat waves, cold waves and fires; (2) Increased risk of under-nutrition resulting from diminished food production in resource poor regions; (3) Consequences on health of lost work capacity and reduced labour productivity in vulnerable populations; (4) Increased risks of food- and water-borne diseases and vector-borne diseases especially in previously considered non-endemic mountain areas; (5) Modest reductions in cold-related mortality and morbidity in the highlands due to fewer cold extremes (6) Increased morbidity and mortality related to cold waves in southern plains (Terai); and (7) Reduced capacity of disease-carrying vectors due to exceeding thermal thresholds especially in the lowland Terai regions.

Climate Change Trend and Disaster

Extreme climate events and climate induced disasters are expected to become more frequent as a result of climate change. There is a strong link between changing climate and disease outbreak. As of the year 2000, South Asian countries (including Bangladesh, Bhutan, India, Maldives and Nepal) have the largest impact of the global burden of diarrhoea, which is expected to exacerbate in future climate scenarios (Ramachandran, 2014). In Nepal, 15% of post-natal deaths (first 59 months) are due to diarrheal diseases (WHO, 2014). Cases of diarrhoea have been decreasing in the country over the past 14 years, with the highest number of diarrheal

incidences occurring in the mountains, followed by the hills and the plains of the Terai. Diarrheal incidences are predicted to rise in the future, owing to the development of more suitable conditions for the spread of the disease.

Despite a two decadal decrease in Malaria cases, over the last seven years, malarial incidences have been spreading to newer locations at higher altitudes (Badu, 2013). In Jhapa district (southeastern Nepal), malaria cases have increased with minimum increase in temperature despite a considerable decrease in total rainfall and a linear trend in relative humidity in the morning (Bhandari et al, 2013). Other studies also detail malarial cases with altitudinal shifts, and malaria vector was found at 1,820 metres above mean sea level (AMSL), with higher densities in the post-monsoon season (Dhimal 2014). The spread of malaria to higher altitudes and new geographic areas poses new challenges to achieving Nepal's vision to eradicate Malaria by 2026.

Climate change is expected to trigger an increase in cases of dengue fever. The spatio-temporal distribution of dengue and lymphatic filariasis vectors along an altitudinal transect in central Nepal shows that dengue virus vectors have already established a stable population up to the middle mountains of Nepal (Dhimal et al, 2014). In 2015, there was a case of a dengue infection where a tourist came in contact with the virus in a mountainous area (Gupta et al, 2016).

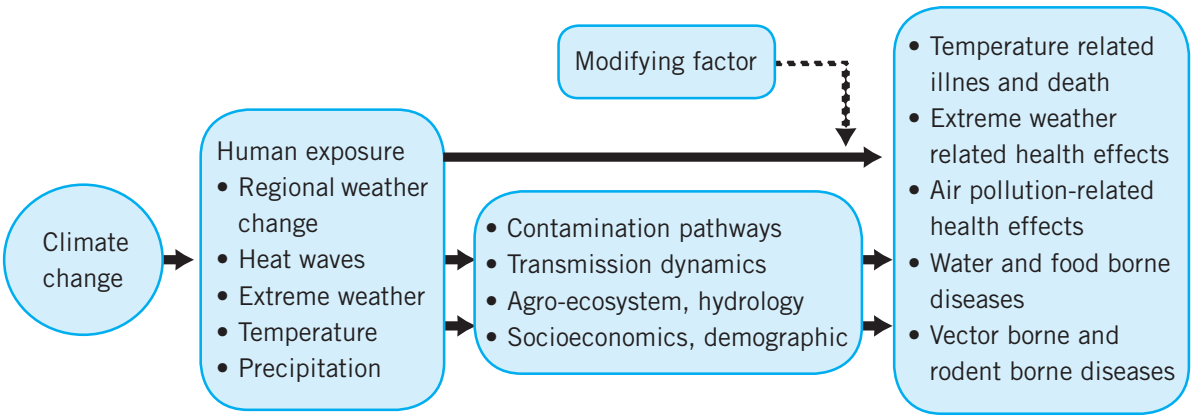
Exposure to the Adverse Impacts of Climate Change

Nepal is classified as one of the hotspots for geophysical and climatic hazards. By global standards, in the two decades from 1988 to 2007, Nepal was in the 23rd position in terms of loss of lives due to natural hazards (MoHA, 2009). There is an increasing trend of health-related hazards in Nepal due to the impacts of climate induced disasters.

Due to massive flooding and landslides, many people in rural and urban areas have lost their houses and land. Data reveals that more than 80% of property loss is attributable to climate-related disasters. In the decade spanning 2000 and 2010 more than 4,000 people died due to climate induced disasters, causing an economic loss of USD 5.34 billion (MoHA and DPNet, 2010). Besides economic losses, the health impact is significant, including physiological stress and mental illnesses caused by shocks and losses (Regmi 2015).

The documented spread of vector borne diseases in new areas located at higher altitudes poses serious additional threats to mountain people and their livelihoods (including tourism). Extreme temperature events increase cases of vector borne diseases (eg, malaria, dengue, black fever "Kalazar") resulting in increased morbidity and mortality rates. Heat waves lead to sudden increase in morbidity and mortality

Figure 1: The Overall Relation Between a Changing Climate and Public health



Source: Based on Patz et al, 2000

rates, and pose specific threats to vulnerable populations in urban areas, in particular to older people, children and those who are suffering from pre-existing health conditions. There are also cases of extreme cold air-borne diseases (Pradhan, 2009). The impacts on water supplies due to extreme events are further aggravating the situation of sanitation and hygiene services.

Climate Change Vulnerability

In Nepal, over 80% of all illness is attributed to inadequate access to clean water supply, poor sanitation and poor hygiene practices. Diarrheal diseases account for a morbidity rate of 3.35%, which is second only to morbidity caused by skin diseases (5.51%), another category of illness associated with dirty water, and poor hygiene and sanitation (NCVST, 2009). Children under five are sensitive to extreme events such as water source contamination during disaster events as it is contamination that causes diarrheal morbidity and mortality. The uneven distribution of health posts and services across regions and the rural/urban divide have increased the sensitivity of certain parts of the population to climate change impacts.

There are attempts to address the issues of climate change in the health and public WASH sectors. The Nepal Health Sector Strategy (NHSS 2015-2020) has considered climate induced concerns in its programmes by integrating and coordinating with relevant sector agencies. The document recognises climate change-related major public health and WASH concerns and provides some practical steps, such as:

- Prevent and control occurrence of vector borne diseases (eg, malaria) spread due to increased temperature at higher altitudes.
- Prevent and control occurrence of water-borne diseases (eg, diarrhoea) spread due to degradation of water sources and supply systems, and lack of proper sanitation and hygiene facilities and behaviours.
- Communicate and collaborate with wider sector stakeholders for synergy towards effective planning and implementation of adaptation.

Substantial improvement has occurred in terms of access to clean drinking water over the past three decades, and 92% of the nation's population had access to clean drinking water in 2015[2]. However, aggregated statistics do not count for differentiated access determined by political and socio-economic factors, such as gender, ethnicity, class etc, as well as by spatial differences. There is a substantial disparity in water supply coverage among the five development regions: the western development region has the highest coverage at 84.6% and the mid-western development region has the lowest at 76.3% (DWSS, 2011). Moreover, the data does not consider the time taken to collect water, a responsibility that usually falls on women's shoulders, and a factor which may serve as a disincentive to using clean water sources (NCVST, 2009). National coverage of sanitation is just 43%. There is also spatial disparity in sanitation coverage: the western development region has the highest at 53.5% and the far-western development region has the lowest at 29.1% (DWSS, 2011).

In the context of climate change, the degradation of catchment areas by drought and the depletion of water sources lead to long-term impacts on WASH systems and overall services and ecosystem health. Scarcity of water for drinking, proper sanitation and hygiene subsequently lead to water- and food-borne diseases.

An increase in the frequency and magnitude of climate induced events like floods and landslides causes loss of human life, damage to WASH infrastructure and human settlements and agricultural land, hardship, and an increased number of morbidity cases. In the context of environmental displacement and post-disaster scenarios, people displaced by extreme events (floods, landslides and drought) face health

[2] Access to an improved water source refers to the percentage of the population using an improved drinking water source. The improved drinking water source includes piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection).

challenges due to unsafe WASH infrastructure and the lack of health services.

Key Gaps

It is clear that health and climate change are intimately connected, and better integration of adaptation into development must factor in WASH and public health considerations. More context-specific research on climate induced vectors is needed, and continuous research on climate change and health must be promoted. This requires a coordinated cross-sectoral effort. Coordination among stakeholders and the integration of climate change concerns into broader health-related development plans and activities (eg, agriculture and water sectors) are paramount.

Disaster risk reduction is also key for reducing the adverse health impacts of climate induced hazards, and the consideration of gender and social inclusion must be an integral part of it. Improved access to water and sanitation for everybody is key to building climate resilience, and particular attention must be given to the most marginalised sectors of society through programmes that implement and improve basic public health measures, secure essential health care including vaccination and child health services, and alleviate poverty. Technological improvement is also key: wastewater treatment for reuse, various rain/fog water harvesting techniques, among other things, can greatly improve the situation.

Database generation and reporting are an essential part of the process, including monitoring. This also relates to the need for enhancing the capacity of the rapid response team (RRT) where disease surveillance, monitoring, response systems, and risk communication methods for reducing the burden of climate sensitive health outcomes are concerned. In terms of monitoring and prevention, it is essential that data be collected and water supply sources be monitored, along with people's behaviour and practices.

Capacity building needs to be strengthened as well. This should lead to increased capacity for disaster preparedness and response. The provision of safe water—collection, treatment and supply, safe on-site sanitation technologies, sustainable waste management (SWM) etc—is an important component. So is better training for health workers on emergency rapid response in preparation for extreme events and climate induced hazards.

The most effective adaptation measure to reduce vulnerability in the near term are programmes that 1) implement and improve basic public health measures such as provision of clean water and sanitation, 2) integrate various tools and techniques for making water safe from the planning phase to the implementation phase, 3) secure essential health care including vaccination and child health services, and 4) increase capacity for disaster preparedness and response, and alleviate poverty.

Chapter 9

Tourism, Natural and Cultural Heritage (TNCH)

Context

The ascent of Mount Everest in 1953 heralded the beginning of the tourism sector in Nepal although visitors of all kinds, including nature explorers (Hooker, 1854), mountaineers (Freshfield, 1903; Smythe, 1930; Herzog, 1952), Buddhist monks (Kawaguchi, 1909) and pilgrims, journeyed through the country prior to this date. In 2016, 0.73 million tourists arrived in Nepal (The Himalayan Times, 2017), most of whom visited Kathmandu, Pokhara, Lumbini, Chitwan and Everest, which together host Nepal's four UNESCO World Heritage Sites (WHS) – i) WHs within Kathmandu Valley, ii) Lumbini, the birthplace of Buddha, iii) Chitwan National Park, and iv) Sagarmatha National Park. Tourism activities in Nepal are highly varied today and include mountain climbing, trekking, bird watching, mountain flights, rock climbing, rafting/kayaking/canoeing, cannoning, hot air balloon rides, bungee jumping, paragliding, mountain biking, jungle safaris, pilgrimage destinations, and cultural and business activities.

The number of tourists arriving in Nepal has been steadily increasing since the 1970s despite being affected in some years by political incidents or natural disasters (Shrestha and Shrestha, 2012). This is a positive trend, and the tourism industry at present directly supports almost half a million jobs (3.5% of total employment) and, as of 2014, directly contributes to 4.3% of total GDP (WTTC, 2015). Tourism forecasts based on positive tourism growth indicate that the industry's contribution to employment will increase to 4% in 2015, and by 2025 it will rise by 3% per annum to provide 681,000 jobs (3.9% of total employment) (WTTC, 2015).

One of the major factors that determines the nature and quality of a tourist destination is its climate (Becken, 2010; Pokharel et al, 2017). Nepal's climatic conditions generally determine the tourist season in the country. Nearly 60% of all tourists arrive during two main seasons—spring (February to April) and autumn (September to November)—which correspond to the months between the summer and winter monsoons (Nyaupane and Chhetri, 2009; Sharma, 2012). Indian tourists, however, generally arrive in the months between April and July (Sharma, 2012).

Climate Change Trend and Disaster

Climatic characteristics that impact tourism in Nepal include temperature, precipitation (rain and snow), clouds, fog, wind and humidity. The increasing temperature trend, especially at higher altitudes which are experiencing warmer winters, has resulted in lower snowfall in these areas (Dahal, 2007). This impacts both mountaineering activities, as well as the aesthetic quality of tourism destinations (Bhandari, 2014). Clouds and fog can severely reduce visibility. This has repercussions on the aviation sector, which is an important part of Nepal's tourism industry, as many rural airports are not equipped with radar technology and require clear visibility to operate (Nyaupane and Chhetri, 2009). Low visibility also means that tourists are unable to view the landscape and its attractions thereby decreasing the quality of their tourism experience (Nyaupane and Chhetri, 2009).

Climate induced disasters, especially as a result of extreme weather events, impact tourism both directly and indirectly (Lama, 2010). Landslides and floods brought on by heavy rainfall restrict access to and

from tourism destinations by destroying or blocking roads, trails, bridges and airports. They also destroy other tourism infrastructure such as buildings, archaeological structures, communication towers and weather stations. In 2016, the Jure and Jalbire landslides occurred as the result of heavy rains and obstructed traffic to Kodari (The Kathmandu Post, 2016), which is the gateway to the Tibet Autonomous Region of China, especially for tourists visiting Mount Kailash or Lhasa. Snowstorms and avalanches, especially in high altitude destinations, obstruct trails and passes, destroy tourism infrastructure including campsites and buildings, and even cause human injury and death. Between 1995 and 2014, avalanches have claimed the lives of at least 273 people from various parts of Nepal (MoHA, 2015).

Glaciers are generally shrinking in the central and eastern Himalaya, although trends for the western Himalaya are uncertain (IDS-Nepal; PAC and GCAP, 2014). Associated with glacier melt is the increased probability of GLOF events, especially in northeastern Nepal (Nepal, 2011; Bhandari, 2014; Markham et al, 2016). GLOFs threaten tourism infrastructure and human lives. For example, the Dig Tsho GLOF event of 1985 caused damage equivalent to more than USD 3,000,000 by destroying an almost completed hydropower station, damaged other infrastructure (including tourism infrastructure) along tens of kilometres downstream, and claimed the lives of five people (ICIMOD, 2011).

Exposure to the Adverse Impacts of Climate Change

Several elements are at risk of exposure to climate change induced hazards within the tourism sector. Tourism infrastructure are at risk especially when situated at high altitudes, near or across rivers and floodplains, and in the proximity of hazards such as landslides, debris flows, floods and GLOFs. Such infrastructure include campsites—particularly base camps for mountaineering expeditions; buildings providing lodgings for tourists—hotels, lodges, resorts and homestays; roads and trails, including mountain climbing routes and high passes; bridges; airports and helipads; communications towers; and meteorological (weather and hydrological) stations.

Archaeological and religious structures, which are tangible artefacts of Nepal's cultural heritage, are also at risk of exposure. Many historical buildings in the Kathmandu Valley are constructed using wood which, when exposed to high levels of humidity, are at risk of decay and pest infestation. In historically dry areas, such as the trans-Himalayan region of Mustang, traditional mud-and-stone artefacts are at risk of leaking and erosion when exposed to high rainfall (Nyaupane and Chhetri, 2009; Lama, 2010).

Nature-based tourism is especially exposed to climate change. Protected areas, rivers, lakes and wetlands, and mountains are integral parts of Nepal's natural heritage. Their exposure to climate change induced hazards results in a negative impact on tourism. Fires, floods and landslides associated with climate change can directly result in wildlife death, or indirectly cause their demise through habitat destruction or alteration. This would then impact nature based tourism, for example in Chitwan National Park where rhinos (and if lucky tiger) sightings attract thousands of tourists every year. Heavy rainfall in central Nepal in 1993 resulted in flooding of rivers in the Terai which killed Chitwan's wildlife and destroyed their habitats, while also damaging tourism infrastructure especially as resorts, roads and bridges were submerged for several days (Nyaupane and Chhetri 2009).

With more than a million people engaged both directly and indirectly in the tourism sector (representing 7.5% of total employment in the country) (WTTC, 2015), more than 3% of the country's population is at risk of exposure to climate change hazards. Especially vulnerable are those who are entirely dependent on tourism as their only livelihood option. Moreover, with the increasing involvement of women in the tourism sector, there is also a higher risk of their exposure to climate change.

Climate Change Vulnerability

Nepal's tourism resources and activities are highly vulnerable to climate change. The bio-geographical location of tourism destinations in the country predisposes them to a number of risks and hazards. Many tourism destinations are situated in Nepal's high

mountains which are highly sensitive to temperature rise (GoN, 2010). Four protected areas—Chitwan National Park, Annapurna Conservation Area, Sagarmatha National Park and Langtang National Park—which host almost 40% of total visitors to the country (Sharma, 2012) are categorized as high or very high in the ecological sensitivity index for climate change vulnerability (GoN, 2010).

Although the tourism sector provides almost half a million jobs in Nepal (WTTC, 2015), the exact proportion of the population which is solely dependent on tourism in the absence of other livelihood opportunities is unknown. Such a population would be highly sensitive to the impacts of climate change on the sector. The seasonal nature of tourism in Nepal is also another factor that increases its sensitivity to climate change. Since foreign tourists continue to be a major source of income that contributes to the national GDP, their travel plans can be affected by any changes in the tourism season (Cabrini, 2010).

The adaptive capacity of the tourism sector is dependent on factors that include socio-economy, policy, capacity and institutions. Both public income—through entry permit fees, trekking and mountaineering permit fees, and tax revenues—and private income generated from tourism can be invested in programmes that enhance adaptive capacity. Currently, numerous government policies and strategies that support tourism directly or indirectly are in place, such as those related to climate change, culture, forests, wetlands and disaster risk management. However, most of them do not address adaptive capacity in the context of tourism. There are also several climate change focused programmes being implemented or in the pipeline in Nepal. Although none of these are tourism-centric, a number of them have implications for the TNCH sector, for example those addressing GLOFs, ecosystem management and disaster risk reduction. However, major tourism related projects under implementation in the country, including the Asian Development Bank's (ADB) project in Bhairawa and Lumbini, the GoN's tourism infrastructure development project, the Samarth-implemented project marketing the Great Himalayan Trail (GHT), and the Nepal Tourism Board's (NTB) support to formulate tourism plans in 10 districts, all lack climate change adaptation programmes.

Skilled human resources in the tourism sector is also a necessity for building adaptive capacity to climate change. Although concrete numbers are unavailable, at least 26,000 Nepalese have been trained in this sector by Nepal's premier institution for capacity building on tourism since 1972, the Nepal Academy of Tourism and Hotel Management (NATHM), and many more through other similar institutions in the country. However, human resources are also required for other tourism-relevant spheres such as rescue, communication and weather forecasting, among others, to enhance adaptive capacity to climate change. Tourism-based institutions play an important role in building climate change adaptive capacity (Lama, 2016) but their numbers and effectiveness in the national context are not known.

Key Gaps

Key gaps in the policy, institution, capacity and knowledge context exist for addressing climate change in the TNCH thematic sector. Nepal's Tourism Policy BS 2065 (2008/2009) and National Culture Policy BS 2068 (2011/2012) do not address climate change. The National Tourism Strategy Plan 2015 mentions climate change, but adaptation mechanisms are not clearly presented in the Strategy. On the other hand, policies from other sectors but relevant to tourism, including the Climate Change Policy BS 2067 (2010/2011), the Forest Policy BS 2071 (2014/2015) and the National Wetlands Policy (2012) among others, do not directly address tourism and adaptation planning for this sector. Nepal's NAPA document (GoN, 2010a) also lacked basic information on tourism vulnerabilities and opportunities for effective adaptation planning (Lama 2016); however, this has been rectified as TNCH is a key thematic sector for the NAP process.

There are several tourism-related institutions that range from the policy level (MoCTCA) to local levels (civil society organizations), and public-private partnerships (eg, Nepal Tourism Board). However, the capacities of these institutions to address climate

change issues are not clearly developed. For instance, a climate change focal person was appointed at MoCTCA, but adaptation planning and programme implementation is inadequate.

Capacity is one of the major gaps that needs to be addressed in the TNCH sector. As mentioned above, the capacity of existing institutions to address climate change issues is currently weak. As a result, the TNCH sector is unable to mobilize adequate funds through on-going projects relevant to tourism to build climate change adaptive capacity. Homestays, which are an important and growing segment of Nepal's tourism, provides an opportunity to link cultural diversity and tourism. Capacity building in this sector could contribute to building adaptive capacity through livelihood diversification in rural communities.

The knowledge gap on climate change issues in Nepal's tourism sector is substantial. While tourism itself is an adequately researched and documented subject, its vulnerabilities and the impacts of climate change on it are only recently being studied (ie since the 2000s). As a result, there is insufficient evidence-based knowledge, especially at the national level, to contribute to policy development or programme planning. Moreover, UNESCO's recommendation on the Historic Urban Landscape (UNESCO, 2015) prioritizes assessing the vulnerability of historic urban attributes to the impacts of climate change. Knowledge on the role of domestic tourism in the socio-economic sector is also lacking. Tourism data is generally collected for foreign tourists arriving in Nepal (Shrestha and Shrestha, 2012), but domestic tourism is steadily growing (Kocheri, 2015) as a result of the improving economy, changing norms and better access to many tourism—especially pilgrimage—destinations.

Women's active participation in the tourism sector has been increasing since the past few decades, but their number, challenges and vulnerabilities have not been adequately studied till date. Such women are generally challenged by existing social norms and as a result face harassment from male co-workers (KC, 2012), in addition to experiencing gender biases in their wages and workloads. Understanding these issues would be an important step towards increasing the adaptive capacity of women, who potentially contribute up to 50% of the work force in the tourism sector.

Inter-sectoral linkages with the TNCH sector are also very critical to addressing vulnerabilities to climate change and to building adaptive capacity in this sector. As Nepal's tourism sector builds on the country's natural heritage, urban and rural cultural heritage and infrastructure, and agricultural inputs, integrating them with the TNCH sector is key to mainstreaming adaptation into the sector in order to achieve the country's development goal.

Chapter 10

Urban Settlements and Infrastructure

Context

Nepal's population has grown rapidly from 12 million to 26.5 million during the last three decades between 1991 and 2011 (CBS, 2011). In Nepal, the level of urbanization is officially defined in terms of municipal[3] population. The number of municipalities has increased by over three times in the last six years from 58 in 2011 to 217 in 2015 (MoFALD, 2017). Recently government has restructured the local bodies and based on this there are 4 metropolitan, 13 sub-metropolitan, 248 metropolis and 479 village council[4] . Many municipalities are, in fact, occupying or expanding new urban settlements in rural areas; nevertheless these are often places where regional in-migration is high, and they are likely to grow into towns and cities in coming years.

This demographic change has induced rural-to-urban migration and subsequent urban growth. In Nepal, about 42% of the total population now live in urban areas (municipalities). Urban population grew by 3.38% annually during the 2001-2011 period. However, urban growth in Nepal is haphazard, which is characterized by inadequate urban infrastructure and services and improper management of urban resources. This has led to the spread of settlements in unsafe and fragile areas that are vulnerable to climate change induced disasters such as floods and landslides. Changing climatic patterns are posing threats to urban livelihoods in the form of more frequent droughts, drying springs and a decrease in the ground water table during the dry seasons. Projections of Nepal's population growth indicate an increase in population to 40 million by 2030 and 46 million by 2050 (UN HABITAT, 2012) which also have implications on urban sector management. This calls for prioritizing our understanding of this sector on urban settlements and infrastructure, and developing effective adaptation plans to address climate change related vulnerabilities.

Primary characteristics of Nepal's urban growth:

- Increased number of municipalities
- Expansion of urban areas
- Relatively steady population increase during initial years of municipality designation
- Rapid increase in population in recent years

Source: Subedi, 2014

Climate Change Trend and Disaster

Increasing temperature and erratic rainfall pattern are directly posing threats to water resources eg, springs, glacier-fed rivers etc. Excess rainfall causes flash floods and/or landslides, flooding rivers and urban floods, which largely impact urban settlements in their proximity and result in loss of human capital as well as infrastructure. In the mid-hills, the drying up of water springs has been reported making water scarcity even more pronounced, particularly in dry seasons (ICIMOD, 2015). For example, people in urban centres in the Terai are experiencing a decrease in river discharge and a decline in ground water table during the dry seasons (Acharya, 2010).

Poor urban planning and inadequate provision of infrastructure (eg, drainage system) have made floods a major problem in urban areas during the monsoon

[3] Municipalities are designated urban areas (cities and towns) meeting minimum criteria related to population, infrastructure and revenues.
[4] This figure is as of 4th May, 2017

Climate change impacts on urban settlements and infrastructure are cross-thematic in nature:

- Increased total rainfall leading to increased riverine floods and increase in average water level in rivers
- Increased intensity of rainfall leading to increased flash floods and debris flows
- Increased ice melt and increased rainfall leading to increase in the likelihood of GLOFs
- Increased total rainfall and intensity of rainfall leading to increased landslides

and heavy rainfall events. The quality and quantity of infrastructure and public services available in the cities or towns are not only inadequate but also not uniformly available. The design guidelines in urban sector are based on climate trends and as such, do not adequately address climate change concerns. Urban floods, dispersion of pollutants to water bodies, and outbreaks of water and vector borne diseases are increasingly being experienced in the cities. Damage to roads and drainage structures is also posing a huge economic loss as transport services and overall daily lives are disrupted.

Another concern regarding climate change in urban areas is the further worsening of urban heat island effects due to increased temperature. Because urban areas are mostly covered by built areas such as concrete and asphalt, both the atmosphere and the surface in cities are warmer than they are in rural areas. Increased temperature leads to health concerns, and puts pressure on energy use for cooling purposes. Unusual weather patterns and rise in climate related extreme events are putting urban settlements and infrastructure at increased risk (Dixit et al, 2007). Many settlements in Nepal are built on risk-prone areas such as on steep slopes prone to landslides and riverbanks prone to floods. In particular, informal/illegal settlements have grown rapidly in cities across Nepal and most of these settlements are built along riverbanks (Acharya, 2010).

Exposure to the Adverse Impacts of Climate Change

More than one-third of the country's population now live in urban areas. Nepal's urban population increase by 1.8% (from 37 to 38.8%) in between 2011 and 2016 (MoUD, 2016, p 22). There is thus increasing pressure on the government to provide adequate facilities to a growing urban population. Rapid and haphazard urbanization in Nepal has largely exposed the urban population to impacts of climate change.

About 44% of households in the urban settlements of Nepal live in houses with foundations made of mud-bonded bricks compared to about 10% of households living in houses with reinforced cement concrete (RCC) foundations (CBS, 2011). The quality and quantity of infrastructure and public services available in the cities or towns is not only inadequate but also not uniformly distributed, which exposes these settlements to a high degree to climate induced disasters. About 42% of households live in houses with outer walls made of bricks and stones in mud mortar. In terms of roof type, about 22.5% of households live in houses with RCC roofs whereas 19% still live in houses with thatched or straw roofs.

About 58% of the country's urban households now have access to tap or piped water supply. The dependency on tube well or hand pumps is also high at 35%. Firewood is still the major source of fuel for cooking in the country as 64% of households depend on it. In urban areas, about 68% of households use liquefied petroleum gas (LPG) for cooking compared to about 21% in rural areas. The road network is increasing by 1,000 km/year starting from 2006-07 when it was 9,399 km, which reached to 12,493 km by 2013-14 (CBS, 2011).

Climate Change Vulnerability

While considering future vulnerability to climate change and adaptation responses, a critical step is to consider how socio-economic development might change the country over future decades. This is important because these socio-economic changes such as population growth, the size of

In the 14th Plan (NPC 2016) the NPC has adopted five strategies that reflect development priorities:

- Transformation of the agriculture sector, and expansion of tourism, industrial, and small and medium enterprises
- Building infrastructure for the development of energy, transport, information and communication, rural-urban linkage, and trilateral linkage with neighbouring countries
- Marked improvement in human development through social development, security and protection,
- Promotion of good governance
- Gender equality, social inclusion, environmental protection, and maximum utilization of science and technology

The urban sector priority is to build organized cities with adequate infrastructure and services

role as well. The lack of effective land use and settlement regulations has contributed to increased vulnerability to floods and other hazards caused by both natural and anthropogenic factors. During the monsoon, rivers swell and cause damage to floodplain habitats. In the last five decades, the Terai has witnessed tremendous growth and development, but infrastructure growth, roads and urbanization have also constrained rainwater drainage in the region causing frequent floods (Dixit et al, 2007).

To address the growing challenges in towns and municipalities, the urban water supply and sanitation policy (2009) provides directions and strategies for effective programming and implementation through integrated urban water supply and sanitation sector projects. The Habitat III National Report 2016, and the National Urban Development Strategy 2017 have included policy actions to address climate change in urban sector.

The government of Nepal has also introduced the Bagmati Action Plan and Solid Waste Management Act (2012). More recently, the government launched the Clean City Programme which covers five components—waste management, water and wastewater management, greenery promotion, pollution control and city beautification.

Despite a few initiatives from the government, the overall adaptive capacity of the urban sector to deal with climate change is low. Urban ministry and municipalities do not have the capacity or the mandate for long-term strategic planning. Future urbanization is expected to magnify the risk of adverse climate change impact. People and assets in cities and towns will suffer from more rapid-onset disasters and the slow-onset effects of climate change. Certain population groups—often the poorest, particularly those living in informal settlements without secure tenure and livelihoods—have the lowest capacity to adapt and will be more vulnerable to the impacts of climate change.

Key Gaps

High risk and vulnerability in urban areas suggest that there is a need to address the challenge of integrating long-term climate change effects into decisions for infrastructure, services and land use. There are opportunities to steer the process towards achieving urban resilience. For this reason, Nepal must engage early in the impending urbanisation process to create resilient, sustainable and low-carbon towns and cities, regardless of size, and work in the long-term through realistic means. If urban planning and development approaches integrate concepts of participation, resilience and the adoption of low-carbon technologies, the country can develop more inclusive, sustainable and resilient towns and cities.

The urban settlements and infrastructure theme faces gaps in following three areas: i) Information, ii) Policy and iii) Capacity.

Information gaps refer to the absence of quality, consistency and sufficiency of knowledge input (eg, data), analysis and outputs (results). Different studies focusing on understanding the impacts of climate change do not always follow scientifically robust methods, climate datasets, and upscaling mechanisms. This makes these studies unsuitable for further use as secondary sources. Inadequate

understanding of climate change impacts and potential adaptation measures makes it difficult to adapt to climate change. In Nepal, the research environment in general is weak. Most of the studies on climate change adaptation are case studies based on perceptions, which mostly mimic similar past studies.

The National Urban Policy, 2007 is silent on climate change although it was prepared more than a decade and after the ratification of the UNFCCC, May 1994. However, the Government of Nepal has already prepared, endorsed or amended policies to guide or support climate change initiatives such as the NAPA, LAPA and Climate Change Policy, 2011, among others. Policies related to WASH such as the National Urban Water Supply and Sanitation Sector Policy (2009) and the National Hygiene and Sanitation Master Plan (2011) exist. However, their implementation on the ground is not efficient.

The urban settlement and infrastructure sector itself is multi-sectoral with at least four ministries (MoUD, MoPIT, MoFALD, and MoWSS) directly involved. Additionally, addressing climate change concerns in urban and infrastructure planning demands additional stakeholders to be engaged. Although the Multistakeholder Climate Change Initiative Coordination Committee (MCCICC) has been formed to ensure institutional coordination, it has yet to meet expectations. In other words, there is a gap between expectation and performance.

Capacity gaps refer to the inadequate human resources and logistical arrangements, along with the deficiency in relevant knowledge. One of the goals of the Sendai Framework for Disaster Risk Reduction is to "substantially reduce disaster damage to critical infrastructure and the disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030", however one of the challenges in Nepal is to build capacity to achieve this goal.

Most municipalities in Nepal lack both human and non-human resources at local levels to address climate change concerns. In addition, the basic minimum understanding and use of various terminologies by different stakeholders differs to a wide degree, which could be addressed by developing a national level guideline on the definition and usage of basic climate change related terminologies.

In addition, addressing climate change concerns requires knowledge creation and building such as the study of climate change trends and projections. Besides technical human resources, government agencies also lack modern equipment and access to the latest technologies required for climate change studies (such as climate change projections) or adaptation measures (such as early warning systems).

Chapter 11

Water Resources and Energy

Context

The water resources and energy sectors are important national assets because of their contribution to national GDP. The hydropower sector can contribute to a large extent if its full potential is realized. At present, the country's installed hydropower capacity is only 887 megawatt (MW), which is about 1.7% of the country's hydropower potential. The hydropower sector contributes to nearly 1.09% of the national GDP. However, electricity dependent sectors such as industry, construction, service and agriculture provide a substantial contribution to GDP. Similarly, Nepal is also aiming to utilize other alternative sources of energy such as solar and wind.

Climatic change such as variability in temperature, precipitation and extreme weather events can affect the quantity, quality and timing of water availability. This can affect a wide range of water use sectors such as irrigation, drinking and other domestic uses, and hydropower, industry and recreational uses (IPCC, 2013). Most perennial rivers originate in the high Himalaya, and glaciers and snowpack contribute to these rivers. Similarly, in the middle hills, water from groundwater sources such as springs (and collections of springs) and ponds are widely used. The impact of temperature and precipitation changes has been visible in the form of shrinking glaciers over the past few decades (Bajracharya et al, 2014), changes in snow cover, and increase in frequency of water related hazards (Richardson and Reynolds, 2000; O'Brien, et al, 2006). These changes might also affect overall water availability and hydrological regime of river systems, which can severely affect energy production and water dependent livelihoods (such as agricultural production).

Water related infrastructure and facilities are at risk due to extreme precipitation events, floods, GLOFs, landslides and sedimentation. On the other hand, electricity demands increase by approximately by 7% each year (NEA, 2015), mainly for rural electrification, industrial and domestic uses. According to the Nepal Electricity Authority (NEA) (2015), the load forecast in 2033/2034 would be about 4.5 times higher than the present energy demand which is about 5,989 gigawatt hours (GWh) in 2013/2014. Climate change impact in conjunction with other environmental changes can disrupt the energy cycle in multiple way such as demand (more energy for cooling and heating), generation, supply and use (WECS, 2014). Because of the dependency on water resources, the ripple effect of climate change on water sources will affect the entire country. Similarly, climate change can affect energy dependent on biomass (fuelwood and agriculture residue), alternative energy sources such as solar and wind.

Climate Change Trend and Disaster

Temperature has been increasing at a higher rate in Nepal in the past few decades. The maximum temperature in Nepal increased at a rate of 0.06°C/year between 1978 and 1994, with higher rates at stations located at higher altitudes, and warming in winter is more pronounced compared to lower regions (Shrestha et al, 1999). Similarly, a decreasing trend in cool days and cold nights and an increasing trend in warm nights has been observed (Baidya et al, 2008). Regarding the precipitation pattern, there is a lack of any clear trend. There were no distinct trends in precipitation in the Nepal Himalaya between 1959 and 1994 (Shrestha et al, 2000).

Climate scenarios data based on GCMs and RCMs also suggest a continuous warming trend by the end of the century for the whole Himalayan region (Lutz et al, 2014) including Nepal (Rajbhandari et al, 2016; NCVST, 2009; Nepal, 2016). Although a change in precipitation is highly variable among different climate models, most of the models indicate an increase in precipitation towards the end of the century.

These changes in precipitation and temperature pattern, including extreme weather events (such as floods and droughts), affect water availability and timing, and cause water related disasters. Because of the monsoon dominated rainfall in Nepal, floods, flash floods and landslides are very common in hilly areas during the monsoon. These water related hazards will increase (eg, frequency, magnitude) in the context of global climate change. Different forms of drought (such as agriculture, meteorological droughts) have direct impact on various sectors. Impact of climate variability on electricity production indicates that economic costs could be equivalent to 0.1% of GDP per year on average, and 0.3% in very dry years (IDS et al, 2014).

Soil erosion and sedimentation are very common during the monsoon and affect irrigation canals, dams and hydropower plant reservoirs (both storage and run-of-the-river). Excessive sedimentation shortens the life span of reservoirs and decreases the efficiency of the power plant. Rising temperatures can cause glaciers to shrink and enhance glacier melt. There is also more rainfall than snow due to high temperature in high altitude areas. It is likely that due to climate change, runoff from glaciated areas will increase in the short term, but in the long run it is expected to decrease when glacier storage diminishes (Bates et al, 2008; Erriksson, 2009).

Beside, glacial lakes are formed behind moraine dams on loose and unconsolidated material. These unstable lakes pose threats to downstream communities and infrastructure in the event of GLOFs. For example, a 1985 GLOF in the Dudh Koshi River Basin damaged the nearly completed Namche Small Hydroelectric Project and caused other damage further downstream (ICIMOD, 2011). Similarly, in recent years, landslides and landslides blocking rivers and causing Landslide Dam Outburst Flood (LDOF) have become common, such as the Sunkoshi landslide dam in 2014. Landslides attributable to intense rainfall, land degradation and development activities are disturbing springs in the middle hills. As most local communities are dependent on springs for water for drinking and domestic use, drying springs and springs discharging less water have a direct impact on local lives and livelihoods.

Exposure to the Adverse Impacts of Climate Change

Climate change poses both physical as well as resource vulnerabilities on the water and energy sector. The effects of changes in precipitation and temperature are expected to change the water balance, runoff and timing of water availability. Change in flow regimes can impact downstream ecosystem and communities significantly. On the other hand, slow onset disasters such as droughts and gradual changes in temperature can affect agriculture production.

Climate change adds uncertainties to water availability. It brings changes in snow and glacier melt pattern, rainfall variability, extreme weather events, stream flow and droughts. River systems fed by glaciers and snowpack are directly exposed to such impacts. Water availability in a river is directly linked to hydropower production. Besides, underground water storage and dependent spring sources are also exposed which is where most people in middle hills get their water. These changes may adversely impact the availability, quality, quantity and timing of water, affecting subsistence livelihood, commercial and recreational use, and the hydropower generation and energy supply chain.

Water related infrastructure are exposed to climate induced disasters such as landslides, floods, GLOFs and flash floods. There are several events where GLOFs have damaged hydropower infrastructure and human settlements in Nepal (Khanal et al, 2015). ICIMOD (2011) has identified 21 potentially

dangerous glacial lakes in Nepal. Water resources and energy infrastructure located directly below glacial lakes are highly exposed to GLOFs.

Excessive sedimentation along with landslides during the monsoon can damage irrigation canals (eg, intake canals with sediment cause the river to flow away from the intake), hydropower dams and turbines, and also decrease the life span of reservoirs. Most hydropower systems and barrages in Nepal are exposed to sedimentation. For example, the July 1993 flood brought down a massive amount of sand and gravel from the Bagmati irrigation barrage and deposited the debris in the middle of the river. The same flood also filled almost half of the dead storage zone with sediment at the Kulekhani Hydroelectric Project site. Besides, degraded watershed conditions may further expose rivers to higher sedimentation.

In the case of micro hydropower plants, extreme weather events such as flash floods, landslides and discharge variability pose challenges to existing systems. Declining efficiency and damage to the system impact access to basic electricity at the household and community levels. When floods damage an existing hydropower system they halt power production for the short- or long-term depending on the magnitude of the impact. This can have a direct impact on livelihood related activities and an indirect impact on household economy in the form of investment in unsustainable sources of energy like kerosene, petrol and diesel. On the other hand, for industries such interruptions can directly affect overall production. In the case of droughts and reduced water availability in rivers, rivulets and springs, people may need to spend more time to collect water for drinking. Women, especially, need to spend a considerable amount of time collecting drinking water, so they are certain to be directly affected.

Communities relying on traditional biomass for energy supply are exposed to climate change impact. Almost 79% of the population relies on traditional biomass for energy supply (CBS, 2011), whereas almost 30% the population does not have access to electricity (NEA, 2014). Increasing spells of drought resulting in forest fires can adversely impact forest resources, the availability of fuelwood and the communities dependent on them.

Climate Change Vulnerability

Almost 91% of Nepal's grid power supply is based on hydropower for electrification and industrial uses. More than any other sector, the water resources and hydropower sector ranks significantly higher in terms of impact of and vulnerability to climate change (Agrawala et al, 2003). Particularly, run-of-the-river power plants are susceptible to rainfall and discharge whereas storage plants are more susceptible to erosion and sedimentation. Similarly, hydropower infrastructure is vulnerable to flash floods, GLOFs, landslides, sedimentation and earthquakes. Transmission lines are sensitive to hazards such as landslides, GLOFs and riverbank erosion which can destabilize pillars, obstructing access for maintenance and repair.

The changing climate is a threat to other sources of energy, directly or indirectly. Although solar photovoltaic technologies are relatively less sensitive to climate change, output varies with changes in cloud regimes, and concentrating and tracking solar technologies are vulnerable to damage from high-gusting winds and hail. Biomass production is highly susceptible to climate change. The energy density of biomass can vary due to variations in temperature (photosynthetic/plant physiological interactions, often driven by CO_2 concentration changes). Apart from these events, other climate induced risks such as floods, flash floods, landslides and sedimentation can pose serious threats to the water and energy sector (Agrawala et al, 2003). Cooking, heating, industrial facilities, micro hydro, wind, hydropower, irrigation and water supply facilities can all be affected.

Micro hydropower plants are built with relatively weak infrastructure (often in landslide prone zones). The dry season flow of small rivers/rivulets is less reliable and directly impacts power generation. Decreasing water availability for irrigation and drinking water poses vulnerability to certain groups in a society. Women might need to spend more time fetching

water when nearby water sources dry and yield less discharge. Similarly, marginalized communities in rural areas rely on community water taps. These systems might have less adaptive capacity to deal with changes in water availability.

In terms of adaptive capacity, it is found that big hydropower projects have the ability to resolve issues relatively faster than those running at the community level. Similarly, the private sector has a higher adaptive capacity than the public or community sectors. For example, Nepal's only reservoir storage hydropower plant, the Kulekhani, has undergone substantial reconstruction to make it flood-resilient (JICA, 2010). However, new reservoir projects under the government's plans and policies would need to be expedited as well and cross-border transmission networks developed further for power trade—to make Nepal's power systems climate-resilient.

The government and particularly the ministries concerning the water and energy sector have low capacity to respond to climate change. The current level of policy responses at the sector level is not enough. Most of the major projects in the water resources and energy sector in Nepal target their immediate development needs. Although the government has started to invest in climate change, there are evidences in the budget of the year 2013-14 that show that no activities were identified for reducing the negative impacts of climate change at the Ministry of Irrigation or the Ministry of Energy. This entails that Nepal needs to move from a development focus to a climate-resilient development focus through its policy and institutions, and plans and budget.

Key Gaps

The Climate Change Policy provides a national level broad framework to address climate change, however it is yet to be implemented in its true spirit. The Climate Change Centre (with strengthened institutional setup) envisioned in policy has not yet come into the existence. In its absence, the execution of strategies and policies relating to climate change adaption is difficult. There is the absence a comprehensive water resource policy, and integrated river basin planning and management were noted as critical barriers to overcome on the policy front.

The Water Resources Strategy (2002) and the National Water Plan (2005) identified five action programmes, but plans relating to climate change were missing. The strategy and plan identified key legal and institutional issues relating to drinking water, irrigation, hydropower and others. However, the non-existence adequate and reliable data is a major constraint in water resource planning, implementation and management. In the changing development and climatic scenario, a timely documentation and evaluation of challenges, and a formulation of policies to anticipate future changes are both necessary.

There is the need to align water and energy related policies, strategies and plans, including a revision of existing policies. In this regard, the role of the Water and Energy Commission Secretariat (WECS), as a central body to develop policies on water and energy, should be strengthened with a firm mandate. Renewable energy policies have provisions for a subsidy in the rehabilitation of damages. However, at the present, when increasing disaster events are being dealt with (the flood of 2016 damaged 18 micro hydropower plants in Baglung district, among which three were completely washed away) the provided subsidy is not enough to address upcoming challenges.

In terms of institutional challenges, the key issues identified were the limited level central-level planning coordination, blurred responsibilities and the lack of coordination between the concerned organizations and departments for water and energy resource development. Besides, there is a inadequate coordination among authorities involved in hydropower development. This is putting existing micro hydropower plants under more pressure. It is a widely accepted fact that energy is critical for development, but energy has not received significant attention in policy debates.

Current levels of governance arrangements are not

adequate for mainstreaming climate change within water resources management and addressing the vulnerability of households and communities. As a mitigation measure for environmental impacts, policy has made appropriate provisions for the resettlement of displaced families, but there is no clarity on adaptive measures resulting from climate change impacts. Benefit sharing mechanisms between downstream hydropower plants and communities living upstream need to be developed for managing watersheds to help control sediment load. At the moment, a revenue-sharing mechanism is oriented towards rural electrification. An effective mechanism where a part of the revenue can be mobilized for watershed management can help in building adaptive capacity of communities.

Chapter 12 Conclusion

A number of knowledge, capacity, institutional and policy gaps—and thus future priorities for adaptation planning—emerge from this synthesis report.

The agriculture and food security (nutrition) sector is among the most at risk of being adversely impacted by climate change. Good information and databases are available for this sector. The sector also has policies and plans that are already integrating climate change. For agriculture and food security, there is the need to do more research and development work tackling the analysis of climate change impact on food security and nutrition. The report also shows that there are still gaps in the understanding of both short-term and long-term trends of climate extremes, and impacts on various crops and livestock. There is also inadequate research documenting how climate change is impacting the fisheries sector. Potential changes in pests and diseases and their impacts on the sector are understudied. One of the challenges of this sector is also inadequate human resources, and capacity to design and deliver adaptation and support services that can provide correct and timely advices to farmers and help them manage climate related risk.

For climate induced disasters, a clear priority is a better understanding of the indirect and macro-economic costs of current climate variability and extremes. The current level of efforts towards integrating climate change into disaster risk reduction policies and plans is slow. In order to advance mainstreaming, it is important to ensure detailed sector adaptation investment plans, with analysis of the options, programmatic activities and costs. Apart from issues related to the absence mainstreaming, there is a inadequate capacity and commitment to set up capacity access and disseminate climate information services. In addition, available weather predictions have limited capacity and reliability.

The forests and biodiversity thematic sector is ahead in terms of integrating and mainstreaming climate change within forest sectoral policies and plans. There is a functional institutional structure in place, the RIC, that effectively addresses climate change impacts and develops mechanisms for enhancing opportunities from market based incentives. However, there is limited research on assessing vulnerability, exposure and climate change impact on the forests and biodiversity sector since it demands long-term engagement. Both government and non-government agencies have not adequately invested in such action research, the generation of reliable data and knowledge, and the dissemination process.

Gender and marginal groups (social inclusion) has recently been recognized as an important sector for adaptation planning. Although there is some information regarding how climate change impacts GESI, there are insufficient gender disaggregated data in most sectors to measures differential impacts of climate change between men and women. The knowledge and information gap in climate change and gender is evident, but it is even more so in socially excluded groups. Another challenge is figuring out how to mainstream GESI in climate relevant policies and plans, including development policies and plans. There is inadequate institutional capacity for formulating adaptation plans and strategies at different levels (national, district and community).

Livelihood and governance is a cross cutting sector for NAP. It is evident that climate change impacts livelihood assets and results in increased poverty and vulnerability. There is a an absence of consistent climate data and climate change scenarios. And it is a challenge to examine climate risk in livelihood sectors with confidence. Nepal's socio-economic and cultural setting and practices

make the designing of adaptation options more challenging. As Nepal has micro-climatic variations, the impacts are also felt at a micro level. It is very difficult to project climate change scenarios at that micro level and the impacts of the same on the diverse livelihoods of the people. There is negligible information on the diverse impact of climate change on different sections of society. In particular, the impacts of climate change on livelihoods need further understanding, both contextually and locally. Climate change is impacting livelihoods, but the nexus between climate change and governance is unclear. Governance challenges are already creating major issues in terms of delivering services and often creating obstacles for the poor to access climate information and the finance needed for responding to climate change impacts.

In the public health (WASH) sector, it is clear that health and climate change are intimately connected, and better integration of adaptation into development must factor in WASH and public health considerations. There is very limited information and data on how climate change impacts the health and WASH sector. More context-specific research on climate-induced vectors is needed, and continuous research on climate change and health must be promoted. Database generation and reporting are an essential part of the process, including monitoring. This also relates to the need for enhancing the capacity of a rapid response team in terms of disease surveillance and monitoring, an effective response system, and proper communication of risks to reduce the burden of climate sensitive health outcomes.

For the tourism, culture and natural heritage sector, key gaps exist in the contexts of policy, institution, capacity and knowledge. There are several tourism-related institutions that range from the policy level (MoCTCA) to local levels (civil society organizations), and public-private partnerships (eg, the Nepal Tourism Board). However, the capacities of these institutions to address climate change issues have not been clearly developed. The knowledge gap on climate change issues in Nepal's tourism sector is substantial. While tourism itself is an adequately researched and documented subject, its vulnerabilities and climate change impacts on tourism have only been recently studied (ie since the 2000s). As a result, there is no sufficient evidence-based knowledge, especially at the national level, to contribute to policy development or programme planning.

The urban settlements and infrastructure sector also lags behind in terms of both understanding how climate change impacts the sector and in terms of taking action to deal with these impacts. The policies and strategies that are already in place rarely consider climate change a threat. The sector faces gaps in the following areas: i) Information, ii) Policy, and iii) Capacity. Information gaps in the sector refer to a lack of quality, consistency and sufficiency in terms of knowledge input (eg, data), analysis and outputs (results). Policy gaps include shortcomings in the preparation or implementation of policies faced by government agencies as a result of legal or institutional barriers. Capacity gaps relate to the inadequate of relevant human resources and logistical arrangements along with the absence of relevant knowledge.

In the water resources and energy sector, a major gap was identified in understanding the implications of weather and climate variability on the water flow and discharge system in both summer and winter. Similarly, information on climate impacts on energy production, irrigation flow, drinking water facilities etc, is still not sufficient. There are also policy and institutional gaps in integrating climate change within the sector. For hydroelectricity, more understanding is needed to understand the potential influence of glacial melt and GLOF risks. In addition, planning and policy instruments are inadequate for strengthening community capacity to deal with changing scenarios, climate induced disaster pruning and the rehabilitation of new risk areas.

Looking at the findings of the synthesis report, there is a need to focus on vulnerability and risk assessment work specific to all sector and cross cutting areas identified under NAP, which are inadequately explored or researched. At the very least, the NAP

should conduct a comprehensive vulnerability and risk assessment in order to both understand the current impact as well as future risk of climate change in respective sectors. It should include an analysis of climate change trends and scenarios, an assessment of climate change vulnerability and risk, and the identification, selection, costing and prioritization of climate change adaptation options. Finally, it is important for the NAP to develop a framework for integrating climate change adaptation into the planning process, and existing and new policies, programmes and activities.

References

Acharya BR. (2010). Urban Poverty: A Sociological Study of Shankhamul Squatter, Dhaulagiri Journal of Sociology and Anthropology, Vol 4, www.nepjol.info/index.php/DSAJ/article/download/4519/3767

Acharya, K. P., Dangi, R. B., & Acharya, M. (2011). Understanding forest degradation in Nepal. Unasylva, 62(2), 238.

ADB. (2016). Basic Statistics 2016. Manila: Economic Research and Regional Cooperation Department, Asian Development Bank.

ADB. (2010). Nepal: Country Partnership Strategy Initiating Paper (2010-2014). ADB, Kathmandu.

Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, 2007: Assessment of adaptation practices, options, constraints and capacity. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 717-743.

Adhikari J, Hobley M. (2011). Everyone Is Leaving—Who Will Sow Our Fields? The Effects of Migration from Khotang District to the Gulf and Malaysia. Kathmandu, Nepal: Swiss Agency for Development and Cooperation (SDC).

Agrawala, S., Raksakulthai, V., van Aalst, M., Larsen, P., Smith, J., & Reynolds, J. (2003). Development and climate change in Nepal: Focus on water resources and hydropower. Organization for Economic Cooperation and Development, Paris, 64.

Alam, M. (2015). Women and Climate Change: Impact and Agency in Human Rights, Security and Economic Development. Georgetown Institute for Women, Peace and Security. Available at https://giwps.georgetown.edu/sites/giwps/files/Women%20and%20Climate%20Change.pdf

Amatya, S.M. (2013). Financing for Sustainable Forests Management in Nepal. INDUFOR, Auckland, New Zealand. Available on: http://www.un.org/esa/forests/

pdf/facilitative-process/Nepal_study.pdf, Accessed on 13 March 2017.

ASHA. (2014). ASHA: Adaptation for Smallholders in Hilly Areas, Final Project Design Report. IFAD, Project No. 1723 Asia and Pacific Division Programme Management Department.

Asian Development Bank. (2010). Overview of Gender Equality and Social Inclusion in Nepal. Asian Development Bank, 6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines.

Badu M. (2013). Assessing the Impact of Climate Change on Human Health: status of Trends of Malaria and Diarrhea with Respect to Temperature and Rainfall Variability in Nepal. Kathmandu University, Nepal.

Baidya, S. K., Shrestha, M. L., & Sheikh, M. M. (2008). Trends in daily climatic extremes of temperature and precipitation in Nepal. Journal of Hydrology and Meteorology, 5(1), 38-53.

Baidya, S., M. Shrestha, and MM. Sheikh. (2008). 'Trends in daily climatic extremes of temperature and precipitation in Nepal'. Journal of Hydrology and Meteorology 5(1):38-53.

Baidya, S.K, R.K. Regmi, and M.L. Shrestha. (2007). Climate Profile and Observed Climate Change and Climate Variability in Nepal. Kathmandu: Department of Hydrology and Meterology, Nepal.

Bajracharya, SR; Maharjan, SB; Shrestha, F; Bajracharya, OR; Baidya, S. (2014). Glacier status in Nepal and decadal change from 1980 to 2010 based on landsat data. Kathmandu: ICIMOD.

Bartlett, R., L. Bharati, D. Pant, H. Hosterman, and P. Mccornick. eds. 2010. Climate change impacts and adaptation in Nepal. Working Paper 139. Colombo Srilanka: International Water Management Institute (IWMI).

Bastakoti, N., S. Dhital, S and DB Gurung. (2011). A comparative study of conventional and organic farming system in Nepal in the context of climate change in Understanding climate change impacts in Nepal (edited by FP Neupane and DR Bhuju: pp1-10. Nepal climate change knowledge management centre, NAST.

Bates, B., Kundzewicz, Z. W., Wu, S., & Palutikof, J. (2008). Climate change and Water: technical Paper vi. Intergovernmental Panel on Climate Change (IPCC).

Bazzaz F.A. (1998). Tropical forests in a future climate: changes in biological diversity and impact on the global carbon cycle, in S. H. Schneider (ed.), Climate Change, Special Issue: Potential Impacts of Climate Change on Tropical Forest Ecosystems, Kluwer Academic Publishers, London, pp. 177–336.

BCN and DNPWC. (2011). The State of Nepal's Birds 2010. Bird Conservation Nepal (BCN) and Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu.

Becken S. (2010). The importance of climate and weather for tourism: Literature review. Land, Environment and People (LEAP), Lincoln University, New Zealand. http://www.lincoln.ac.nz/PageFiles/6750/WeatherLitReview.pdf Accessed on 13 March 2017.

Bhandari G., Dhimal, M., Gurung, S., Bhusal, G. (2013). Climate Change and Malaria in Jhapa: Emerging Evidences. Journal of Health Management 15(1):141-50.

Bhandari LN. (2014). Climate change impacts and adaptation strategies on tourism in Nepal. Crossing the Border: International Journal of Interdisciplinary Studies 2(1):113-126.

Bhattachan, K. B. (1997). People/Community-Based Development Strategy in Nepal," pp.100-148, in Developmental Practices in Nepal, Edited by Krishna B. Bhattachan and Chaitannya Mishra, Central Department of Sociology and Anthropology, Tribhuvan University, Kathamdnu.

Billmire Michael, French Nancy H. F., Loboda Tatiana, Owen R. Chris, Tyner Marlene. (2014). Santa Ana winds and predictors of wildfire progression in southern California. International Journal of Wildland Fire 23, 1119-1129.

Bishokarma, N.K. and S.R. Sharma. (2013). Climate Change and Food Insecurity: Institutional Barriers to Adaptation of Marginal Groups in the Far-western Region of Nepal. 26 May 2016. <http://link.springer.com/chapter/10.1007/978-94-007-6719-5_8)>.

Boyd E., Juhola, S. (2009). Stepping up to the climate change: Opportunities in re-conceptualising development futures. Journal of International Development 21(6): 792–804

Boyd, E., Hultman, N., Roberts, J. T., Corbera, E., Cole, J., Bozmoski, A., & Liverman, D. M. (2009). Reforming the CDM for sustainable development: lessons learned and policy futures. environmental science & policy, 12(7), 820-831.

Boyd, J. (2011) Exploring social barriers to adaptation: insights from Western Nepal. Glob Environ Chang 21(1):1262–1274.

Bryant, M. D. (2009). Global climate change and potential effects on Pacific salmonids in freshwater ecosystems of southeast Alaska. Climatic Change, 95(1-2), 169-193.

Cabrini L. (2010). Climate change and tourism facing the challenge. In Schott C (ed.) Tourism and the Implications of Climate Change: Issue and Action (First ed., Vol. 3, pp. 49-64). Haward House, Wagon Lane: Emirald Books.

Cannon, T. (2002). Gender and climate hazards in Bangladesh. Gender and Development, 10(2), 45–50.

Carter, J, Pokharel B and Rai Parajuli, R. 2011. Two Decades of Community.

Forestry in Nepal: what we learned? Nepal Swiss Community Forestry Project. Kathmandu.

CBS. (2011). National Population and Housing Census 2011. National Report. National Planning Commission Secretariat. Central Bureau of Statistics. Kathmandu, Nepal.

CBS. (2012). National Population and Housing Census 2011. Central Bureau of Statistics, National Planning Commission Secretariat, Kathmandu.

CBS. (2014). Environment statistics of Nepal. Central Bureau of Statistics, Kathmandu, Nepal.

CBS. (2017). Report on National Climate Change Impact Survey. Central Bureau of Statistic, Kathmandu.

Chapagain, B and Gentle, P. (2015). Withdrawing from Agrarian Livelihoods: Environmental Migration in Nepal. Journal of Mountain Science 12(1). DOI:10.1007/s11629-014-3-17-1

Chaudhari, D. (2014). Climate Change: Livelihoods, Adaptation and Employment from Nepal Perspective. Carbon Market Watch: Civil Society Workshop on Sustainable Development & Future Climate Politics in India.

Chitale, V.S., Shrestha, H.L., Agrawal, N.K., Choudhury, D., Gilani, H., Dhonju, H.K., and Murthy, M.S.R. (2014). Forest climate change vulnerability and adaptation assessment in Himalayas, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-8, 2014 ISPRS Technical Commission VIII Symposium, 09 – 12 December 2014, Hyderabad, India.

Cutter, S., B. Osman-Elasha, J. Campbell, S.-M. Cheong, S. McCormick, R. Pulwarty, S. Supratid, and G. Ziervogel, 2012: Managing the risks from climate extremes at the local level. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I

and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 291-338.

Dahal N. (2007). Perceptions of Climate Change in the Himalaya. Available at http://www.cru.uea.ac.uk/tiempo/newswatch/feature050910.htm.

Dahal, N. (2006). Implications of Climate Change in Nepal: Some Observations and Opportunities. Paper presented at 23rd Warden Seminar, November 2006 held in Pokhara Nepal.

Devkota K, Manschadi A, Devkota M, LaLamers JPA, Ruzibaev E, Egamberdiev O, Amiri E, Vlek PLB. (2013). Simulating the impact of climate change on rice phenology and grain yield in irrigated drylands of Central Asia. J Appl Meteorol Climatol 52(9):2033–2059.

Devkota, L. P., & Gyawali, D. R. (2015). Impacts of climate change on hydrological regime and water resources management of the Koshi River Basin, Nepal. Journal of Hydrology: Regional Studies, 4, 502-515.

DFRS. (2015). State of Nepal's Forests. Forest Resource Assessment (FRA) Nepal, Department of Forest Research and Survey (DFRS). Kathmandu, Nepal.

Dhimal M. (2014). Spatio-Temporal Distribution of Malaria and Its Association with Climatic Factors and Vector Control Interventions in Two High Risk Districts (Morang and Kailali), NHRC, Nepal.

DHM. (2015). Climate trends in Nepal. Department of Hydrology and Meteorology. Kathmandu.

Dixit, A. (2011). Climate change in Nepal: Impacts and adaptive strategies. World Resources Report.

Dhimal, M., Ahrens, B., & Kuch, U. (2014). Malaria control in Nepal 1963–2012: challenges on the path towards elimination. Malaria journal, 13(1), 241.

Dixit, A., Subedi, Y., Aryal, N., Wenju, R. and Shrestha, A. (2016). Climate Finance: Fund Flow from National to Sub-National Level in Nepal, Kathmandu, Nepal: ISET-Nepal.

Dixit, A., Upadhya, M., Pokhrel, A., Dixit, K. M., Rai, D. R., & Devkota, M. (2007). Flood Disaster Impacts and Responses in Nepal Terai's Marginalised Basins. Working with the Winds of Change: Toward Strategies for Responding to the Risks Associated with Climate Change and Other Hazards, 119-157.

DoF. (2017). CFUG Database Record Available in MIS. DOF, Babarmahal, Kathmandu. Available on: http://dof.gov.np/dof_community_forest_division/community_forestry_dof. Assessed on 14 March 2017.

Dulala, H.B., Brodnig, G., Thakur, H.K., & Green-Onoriose, C. (2010). Do the poor have what they need to adapt to climate change? A case study of Nepal. Local Environment, 15 (7), pp. 621-635.

DWIDP. (2015). Annual Disaster Review, 2014. Department of Water Induced Disaster Prevention. Kathmandu. Also Available at: http://dwidm.gov.np/wp-content/uploads/2016/06/disaster-review-2015_20150914035801.pdf accessed on: 13 March, 2017

DWSS, Department of Water Supply and Sewerage (2011). Nationwide Coverage and Functionality Status of Water Supply and Sanitation in Nepal. Kathmandu.

Easterling, W.E., Aggarwal, P.K., Batima, P., Brander, K.M., Erda, L., Howden, S.M., Kirilenko, A., Morton, J., Soussana, J.F., Schmidhuber, J. & Tubiello, F.N. (2007). Food, fibre and forest products. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. & Hanson, C.E. (eds.). Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel of Climate Change (IPCC). Cambridge University Press, Cambridge, UK. p. 273–313.

Enarson, E., & Morrow, B. (1998). The gendered terrain of disaster: Through women's eyes. Westport, CT: Praeger Press.

Eriksson, M., Jianchu, X., Shrestha, A. B., Vaidya, R. A., Nepal, S., & Sandström, K. (2009). The changing Himalayas: impact of climate change on water resources and livelihoods in the greater Himalayas. International centre for integrated mountain development (ICIMOD).

FAO. (2014). Managing Climate Risks and Adapting to Climate Change in the Agriculture sector in Nepal, FAO, Rome.

Feed the Future. (2014). The US Government's Global Hunger and Food Security Initiative www.feedthefuture.gov/country/Nepal. GoN and WFP (Nov 2011) Nepal Food Security Bulletin. Issue 33.

FIAN. (2013). Baseline study and project design on people's perceptions on climate change and right to food in Banke (Terai), Dailekh (Hills) and Mugu (Himalaya) in Nepal. Kathmandu: Food-first Information and Action Network (FIAN).

Freshfield D. (1903). Round Kangchenjunga: A Narrative of Mountain Travel and Exploration. Edward Arnold, London.

Gaire, N. P., Koirala, M., Bhuju, D. R., & Borgaonkar, H. P. (2014). Treeline dynamics with climate change at the central Nepal Himalaya. Climate of the Past, 10(4), 1277-1290.

Gentle, P. and Maraseni, T.N. (2012). Climate change, poverty and livelihoods: Adaptation practices by rural mountain communities in Nepal. Environment Science and Policy, DOI: 10.1016/j.envsci.2012.03.007

GoN. (2010). National Adaptation Plan of Action (NAPA). Government of Nepal. Kathmandu.

GoN. (2001). The Hydropower Development Policy, 2001. Ministry of Water Resources. Singhadurbar.

GoN. (2015). Constitution of Nepal 2015, Article 18, Kathmandu, Nepal.

GoN. (2011). Caste Based Discrimination and Untouchability (Offence and Punishment) Act, 2011. Available at http://www.lawcommission.gov.np/en/documents/2015/08/caste-based-discrimination-and-untouchability-offence-and-punishment-act-2068-2011.pdf

GoN/Central Bureau of Statistics. (2010-11). Nepal Living Standard Survey 2010-2011, Third. Available at http://cbs.gov.np/nada/index.php/catalog/37 also see http://cbs.gov.np/image/data/Population/Major%20Highlights/Major-Finding.pdf (for major highlights on CBS data).

GoN/UNDP. (2014). Nepal Human Development Report: Beyond Geography, Unlocking Human Potential. Available at http://www.npc.gov.np/images/download/NHDR_Report_2014.pdf

GoN and WFP.(2011). Nepal Food Security Bulletin. Issue 33. November.

Gupta B.P., Adhikari A., Rauniyar R., Kurmi R., Upadhya B.P., Jha B.K. (2016). Dengue virus infection in a French traveller to the hilly region of Nepal in 2015: a case report. Journal of Medical Case Reports 10: 65-71.

Gurung, O. (2009). Social Inclusion: Policies and Practices in Nepal. Occasional papers in Sociology and Anthropology. Central Department of Sociology / Anthropology. Tribhuwan University, Kirtipur, Kathmandu, Nepal.

Handmer, J., Y. Honda, Z.W. Kundzewicz, N. Arnell, G. Benito, J. Hatfield, I.F. Mohamed, P. Peduzzi, S. Wu, B. Sherstyukov, K. Takahashi, and Z. Yan, 2012: Changes in impacts of climate extremes: human systems and ecosystems. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 231-290.

Herzog M. (1952). Annapurna: First Conquest of an 8000-meter Peak. Translated by Nea Morin; Janet Adam Smith. New York: E.P. Dutton & Co., Inc.

Hooker JD. (1854). Himalayan Journals: Notes of a Naturalist in Bengal, the Sikkim and Nepal Himalayas, the Khasia Mountains, &c. John Murray, London, UK. 382 pgs.

Hussain, A., Rasul, G., Mahapatra, B. and Tuladhar, S., (2016). Household food security in the face of climate change in the Hindu-Kush Himalayan region. Food Security, 8(5), pp.921-937.

IBRD/ The World Bank and The United Nations, (2010). Natural hazards, unnatural disasters: the economics of effective prevention. Washington.

ICIMOD. (2011). Glacial lakes and glacial lake outburst floods in Nepal. Kathmandu: ICIMOD.

ICIMOD. (2010). Climate change impact and vulnerability in the eastern Himalayas – Synthesis report. Kathmandu: International Centre for Integrated Mountain Development.

ICIMOD. (2011). Gender Experiences and Responses to Climate Change in the Himalayas. Available at http://lib.icimod.org/record/27008/files/attachment_781.pdf

ICIMOD. (2011). Glacial lakes and glacial lake outburst floods in Nepal. Kathmandu: ICIMOD.

ICIMOD. (2015). Reviving the drying springs, Issue brief.

Gurung, DD. and Bisht, S. 2014. Women's empowerment at the frontline of adaptation: Emerging issues, adaptive practices, and priorities in Nepal. ICIMOD Working Paper 2014/3. Kathmandu: ICIMOD. Available at http://lib.icimod.org/record/29811/files/WE_14.pdf

ICIMOD. (2016). International Symposium on 'Transforming Mountain Forestry': Bridging transboundary challenges with 21st Century paradigms for the welfare of mountain people, forests, and the environment in the Hindu Kush Himalayas. ICIMOD Proceedings 2016/1. Kathmandu: ICIMOD.

IDS-Nepal, PAC and GCAP. (2014). Economic Impact Assessment of Climate Change in Key Sectors in Nepal. IDS-Nepal, Kathmandu, Nepal.

IIED. (2014). Climate change financing in Nepal. Briefing. IIED, London.

IPCC. (2012): Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

IPCC. (2014): Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IPCC. (2014). Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

IPCC. (2013). Climate Change 2013. The Physical Science Basis. Working Group I contribution to the fifth Assessment report of the Intergovernmental Panel on Climate change. Summary for policymakers.

ISET – N. (2015). Risk Nexus: Urgent case for recovery: what we can learn from the August 2014 Karnali River floods in Nepal. ISET Nepal. Kathmandu. http://floodresilience.net/solutions/item/urgent-case-of-recovery-what-we-can-learn-from-the-august-2014-karnali-river-floods-in-nepal

Jayasawal, D. and Bishwokarma, D. (2016). Scientific Forest Management Initiatives in Nepal: MSFP Initiatives and Lessons Learnt, Multi-Stakeholder Forestry Programme, Ekantakuna, Lalitpur.

JICA. (2010). Japan/JICA NPPR Background Paper. NPPR Annual Meeting Report. 9-10 September, 2010.

Joshi, P.K., Rawat, A., Narula, S. and Sinha, V. (2012). Assessing impact of climate change on forest cover type shifts in Western Himalayan Eco-region, Journal of Forestry Research, 23(1): 75-80.

Karki G. (2015). Climate Change Vulnerability Assessment and Potential Adaptation Measures for Local Communities of the Chure Project Area. WWF Nepal/Sustainable Land Management Project.

Joshi, N.K. (2011). Poverty and Climate Change in Nepal: Poverty Analysis in Far Wester and Western Hills. Phd Thesis. Graduate school of International Development and Cooperation, Hiroshima University, Japan.

Kawaguchi E. (1909). Three Years in Tibet. (Reprint 1995) Book Faith India, Delhi.

KC S. (2012). Roles and challenges of women in tourism sector of Western Nepal: A micro-ethnographic study. Nepal Tourism and Development Review 2:32-59.

Khanal, N. R., Mool, P. K., Shrestha, A. B., Rasul, G., Ghimire, P. K., Shrestha, R. B., & Joshi, S. P. (2015). A comprehensive approach and methods for glacial lake outburst flood risk assessment, with examples from Nepal and the transboundary area. International Journal of Water Resources Development, 31(2), 219-237.

Kocheri S. (2015). Nepal's tourism shaken by natural calamity. http://blog.euromonitor.com/2015/07/nepals-tourism-shaken-by-natural-calamity.html Accessed on 17 March 2017.

Kumar, P. (2012). Assessment of impact of climate change on Rhododendrons in Sikkim Himalayas using Maxent modelling: limitations and challenges, Biodiversity and Conservation, 21 (5): 1251-1266.

Lama AK. (2010). Vulnerability of nature-based tourism to climate change: Stakeholders' perception of and response to climate change in the Lower Mustang region of the Annapurna Conservation Area. Canterbury, New Zealand.

Lama AK. (2016). Understanding Institutional Adaptation to Climate Change: Social resilience and adaptive governance capacities of the nature based tourism institutions in the Annapurna Conservation Area, Nepal. Würzburg University Press, Germany.

Laxen, J. (2015). Analytical Study on Assessing the Value of Forests, the Political Economy of Land Use and the Carbon Emissions from the Drivers of DD: Forest Sector Total Economic Valuation Report for Nepal. MoFSC/REDD Cell, Kathmandu, Nepal.

Leduc, B. (2009). Background paper for the e-discussion in October 2009 on Climate change in the Himalayas: The gender perspective. ICIMOD, Kathmandu, Nepal.

Lutz, A. F., Immerzeel, W. W., Shrestha, A. B., & Bierkens, M. F. P. (2014). Consistent increase in High Asia's runoff due to increasing glacier melt and precipitation. Nature Climate Change, 4(7), 587-592.

Macchi, M., Gurung, A.M., Hoermann, B., and Choudhury, D. (2011). Climate Variability and Change in the Himalayas: Community perceptions and responses. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

Macchi, M., Gurung, A. M., & Hoermann, B. (2015). Community perceptions and responses to climate variability and change in the Himalayas. Climate and Development, 7(5), 414-425.

Mainlay, J. and Tan, S.F. (2012). Mainstreaming gender and climate change in Nepal. IIED Climate Change Working Paper No. 2, November 2012.

Malla, G. (2008). Climate Change and its Impact on Nepalese Agriculture, Journal of Agriculture and Environment (9).

Maraseni, T. N. (2012). Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal. Environmental science & policy, 21, 24-34.

Markham A, Osipova E, Lafrenz Samuels K, Caldas A. (2016). World Heritage and Tourism in a Changing Climate. United Nations Environment Program, Nairobi, Kenya and United Nations Educational, Scientific and Cultural Organization, Paris, France.

MoAD. (2012). Crop Situation Update: A joint assessment of 2011 summer crops and outlook of 2011/12 winter crops (January 2012).

MoAD. (2013). MOAD Statistics, 2013. Government of Nepal.

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

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

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

MoF. (2012). Economic Survey 2011/2012. Kathmandu, Nepal: Ministry of Finance.

MoH. (2015). Climate Change Health Adaptation Strategies and Action Plans for Nepal (2016-2020), Government of Nepal, Ministry of Health, Kathmandu.

MoSTE. (2014). Second National Communication Report to UNFCCC. http://unfccc.int/resource/docs/natc/nplnc2.pdf

MoUD. (2016). Third United Nations Conference on Housing and Sustainable Urban Development (Habitat III) – Nepal National Report. Kathmandu: Government of Nepal, Ministry of Urban Development.

MoFSC. (2014). Nepal Biodiversity Strategy and Action Plan (2014-2020). Ministry of Forests and Soil Conservation, Kathmandu.

MoF. (2016). Fiscal Budget 2016/2017. Ministry of Finance, Kathmandu.

MoFALD. (2017). Municipalities in Nepal. Accessed from MoFAID Website 17th May, 2017. http://lgcdp.gov.np/content/map-nepal-displaying-updated-no-vdcs-and-municipalities

MoFSC. (2011). Role of Forest on Climate Change Adaptation. Ministry of Forest and Soil Conservation, REDD - Forestry and Climate Change Cell, Kathmandu.

MoFSC. (2015). Forest Policy 2015. Government of Nepal. (2009). Nepal Forestry Outlook Study. Working Paper No. APFSOS II/WP/2009/05, Bangkok.

MoHA and DPNet. (2013). Nepal Disaster Report, 2013. MOHA and DPNet. Kathmandu.

MoHA and DPNet. (2015). Nepal Disaster Report, 2015. MOHA and DPNet. Kathmandu. http://www.drrportal.gov.np/uploads/document/329.pdf

MoHA. (2015). Nepal Disaster Report 2015. Government of Nepal, Ministry of Home Affairs (MoHA) and Disaster Preparedness Network-Nepal (DPNet-Nepal).

MoHA. (2009a). National strategy for disaster risk management 2009. Unofficial translation. Ministry of Home Affairs, Government of Nepal.

MoHA. (2016). Disaster Risk Reduction in Nepal. Achievements, Challenges and Way Forward. National Position Paper for AMCDRR 2016, 2-5, November, New Delhi, India.

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

MSFP. (2015).Creating Jobs and Income through Forestry in Nepal. Multistakeholder Forestry Programme, Nepal.

MoSTE. (2014). Second National Communication Report. Kathmandu: Ministry of Science, Technology and Environment.

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. Proceedings of the national academy of sciences, 104(50), 19680-19685.

MoCTCA. (2009). Tourism Vision 2020. Kathmandu. Retrieved from http://www.tourism.gov.np/uploaded/Tourism-Vision-Booklet.pdf

NAST and OPML. (2016). Understanding Demand and Supply of Climate Change Knowledge Management in Nepal. Nepal Academy of Science and Technology, Nepal and Oxford Policy Management Limited, India, Action on Climate T oday Initiative.

Nayava, J.L and Gurung, D. B. (2010). Impact Of Climate Change On Production And Productivity: A Case Study Of Maize Research And Development In Nepal in The Journal of Agriculture and Environment Vol:11, Jun.2010 Technical Paper 59:.

NCVST. (2009). Vulnerability Through the Eyes of Vulnerable: Climate Change Induced Uncertainties and Nepal's Development Predicaments, Institute for Social and Environmental Transition-Nepal (ISET-N, Kathmandu) and Institute for Social and Environmental Transition (ISET, Boulder, Colorado) for Nepal Climate Vulnerability Study Team (NCVST) Kathmandu.

NHRC. (2011). National Health Research Policy of Nepal. Ministry of Health and Population. Government of Nepal.

NEA. (2014). Nepal Electricity Authority- A year in Review- Fiscal Year 2013/2014. Kathmandu, Nepal.

NEA. (2015). Load Forecase Report. Planning , Monitoring and Information Technology. System Planning Department. Nepal Electricity Authority.

Nepal SK. (2011). Mountain tourism and climate change: implications for the Nepal Himalaya. Nepal Tourism & Development Review 1(1):1-14.

Nepal, S. (2016). Impacts of climate change on the hydrological regime of the Koshi river basin in the Himalayan region. Journal of Hydro-environment Research, 10, 76-89.

NPC. (2016). Fourteenth Plan (Fiscal Year 2073/74-2075/76) Approach Paper (in Nepali). Kathmandu, Nepal: National Planning Commission, Government of Nepal.

NPC. (2015). Sustainable Development Goals, 2016-2030, National (Preliminary) Report. Government of Nepal, National Planning Commission, Kathmandu, Nepal.

NSET. (2009): Global Assessment of Risk Nepal Country Report Final, submitted to United Nations Development Program (UNDP) – Nepal Pulchowk, Lalitpur Kathmandu.

Nyaupane GP and Chhetri N. (2009). Vulnerability to climate change of nature-based tourism in the Nepalese Himalayas. Tourism, Geographies: An International Journal of Tourism Space, Place and Environment, 11(1):95-119.

O'Brien, G., O'Keefe, P., Rose, J., & Wisner, B. (2006). Climate change and disaster management. Disasters, 30(1), 64-80.

Onta, N. and Bernadette, P. (2011). The Role of Gender and Caste in Climate Adaptation Strategies in Nepal: Emerging Change and Persistent Inequalities in the Far-Western Region. Mountain Research and Development Vol. 31, No. 4, The Global Energy Crisis: Opportunities and Challenges for Mountain Areas (Nov 2011), pp. 351-356.

Olsson, L., M. Opondo, P. Tschakert, A. Agrawal, S.H. Eriksen, S. Ma, L.N. Perch, and S.A. Zakieldeen, (2014). Livelihoods and poverty. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 793-832.

Pant D, Gautam K. (2013). Policy provisions and local response on climate change adaptation in Nepal. Regional climate change adaptation knowledge platform for Asia. Stockholm Environment Institute, Bangkok.

Patz J.A., McGeehin M.A., Bernard S.M., Ebi, K.L., Epstein, P.R., Grambsch, A., Gubler, D.J., Reither, P., Romieu, I., Rose, J.B., Samet, J.M., Trtani, J. (2000). The potential health impacts of climate variability and change for the United States: executive summary of the report of the health sector of the US National Assessment. Environmental Health Perspectives; 108(4): 367-376.

Pokharel R, Poudel J, Sharma AR, Grala RK. (2017). A study of climate variability and socioeconomic impact on tourism industry of Nepal. Sustainability in Environment 2(1):20-35.

Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso. (2014). Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 485-533.

Poudel, S. and K. Kotani. (2012). 'Climatic impacts on crop yield and its variability in Nepal: do they vary across seasons and altitudes?' Climatic Change: 1-29.

Practical Action. (2009). Temporal and Spatial Variability of Climate Change over Nepal (1976-2005), Practical Action, Kathmandu Office.

Pradhan B. (2009). Climate Change and Health, Institute of Medicine, Tribhuvan University, Nepal.

Rai, R.K. and Scarborough, H. (2012). Understanding the Effects of the Invasive Plants on Rural Forest-dependent Communities, Small-scale Forestry, doi 10.1007/s11842-014-9273-7.

Rajbhandari, R., Shrestha, A. B., Nepal, S., & Wahid, S. (2016). Projection of future climate over the Koshi River basin based on CMIP5 GCMs. Atmospheric and Climate Sciences, 6(02), 190.

Star, C., Pradhan, B., Pandit, A. (2016). Climate Change and Human Health Adaptation. In Responses in Nepal. Series: Advances in Asian Human-Environmental Research: 131-152. Springer.

Regmi, B. R. and A. Adhikari. 2007. Climate change and human development-risk and vulnerability in a warming world (HDR 2007 Nepal Case Study), Occassional Paper, Human Development Report Office: UNDP.

Regmi, B., Star, C., Pradhan, B., Pandit, A. (2016). Classification of adaptation measures in criteria for evaluation: Case studies in the Gandaki River Basin.

Regmi, B. R., L. Thapa, R. Suwal, S. Khadka,GB . Sharma and BB. Tamang. (2009). 'Agro-biodiversity Management: An Opportunity for Mainstreaming Community-based Adaptation to Climate Change'. Journal of Forest and Livelihood 8(1):113-121.

Regmi, B. R., Star, C., & Leal Filho, W. (2016). An overview of the opportunities and challenges of promoting climate change adaptation at the local level: a case study from a community adaptation planning in Nepal. Climatic Change, 138(3-4), 537-550.

Regmi, B. R., Star, C., Paudyal, A., & Karki, R. C. (2015). Strengthening Climate Change Adaptation in Nepal: Needs and Perspectives. In Climate Change in the Asia-Pacific Region (pp. 245-262). Springer International Publishing.

Regmi, B.R. and Bhandari, D. (2013). Climate Change Adaptation in Nepal: Exploring Ways to Overcome the Barriers. Journal of Forest and Livelihood. 11(1).

Ribot, J. (2010). Vulnerability does not fall from the sky: toward multiscale, pro-poor climate policy. Social dimensions of climate change: Equity and vulnerability in a warming world, 2, 47-74.

Richardson, S. D., & Reynolds, J. M. (2000). An overview of glacial hazards in the Himalayas. Quaternary International, 65, 31-47.

Rimal B, G Karki, E Trines and WV Goor. (2015). Analytical Study on Assessing the Value of Forests, the Political Economy of Land Use and the Carbon Emissions from the Drivers of Deforestation and Forest Degradation: An Assessment of Drivers of Deforestation and Forest Degradation in Nepal. Ministry of Forests and Soil Conservation, REDD Cell. Kathmandu.

Selvaraju, R. (2014) Managing climate risks and adapting to climate change in the agriculture sector in Nepal. Food and Agriculture Organisation, Italy. http://www.fao.org/publications/card/en/c/bf0b71f3-18f8-58a3-8975-2e8ad115b245/.

SOFI (2014) The State of Food Insecurity in the World: strengthening the enabling environment for food security and nutrition, FAO, IFAD and WFP.

Sharma M. and Dahal S. (2011). Assessment of climate change impacts and local adaptation measures in the livelihoods of indigenous communities in the hills of Sankhuwasabha district In Understanding climate change impacts in Nepal (edited by FP Neupane and DR Bhuju.2011:pp11-18) Nepal climate change knowledge management centre, NAST.

Sharma P. (2012). Tourism in Nepal 2030. pp 73–92. In Sharma SR, Upreti BR and Pyakuryal K (eds) Nepal 2030: A Vision for Peaceful and Prosperous Nation. Kathmandu: South Asia Regional Coordination Office of the Swiss National Centre of Competence in Research (NCCR North-South) and Department of Development Studies, Kathmandu University.

Sharma, K.P. (2009). Climate Change Trends and Impacts on Livelihood of People. Kathmandu: Jalsrot Vikas Sanstha/Nepal Water Partnership.

Sherchand, K., Sharma, A., Regmi, R.K., Shrestha, M.L. (2007). Climate Change and Agriculture in Nepal. Department of Hydrology and Meteorology Kathmandu.

Shrestha HP, Shrestha P. (2012). Tourism in Nepal : A Historical Perspective and Present Trend of Development. Himalayan Journal of Sociology & Antropology, 5, 55–75.

Shrestha, A. B., C. P. Wake, P.A. Mayewski, and J.E. Dibb. (2000). 'Precipitation fluctuations in the Nepal Himalaya and its vicinity and relationship with some large scale climatological parameters'. International Journal of Climatology 20(3):317-327.

Shrestha, A. B., C. P. Wake, Paul, A.M and Jack, E.D. (1999). "Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records from Nepal for the period 1971-94." Journal of Climate 12: 2775-2787.

Shrestha, M., Kafle, S. K., Gurung, M. B., Nibanupudi, H. K., Khadgi, V. R., & Rajkarnikar, G. (2014). Flood Early Warning System in Nepal: A Gendered Perspective. ICIMOD Working Paper 2014/4. International Center for Integrated Mounatin Development, Kathamndu, Nepal.

Smith, Paul J., Brown, S and Dugar S. (2017). Community-based early warning systems for flood risk mitigation in Nepal. Nat. Hazards Earth Syst. Sci., 17, 423–437, 2017. www.nat-hazards-earth-syst-sci.net/17/423/2017/ doi:10.5194/nhess-17-423-2017

Smythe F. (1930). The Kangchenjunga Adventure. Victor Gollancz, London.

Spittlehouse D.L. and Stewart, RB. (2003). Adaptation to climate change in forest management. British Columbia Journal of Ecosystems and Management 4(1):1–11.

Sthapit, B.R. and Shrestha, P. (2008). Stability of social seed networks and nodal farmers in rice seed flow system: Does it matter for on-farm conservation? Agriculture and Human values (submitted).

Subedi, B. P. (2014). Urbanisation in Nepal: Spatial Pattern, Social Demography and Development. In Population Monograph of Nepal Volume III (Economic Geography) (pp. 95-154). Kathmandu, Nepal: Central Bureau of Statistics.

Subedi, B.P., Ghimire, P.L., Khanal, S.C., Gyawali, S., Katwal, P., Sthapit, K.R. and Gauli, K. (2014). Potential of Forestry Sector in Economic Growth and Development: Short Concept Notes on Five Themes. Kathmandu: Multi Stakeholder Forestry Programme.

The Himalayan Times. (2017). As many as 729,550 tourists visited Nepal in 2016. https://thehimalayantimes.com/nepal/as-many-as-729550-tourists-visited-nepal-in-2016/ Accessed on 15 March 2017.

The Kathmandu Post. (2016). Rain-induced landscalides block Araniko Highway. http://kathmandupost.ekantipur.com/news/2016-07-31/rain-induced-landslides-block-araniko-highway.html Accessed on 27 March 2017.

Thieme S., Mueller-Boeker U. (2010). Social networks and migration: Women's livelihoods between far west Nepal and Delhi. European Bulletin of Himalayan Research 35/36:7–122.

UNDP. (2016). I Human Development Report 2016: Human Development for Everyone. United Nations Development Programme, New York, NY 10017 USA.

UNDP. (2014). Gender Development Index. Available at http://hdr.undp.org/en/composite/GDI

UNDP. (2009). Nepal Human Development Report 2009, UNDP, Nepal.

UNEP. (2010). Integrated Solutions for Biodiversity, Climate Change and Poverty. UNEP Policy Series 1, Ecosystem Management.

UN-HABITAT. (2012). Nepal and natural disaster. UN-HABITAT website. Accessed on June 16, 2012, from http://ww2.unhabitat.org/ programmes/rdmu/documents/NPdisaster.pdf

UNESCO. (2015). Revisiting Kathmandu: Safeguarding Living Urban Heritage. Proceedings of an international symposium that took place in the Kathmandu Valley, 25–29 November 2013. http://unesdoc.unesco.org/images/0023/002317/231755E.pdf Accessed on 15 March 2017.

UNDP. (2013). Human Development Report 2013. The rise of the South: Human progress in a diverse world. New York, United Nations Development Programme.

Uprety, D. and Bishwokarma, D. (2016). Enhancing Resilience of Vulnerable Communities to Climate Change: MSFP Initiatives and Lessons Learnt, Multi-Stakeholder Forestry Programme, Ekantakuna, Lalitpur.

Verma R, Nellemann C, Hislop L. (2011). Women at the Frontline of Climate Change: Gender Risks and Hopes. Arendal, Norway: United Nations Environment Programme, GRID-Arendal.

WECS. (2014). Climate Change: Implication for the Energy Sector. Key Findings from the Intergovernmental Panel on Climate Change fifth Assessment Report. University of Cambridge.

WHO, World Health Organization (2014). Diarrheal Disease Risk Reductions Associated with Improvement in Sanitation and Drinking Water.

World Economic Forum. (2013). The Global Gender Gap Report, 2013. Available at http://www3.weforum.org/docs/WEF_GenderGap_Report_2013.pdf

WFP. –WFP. (2009). Food security Situation in Nepal. Kathmandu, Nepal:WFP.

WTTC. (2015). Travel & tourism: Economic impact 2015 Nepal. http://www.wttc.org/-/media/files/reports/economic impact research/countries 2015/nepal2015.pdf Accessed on 15 March 2017

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