Government of Nepal
Ministry of Population and Environment

Vulnerability and Risk Assessment Framework and Indicators for National Adaptation Plan (NAP) Formulation Process in Nepal

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FOREWORD

The Government of Nepal (GoN) is committed to respond to climate change risks and impacts through integrated policies and affirmative actions. The GoN as a party to the United Nations Framework Convention on Climate Change (UNFCCC), initiated the National Adaptation Plan (NAP) formulation process with a launching workshop held in Kathmandu in September 2015. The NAP formulation process in Nepal is led by the Ministry of Population and Environment (MoPE). MoPE has engaged seven thematic working groups (TWGs) and two Cross-cutting Working Groups (CWGs), which cover the major climate change sensitive sectors in the NAP formulation process.

The NAP 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 and other Least Developed Countries (LDCs) to reduce their 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 framework and indicators on Vulnerability and Risk Assessment (VRA) have been developed by the NAP expert team, with input and feedback from MoPE and experts from Practical Action and International Centre for Integrated Mountain Development (ICIMOD), to support the NAP process. The VRA framework presented here is based on the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and the NAP technical guidelines, and has been devised for use in the overall vulnerability and risk assessment that is required for the NAP formulation process.

The VRA framework and indicators offer a range of options to deal with each element of the NAP process and are based on guiding principles of the NAP process. These are not prescriptive, and respective thematic and CWCs can decide on the specific steps for their sectoral assessment process.

On behalf of MoPE, I thank the efforts of Ram Prasad Lamsal (Joint secretary), Naresh Sharma (NAP Coordinator), the NAP team, experts of Practical Action and ICIMOD involved in preparing the document,and members of the thematic and cross-cutting working groups for guiding the process. I also appreciate the funding and technical support of Action on Climate Today (ACT) – a UK Aid funded initiative led by Oxford Policy Management Limited (OPML) and Practical Action; and Support to Rural Livelihoods and Climate Change Adaptation in the Himalayas (Himalica) project led by International Centre for Integrated Mountain Development (ICIMOD).

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Contents

Contents

Acronyms

ACT	Action on Climate Today
AEPC	Alternative Energy Promotion Centre
ANSAB	Asia Network for Sustainable Agriculture and Bio-resources
CAA	Civil Aviation Authority of Nepal
CBS	Central Bureau of Statistics
CCA	Climate Change Adaptation
CDR	Crude Death Rate
COP	Conference of the Parties
DDC	District Development Committee
DDRRC	District Disaster Risk Reduction Centre
DFO	District Forest Office
DFRS	Department of Forest Research and Survey
DHM	Department of Hydrology and Meteorology
DNPWC	Department of National Parks and Wildlife Conservation
DoA	Department of Archaeology
DoED	Department of Electric Development
DoF	Department of Forest
DoFish	Department of Fisheries
DoHS	Department of Health Services
DoIn	Department of Industry
DoIr	Department of Irrigation
DoLIDAR	Department of Local Infrastructural Development and Agricultural Roads
DoR	Department of Road
DoS	Department of Survey
DPR	Department of Plant Resources
DSCWM	Department of Soil Conservation and Watershed Management
DUDBC	Department of Urban Development and Building Construction
DWIDM	Department of Water Induced Disaster Management
DWSS	Department of Water Supply and Sewerage

EbA	Ecosystem Based Adaptation
FAO	Food and Agriculture Organisation
FC	Faecal Coliforms
FECOFUN	Federation of Community Forestry Users, Nepal
FNCCI	Federation of Nepalese Chambers of Commerce and Industry
GCM	Global Circulation Model
GDP	Gross Domestic Product
GESI	Gender Equality and Social Inclusion
GLOF	Glacier Lake Outburst Flood
GPCM	Global Precipitation Climatology Centre
GWRDC	Gujrat Water Resource Development Committee
HAN	Hotel Association of Nepal
HKH	Hindu Kush Himalayan
HSN	Heritage Society of Nepal
IBN	Investment Board Nepal
ICIMOD	International Centre for Integrated Mountain Development
IMNCI	Integrated Management of Neonatal and Child Illness
ILO	International Labour Organisation
IPCC	Intergovernmental Panel for Climate Change
IPPAN	Independent Power Producers' Association, Nepal
IUCN-	International Union for Conservation of Nature
JE	Japanese Encephalitis
KUKL	Kathmandu Upatyaka Khanepaani Limited
LDCs	Least Developed Countries
LDOF	Landslide Dam Outburst Flood
LEG	Least Developed Countries Expert Group
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
LWF	Lutheran World Federation
MCPM	Minimum Compliance Performance Measurement
MoAD	Ministry of Agricultural Development
MoCPA	Ministry of Cooperative and Poverty Alleviation
MoCTCA	Ministry of Culture, Tourism and Civil Aviation
MoEd	Ministry of Education
MoEn	Ministry of Energy
MoF	Ministry of Finance
MoFALD	Ministry of Federal Affairs and Local Development
MoFSC	Ministry of Forests and Soil Conservation
MoH	Ministry of Health
MoHA	Ministry of Home Affairs
MoIr	Ministry of Irrigation
MoIC	Ministry of Information and Communication
MoLD	Ministry of Livestock Development,
MoLE	Ministry of Labour and Employment
MoLRM	Ministry of Land Reform and Management
MoPE	Ministry of Population and Environment
MoUD	Ministry of Urban Development
MoWCSW	Ministry of Women, Children and Social Welfare
MoWSS	Ministry of Water Supply and Sanitation
NARA	Nepal Association of Rafting Agents
NARC	Nepal Agricultural Research Council
NAST	Nepal Academy of Science and Technology,

NBSAP	Nepal Biodiversity Strategies and Action Plans,
NCA	Nepal Canyoning Association
NCD	Noncommunicable Disease
NEA	Nepal Electricity Authority
NHRC	Nepal Health Research Council
NLCDC	National Lake Conservation Development Committee
NLSS	Nepal Living Standards Survey
NMA	Nepal Mountaineering Association
NPC	National Planning Commission
NRB	Nepal Rastra Bank
NTA	Nepal Telecommunication Authority
NTB	Nepal Tourism Board
NTFP	Non-timber Forest Product
NTNC	National Trust for Nature Conservation
NWSC	Nepal Water Supply Cooperation
OPD	Outdoor Patient Department
OSR	Own-source Revenue
OPML	Oxford Policy Management Limited
PPCR	Pilot Programme for Climate Resilience
RCP	Representative Concentration Pathway
REDD	Reducing Emissions from Deforestation and Forest Degradation
RIC	REDD Implementation Centre
RoR	Run-of-the-River
RRT	Rapid Response Team
RWH	Rain Water Harvesting
SMART	Simple Measurable Attainable Realistic and Time-bound
SWC	Social Welfare Council
TAAN	Trekking Agents Association of Nepal
Tavg	Average Temperature
Tmax	Maximum Temperature
Tmin	Minimum Temperature
TSS	Total Suspended Solids
U5MR	Under-five Mortality Rate
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VBD	Vector-borne Disease
VPD	Vaccine Preventable Disease
VRA	Vulnerability and Risk Assessment
WASH	Water, Sanitation and Hygiene
WBD	Water-borne Disease
WECS	Water and Energy Commission Secretariat
WFP	World Food Programme
WUSC	Water Users and Sanitation Committee
WS	Water Supply
WT	Water Treatment
WWF	World Wildlife Fund

Chapter 1
Introduction

The Government of Nepal (GoN) has recognised climate change adaptation as fundamental to safeguarding climate vulnerable communities and ecosystems. Nepal is among the leading countries to have made efforts to enhance climate change awareness and to have initiated a government-led process with representation from multi-stakeholders to identify adaptation needs at local and national levels. The country has developed legal policy instruments, devised frameworks and strategies on planning and financing, and implemented a number of projects and programmes to enhance the resilience of people and their livelihoods.

The GoN, as a party to the United Nations Framework Convention on Climate Change (UNFCCC), initiated National Adaptation Plan (NAP) formulation process with a launching workshop held in Kathmandu on 18 September 2015. The NAP formulation process is based on the provisions of Paris Agreement, current country's 14th Plan (FY 2016/17-2018/19) and Nepal's Nationally Determined Contribution (NDC).

The 16th session of Conference of the Parties (COP) to UNFCCC, held in Cancun in 2011, agreed to establish a process to enable Least Developed Countries (LDCs) to formulate and implement NAP, building on the experience gained in preparing and implementing National Adaptation Programmes of Action (NAPA) as a means of identifying medium and long-term adaptation needs. COP 17 held in Durban (2011) laid out the initial guidelines for NAP process, and the LDC Expert Group (LEG) prepared NAP technical guidelines. The agreed overall objectives of NAP process are:

a. reduce vulnerability to the impacts of climate change by building adaptive capacity and resilience; and

b. facilitate 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 NAP formulation process in Nepal is led by the Ministry of Population and Environment (MoPE). MoPE has engaged seven Thematic Working Groups (TWGs) and two Cross-cutting Working Groups (CWGs), which cover the major climate change sensitive sectors. The nine concerned ministries coordinate the respective working groups as per the business allocation rules of the GoN 2015. The TWGs are 1) Agriculture and food security (including nutrition); 2) Forests and biodiversity; 3) Water resources and energy; 4) Public health (WASH); 5) Climate-induced disasters; 6) Urban

settlements and infrastructure; and 7) Tourism, natural and cultural heritage; the CWGs are on 1) Gender and marginal groups (social inclusion), and 2) Livelihoods and governance;

The TWGs and CWGs are currently engaged in technical discussions on the methodology and approaches to carryout theme-based assessment and analysis of climate change impact, vulnerability, and risk. Based on the experiences of NAPA and the design of the Local Adaptation Plans for Action (LAPA), MoPE has initiated the process of devising a country-relevant vulnerability and risk assessment framework for the NAP. The methodology and indicators have been agreed by the TWGs and CWGs, including wider stakeholders engaged in the NAP process.

The assessment of impacts, adaptation, and vulnerability in Nepal's NAP process evaluates how patterns of risk or potential benefit are shifting due to climate change, and considers how impacts and risks related to climate change can be reduced and managed through adaptation. The framework assesses needs, options, opportunities, constraints, resilience, limits, and other aspects associated with adaptation. This document has been prepared to facilitate the process of developing a common understanding on the 'Vulnerability and Risk Assessment (VRA)' methodological framework and tools for Nepal's NAP formulation process. The VRA framework presented here is based on the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and the NAP guidelines, and has been devised for use in the overall vulnerability and risk assessment that is required for NAP formulation process. The methodological process for conducting VRA and the indicators for the thematic sectors and country-specific cross cutting sectors are also presented.

Nepal's NAP formulation process has received support from Action on Climate Today (ACT), a UKAid funded initiative led by Oxford Policy Management Limited (OPML); Practical Action; Support to Rural Livelihoods and Climate Change Adaptation in the Himalayas (Himalica) and the International Centre for Integrated Mountain Development (ICIMOD); and other relevant stakeholders.

Chapter 2
Vulnerability and Risk Assessment Framework

2.1. Relevance of Vulnerability and Risk Assessment in Adaptation Planning

Human interference with the climate system has been ascending and climate change poses risks for both human and natural systems. VRA has been recognised globally as a critical step in adaptation planning and implementation (IPCC 2014a). Many climate change adaptation efforts aim to address the implications or risks of potential changes in the frequency, intensity, and duration of weather and climate events that affect human and natural systems.

An approach based on risk provides a framework for utilising information on the full range of possible outcomes, including not only the most likely outcomes, but also events with low probability but high consequences. Another new element is the recognition of evidence that the impacts of climate change involve a number of interacting factors, with climate change adding new dimensions and complications. The implication is that understanding the impacts of climate change requires a very broad perspective as risk is not only determined by climate and weather events (hazards) but also by the exposure and vulnerability of the human and natural systems to these events (IPCC 2014a).

In order to reduce risk effectively, it is essential to understand how vulnerability is generated, how it increases, and how it builds up (O'Brien et al. 2004). Vulnerability describes a set of conditions among people that derive from both historical and prevailing cultural, social, environmental, political, and economic contexts. In this sense, vulnerable groups are not only at risk because they are exposed to a hazard, but also as a result of marginality, of everyday patterns of social interaction and organisation, and of access or lack of access to resources (Watts and Bohle 1993; Morrow 1999; Bank off 2004). Thus, the effects of a disaster on any particular household, community, or system result from a complex set of drivers and interacting conditions.

Adaptive capacity is another important element in most conceptual frameworks of vulnerability and risk. It refers to the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC 2014). The adaptive capacity of the individual, communities, and the government also matters for reducing impact of climate change (Sharma and Patwardhan 2008).

VRA is an important element in the NAP formulation process. Climate risk analysis will help Nepal

identify adaptation deficits, and will guide the selection of vulnerable and at-risk geographical areas, physiographic regions, populations, and resources. This will facilitate the identification of adaptation options and ultimately guide in compiling the medium and long-term adaptation needs and priorities of the country, while devising strategies for mainstreaming climate change adaptation in development policies and plans.

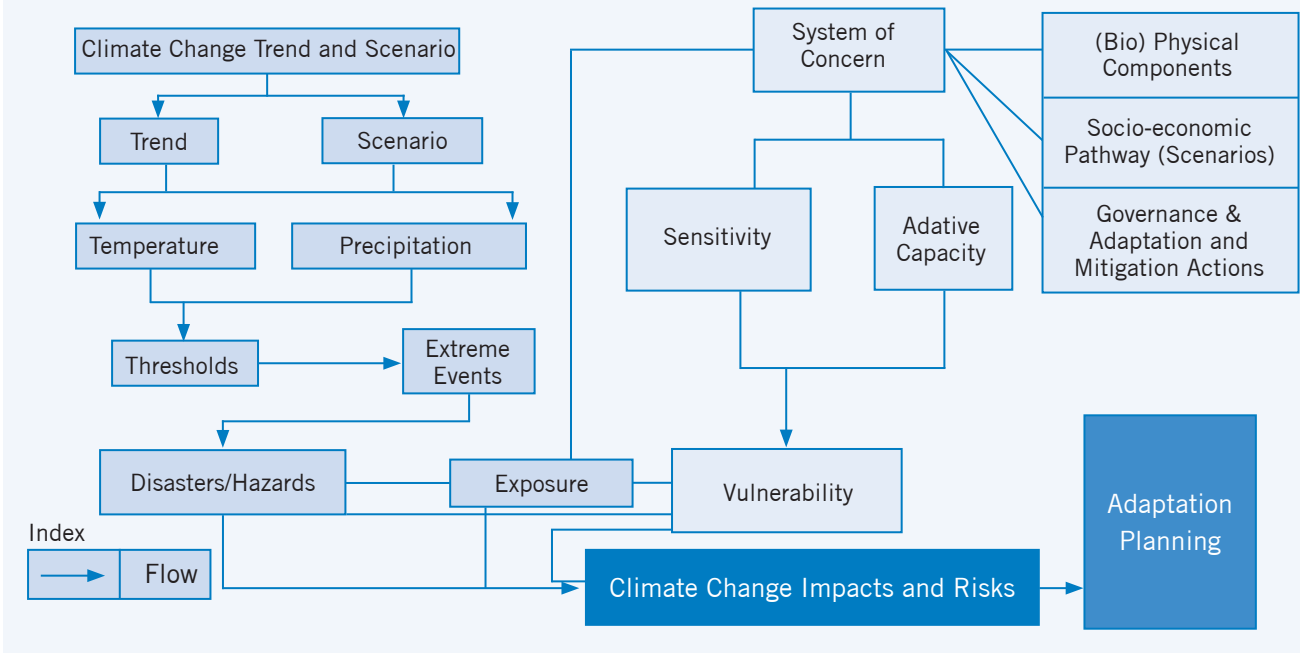
2.2. Conceptual Framework for Vulnerability and Risk Assessment

Nepal's NAP formulation process has proposed a framework for vulnerability and risk assessment (VRA) using IPCC-AR 5 as a base. The IPCC framework considers risk as a function of hazard, exposure, and vulnerability. The proposed framework unpacks the elements of risk and customises them to needs and applicability in the national context. The framework assumes that the risk of climate related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the exposure and vulnerability of human and natural systems. Changes in the climate system (trends and scenarios), biophysical system, and socio-economic processes (including governance and adaptation and mitigation actions) are drivers of hazards, exposure, and vulnerability.

The definitions of key terminologies used in the framework, which guide the overall assessment and analysis, are given below in alphabetical order (IPCC 2014b):

- **Adaptive capacity (in relation to climate change impacts):** The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of climate change.
- **Climate trends:** Patterns in climate variables such as temperature and precipitation observed in historic datasets.
- **Climate projection:** A projection of the response of climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasise that climate projections depend upon the emission/concentration/radiative forcing scenario used, and that these scenarios are subject to substantial uncertainty as they are based on assumptions concerning future socio-economic and technological developments and others that may or may not be realised.

Climate Change Vulnerability and Risk Assessment Framework



- **Climate extreme events:** The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) end of the observed values of the variable such as high temperatures (e.g., heat waves), or extremely heavy rainfall.

- **Disaster:** Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.

- **Exposure:** The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

- **Hazard:** The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss of property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.

- **Impacts:** Effects on natural and human systems. In this report, the term impact is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction between climate changes or hazardous climatic events occurring within a specific time period, and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are subset of impacts called physical impacts.

- **Risk:** The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends were to occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risk of climate-change impacts.

- **Sensitivity:** Predisposition of society and ecosystems to suffer harm as a consequence of intrinsic and context conditions making it plausible that such systems once impacted will collapse or experience major harm and damage due to the influence of a hazard event.

- **Threshold:** A critical limit within the climate system that induces a non-linear response to a given forcing.

- **Vulnerability:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

2.3. Assessment Methods and Approaches

Although there are various ways of calculating vulnerability and risk, the framework proposed by Nepal mostly refers to IPCC-AR5. The assessment approach includes both impacts that have already occurred and the risk of future impacts, and especially the way that such risks are anticipated to change with climate change and with investments in adaptation. For both past impact and future risk, a core focus of the assessment depends on characterising vulnerability, disasters/hazards, and exposure. Nepal's NAP process will use climate scenario analyses, emission scenarios, and socio-economic pathways available from national, regional and international research centres to characterise broad future climate risk and the level of uncertainty.

Characterising current and past climate is an important step in understanding climate change and climate variability. A climate trend analysis for Nepal is being prepared using daily temperature and precipitation data since past 30 years to

represent baseline climate, and projections to represent future climate scenarios. It will use data collected and managed by the Department of Hydrology and Meteorology (DHM) through various stations across Nepal.

For the baseline, a gridded dataset will be prepared for 0.01 degree (1 km x 1 km) using a suitable methodology specific for mountain conditions for the interpolation of temperature and precipitation data. The assessment will include calculation of a Nepal average, individual district averages, and individual physiographic zone averages for annual and seasonal precipitation, and maximum and minimum temperatures, for each year (1971–2015) using the gridded data. The assessment will also calculate precipitation and temperature trends for annual, seasonal (four seasons), and decadal trends at different spatial resolutions (district, physiographic zone).

The climate scenarios for Nepal to be used in the analysis will be derived from representative climate models for the Hindu Kush Himalayan (HKH) region using the advanced envelope-based selection approach proposed by Lutz et al. (2016). This approach includes 94 General Circulation Models (GCMs) for the Representative Concentration Pathway (RCP) 4.5 and 69 GCMs for RCP 8.5. In the first step, 20 GCMs were selected for each RCP based on changes in mean air temperature and annual precipitation. In the second step, the GCMs were refined based on projected changes in four indices for climate extremes (extreme wet days, consecutive dry days, warm spell duration index, cold spell duration), resulting in the selection of 8 GCMs for each RCP. In the third step, four of these GCMs were selected for each RCP based on the skill of the models in simulating the annual cycle of air temperature and precipitation for the Himalayan region. The reference dataset (1981–2010) for precipitation was taken from Watch Forcing Data ERA-Interim (WFDEI) bias-corrected using Global Precipitation Climatology Centre (GPCC) and observed glacier mass balance data. The temperature data were bias corrected using observed station data from the region. The GCM datasets were downscaled to 10 km resolution using the quantile mapping method. The data cover the period from 2011 to 2100 for precipitation, Tmax, Tmin, and Tavg. The projected data will be compared with the reference dataset to assess changes in precipitation and temperature. Two future scenarios have been proposed in order to match the changes under future projections with NAP's medium and long-term periods: medium term (2015–2045) representing 2030, and long-term (2035-–2065) representing 2050. Climate change scenarios in the form of changes in precipitation and temperature will bee estimated for the whole of Nepal, with disaggregated values extracted for districts, development regions, and physiographic zones. In addition to climate scenarios, different socio-economic pathways will be also be used in the scenario analysis.

Disasters and hazards will be assessed by observing past and current impacts of extreme events and potential future occurrences of hazardous events. Exposure will be assessed based on the presence of people, ecosystems, resources, infrastructure, and others in places and settings that are currently impacted or could be affected. Vulnerability is a function of the sensitivity and adaptive capacity of exposed units and systems and will be assessed by looking at how sensitive or susceptible the exposed system is to harm, and the capacity of the system to cope or adapt to the impacts. Risk is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends were to occur. Risk results from the interaction of vulnerability, exposure, and hazard. All these assessment elements will provide guidance for identifying medium and long-term adaptation options.

The VRA is based on integration and complementarity of science-first (top-down) and policy-first (bottom-up) approaches. No single approach will be entirely adequate and successful and adaptation assessment and planning will require a careful mix of the two approaches. This integrated approach is particularly relevant in the context of Nepal to bridge the gap in information and knowledge on climate change. The top-down approach involves long-term regional climate change modelling and impact projections and identification of adaptation strategies using technological cost-benefit analyses (Kelly and Adger 2000). The bottom-up or community-based approach involves engaging local stakeholders and communities by encouraging self-assessment

of climate impacts from experience and practice (Van Aalst et al. 2008). The bottom-up approach mostly relies on local and regional level consultations, field observations, and interactions with climate vulnerable households and communities. Guidelines and toolkits available at national, regional, and global levels will be used to analyse climate change impacts, vulnerability, and risk. The tools will be selected based on the assessment scale (local or national), data needs, outputs, and applicability.

The VRA will be guided by the indicators that have been identified to quantify or qualify hazards, exposure, and vulnerability. Data for the indicators will be acquired from national repositories such as the Central Bureau of Statistics (CBS), specialised organisations, concerned ministries, local development agencies, and others. Data gaps for critical indicators will be filled using different levels of consultation, literature reviews, and field observations. Weightage for indicators will be decided on the basis of international practice, national circumstances and development priorities, and expert judgment. All data will be normalised using standard statistical formulae, and results will be ranked.

The outputs of the VRA, as indicated in the NAP technical guidelines, comprise lists of vulnerability and risk including a description of the context, root causes, trends, and potential assumptions. The factors used to help characterise vulnerability and risk include magnitude, timing, persistence and reversibility, likelihood, distributional aspects, importance of the risk systems, potential for adaptation, and thresholds or trigger points (spatial, temporal, social, cultural, economic, and others). Once identified, the vulnerability and risks will be ranked in terms of threat and impact. The ranking criteria for climate risks include, but are not limited to, the order of magnitude of the potential climate change impacts, probability and level of confidence, reversibility, urgency of action, biophysical sensitivity, type of impact, and other factors such as policy relevance and development priorities. The ranking of climate risks will be carried out in a participatory consultative process. The outputs of the assessment will include individual and composite maps; tables of hazards, exposure, and vulnerability; and a risk index. These will be used to prepare the final NAP document.

2.4. Key methodological steps for VRA assessment

The methodological steps used to analyse current climate and future climate change scenarios, assess climate vulnerability and risk, and identify adaptation options at multiple scales, regions, and sectors are as follows:

Step 1

Scoping vulnerability and risk: The scoping task is an important step to set the boundaries for the vulnerability and risk assessment methodology. This process involves stocktaking of existing methodology, approaches, and frameworks for undertaking vulnerability and risk assessment. It also helps in understanding the divergent concepts and terminologies used by the IPCC and UNFCCC reference documents.

Step 2

Developing the VRA framework: The NAP technical guidelines allow countries to develop their own country-specific frameworks for assessing vulnerability and risk. The VRA framework developed by Nepal will be very useful in terms of guiding the assessment and illustrating the logical linkages between hazard, exposure, vulnerability, and risk leading to adaptation planning.

Step 3

Identifying key indicators for hazard, exposure, and vulnerability (sensitivity and adaptive capacity) for different thematic and cross-cutting areas: The main purpose of this step is to outline the most relevant indicators to measure and assess trends in hazards, exposure elements, state of sensitivity, and adaptive capacity of people and systems. The indicators will be used for both quantifying and qualifying the extent, trends, and future scenarios of the assessment units.

Step 4

Exploring data sources, nature, and character: The data sources will determine the availability and quality of data. Daily data from DHM stations will be used for climate trends and scenarios, together with data from several other regional and global

centres. The major sources for socio-economic data are the CBS and relevant ministries. Sector specific data will be derived from relevant government agencies and institutions.

Step 5

Data collection, tabulation, filtering, and normalisation: This step involves data collection from various sources such as government, regional and global centres, international and national organisations, and other national and local stakeholders. After the data has been collected, it will be tabulated, filtered, and normalised.

Step 6

Weightage and composite value: The data will be given weightage and composite values during the analysis process. The criteria and weightage indices will be developed based on national consultations and expert opinion.

Step 7

Analysis of data: This stage involves analysing the data to identify trends in variables and indices that could be useful to support planning and decision making. This step also involves characterising broad future climate risks and levels of uncertainty through climate and socio-economic scenarios.

Step 8

Identifying climate change impact and risk: The analysis will generate products for climate trends and scenarios, observed and projected impacts, risks, and vulnerability. It will rank climate change impacts and risks at sectoral and national levels. The ranking will be achieved through a consultative process. The identified impacts and risks will help in designing adaptation options for the NAP.

Chapter 3
Indicators for Vulnerability and Risk Assessment

Indicators are measurable variables used to represent an associated (but non-measured or non-measurable) factor or quantity. Indicators are also observations or calculations that can be used to track conditions and trends. In the NAP process, indicators refer to the representation of associated elements of analysis such as exposure, sensitivity, and adaptive capacity. The indicators have been chosen so as to achieve the twin objectives of the NAP: (1) to reduce vulnerability to the impacts of climate change by building adaptive capacity and resilience; and (2) to facilitate the integration of climate change adaptation into relevant new and existing policies, programmes, and activities in a coherent manner, in particular into development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The overall purpose of selecting indicators for the vulnerability and risk assessment for the NAP is to support systematic assessment of the elements of hazard, exposure, sensitivity, and adaptive capacity. The following process-based individual and collective steps were used to develop Specific, Measurable, Realistic, and Time-bound (SMART) indicators for the VRA:

- Reviewing the IPCC definitions of hazard, exposure, and vulnerability (sensitivity and adaptive capacity), which together form risk.
- Grouping of hazards into (a) climatic extreme events (e.g., consecutive dry, wet, hot, or cold days; extreme rainfall), (b) climate-induced hazards (e.g., flood, GLOF, landslide, heat wave, cold wave, wind storm), and (c) sector-specific hazards (e.g., urban floods).
- Listing of indicators for exposure encompassing the system of concern.
- Listing of indicators for adaptive capacity and sensitivity of the exposed system (or elements) taking into account physical factors (e.g., presence of infrastructure) and socio-economic factors (e.g., age, income, gender).
- Compiling indicators as a 'long-list', together with units of measurement and data sources.
- Sharing of indicators with thematic and cross cutting working group members and experts, and preparation of draft shortlist of indicators.
- Finalising the indicators after soliciting feedback from all the thematic and cross-cutting working groups including relevant institutions.
- Agreeing on probable data sources and the process of data collection.

The process of developing indicators engaged all members of the seven thematic working groups and two cross-cutting areas. There were also

several consultations with experts and relevant institutions working on climate change in Nepal. The indicators agreed for each thematic and cross-cutting sector are presented in this report in the following sections.

3.1. Vulnerability and Risk Assessment Indicators for Agriculture and Food Security (Nutrition)

The agriculture, fishery, and livestock sectors play a key role in supporting Nepal's economic growth, local livelihoods, and food security. Agriculture contributes one-third of national Gross Domestic Product (GDP) and supports the livelihoods of two-thirds of the population. Although the majority of the population is engaged in agriculture, the sector is not fully developed. Productivity and competitiveness are low, adoption of improved technology is limited, and even though most cultivated areas are devoted to cereal crops, there is a growing food deficit and malnutrition is high (MoAD 2014). The indicators agreed for assessment of hazard, exposure, sensitivity, and adaptive capacity in the agriculture and food security sector are summarized briefly in the following and listed in the tables below.

The issue of climate change has now joined the existing challenges in the agricultural sector. The evidence on climate change in Nepal indicates increasing temperatures and changing patterns of precipitation. The major hazards and climate extreme events that impact agriculture and food security are extreme hot and cold days, consecutive wet and dry days, extreme weather variability, and climate-induced hazards such as floods, landslides, crop inundation, drought, and hailstorms. These have negative impacts on crop and livestock productivity and food supply systems, which in turn have major implications for the livelihoods of poor and vulnerable households. The increasing trends in temperature and extreme events are high potential hazards for agriculture. The National Adaptation Plan (NAP) has identified agriculture and food security (nutrition) as a major thematic sector for adaptation planning. Within this, there are key focus areas of concern in terms of climate change impacts and adaptation planning. As part of the NAP process, the stocktaking exercise identified four systems which directly support the livelihoods, food security, and GDP of the nation: agriculture, apiculture, and horticulture; livestock and poultry; fisheries; and food security and nutrition. These systems are highly exposed and sensitive to climate change impacts.

Agricultural resources, infrastructure and services, farming systems, and the population dependent on this sector are **exposed** to climate change hazards and extreme events. The exposure elements identified in the agriculture and food security thematic sector are farming population dependent on agriculture (field crops, horticulture, apiculture, and livestock rearing); water bodies and surface irrigation schemes; fish farms and ponds; agricultural land area; population of livestock; poultry farms; horticultural area; rangeland area, including grass and fodder; agricultural road and market network; and agricultural labour population.

The sensitivity of the agriculture and food security thematic sector rests on a number of factors. The key indicators for **sensitivity** include income disparity; landholding capacity, land ownership, and tenure; livelihood dependency on agriculture; geography and access; gender inequality; seasonal and out migration; population structure; geomorphology; farming system; cropping pattern; land use and land cover change; productivity and distribution; age factor; and food stability.

The overall **adaptive capacity** is assessed as an accumulation of determinants such as socio-economy, policies and institutions,technological infrastructure, environment, and financial and governance system. The indicators broadly include the availability of income, assets, and livelihood diversification; improved infrastructure; access to technology and decision-making for a; changed cropping, livestock, and aquaculture practices; new crop and animal varieties/breeds; indigenous, traditional, and local knowledge, technologies, and methods; efficient irrigation; water-saving technologies; conservation agriculture; food storage and preservation facilities; early warning systems; improved policy and agricultural services (decentralized extension system); financial incentives (insurance and financial services); and adaptation projects and programmes.

1. Indicators for hazard

Elements of hazard	Data source
Climate extreme events: - Extreme heat - Consecutive dry days - Consecutive cold days - Heat waves - Cold waves (fog) - Extreme weather variability - Warm, cold, dry and wet spell	DHM
Climate-induced hazards: - Flood - Drought - Landslides - Hailstorm	DHM, ICIMOD, MoHA
Sector specific hazards: - Crop inundation - Seasonal shift/temporal variability - Shifting of temperature is olines - Irrigation sediment - Pests and diseases outbreak	MoAD, DHM, MoIr, MoAD

2. Indicators for exposure

Elements of Exposure	Unit	Data source
Farming population (agriculture, horticulture, apiculture, livestock)	HH	CBS, Agri. stat.
Irrigation schemes	No./Km	MoI DoI, ICIMOD
Fish farms and ponds: - Number - Area	 No. Ha	MoAD, Agi Stat,
Agricultural land area	Ha	CBS, Agri. stat.
Population of livestock	No.	CBS, Agri. stat.
Poultry farms	No.	CBS, Agri. stat.
Horticulture area	Ha	CBS, Agri. stat.
Rangeland area	Ha	MoLD, RIC
Agriculture road and market network: - Road length - Markets	 Km No.	DoLIDAR
Agriculture labour population	No.	CBS
Agro-eco systems: - Types - Area	 No. Ha	NARC

3. Indicators for sensitivity

Sub-system	Elements of Sensitivity	Unit	Data source
Agriculture, apiculture and horticulture	Income disparity	HH, %	CBS, UNDP
	Land holding, land ownership and tenure	HH %	CBS, Agri.Stat.
	Livelihood dependency on agri-culture	HH %	CBS, MoAD
	Geography and access	Index	CBS
	Gender inequality	Index	CBS, District Profile
	Seasonal and out migration	No.	CBS, DoS, MoAD
	Population structure	No. %	
	Geomorphology (edaphic factor, aspects, altitude, terrain)	Index	ICIMOD, NARC
	Farming system (rain-fed, single)	Ha/Type	NARC
	Cropping pattern	Ha	NARC
	Land cover and land use change	Ha	CBS, MoFSC
	Species composition	Index	MoAD, NARC
	Phenological characteristic changes	Index	MoAD, NARC
Livestock and poultry	Cattle shed structure: - Type - Number	 Type No.	MoLD, RIC
	Livestock rearing practices	Type	MoLD
	Pressure on rangeland	Ratio	MoLD, MoFSC
Fisheries	Productivity and distribution	Mt/ha	MoAD, Agri. Stat.
Food security and nutrition	Living standard	Index	NLSS
	Age factor	Index	
	Food stability	Index	

4. Indicators for adaptive capacity

Sub-system	Elements of adaptive capacity	Unit	Data source
Agriculture, apiculture and horticulture	Availability of irrigation: - Source - Coverage - Type - Functional structure	No. Ha, Km	MoI, MoAD, Agri. Stat., Agri. Census
	Agro-biodiversity pocket	No. Ha	MoAD, NARC, LI-BIRD
	Use of efficient agro-tools and implements (modern, indigenous)	No.	MoAD, Agri. Stat., CBS
	Use of environment-friendly technology and practices	No.	MoAD, NARC, Agri. Stat.
	Transportation facilities, market structures, collection centres, storage centres, warehouse and network	Km No.	MoAD, Agri. Stat., CBS
	Service (decentralized extension) centres, technology (early warning system) and human resource (including agriculture advisory system)	No.	MoAD
	Availability of stress/flood tolerant genotypes, community seed banks and gene banks (indigenous and underutilized)	No.	MoAD, NARC, LI-BIRD
	Government budget/investment in agriculture including human resources available	NRs/No.	MoAD, MoF
	Insurance and financial services*	No.	NRB, Insurance companies
	Farmers groups, cooperatives and networks	No.	MoAD, MoCPA
	State investment and GDP contribution*	NRs	MoF, NPC, MOAD, MoLD
	Policy, program and project support*	No. HH	NPC
	Income poverty*	HH, %	UNDP
	Agro-based industries, enterprises and employment*	No.	MoAD, FNCCI, DoIn., CBS
Livestock and poultry	Availability of water facilities	No.	MoLD, Agri. Stat., CBS, MoI
	Housing system	Type	MoLD, CBS
	Use of improved breed	No.	MoLS
	Use of improved technologies	No. HH	MoLD
	Service centres (resources and infrastructure)	No.	MoLD
	Availability of stress tolerant genotypes of fodder	No.	MoLD, NARC
	Availability of fodder and forage area	Ha	MoLD
	Rangeland carrying capacity	LSU/ha	MoLD, RIC

Fisheries	Pond structure	No.	DoFish
	Water sources	Ha, km	
	Insurance	No	
	Market networks	No	
	Hatchery	No	
	Road access	Km	
	Adaptive breeds	No	
Food security and nutrition	Food sufficiency	No/Ha/ months	MoH, WFP, FAO, MoAD, NPC, MOF
	Nutrition status		
	Storage		
	Distribution channel		
	Food diversity		
	Food accessibility		
	Health		
	Food utilization		

* Used for other sub-sectors

3.2. Vulnerability and Risk Assesment (VRA) Indicators for Climate-induced Disasters

Nepal is exposed to extreme climate events such as extreme hot and cold days, and extreme dry and wet days. The country is also experiencing increased frequency, intensity, and magnitude of climate-induced disasters such as floods, landslides, droughts, windstorms, hailstorms, cloudbursts, fires, and epidemics. Evidence shows that 49 of Nepal's 75 districts are prone to floods and/or landslides, 23 to wildfires, and 1 to windstorms (NDR 2009). In 2016, the Global Climate Risk Index ranked Nepal as the 17th most climate vulnerable country (Kreft et al. 2016).

Climate change and the associated hazards will affect many components of human security in addition to inhibiting sustainable development in the areas of natural and built environment, livelihoods, food security, individual and public health, personal security, community sustainability, and culture. The records show that between 1971 and 2010, climate-related disasters accounted for close to 25% of deaths, 84% of disasters, and 76% of economic losses in the country. The Nepal Disaster Report 2015 shows that disasters have a negative impact on the nation's social and economic development (MoHA 2015).

The economic impacts of climate change are significant and are likely to result in a major setback to national GDP. The impacts of climate variability and extreme events are currently dominated by floods, but they also include rainfall variability, which affects agriculture (rain-fed agriculture, soil erosion, droughts), and low season river flows,which reduce hydroelectricity generation. The direct cost of these events is equivalent to 1.5–2% of current GDP/year (approximately USD 270–360 million at 2013 prices), and as much as 5% in extreme years. The economic costs of droughts are also extremely high. The drought events in 2006 and 2009 incurred estimated direct economic costs from lost agricultural output equivalent to 1.9% and 0.4% of GDP, respectively (IDS-Nepal et al. 2014).

Two sets of indicators have been identified for the thematic sector on climate-induced disaster: one related to the impacts of disaster matched by the system of concern, and the other the adaptive capacity to deal with these impacts. The indicators are in line with the identified hazards which are categorized as 1) climate extreme events, 2) climate-induced hazards, and 3) non-climatic hazards potentially affected and/or triggered by climate change (secondary hazards). The hazards are also categorized as rapid or slow onset types. Floods and landslides are considered rapid onset disasters, while drought, forest fires, snow melt, and regional sedimentation are slow onset disasters.

The impacts of such climate-related extremes include alteration of ecosystems, disruption of food production systems and water supply, damage to infrastructure and settlements, morbidity and mortality, and consequences for mental health and human well-being. Population, settlements, different kinds of infrastructure, natural resources, and cultural sites are exposed to climate-induced hazards and risks. The exposure varies with location and setting.

Adaptive capacity is a function of social, cultural, natural, economic, technological, and infrastructural factors. The indicators for adaptive capacity in this thematic area include policy and institutional response; technologies and tools, such as early warning systems and agriculture information management systems; financial mechanisms, such as insurance and investments; disaster risk reduction activities, including increased capacity for disaster preparedness and response (relief, rehabilitation, and preparedness); and household adaptive capacity indicators such as income and other social and economic assets.

1. Indicators for hazard

Elements of Hazard	Data source
Climate extreme events: - Cold and heat waves - Thunderbolts/hailstorm/snowstorm - Windstorms - Consecutive cold days - Consecutive hot days - Consecutive wet days - Consecutive dry days - Extreme rainfall/snowfall	DHM, ICIMOD
Climate-induced disasters: - Floods - Landslides - Glacier Lake Outburst Flood (GLOF) - Droughts/dry spell - Urban flooding - Fire - Avalanche - LDOF	MoHA
Hazards potentially triggered by climate change (secondary hazards): - Epidemics/diseases - Famine - Pest outbreak - Invasive species - Sediments	MoAD

2. Indicators for impact of disasters

System/Sub-system	Elements of impact	Unit	Data source
Human capital	Death	No.	MoHA, DWIDM, District offices, CBS
	People missing	No.	
	Affected family/population	No.	
	People injured	No.	
	People displaced	No.	
	Displaced family	No.	
Natural	Forest area loss	Ha	DoF
	Agricultural area loss	Ha	DoA
	Water sources/ springs/ lakes/ ponds/ reservoirs etc.	No.	MoAD, MoE, DoF, MoFALD, MoWR
Physical	Government houses fully damaged	No.	MoHA, DWIDM, CBS
	Government houses partially damaged	No.	
	Private houses fully damaged	No.	
	Private houses partially damaged	No.	
	Settlements affected	No.	DWIDM, MoHA, DDC
	Community buildings destroyed	No.	DDC
	Roads destroyed	Km.	DoR, DoLIDAR, CBS
	Bridges destroyed	No.	DoR, CBS
	Water supply system affected	No.	DWSS
	Sewerage system damaged	No.	DWSS
	Hospitals damaged	No.	MoH
	Health posts damaged	No.	
	Schools/colleges damaged	No.	CBS, MoE
	Communication towers affected	No.	MoIC
	Irrigation facilities affected	No.	MoI
	Hydropower damaged	No.	MoE, AEPC
	Cultural and religious sites destroyed (temples and monasteries)	No.	MoCTCA
Financial	Estimated loss of property	NPR	MoHA
	Loss of cattle	No.	
	Loss of crop	NPR	

3. Indicators for adaptive capacity

System/Sub-system	Elements of Adaptive capacity	Unit	Data source
Human capital	Human Development Index (HDI)	Index	CBS, MoHA, UNDP, DWIDM
	Skilled human resource for DRR: - People trained in search and rescue - Women trained in search and rescue - Firefighters - Trained in First aid - Trained in Shelter management - Counsellors	 No. No. No. No. No. No.	
	People employed	No.	
	Gender inequality	Index	
	Specialised response team for particular disaster (flood, fire)	No.	
	People having disaster risk knowledge	No.	
Social capital	Community DRR response groups	No.	MoHA, MoFALD, NPC, DDC, political manifesto, MoCPA
	Community organisations and advocacy networks	No.	
	Existence of social support system / culture of support to victims / safety nets	Yes/No	
	Institutions at various levels to prepare and respond to disasters	No. Coverage	
	Political commitment to DRR	Political manifesto	
	DRM policy, plan and strategy, programs and projects	No.	
	Saving and credit groups and cooperatives	No.	
Natural capital	Access to natural resources (forest, water, land) for recovery	Yes/No	MoAD, MoE, DoF, MoFALD, MoWR
	Natural resource based livelihood options	No.	
Physical capital	Access to weather information services	Coverage	DHM, MoHA, UNDP, DoF, DoLIDAR, DoH, MoH, NEA, CBS, DDRC, NRCS, Nepal Police, DDC
	Access to early warning system	Coverage	
	Emergency response equipment and infrastructure: - Ambulance (helicopter) - Fire-fighters - Rescue shelters - Open space - Road connectivity - Bridges - Hospital services - Electricity access - Warehouse - Pre-positioning of disaster rescue and relief items	 No. No. No. Area Km No. No. No. No. No/hh coverage.	
	Communication – TV, radio, mobile/phone	No.	
	Access to seeds and planning material (seed bank, gene bank)	No. Tons	

Financial capital	Budget allocation to Disaster Risk Management (DRM) at national and local level	%	MoF, NPC, MoFALD, DDC, PM office, DoF, MoHA, Bima Samiti, Sahakari Board
	DRM Fund at national and local levels	NPR	
	Insurance: - People - Assets (livestock, crop, house, business, etc.)	% NPR	
	Access to credit	No./NPR	
	Access to saving	NPR	

3.3. Vulnerability and Risk Assessment Indicators for Forest and Biodiversity

A healthy environment, the availability and quality of natural resources, and rich biodiversity are critical components for life-supporting systems and key determinants of economic performance. Nepal's unique geography, with its dramatic changes in elevation along a relatively short north-south transect (150–250 km) and related variability in physiographic and climatic conditions, is associated with a uniquely rich diversity of flora and fauna. Occupying an area of only 0.1% of the global map, Nepal is home to 3.2% of the world's flora and 1.1% of the fauna. Of these, 350 floral species and 160 faunal species are endemic to Nepal (found nowhere else in the world) (MoFSC 2010).

Nepal has 118 ecosystems, 75 vegetation types, and 35 forest types. Forests cover about 45% of the country's land area and are Nepal's prime natural resource. The forestry sector is estimated to contribute between3.5% (FAO 2009) and 15% (MoFSC 2010) of Nepal's national GDP, compared to around 1% globally.

The prevailing climate influences the status and quality of biodiversity and ecosystems, and any change in climatic conditions directly affects their function. Nepal is experiencing changes in climate, and the impacts of both slow and rapid onset climatic phenomena on natural resources and the environment is evident. Changes in temperature patterns during the past century have affected the length of the growing season resulting in significant implications for species growth and production. Sector specific hazards, such as forest fire, diseases and pests, and intrusion of alien invasive species, have had a negative impact on forests and biodiversity. The expansion of invasive species in Nepal's forests is considered an important driver of forest degradation in the country.

Forest and biodiversity is considered to be one of the crucial climate sensitive thematic sectors in Nepal's NAP process. As physically exposed assets, their growth and sustenance are broadly dependent on climatic and edaphic factors. Exposed elements within the forest and biodiversity thematic sector include biophysical and socio-economic elements, such as forests, water bodies, ecosystems, watersheds, and flora and fauna, and forest dependent populations, including indigenous communities.

Indicators for vulnerability are drawn from the sector's sensitivity and adaptive capacity. Sensitivity indicators for biophysical elements include forest growth, productivity, and species distribution; bottlenecks for faunal migration; habitat fragmentation, and pressure on forest and biodiversity resources, and phenological changes. The sensitivity indicators for forest dependent communities include the economic status of households, extent of dependence on forest resources, and gender and ethnicity.

The adaptive capacity of forests and biodiversity is determined by the richness of natural resources, existing policies and response mechanisms, and capability of both ecosystems and human population to respond to climate change impacts. Some of the indicators for assessing adaptive capacity in this sector include forest management regimes, ecosystem richness, availability of forest and biodiversity resources, ecosystem health, available human resources and services, existing infrastructure, income and employment from the forestry sector, and government policies, plans, programmes, and investments.

1. Indicators for hazards

Elements of Hazards	Data source**
Climate extreme events: – Extreme heat – Consecutive dry days – Consecutive wet days – Heat wave – Cold wave	DHM
Climate-induced hazards: – Landslides – Floods – GLOF – Windstorm – Hailstorm – Extreme snowfall – Droughts	MoHA, ICIMOD DWIDM DoF, MoAD,
Sector specific hazards: – Diseases and pests – Forest fires – Expansion of alien invasive species	DNPWC, DFRS, DPR WWF, NTNC, DPR, IUCN

2. Indicators for exposure

Elements of Exposure	Unit**	Data source**
Forest coverage	Ha	DFRS/FRA, REDD IC, DoF, DFO, ICIMOD
Floral species diversity	No.	DFRS, DPR, DNPWC, DoF, IUCN
Faunal species diversity	No.	DNPWC, DFRS, DPR, IUCN, DoF
Watersheds	No. Ha	DSCWM, NLCDC, IUCN
Ecosystems: types and area • Forest • Wetland • Rangeland • Agro-ecosystem • Mountain/glacial/rock	No. Ha	DNPWC, DFRS, DoF, IUCN, NLCDC, RIC, MoLD, MoFSC/ NBSAP, NARC
Forest dependent human population, indigenous community/households, marginalised households	No.	MoFSC, CBS,
Forest based industries/enterprises	No.	DoF, DoI

3. Indicators for sensitivity

Elements of Sensitivity	Unit	Data Source
Forest growth Forest productivity Species distribution	Tonne/ha/Year	DFRS, ICIMOD Generate from case studies
Bottlenecks (corridors and linkages)	No.	DNPWC
Habitat fragmentation	Ha	DNPWC, ICIMOD, WWF
Phenological changes	Species, %	DFRS, DPR, ICIMOD

4. Indicators for adaptive capacity

Sectors (sub-system)	Elements of Adaptive capacity	Unit**	Data Source**
Forestry	Availability of water bodies	No. Ha	MoFSC, ICIMOD
	Forest types (composition)	No. Ha	DFRS, DoF, DNPWC, DPR
	Forest growing stock Forest regeneration	m^3/Ha (mode) No./ha	DFRS, DoF
	Location and physical access to forest	Ha No.	DoF
	Forest actors, institutions*	No.	MoFSC, DoF, DFO, DNPWC
	Policy, programme, projects*	No. coverage	MoFSC
	Human resources *	No.	MoFSC
	Forest management regimes Revenue and expenditure	No. Ha NPR	DNPWC, DoF
	Response mechanism and capacity (e.g. combating forest fires) Recovery mechanism and capacity (e.g. plantation, protection)	No. NPR	DoF, DNPWC
	National annual budget and expenditure*	NPR	MoFSC
	Income and employment from forestry enterprises*	NPR No.	DoF
	Forest roads and fire lines	Km	DoF, DNPWC
Biodiversity	Buffer Zones	No. area	DNPWC
	Floral and faunal species' richness (species diversity index)	Diversity index	DNPWC, DPR, IUCN, NAST, WWF, DoF
	Ecotones	No.	DNPWC, NTNC, WWF, DFO
	Suitable habitats for flagship species	Ha	DNPWC, NTNC, WWF, DoF
	Corridors	Ha	WWF, DNPWC
	Revenue and expenditure in PAs	NPR	DNPWC, NTNC, NTB

* indicates that the indicators are applicable to all sub-systems

3.4. Vulnerability and Risk Assessment Indicators for Gender and Marginalised Group (Social Inclusion)

The impacts of climate change fall on people differently, with those already suffering from socio-economic disadvantage affected disproportionately. Gender determines social space and the availability or non-availability of opportunities to women and men, thereby influencing both vulnerability and the ability to prepare, respond, and recover in the wake of disaster. Existing vulnerabilities are further complicated by gendered power relations. In other words, existing inequalities compound vulnerability and are exacerbated by disasters. Thus the risk of and vulnerability to the impacts of climate change are higher for socially and geographically marginalised and excluded groups like Dalits, Madhesi, Muslims, Aadibasi, Janajati, and others.

In Nepal, women and men have unequal access to natural resources and land ownership; women have limited opportunities to participate in decision making and limited access to markets, capital, training, and technology. They also largely work as farmers, caretakers, and in informal sectors, and their work is not recognized. During extreme events, women often experience additional duties as caregivers and, due to the high rate of male outmigration, may be responsible for an entire household. Thus they may face particular challenges including psychological and emotional distress, reduced food intake, and adverse mental health outcomes resulting, for example, from displacement (IPCC 2014). Women-headed households now comprise 25.7% of all households in Nepal, and women own 26% of property (GoN/UNDP 2014). Approximately 70% of women are employed in agriculture contributing 60.5% of the agricultural economy (Gurung and Bisht 2014).

The extreme variability in weather and increasing number of **climate extreme events and climate-induced disasters,** such as extreme rainfall, hot and cold days, flooding, drought, and landslides, are having a direct impact on farming systems. The impacts of climate change are expected to be greater for those whose livelihoods depend on natural resources, who often belong to marginalised groups. In rural areas, women are also primarily responsible for collecting water and firewood. Hence the drying up of springs and other water sources has particular gendered implications.

Climate change impacts everyone, but its impacts are not distributed equally; the **exposed** elements in the gender and social inclusion thematic areas of NAP include women, men, marginalised and socially excluded populations,and occupational and livelihood groups such as fisher folks, wage labourers, and herding communities. Climate sensitive natural resources, such as water bodies, forest and agriculture, infrastructure, and services that women and marginalised groups depend on, are also included as exposure units.

Vulnerability and risk provides information on how ecosystems and populations characterised by social determinants such as gender, ethnicity, caste, and socio-economic class are affected by climate change. This helps to inform adaptation planning and make it more effective. The **sensitivity** indicators for GESI chosen for the NAP process are characterised by socio-economic, cultural, institutional, and geographic factors such as gender, ethnicity, age, economic condition, landholdings, physical ability, proximity, and dependence on natural resources.

The **adaptive capacity** indicators include various socio-economic, technological, policy and governance, and socio-cultural elements that help build the adaptive capacity of women and marginalised groups. The indicators cover aspects such as social protection systems (insurance, credit facilities, savings and credit); reservations, allowances and special privilege systems; access to and ownership of natural resources; GESI focused mainstreamed policy, plans, programmes and budgets; participation and decision making; and supportive institutional structures.

1. Indicators for hazard

Elements of Hazard	Data Source
Climatic extreme events – consecutive hot days – consecutive cold days – consecutive wet days – consecutive dry days – extreme rainfall – heat wave – cold wave Climate-induced hazards – floods – landslides – drought – storm – GLOF – LDOF – Accelerated fire (forest, settlement)	DHM, DoF, ICIMOD, MoHA, MoFSC, ICIMOD

2. Indicators for exposure

Exposure element	Unit of Measurement	Data Source
Women population	No.	CBS
Men Population	No.	CBS
PwDs population	No.	CBS
Marginalised and socially excluded communities' population	HH/No.	CBS
Occupational and livelihood groups (fisher folks, blacksmith, NTFP dependent group, wage laborers, herding communities etc.)	HH	CBS
Water bodies (River, Ponds, Spring and Wetland)	No., ha	MoFSC, ICIMOD, WWF
Farming system (shifting cultivation)	No.	Case Study
Grazing lands in high mountain	Ha	Case Study
Infrastructure (GESI)	No.	Case Study

3. Indicators for sensitivity

Elements of Sensitivity	Indicators	Data Source
Age group	%	
Household head	%	
Geographic disparity	%	
Reservation category	%	
Economic condition	No/%	CBS,
Occupation	Status	MoLRM, MoWCSW
Land type	Types	
Land holding	Ha	Case studies
Cultural setting and practices	Status	
Access of natural resources	Km	
Proximity to facility	No.	
Institutions	No.	

4.Indicators for adaptive capacity

Elements of Adaptive Capacity	Unit of measurement	Data Source
Social protection system (insurance, credit facilities, saving –credit) - Insured population - People engaged in saving and credit, - Covered by subsidized loan targeted for women/marginalised groups	% % 	CBS
Reservations, allowances and special privilege systems - widow population covered by widow allowance - senior citizen covered by senior citizen allowance - disable population covered by disability allowance - population covered by Endangered Indigenous People's allowance - children population covered by child grant - students (disabilities, remote mountain region, highly marginalised groups) covered by scholarships - students covered by Food for Education programme - pregnant women covered by Aama - Various Employment Programme - joint land ownership	%	Policies and budgets, District Profile, MoFALD, MoWCSW
Gender and marginalised community mainstreaming strategy, plans, programmes and implementation mechanisms, (Implementation status)	No.	NPC, line ministries, Department, Districts

Access and ownership to natural resources by women and marginalised groups - Land ownership by women - Representation in local forest users groups - Representation in water and sanitation users committees - Representation in farmers' group	%	CBS, MoLRM, MoWSS, MoFSC, FECOFUN, MoAD
Employment of women/marginalised communities (Disaggregated by type)	%	CBS
Awareness, education and social sensitization programmes specific to disaster, climate change, agriculture etc. for women and marginalised groups	No.	NPC, Line agencies
Advocacy networks of special groups institutions and organisations working for GESI issues- women/SI groups- REDD+, CCA)	No. No.	Line Ministries, FECOFUN, Review and Consultation
Women/socially excluded population's participation in decision making and programme planning (programmes specific to LAPA , REDD+, EbA, Hariyo Ban, PPCR)	No.	Line Ministries, REDD Implementation Centre, FECOFUN, Review and Consultation
Access to information - Women with mobile phone - marginalised population - language and dialect	%	CBS
Gender responsive budget allocation and investment (specific to CCA) - Budget allocation for youth focused program - Budget allocation for socially excluded groups - Budget allocation for senior citizens	% % %	MoF, line ministries
Inclusive DRR including access to early warning system on disasters and response and differentiated recovery mechanism - DRM/DRR technologies and equipment- (rescue training to technology) - DRM/DRR system prioritizing senior citizen, PwDs, children, pregnant women	No.	MoHA, Specialised agencies Case study
Women/SI group population in leadership position in community institutions	No.	FECOFUN, Water Users Association Case Study
Access to safe drinking water, forest products and agriculture services (marginalised community)	HH	CBS

3.5. Vulnerability and Risk Assessment Indicators for Livelihoods and Governance

In Nepal, climate change impacts are expected to exacerbate poverty and increase the inequality and vulnerability of rural and urban households. Nepal ranks 145th of 188 countries in terms of human development; 25.4% of the population lives below the national poverty line (UNDP 2014). Adding to this, Nepal is now ranked among the top 17 nations vulnerable to climate change (as of 2014, Kreft et al. 2016).

Weather events and climate affect natural assets such as rivers, lakes, and fish stocks that form the basis of many livelihoods. Climate change will lead to a decline in agricultural productivity in many areas of Nepal for crops such as rice, which will negatively impact more than 70% of rural livelihoods. The extent of the impact on human health, security, livelihoods, and poverty will vary across Nepal. Greater dependence on agriculture and natural resources makes women highly sensitive to climate variability, extreme climate events, and climate-induced disasters. The existing vulnerabilities in Nepal result from the high prevalence of poverty, isolation, and marginality, together with low human development.

The poor and marginalised populations are more concentrated in rural and remote areas and pockets of urban settlements, which are directly exposed to climate change impacts. The indicators for exposure for the livelihood and governance sector mostly include people and the resources they depend on for their livelihood. For example, poor marginalised farmers who are practising subsistence agriculture are more exposed to the adverse impacts of climate change on agriculture. The destruction and depletion of water bodies such as wetlands, ponds, and rivers exposes women, and poor and rural households more because of the additional stresses caused by poor accessibility and low availability of water. Livelihood dependent resources, infrastructure, and services are also exposed to climate change. These include major natural resource-based livelihoods and occupations such as agricultural farming, forest enterprise, fishing, and pastoralism.

The difference in vulnerability to climate change among people and resources is determined by the degree of sensitivity and adaptive capacity. Sensitivity in this context refers to the way in which people, livelihood systems, and governance are susceptible to the impacts of climate change. The indicators include dimensions of physical assets, such as land use type, ownership, and farming systems; social dimensions such as socio-cultural structures, population structure, and remoteness; and indicators such as income source, migration status, and displacement pattern.

Adaptive capacity in the context of livelihood and governance is the ability of the existing system and structure to respond effectively to climate change. Overall, the adaptive capacity indicators converge around socio-economic, cultural, institutional, and geographical factors. The indicators include income, assets; improved infrastructure; access to technology and decision-making for a; increased decision-making power; changed cropping, livestock, and aquaculture practices; reliance on social networks; improved access to, and control of, the resources on which livelihoods are based; disaster risk reduction; social safety nets and social protection; and access to insurance schemes. In addition, the indicators cover various aspects of governance such as policies and plans, institutions and stakeholders, financial mechanisms and investments, and accountability and transparency mechanisms.

1. Indicators for hazards

Elements of Hazards	Source
Climatic extreme events – Consecutive hot days – Consecutive cold days – Consecutive dry days – Consecutive wet days – Heat waves – Cold waves Climate-induced hazards – Drought – landslide – Floods – GLOF – LDOF – Disease and pests outbreaks	DHM, MoHA , ICIMOD

2. Indicators for exposure

Elements of exposure	Unit of measurement	Data Source
Agriculture Land (cereal, Area of cash crops Area of horticulture, fisheries, livestock,)	Area (Ha)	CBS, MoAD
Agriculture based enterprise/industries	No.	CBS, MoAD
Public land (VDC , school land, road side, river banks, etc)	Area (Ha)	MoFALD
Forest under participatory forest management	Area (Ha)	MoFSC
Forest based enterprise/industries	No.	MoF
Mines, quarry sites, ore	No.	CBS
Water bodies (ponds, river, wetlands, reservoirs etc)	Area (Ha)	MoWR
Population of forest dependent people (NTFP collectors, charcoal collectors, wood worker)	No.	DoF, ANSAB,
Population of farmers	No.	CBS, Agri. stat.
Population of agriculture wage labour	No.	ILO, MoLE
Culture, traditional/indigenous occupation, festivals	Types/kinds	MoCTCA
Road	Km	DOR
Health service centre	No.	MOH
Agriculture Collection and Market centre	No.	MoAD

3. Indicators for sensitivity

Elements of sensitivity	Unit of measurement	Data Source
Land use type	Types	MoAD
Land ownership	HH	MoAD
Farming system and practices, Cropping pattern, species composition	Types	CBS
Types of farmers/users/groups	No.	MOAD
Food sufficiency	HH	CBS, MoAD
Socio-cultural structure (caste system, gender based discrimination)	Types	CBS, Case study
Population structure	No.	MoWCSW/MoHA
Population growth rate	%	CBS
Remoteness	Km	CBS
Income sources	HH	DOR
Migration status/displacement pattern	Status and pattern	MoLE

4. Indicators for adaptive capacity

Elements of Adaptive capacity	Units	Data source
Physical capital		
Irrigation facility	Area (ha)	MoAD, CBS
Agricultural Productivity	Ton / hectare	CBS
Forest products (Timber and non-timber)	Cubic feet	DOF, ICIMOD
Water bodies sufficiency (drinking water, irrigation)	Cubic meter supply	WECS, MOI, MoSWS
Social capital		
Community groups (Community forestry user group, forester user, leasehold forestry group, buffer zone community forestry user group)	No.	DoF, MoCPA, MoAD
Micro Saving credits, Cooperatives	No.	MoCPR, MoF
Others (Mothers, youth, etc.)	No.	MoWCSW
Households benefitting from different social protection schemes	No.	MoFALD
Human capital		
HDI	Index	UNDP
GDI	Index	UNDP
Income Poverty	Index	UNDP
Physical capital		
Access to road/airport (district and geography)	HH	DoR, DOLIDAR
Access to bridge (district and geography)	HH	DoR, DOLIDAR
Access to safe drinking water source	HH	MoDWS
Access to market and collection centre	HH	MoI, FNCCI
Access to electricity	HH	FNCCI

Access to education	HH	MoEd
Access to health services	HH	MoH
Access to alternative energy sources	HH	AEPC
Access to communication	HH	Telecom
Financial capital		
Banks	No.	MoF
Cooperatives	No.	MoCPA
Per-capita income	NPR	MoF
Access to credit	HH	MoF, NRB
Revenue collections	NPR	MoF
Remittances	NPR	MoF

5. Indicators for governance

Actors/structure	Unit	Data source
Central, regional, district, VDC level structure dealing with climate change related issues	Profile	Ministries
Private sectors dealing with climate change	No.	FNCCI
Civil society (I/NGO, CBOs) dealing with climate change	No.	SWC
Coordination mechanism	Structure	Ministries
Climate change related projects and programme	No.	Ministries
Institutions and processes		
Role and policy mandates	Document	MoPE
Transparency: Access to information	Population	Ministries
Planning, implementation and monitoring mechanism	Structure	Ministries
Effectiveness and efficiency	Instrument	MCPM, MoFALD
International source/budget for climate change	NPR	MOF
Financial flow		MOF
Budget allocation for climate change activities	Percentage	MoF
Expenditure on climate change of allocated budget	Area/percentage	MoF/NPC
Corruption status	Index	Transparency International
Participation in climate change adaptation planning and implementation	Population	MoPE, MoFALD, MoFSC, MoAD
Integration within sector policies and plans	Structure	MoPE, MoFALD, MoFSC, MoAD

3.6. Vulnerability and Risk Assessment Indicators for Public Health (WASH)

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).

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC-AR5) has indicated that climate change impacts on human health will be multi-fold. A number of adverse public health impacts are expected to worsen in climate-related disasters such as storms, floods, landslides, extreme heat, drought, and wildfires (IPCC 2014).

Extreme climate events and climate-induced disasters are expected to become more frequent in Nepal as a result of climate change. There is a strong link between disease outbreaks and climate change (Patz et al. 2000). As of 2000, South Asian countries (including Bangladesh, Bhutan, India, Maldives, and Nepal) had the highest burden of diarrhoea and malnutrition in the world, and this is expected to be exacerbated under future climate scenarios (Ramachandran 2014). A number of recent studies have highlighted the burden of diarrhoeal disease in mountain regions. There is an increasing trend in vector-borne and water-borne diseases in both rural and urban areas in Nepal, often with a shift to higher altitudes (Badu 2013); malaria, kala-zaar, and arboviral diseases are all common and likely to be affected by climate change (Dhimal and Bhusal 2009). In addition to disease, there is also an increasing trend in health-related hazards as a result of the impacts of climate-induced disasters. Nepal is classified as a hot-spot for geophysical and climatic hazards (MoHA 2009). Globally, in the two decades from 1988 to 2007, Nepal was in 23rd position in terms of loss of life due to natural disasters (MoHA and DPNet 2009). More than 4,000 people died in the last ten years as a result of massive flooding and landslides, including associated outbreaks of water-borne and vector-borne diseases, with an economic loss of USD 5.34 billion. In addition to the economic loss, households experience a high level of physical and mental stress as a result of losing family members (Regmi et al. 2016).

The National Adaptation Plan (NAP) process in Nepal has identified Public Health and Water, Sanitation and Health (WASH) as a key thematic area due to its **exposure** and vulnerability to climate change. A large proportion of the population in both rural and urban areas depend on climate sensitive sectors, thus they are exposed and vulnerable to climate change. The exposure indicators in this sector include human population, health facilities, infrastructure and services, human resources working in the sector, and, specifically for WASH, water sources, water infrastructure and services, and sanitation infrastructure and services.

Vulnerability in the public health and WASH sector looks at the **sensitivity** of the exposed population, resources, and services, and their capacity to respond to climate change impact. Sensitivity indicators include population characteristics and features, infrastructure location and condition, access to and quality of services, and population dynamics including socio-economic differences.

The **adaptive capacity** indicators mostly refer to the existing capacity in terms of human resources, investments (both national and international) in emergency response and preparedness, policy and institutions, technological advances, early warning systems and hazard monitoring, and technological practices, as well as the socio-economic capability of the population in terms of their ability to access and benefit from services.

1. Indicators for hazards

Elements of Hazard	Unit of measurement	Data source
Climate Extreme Events: – Heat waves – Cold waves – Consecutive hot days – Consecutive cold days – Consecutive dry days – Consecutive wet days – Extreme rainfall/snowfall	Duration, intensity, frequency, coverage (Ha)	DHM, MoHA, DWSS, DWIDM, DoHS, DoA
Climate-induced Hazards: – Floods – Landslides – Drought – Forest Fire	Area (Ha) Area (Ha), number Area (Ha) Area (Ha)	
Sector-Specific Hazards: – Sediment load (turbidity and suspended solids) – Water contamination (chemical and microbiological) – Outbreak of diseases (VBD, WBD, Seasonal Flue) – Outbreak of famine (result of drought, flood, climate variability)	Turbidity (NTU), TSS FC Count, PPM No of events and coverage (population) No of events and coverage (population), duration	

2. Indicators for exposure

Elements of Exposure	Unit of Measurement	Data source
Population	Nos.	CBS
Health infrastructure and services Infrastructures: (Hospitals, healthcare units at different level, drug stores,labs) Government Hospitals, Private hospital/lab, Registered Pharmaceuticals, Blood transfusion cenres	Nos. Nos.	DoHS, Department of Drug Management, NHRC
Water supply infrastructures and services Drinking Water Supply Systems Stream Intakes Sprint intakes Pipelines Pump stations Water treatment plants Reservoirs	Nos, KM	DWSS/KUKL/NWSC

Sanitation infrastructures and services – Sanitation Systems (Sewerage lines, private toilets, public toilets, septic tanks, water treatment plants Landfill sites)	Nos., KM	DWSS/KUKL/ NWSC/MoFALD
Water sources – Ground (deep, shallow) – Surface – Spring – Watersheds	Nos., Yield (l/s), Level (m), Area (hectare)	CBS, GWRDC, DWSS, DOI

3. Indicators for sensitivity

Elements of Sensitivity	Unit of measurement	Data Source
Average time required to reach the nearest health center	Hours	DoHS
Mobility of population	Frequency	Consultation
Mortality rate (CDR, U5MR)	Per 1000	DoHS
Disease prevalence and incidence of disease including trend (NCD, Malaria, Dengue, JE, Malnutrition, Psychosocial effect)	Status	DoHS
Age, gender (NPC category, wealth quantile and ecological belt)	Population, %	DoHS
Race, ethnicity	Population, %	CBS
Poverty	Population, %	CBS
Disparities (geographic, social)	Status	Consultation
Access to care and public health facilities	Population, %	DoHS
Pre-existing health condition	Status, Population, %	DoHS,
Infrastructure condition (Example: water supply systems already having functionality problems)	Status, %	DoHS, DWSS
Population density (urban and rural)	Status, %	CBS
Occupation type	Population, %	CBS
Location of infrastructures (Example: Hospitals, WTTPs on the river banks, WASH facilities such as intakes/pipes) etc.)	Proximity	Consultation, DoHS, DWSS
Condition of water sources and watersheds	Yield, status, %	DWSS, MoFSC
Water demand rate	Liters per capita per day	DWSS

4. Indicators for adaptive capacity

Elements of Adaptive Capacity	Unit of measurement	Data Source
Availability of improved sanitation (toilet)	HH Coverage (%)	DWSS
Adequate water supply (quantity)	HH coverage (%)	DWSS
Solid waste collection and management	Number, coverage	MoWSS, MoH, MoFALD
Surveillance system (water supply, disease) Water supply (quality and quantity) VPD Disease: Kalazaar, Malaria, Filariasis, Kalazaar, Malaria, Filariasis, Polio, Measles	Status, No.	DoHS

Elements of Adaptive Capacity	Unit of measurement	Data Source
Awareness on health and WASH	Population covered (%)	DoHS
Post-disaster health management system (strategy and plan to maintain or resume healthcare services-contingency plan)	Status	DoHS
Water safety plan	Number of WS systems, population	DWSS
Essential healthcare including vaccination and child health care services – Immunization – IMNCI – OPD services – Nutrition program – Disease control program – Free medicine – Safe motherhood programme	Population, %, Status	DoHS
Building codes and practices	Status	MoUD
Improved drainage	Status, coverage (HH)	MoUD, DWSS
Diversity of water resources	Status	MoWSS
Water Treatment Practices (Point of use WT)	HHs, %	DWSS
Technology practices enhancing water availability and water use efficiency (Example: RWH)	Status	DWSS
Health Early Warning System	Status	DoHS
Emergency healthcare service	Status	DoHS
Hospital bed per 100,000 population	Number	DoHS
Medical practitioners per 100,000 population Doctors Nurses Paramedic Ayurvedic and other (alternative and traditional health care provider)	Number, status	DoHS
Institutions and functioning (Example: sanitation systems operated by municipalities, WUSCs, RRTs,)	Status	MoH, MoWSS, DWSS, MoFALD
Policy, strategy, plan and programs (Health and WASH)	Status	MoWSS, MoH
Micro –stratification of Malaria	Status	DoHS
Health insurance (defined package)	% of population	DoHS
Alternative and traditional medicines and services	Status	DoHS
Income/saving	HHs, %	CBS
International/national emergency healthcare budget	NPR, %	MoF, MoH
Investment of state/non-state sector budget for health and WASH	NPR, %	MoF, MoH, MoWSS
Health Service Management Committee	No.	DoHS
Exposure to media (MF/Radio, TV, Print media)	Population coverage	CBS

3.7. Vulnerability and Risk Assessment Indicators for Tourism, Natural and Cultural Heritage

Tourism is a vehicle for socio-economic development as a result of its potential to earn foreign exchange, create employment, reduce income and employment disparities, strengthen linkages among economic sectors, control outmigration of local youth, and help alleviate poverty (Kurk 2009). The 2014 tourism employment survey identified a total of 138,148 persons directly engaged in the tourism sector in Nepal (MoCTCA 2014). The World Travel and Tourism Council (WTTC) 2014 report indicated that travel and tourism in Nepal generated 504,000 direct jobs in 2012 (3.2% of total employment), and this figure was expected to grow to 536,000 (3.3% of total employment) in 2014 (MoCTCA 2015).

The climatic condition of destinations plays an important role in the tourism industry. **Climate change induced disasters** impact the tourism industry both directly and indirectly by damaging tourism-related infrastructure and resources, and disturbing tourism activities, water supply, organic farming, and the well-being of tourism service providers. Receding snow lines, melting glaciers, increased frequency of cloudbursts, floods, and landslides have the potential to change the nature and quality of tourism resources (Sharma 2012). Avalanches in November 1995 killed 43 people (including foreign trekkers) in the *Khumbu* and *Kanchanjunga* areas. On 2nd January 1999, five people were swept away by an avalanche in Chunchet Village Development Committee Ward No. 8 in *Gorkha* district. In November 2014, unseasonal snowfall and avalanches resulting from the effects of Cyclone *Hudhud* killed at least 43 trekkers and guides between 2005 and 2014, a total of 235 people were killed by inclement weather in the country, including avalanches and snowstorms (MoHA 2015).

Tourism, including that based on natural and cultural heritage, was taken as a major climate sensitive thematic sector in the preparation process for Nepal's (NAP). Exposure in this sector refers to the elements in an area in which climate hazard events occur. Exposure indicators include the presence of people at the tourist destination with livelihoods dependent on the system, including natural and cultural heritage sites. It also includes services and resources for the tourism sector such as base camps and campsites; infrastructure such as airports, hotels, trekking trails, and roads; economic, social, and cultural assets, including religious and pilgrimage sites; protected areas; archaeological and historical sites; and sites with aesthetic value.

Nepal's tourism resources and activities are highly vulnerable to climate change. In the NAP process, vulnerability is understood as the outcome of sensitivity and adaptive capacity. The sensitivity indicators for this thematic sector include the physical predisposition of the population, infrastructure, and environment that can be damaged by a hazard event. Sensitivity is determined by population growth rate, age group, household income, remoteness and migration. The sensitivity indicators include geographical and ecological location, proximity and flow of tourism at a specific location, and quality of communication, services, and infrastructure.

The degree of vulnerability is influenced by limitations in access to and mobilization of human resources and institutions, and the level of capacity to anticipate, adapt, and respond in absorbing socio-ecological and economic impact. The overarching indicators for **adaptive capacity** include institutional, infrastructural,and environmental capacity and socio-economic components. The adaptive capacity indicators selected for the sector include policies, plans and investments in the sector; socio-economic status of the population engaged in tourism; financial mechanisms such as insurance, investments, and private sector engagement; existing infrastructure and its capabilities; and services such as early warning systems, rescue, and rehabilitation.

1. Indicators for hazard

Elements of Hazard	Data source**
Climate extreme events: - Consecutive wet days - Consecutive dry days - Heat wave - Cold wave - Extreme temperature - Extreme precipitation	DHM, ICIMOD
Climate-induced disasters: - Landslide - Flood - Snowstorm - GLOF - Forest fire	DHM, ICIMOD
Sector specific - Weather variability and seasonal shift Dense fog - Avalanche - Snow storm	DHM, ICIMOD

2. Indicators for exposure

Elements of Exposure	Unit	Data source**
Base camps Campsites	No.	NMA, TAAN, MoCTCA
Tourism infrastructure: - Airports - Helipads - Hotels - Tea houses - Homestays - Roads - Climbing routes - Trekking routes - High passes - Archaeological structures - Communications - Weather stations	 No. No. No. No. No. Km No. No. No. No. No, No.	MoCTCA, HAN, DoR, CAAN, NTA, DHM, DoA
Religious and pilgrimage sites	No.	HSN, DoA, MoCTCA
Protected areas and important biodiversity areas	Ha	DNPWC, NTNC, ICIMOD, WWF, IUCN
Mountains and peaks	No.	DoS, ICIMOD, NMA, MoCTCA
River system: - Rafting - Canoeing	 No. No.	NARA, ICIMOD
Recreation sites	No.	NTB, TAAN, HAN, DDC (District Profiles), NTNC
Lakes and wetlands	No.	NLCDC, DoF, DNPWC, IUCN
Population depending on tourism-based livelihoods	No.	NTB, HAN, TAAN, NMA, CBS
Archaeological and historical sites	No.	DoA

3. Indicators for sensitivity

Sectors (sub-system)	Elements of Sensitivity	Unit	Data Source
Mountaineering Expedition Aerial activities Trekking, excursions Canyoning, rafting Pilgrimage Tourism infrastructure Cultural heritage and historical monuments Jungle safari, wildlife watching	- Geographic and ecological location		DoS, NMA
	- Proximity of tourism sites and destinations to hazard prone areas like landslide, flood, avalanche, snowstorm	Km	TAAN, NMA, HAN, MoCTCA
	- Flow of tourists in specific location	No.	MoCTCA, DNPWC, NTNC
	- Geological setting	Types	DoS, ICIMOD
	- Water quality and availability	Status	NARA, DHM
	- Visibility for mountain flight and regular flights	No.	DHM
	- Physical and structural condition of archaeological and historical sites	No.	DoA
	- Livelihood sources	Types	CBS
	- Snow cover area	Sq km	DoS, DHM, ICIMOD
	- Population density in destination	No.	CBS
	- Pressure on protected areas	Types	DNPWC

4. Indicators for adaptive capacity

Sectors (sub-system)	Elements of Adaptive capacity	Unit	Data Source
Mountaineering Expedition Aerial activities Trekking, excursions Canyoning, rafting Pilgrimage Tourism infrastructure Cultural heritage and historical monuments Jungle safari, wildlife watching	- Household Income status	Rupees	MoCTCA, NMA, TAAN, CAAN, NTB, NCA, HSN, DoC, DoR, NTB, HSN, DoA
	- Investment and revenue (government and private)	Rupees	
	- Insurance: infrastructure, business and professionals	No.	
	- Access to infrastructure: trekking route, airport, helipad, historical and archaeological structure, water source, camping site, accommodation	Covered km	
	- Services: rescue, Information Communication and Technology	No.	
	- Policies, programs and plans (e.g. rapid recovery plan)	No. Functionality	
	- Investment by government and private sector in tourism sector	NPR.	
	- Skills (availability of skilled guides), knowledge and capacity	No.	
	- Existing institutions and networks	No.	
	- Diversity of destinations and activities	No.	

3.8. Vulnerability and Risk Assessment Indicators for Urban Settlements and Infrastructure

More than half of the world's population now live in urban areas. In Nepal, the urban population currently accounts for about 42% of the national population, compared to 17% in 2011 (NPC 2016). This growth, largely fuelled by rural-to-urban migration, has been mostly haphazard and accompanied by inadequate and sub-standard urban infrastructure and services. Urban expansion has also occurred in unsafe and geologically fragile areas such as along riverbanks and on steep slopes prone to landslides. Nepal's urban growth is primarily characterised by: (1) an increase in the number of municipalities; (2) expansion of urban areas; (3) initially, relatively steady increase in the population of designated urban areas; and (4) rapid increase in population in recent years (Subedi 2014).

Although Nepal's urbanization process is expected to deliver socio-economic growth and development, it also presents potential risks. Both cities and towns, including rural settlements, are exposed to recurring rapid-onset natural hazards such as floods. Longer term, slower-onset changes, such as increased temperature and changing rainfall patterns, are already having serious impacts, some of which are contributing to rural-urban migration. Intense rainfall will lead to an increasing loss in assets and lives in urban areas as a result of floods, especially in flood-prone areas such as the Terai and places where there is increased water runoff due to the increase in impermeable surfaces. Increasing water shortages may result in higher prices for services, thereby threatening affordability and incomes.

Rapid urbanization and growth in Nepal's large cities has been accompanied by an increase in the number of highly vulnerable urban communities living in informal settlements. Many such settlements are located on land exposed to extreme weather such as river banks that are prone to flash floods. Moreover, a high proportion of the population, of the built assets (both private property and public infrastructure), and of the economic activities in urban areas are exposed to climate extreme events and climate-induced disasters. The exposed elements include people, assets, and infrastructure. These are mainly related to urban (municipal) settlements and buildings and major district-level infrastructure, in particular roads, water supply, and sewerage systems, and encompass the urban ecosystem and environmental services.

The indicators for **sensitivity** and **adaptive capacity** measure the vulnerability of the exposed systems to climate change in the context of urban settlements and infrastructure. These indicators are influenced by physical factors (e.g., presence of roads) and socio-economic factors (e.g., income, age, and gender). The sensitivity of urban settlements and infrastructure is determined by the geographical location of properties (or physical exposure to hazards), their age, materials used in construction, and design considerations related to climate change risks.

The **adaptive capacity** indicators include population indices such as the Human Development Index (HDI) and Human Poverty Index (HPI); the urban infrastructure system, including availability and access to urban services; urban settlements, including various kinds of building; and urban planning and management.

1. Indicators for hazards

Elements of Hazard	Data source
Climate extreme events: - Consecutive dry days - Consecutive wet days - Consecutive hot days - Consecutive cold days - Extreme rainfall (P99, P95) - Cold nights/days (10th percentile) - Warm nights/days (90th percentile)	DHM, ICIMOD, DWIDM, MoHA, DSCWM, Case study
Climate-induced hazards: - Floods - GLOF - Landslide - Heat wave - Cold wave - Windstorm	
Sector-specific hazards: - Urban floods - Urban heat island - Fire	

2. Indicators for exposure

Elements of Exposure	Unit	Data source
Population system: - Urban (municipal) population	No.	CBS, Municipal profiles
Urban settlements: - Urban built-up area	Ha.	Municipal profiles, GIS maps/satellite images
Rural settlements: settlement clusters (comprising of at least 20 houses)	No. of settlements/ pop. (or No. of HHs)	DDC profile, village profile, maps
Social infrastructure (at district level): - Public buildings (hospital, school, administrative buildings, etc.)	No.	MoH, CBS, MoEd, DUDBC, MoFALD, Municipal office
Physical infrastructure (at district level): - Roads: strategic roads (highways), local/rural roads	Km	DoR, DoLIDAR
- Bridges: SRN bridges, other bridges including suspension bridges	No.	DoR, DoLIDAR, Muncipal office, Helvetas
- Water supply and sewerage: ▪ WS schemes (serving at least number of beneficiaries)	No.	DWSS
▪ Pipeline network	Km	DWSS
▪ Sewer network	Km	DWSS
▪ Storm-water drains	Km	DWSS
Communication towers/lines	No.	NTA
Watersheds supplying drinking water	Sq. km.	DSCWM
Urban water bodies: - Wetlands and ponds	No. Sq. km.	Municipal office

3. Indicators for sensitivity

System/Sub-system	Elements of Sensitivity	Unit	Data source
Population system:			
- Urban population	Urban net population density	ppha	CBS, Municipal profiles
	Dependent population (age under 5 and over 65 years)	%	CBS, Municipal profiles
	Population living in informal settlements	No. / No. of HHs	Municipalities, Squatters' organisations, Lumanti, LWF, study reports
	Population living in risk-prone areas	No. / No. of HHs	Maps, study reports
Urban infrastructure system (coverage of urban services):			
- Water supply and sanitation	Discharge capacity of watershed	Cusec	DWSS, DSCWM
Urban settlements:			
- Built-up area	Rate of urbanization	% (average growth per annum)	CBS, Municipal office
	Built-up area in landslide-prone locations	Ratio of at-risk built-up area to total built-up area	Municipal office, DUDBC, maps, study reports
	Built-up area in floodplains	Ratio of at-risk built-up area to total built-up area	Municipal office, DUDBC, maps, study reports
Private buildings:			
- Urban and rural private buildings	HHs by type of their foundation	%	CBS, Municipal profiles
	HHs by type of their outer walls of their house	%	
	HHs by roof of their house	%	
	Buildings aged 30 years and above	%	
Social infrastructure (district):			

- Public buildings	Age of buildings	No.	DDC office
	Types of buildings (kachchi/pakki)	No.	DDC office
	Buildings on locations sensitive to floods	No.	DDC office
	Buildings on locations sensitive to landslides	No.	DDC office
Physical Infrastructure (District):			
- Roads and bridges ▪ Roads: strategic roads, local/rural roads ▪ Bridges: SRN bridges, other bridges	Age of structure	Years	DoR, DoLIDAR, DDC, Helvetas
	Maintenance status	Regular/ irregular	
	Location to floods and/ or landslides	H/M/L	
- Water supply and sanitation: ▪ Major water supply schemes ▪ Wastewater treatment plants ▪ Underground WS pipelines, underground sewer lines, storm-water drains	Maintenance status	Regular/ irregular	DWSS, maps, MoHA
	Location to floods and/ or landslides	H/M/L	
- Landfill sites	Location sensitivity to floods and/or landslides	H/M/L	Maps, MoHA
- Communication towers	Location sensitivity to floods and storms	H/M/L	Maps, MoIC
- Electricity transmission and distribution system (Ref. Water Resources and Energy Thematic Area)			
- Urban planning and management:			
- Financial capacity	Own-source revenue (OSR)	%	Municipal office

4. Indicators for adaptive capacity

System/Sub-system	Elements of Adaptive capacity	Unit	Data source
- Urban population	Human Development Index	Index	CBS, NPC
	Human Poverty Index	Index	
	Gender Inequality Index	Index	
	Urban employment rate	%	CBS
Urban infrastructure system (coverage of urban services):			
- Roads	Population served by roads	Km/pop.	DoR
	Road network	Km/sq.km.	DoR
	Road connecting adjoining districts	No. of adjoining districts connected with roads	DoR
- Water supply and sanitation	Access to piped drinking water	% HHs	DWSS
	Alternative sources of drinking water	No.	DWSS
	Water supply schemes	No.	DWSS
	Watersheds supplying water	No./sq.km.	DWSS, DSCWM
	Access to sanitation	% of HHs	DWSS
- Solid waste management	Access to organized solid waste management	% of HHs	Municipal office
	Capacity of landfill sites	No. of years	Municipal office
- Communication	Mobile users	No.	NTA
	Access to internet	% of pop.	
	FM/TV coverage	Yes/no	
Urban settlements:			
- Built-up area	Protection of built-up areas from landslides	Ratio of protected built-up area to total landslide risk-sensitive built-up area	Municipal office, DUDBC, map, study reports
	Protection of built-up areas from floods	Ratio of protected built-up area to total flood risk-sensitive built-up area	Municipal office, DUDBC, map, study reports
- Open and green space	Open area	Sq.km.	Municipal office
	Urban parks and forests	Sq.km.	Municipal office

- Water bodies (wetlands and ponds)	Capacity	m^3	Municipal profile, NLCDC, District profiles
Private buildings:			
- Urban private buildings	Buildings insured against natural disasters	% buildings insured to total buildings	Insurance companies
Social infrastructure (district):			
- Public buildings	Structural robustness	H/M/L	DUDBC, DDC, line agencies
	Capacity to provide intended services	H/M/L	DUDBC, DDC
Physical Infrastructure (District):			
- Roads and bridges ▪ Roads: strategic roads, local/ rural roads ▪ Bridges: SRN bridges, other bridges	Share of black-topped or concrete roads	%	DoR, DoLIDAR, DDC, Helvetas
	Investment including on repair and maintenance	H/M/L	
	Institutional capacity to repair and maintain	H/M/L	
	Sector policies including legal provisions	H/M/L	
- Water supply and sanitation: ▪ Major water supply schemes ▪ Wastewater treatment plants ▪ Underground WS pipelines, underground sewer lines, storm-water drains	Factor of safety in design with respect to CC	H/M/L	DWSS
	Investment including on repair and maintenance	H/M/L	
	Institutional capacity	H/M/L	
	Sector policies including legal provisions	H/M/L	
Urban planning and management:			
- Financial capacity	Municipal budget	NPR.	Municipal office
	Climate change budget allocation	NPR. %	MoF, Municipal office
- Plans and policy support	Plans prepared for urban resilience	Yes/No	Municipal office
	Projects implemented for urban resilience	Yes/No	Municipal office
- Technical capacity	Technical human resources in municipalities	No. of engineers	Municipal office
- Risk preparedness - Institutions and organisations (government and community)	Prepositioning capacity (warehouse, fire brigade, ambulance)	H/M/L	Municipal office, DDC, MoHA

3.9. Vulnerability and Risk Assessment Indicators for Water Resources and Energy

Water resources and energy provide the backbone for Nepal's social and economic development. These sectors have largely defined economic growth, and they will continue to support the process of economic transformation for decades to come. Nepal has abundant water resources sufficient to support the water and energy demand of the country. However, only a small portion (estimated at 15 billion cubic metres) is utilized for economic and social purposes. The major portion of energy demand and supply is still provided by traditional sources, including fuel wood. Traditional, commercial, and renewable sources of energy provided 55, 42, and 3% respectively of energy consumption in the first eight months of Fiscal Year 2015/16 (MoF 2016).

The resilience of water resources and the energy sector will be key determinants in Nepal's ability to sustain social and economic development. Destruction of critical infrastructure by floods, including glacial lake outburst floods (GLOFs), and landslides, which are expected to increase in the coming decades,is a threat to the country's development objectives. The impact of climate change is already evident in the water sector in Nepal. The estimated total direct annual economic cost of water-induced disasters is USD 270 million per year, equivalent to 1.5% of current GDP at 2013 price. However, there is a wide variability over time, and in exceptional years the damage caused by floods can cost as much as 5% of national GDP.

The ability to produce and distribute energy and thus ensure energy security is another key component that may be affected by climate change. Extreme climate events such as heat waves, prolonged periods of drought, and erratic and intense rainfall impact the functioning of hydro-power production. An analysis of the impact of climate variability on electricity production, and the subsequent impact of planned interruptions, indicates that the economic cost of loss and damage could be equivalent to 0.1% of GDP per year on average, and 0.3% in very dry years (MoSTE 2014).

Climate hazards that may impact the water and energy thematic sector are grouped under three categories: climate extreme events, climate-induced hazards, and sector specific hazards. Climate extreme events include consecutive hot days, dry days, cold days, and wet days; summer maximum and winter minimum temperature; extreme rainfall; and annual maximum and minimum temperature. Climate-induced hazards include landslides, floods (including flash floods), GLOFs and Landslide Dam Outburst Floods (LDOFs), heavy snowfall, and storms. The sector specific hazard is sediment loading.

The exposure elements in the water and energy thematic sector have been grouped into four sub-sectors for the assessment of climate change vulnerability and risk: (1) water systems, (2) hydropower, (3) biomass energy, and (4) energy demand. The main elements exposed to changes in the climatic conditions are snow cover, glaciers, springs, groundwater, rivers, lakes, reservoirs, wetlands, hydropower plants, transmission lines, distribution networks, and the people who depend on different water and energy uses.

Vulnerability in the water and energy sector is measured by looking at the sensitivity of the exposed elements and their adaptive capacity to respond to climate change impacts. The sensitivity indicators relate to the physical, technical, economic, age, and ownership practices of the exposed elements. The indicators for adaptive capacity relate to socio-economic factors, technology, management, institutions, investment, human resources and strategies, and plans and policies.

1. Indicators for hazards

Elements of Hazards	Data source
Climate extreme events: - Consecutive hot days - Consecutive dry days - Consecutive wet days - Summer max temperature - Winter minimum temperature - Extreme rainfall - Annual maximum temperature - Annual minimum temperature	DHM
Climate-induced hazards: - Landslides - Floods/flash floods - GLOFs - LDOFs - Heavy snowfall - Storm	DWIDM, MoHA, ICIMOD, EMDat
Sectoral specific hazard: - Sediment	DWIDM

2. Indicators for exposure

Elements of Exposures	Unit	Data source
Snow cover	Area (m^2)/trend	WECS, national statistics
Glaciers	Area (m^2)/ volume (m^3)	WECS, national statistics, ICIMOD
Springs	Flow (Lps), No	District consultations
Ground water	Height (m)	Groundwater Resource Development Board
Rivers	Flow (m^3/s)	DHM
Lakes, reservoir, wetlands	Area (m^2) Volume (m^3) Number	DHM, ICIMOD, DNPWC
Hydropower plants	Number MW	DoED, NEA, IPPAN, AEPC
Transmission lines	Km	NEA
Distribution network	Km	NEA
People depending on different water uses (irrigation, drinking water)	HH	WECS
People depending on different energy sources (biomass, firewood, agriculture residue, animal dung)	HH	CBS

3. Indicators for sensitivity

Sectors (sub-system)	Elements of Sensitivity	Unit	Data source
Water systems	Catchment characteristics – coverage	Ha	DSCWM
	Land use pattern	Ha	DoS
	Demand of water for competitive uses	LPCD	WECS
	Discharge	m^3/s	DHM
	Glacier lakes – potentially dangerous	No.	WECS, ICIMOD, DHM
Hydropower	Demand for electricity	MW	NEA
	Types and size of generating systems (micro, small, medium, large)	Number MW	NEA, IPPAN
	Proximity to hot spot (GLOF, flood, landslide)	Km	NEA
	Age of infrastructure	Years	NEA, IPPAN
	Ownership (private, public, community)	Type	NEA, IPPAN
Biomass energy	Biomass availability	MT	AEPC
	Biomass dependency	HH	
	Technology	Type	
Energy demand	Economic status of consumer		MoF, NRB, DoED
	Electricity price	NRs	NEA

4. Indicators for adaptive capacity

Sectors (sub-system)	Elements of Adaptive capacity	Unit	Data source
Water systems	Reservoir storage capacity	m^3	WECS, DHM, MoE, MoI
	Watershed management: - Number - Area	No. m^2	DSCWM, DoIr, DoED, IPPAN, NEA, WECS
	Water bodies (wetland, lake, river, pond, spring) management	Ha.	DSCWM, DoIr, DoED, IPPAN, NEA, WECS, ICIMOD
	Usable water availability (monsoon/non-monsoon) – volume	bcm	WECS, ICIMOD, DHM
	Institution*	No. Status	Review, consultation
	Investment, revenue*	NPR	MoE, MoI, MoF
	Human resource*	No.	MoE, MoI, WECS
	Strategies, policies and plans; research and studies*	Status	Review, consultation

Hydropower	Hydro capacity	MW	NEA, DoED, IPPAN
	Hydropower mix (micro, mini, small, RoR, storage)	%	DoED, NEA, AEPC
	Insurance	Coverage	Bima Samittee, AEPC, IPPAN
Biomass energy	Access to technology, diversity in alternate energy resources	Status Types	AEPC, CBS
	Household income	NPR	CBS, NRB
	Financial instruments (subsidy, credit)	NPR Status	MoF, AEPC
Energy demand	Demand side management	Status	WECS, NEA, CBS, MoF, NRB, MoEn, NPC, IBN
	Energy efficiency	Status	MoE
	Energy mix (diversity in energy use / cross-border trade-note)	Status	WECS

* Used for other sub-sectors

Chapter 4
The Way Forward

The proposed methodology and indicators for vulnerability and risk assessment (VRA) will guide Nepal's National Adaptation Plan (NAP) process. The methodology and indicators will be further refined and updated based on the consultative process and application during the sectoral assessment and analysis. NAP is a process and learning opportunity for stakeholders and agencies in Nepal, and the methods for VRA will be further customized and aligned with the current capacity of the country to understand and apply them at different levels and in different contexts. The methodological framework and process proposed in this document will not only help in the NAP formulation process, but will also act as a reference document for other countries in the region.

NAP is a country-driven process. The approach for VRA proposed for Nepal's NAP process uses a complementary approach combining scientific and community-based assessment. There are a number of advantages in using an integrated approach in Nepal, including that it helps fill the gaps in knowledge that exist when a single approach is used. Further, the climate projections and models have marked limitations as a result of the challenges involved in improving the quality of the downscaled climate scenarios, and they do not offer much in terms of understanding local level impact and risk. The bottom-up approach is thus important for elucidating the real issues that communities are facing and the impact on local resources. Combining the two approaches will make the climate change assessment more rigorous and realistic.

The indicators proposed for Nepal's NAP formulation process are sector specific and based on past experience, including expert judgment. The indicators mostly represent measurable elements that help in quantifying and qualifying hazards, exposure, sensitivity, and adaptive capacity. Measurement of these indicators appears to be feasible, based on the availability of data. The majority of the indicators can be quantified. However, some indicators still need to be qualified and explained using descriptive information.

The VRA analysis will also depend on the available science, knowledge, and resources within the country. The methods for developing and applying climate change scenarios are the focus of an IPCC task group (the TGCIA), and recommended methods and global scenario data are maintained on the IPCC Data Distribution Centre website. However, due to data and knowledge gaps, it is difficult to rely on global and regional scenarios and models. Thus in addition to scenario analysis, Nepal's NAP process will use expert judgment and a consultative process to develop a consensus on the criteria and indices for assessing and

projecting climate risk and impact. The climate data analysis and modelling for Nepal's NAP will be guided by the sectoral, geographical, administrative, and socio-economic units needed to characterise climate change and thus facilitate different planning approaches.

Nepal has proposed an eight-step methodological process for carrying out the VRA. However, the NAP process is designed to be flexible, with countries able to choose those steps and elements needed to accomplish the planning process. Nepal will follow existing experience at global and national level when choosing the tools and techniques for VRA. Top-down assessment and bottom-up assessment need different tools and techniques. For example, bottom-up assessment can be carried out through community-based vulnerability analysing tools such as CVCA (climate vulnerability and capacity analysis), participatory vulnerability analysis techniques, and poverty and vulnerability analysis. The tools for top down assessment include climate models and scenarios, hydrological and crop modelling, and risk analysis.

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