Vulnerability and Risk Assessment and Identifying Adaptation Options

Sectoral Report

GESI, Livelihood, and Socio-Economic

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Foreword

Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. The latest IPCC report confirms that human activities have changed our climate and led to the more frequent heatwaves, floods, droughts, and wildfires that we have seen recently. The evidence is incontrovertible. This highly influential report provides the evidence base and impetus to develop policy strategies and practices that will help people around the world and in Nepal live with and adapt to change.

Nepal has been a pioneer in the development and implementation of effective adaptation policies and practices. Nepal has made a strong commitment to updating a mid-long term National Adaptation Plan (NAP) every ten years, as well as conducting a National level Vulnerability and Risk Assessment every five years to inform climate resource allocation policies. Vulnerability and Risk Assessment (VRA) was initiated to assess vulnerability and risk at the national, physiographic, province, municipal, and sector levels to inform the Government of Nepal's current NAP formulation process.

I am pleased to see that the VRA report on Gender and Social Inclusion (GESI) was prepared by identifying sector-specific current vulnerability and future risk based on a solid scientific foundation and information. This report is the result of a thorough consultation process with national and provincial stakeholders and experts. This report, I believe, provides an opportunity for policymakers, decision-makers, and practitioners to make informed decisions about sector-specific vulnerability and risk to build a climate-resilient society and reduce the impacts of climate change at the local, provincial, and federal levels.

On behalf of the Ministry of Forests and Environment, I would like to thank the distinguished Chair - the Joint Secretary of the Ministry of Womens, Children and Senior Citizens, and all the respected thematic group members who provided technical guidance to finalize this report. In addition, I gratefully acknowledge the assistance provided by the Climate Change Management Division, particularly Dr Radha Wagle and all technical committee members.

I also take this opportunity to acknowledge the funding and technical support of the British Embassy Kathmandu, and Policy and Institutions Facility (PIF) /Oxford Policy Management Limited.

Dr Pem Narayan Kandel
Secretary
Ministry of Forests and Environment (MoFE)

Acknowledgment

The National Climate Change Policy (2019) identifies eight thematic areas and four cross-cutting areas which will be impacted by climate change. As such, there is a pressing need to understand how public and private investments might be impacted. Without adequate information on risks and vulnerability, it will be difficult to translate policy into action. To plan and implement a successful adaptation strategy, it is vital to understand the likely impacts of climate change on different sectors and communities, and, in particular, how these may evolve in the future.

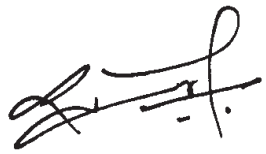
A National Adaptation Plan (NAP) needs to be developed based on a strong scientific foundation and reliable evidence. This includes data and information about how the climate has evolved in the recent past and how it may further change in the future. To realize this, the MoFE has carried out detailed Vulnerability and Risk Assessments (VRAs) of the thematic areas identified by the National Climate Change Policy at the municipal, district, and regional scales. The VRA framework and methodology presented in the report are based on the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and the NAP technical guidelines of the UNFCCC.

This VRA report contributes to the establishment of a strong baseline for climate change impacts, risks, and vulnerabilities in Nepal. In particular, it presents relevant information on social and structural vulnerabilities and risks triggered by the interaction of climate change and socio-economic, governance, political and cultural norms and practices. The report also offers a range of adaptation options for reducing root causes of vulnerability and risk, including enhancing social inclusion and reducing gender disparity.

On behalf of the Climate Change Management Division (CCMD), I would like to extend my appreciation to the chair, vice-chair, member secretary, and all the members of the Thematic Working Groups (TWGs) on Gender and Social Inclusion (GESI) for providing guidance and input in the VRA process. Also, I acknowledge the input provided by federal, provincial, and local governments, national and international organizations, community-based organizations, and communities.

Special thank goes to the technical committee members Raju Sapkota, Dr Arun Prakash Bhatta, Srijana Shrestha, Hari Pandey, Dr Indira Kandel, Gyanendra Karki, and Dr Bimal Raj Regmi who supported and facilitated the VRA process. We would also like to thank Basana Sapkota, Dr Nilhari Neupane, Dr Shiba Banskota,, Apar Paudyal, Dr Ram Prasad Lamsal, Dr Pashupati Nepal, Dr Bhogendra Mishra, Regan Sapkota, Pratik Ghimire, Rojy Joshi, Bamshi Acharya, Goma Pandey, and Prashamsa Thapa, from the PIF, who provided technical insights and were involved in producing this report.

Besides, I also take this opportunity to acknowledge the funding and technical support of the British Embassy Kathmandu, and Policy and Institutions Facility (PIF) /Oxford Policy Management Limited.



Dr Radha Wagle
Joint Secretary
Climate Change Management Division
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List of Acronyms

CBS	Central Bureau of Statistics
CCA	Climate Change Adaptation
CEDAW	Convention on the Elimination of all Forms of Discrimination Against Women
COP	Conference of the Parties
DHM	Department of Hydrology and Meteorology
DRRM	Disaster Risk Reduction and Management
GDI	Gender Development Index
GDP	Gross Domestic Product
GESI	Gender Equality and Social Inclusion
GII	Gender Inequality Index
GLOF	Glacial Lake Outburst Flood
FGDs	Focused Group Discussions
HDI	Human Development Index
ICIMOD	International Centre for Integrated Mountain Development
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Plans for Action
L&D	Loss and Damage
MICS	Multi-Indicator Cluster Survey
MoF	Ministry of Finance
MoFE	Ministry of Forests and Environment
MoHA	Ministry of Home Affairs
MoLES	Ministry of Labour, Employment and Social Security
MoPE	Ministry of Population and Environment
MoSTE	Ministry of Science, Technology and Environment

MPI	Multidimensional Poverty Index
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NDHS	Nepal Demographic Health Survey
NLFS	Nepal Labour Force Survey
NLSS	Nepal Living Standard Survey
NPC	National Planning Commission
NTFP	Non-timber Forest Product
SDGs	Sustainable Development Goals
TWG	Thematic Working Group
UNFCCC	United Nations Framework Convention of Climate Change
VRA	Vulnerability and Risk Assessment
WB	World Bank

Executive Summary

Background: This assessment provides an analysis of socio-economic trends and scenarios, including vulnerability and risk assessment for GESI, livelihood, and governance sector, and recommendations to address the causes of social and structural vulnerability to climate change. The objective has been to determine which social and demographic groups, across a wide range of geographical locations, are the most vulnerable to climate change impacts in Nepal and to identify adaption options for them.

The assessment considered biophysical and social vulnerabilities leading to differential impact based on long-standing social, economic, cultural, and geographic inequalities and confirms that socio-economic factors exacerbate and magnify other forms of vulnerabilities and inequalities. The findings reiterate that impacts of climate change are not gender-neutral and adaptation responses to these impacts, whether at the policy level or on the ground in vulnerable communities, must be gender-responsive and inclusive. Adopting a gender-responsive approach to adaptation will also help to align climate policies and actions with other commitments, including the Sustainable Development Goals (SDGs), Disaster Risk Reduction and Management (DRRM), the Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW), among others. The recommendations of this assessment are expected to facilitate the integration of climate change priorities in the development agenda and planning and budgeting process across all sectors and at all levels.

Methodology: The vulnerability and risk assessment framework and the methodological process are aligned with the VRA framework of Nepal, 2017 which is based on the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and the NAP guidelines. The framework considers risk as a function of hazard, exposure, and vulnerability. The approach includes both impacts that have already occurred and the risk of future impacts, and the way that such risks are anticipated to change with investments in adaptive infrastructure, ecosystems, and human settlements. Similarly, climate trends and scenario analyses and socio-economic pathways available from national, regional, and international research centers have been used to characterize broad future climate risk and the level of uncertainty.

The study used both top-down and bottom-up approaches and considered pre-existing social structures and conditions of diverse groups and their specificities leading to differential impacts. Additionally, GESI analysis and policy review was used to identify gaps in policy and practice of climate change actions at various levels. The findings were validated through local and provincial consultations carried out with diverse stakeholders, including political leaders, government officials, community representatives, and experts from various fields.

Socio-economic scenarios: The assessment analyzed socio-economic trends and scenarios. The analysis considers key demographic factors such as population patterns (i.e., growth and trend of male and female population), population density, urbanization trends, and growth of female-headed households. The projection shows that the population of Nepal is expected to reach 34 million by 2031 and 42 million by 2050. The urban population will reach 53% of the whole by 2051 from the current level of 20%. There will be an overall reduction in poverty at a national level but projections show that the rate will be sluggish for Province 2

Trend analysis indicates a rapid increase in male labour out-migration predominantly from P and Bagmati and Lumbini Provinces. The out-migration of young household members increases the sensitivity of those left behind (i.e., the elderly, children, and women) and leads to an increase in female-headed households. Female-headed households are projected to reach 3.1 million by 2051 from the current 1.3 million if the same growth trend is followed. Demographic indicators, like population and urbanization are dynamic, and directly linked with exposure components of risks whereas other socio-economic indicators, like poverty, labour out-migration, and female-headed households, are linked with sensitivity.

Climate change trends and scenarios: The annual maximum temperature trend show an increase of 0.056°C/year, while the minimum temperature trend shows an increase of 0.002°C/year, which is insignificant. Minimum temperatures will decrease in a few mountainous districts such as Humla and Manang, and increase in the central Terai region of Province 2 and the middle mountain region across Nepal from east to west. Average annual precipitation is expected to increase in both the short-term (2030) and long-term (2050). In addition, the annual average temperature will continue to rise. According to the study, average annual precipitation may increase by 2-6% in the medium term (2016-2045) and by 8-12% in the long term (2036-2065). In addition, the average temperature may rise by 0.92-1.07°C in the medium term and 1.30-1.82°C in the long term. The post-monsoon season is expected to have the greatest mean temperature increase (1.3-1.4°C in the medium-term and 1.8-2.4°C in the long-term) followed by the winter season (1.0-1.2°C in the medium-term and 1.5-2.0°C in the long-term).

Hazards and Impacts: The hazard analysis shows that, based on the available data of loss and damage from different climate-induced disastrous events between 1971 and 2019, on average, about 647 people die from climate-induced disasters in Nepal each year. The maximum number of climate-induced disaster deaths occurred in 2001 when 1,866 people lost their lives due to epidemics, landslides, thunderbolts, fire, flood, heavy rainfall, and windstorms. The average economic loss per year is 2,778 million Nepalese Rupees, which is about 0.08% of GDP (at the current price) of FY2018/19. The maximum economic loss of 63,186 million NPR was incurred in 2017 during the Terai floods, which was about 2.08% of GDP (at the current price).

Floods, landslides, epidemics, and fires are the major climate-related disasters in Nepal. Hazard-wise comparison of deaths and economic losses show that epidemics caused the most deaths (52.8%), followed by landslides (16.7%), and floods (12.7%). However, floods impacted about 71% of the total affected population, followed by landslides (9.5%), and epidemics (8.2%). Fires caused the most economic losses (56.6%), followed by floods (31%) and landslides (3.7%).

Stakeholders said that the major hazards impacting the communities were rising temperatures, floods, landslides, droughts, heat waves, cold waves, forest fires, and fast melting of snow and glaciers, including glacial lake outburst floods (GLOFs). They reported an increase in the magnitude and frequency of the current hazards.

The findings further show that the impacts of climate-induced hazards, both slow and rapid onset events, are massive. Drying up of springs, degradation of habitat of flora and fauna, and increase in forest fires, mostly impacted women and ethnic groups dependent on water, agriculture, and forestry. Heat and cold waves impacted those working outdoors, the poor, women, children, and the elderly. Vector- and water-borne diseases led to health and WASH challenges. Floods mostly impacted marginalized and landless households resulting in loss of life and property, food insecurity,

disruption of transport and communication, and outbreaks of water- and vector-borne diseases. Forest fires led to the loss of property and livestock, mostly impacting poor and marginalized households. Droughts impacted agricultural productivity, mainly of smallholder farmers.

The impact of extreme climatic events also included migration due to water scarcity, loss of employment opportunities, and production decline. Further, it led to an increase in the workload of women (e.g., traveling long distances to fetch water), school dropouts, and forced resettlement. Male migration also led to an increase in female-headed households, further increasing women's workload. The most impacted were women (pregnant, household heads, illiterate, and belonging to ethnic and poor communities), the elderly, children and infants with health issues, PWDs, poor and marginalized farmers, landless and squatters living in slums and disaster-prone areas, and natural resource-dependent communities (i.e., whose livelihood depended on fishing, Non-Timber Forest Product collection, etc.) such as indigenous people, *Dalits, Tharu, Musahar Majhi, Raute, Chepang, Satar,* etc. Issues of social disharmony and an increase in gender-based violence were common as a result of climate stressors and disasters.

Exposure: Five districts, namely Kailali, Rupandehi, Morang, Jhapa, and Kathmandu, were found to be in the very high exposure category, which is mainly due to demographic factors. As demographic characteristics are dynamic, population growth and migration patterns can affect the exposure ranking of these districts. The rural to urban migration trends may also increase the exposure of urban centers in the future.

On the other hand, several mountain districts, such as Humla, Bajhang, Dolpa, Gorkha, Solukhumbu, and Taplejung, show a moderate degree of resource-related exposure due to their larger district area and smaller population size. Districts with lower population sizes and smaller land areas contributed to low exposure. These districts include Tehrathum, Dhankuta, Rasuwa, Nuwakot, Lamjung, Manang, Myagdi, Parbat, and Arghakhanchi.

Sensitivity: The result of sensitivity reveals that twenty districts out of seventy-seven fall in the category of very high sensitivity. The next twenty-one districts fall in high sensitivity rank, showing over 55% under high to a very high rank of sensitivity. The higher sensitivity of districts may contribute to higher vulnerability if their adaptive capacity is low. Out of the twenty highly sensitive districts, six districts fall in Sudhurpaschim Province; five districts in Province 2; four districts in Karnali Province; two districts in Bagmati Province; and only one district in Gandaki Province. There are no districts that fall into the higher sensitivity rank in Province 1. The higher prevalence of *Dalit* and *Janjati* population, higher population growth rate, poverty incidence, food poverty, and lack of access to resources are the major contributing factors for higher sensitivity in Sudhurpaschim Province and Karnali Province. In Gandaki and Lumbini Provinces, poverty incidence, female-headed households, labour migration, and population of *Dalit* and *Janjati* are the major determinants for higher sensitivity. In Bagmati Province and Province 2, poverty incidence, higher labour migration, and higher dependency ratio contributed to higher sensitivity among others.

Adaptive Capacity: Adaptive capacity includes a broad range of socio-economic indicators (e.g., HDI, GDI, GDP, per capita income, etc.), access to physical and natural resources, and policy and governance-related indicators. Only two districts, Kathmandu and Morang fall into the very high adaptive capacity category and seven districts, namely Sunsari, Lalitpur, Rupandehi, Chitawan, Dang, Kaski, and Jhapa, fall into the high adaptive capacity category. There are 9 districts (12%) with better adaptive capacity. The province-wise analysis shows that three districts from Province 1

fall into very high (Morang) and high (Jhapa and Sunsari) adaptive capacity rank. In Bagmati Province, Kathmandu is ranked in a very high adaptive category; and Lalitpur and Chitwan are ranked in the high adaptive category. In Gandaki Province, only Kaski district has high adaptive capacity. In Lumbini Province, Rupandehi and Dang fall in the same (high) category. None of the districts in Province 2, and Karnali, and Sudhurpaschim Provinces fall into high or very high adaptive capacity rank.

The analysis shows that differences in terms of access to information, knowledge, technologies, services, support networks, and social inequality puts certain groups at a disadvantage and restricts their ability to respond to climate-related challenges. The gendered expectation on women to fulfill their responsibilities as caregivers for their families creates an extra burden on them during extreme climate events. Higher rates of illiteracy and a lack of access to information about climate change contribute to their inability to respond appropriately. Similarly, gender inequalities in access to assets, financial capital, and livelihood options further constrain their overall adaptive capacity.

Vulnerability: Altogether fourteen districts fall into a very high vulnerability rank. Among these, six districts are from Sudhurpaschim Province (Achham, Bajura, Baitadi, Bajhang, Doti, and Dadeldhura); five from Karnali Province (Kalikot, Dailekh, Jajarkot, Western Rukum, Salyan); two from Lumbini Province (Eastern Rukum and Rolpa); and one from Province 2 (Mahottari). None of the districts from Province 1, Gandaki Province, and Bagmati Province is 1 are ranked in the very high vulnerability category. Vulnerability in Sudhurpaschim, Karnali, and Lumbini Provinces is mostly characterized by high sensitivity and very low adaptive capacity. Sensitivity is mostly due to poor socio-economic indicators, including higher poverty incidence, food poverty, low income, lower HDI, and GDI, combined with lack of resources and services such as access to clean drinking water and sanitation. Factors responsible for the ranking of Province 2 are related to indicators like higher dependency ratio, higher labour migration, poverty, and lower HDI.

The findings show that communities and individuals are exposed to different risks of hazard, even within the same district or locality. Context-specific conditions shape multidimensional vulnerability and differential impacts. Households that have limited assets and/or those that experience disadvantages and marginalization due to gender, age, class, race, (dis)ability, and/or ethnicity are highly vulnerable. Women's and men's experiences of climate stressors tend to be different due to different gender norms and practices.

Risks: Nine districts fall into the very high-risk category: one district from Province 1 (Morang); six districts from Province 2 (Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, and Bara); one from Lumbini Province (Dang); and one from Sudhurpaschim Province (Kailali). All the districts ranked in the high-risk category are from the Terai region of Nepal. Districts ranked in the very high-risk category are commonly characterized by high to very high exposure, high to very high vulnerability, and mostly moderate to low adaptive capacity. Despite its very high adaptive capacity and very low vulnerability, Morang is ranked in the high-risk category due to its higher exposure and higher hazard rank. In the other high-risk districts, all three risk components, i.e., hazards, exposure, and vulnerability, are amplified. Kathmandu also has high exposure and low vulnerability like Morang, but due to its moderate level of hazards falls into the very low risk category.

External factors influencing risks and vulnerabilities: There are significant regional disparities in development, with mountain regions lagging and quite significant development gaps between rural and urban areas that have been attributed to differentials in income, education, and access to infrastructure/services. Apart from these regional disparities, human development inequalities along

the lines of caste and ethnicity are also quite high. The findings from the socio-structural vulnerability assessment also reiterate the fact that the impacts of climate change are experienced differently by women and marginalized populations due to their historical marginalization and resulting social, economic, cultural, and political inequalities. Consequently, they often lack the resources and capacities necessary to adequately respond to these challenges. Furthermore, differences in experiences related to climate change are influenced by other social categories, such as age, class, race, ability, and sexuality, among others. The impact of climate change is higher for socially and geographically marginalized and excluded groups like *Dalits, Madhesi, Muslims, Aadibasi,* and *Janajati,* people with disabilities, children, the elderly, and others.

An additional major concern is the rapid population growth which is manifested in many parts of the country through changes in land use patterns and degradation or loss of forests and lowered agricultural productivity. Nepal's rural to urban migration rate has led to the growth of urban centers, and increasing squatter settlements in urban locations.

Adaptation options: Adaptation options are proposed to reduce both socio-structural and biophysical vulnerabilities related to climate change. To reduce vulnerabilities, especially among the most disadvantaged groups, the focus should be on balanced economic growth across provinces with a comprehensive strategy integrating social protection, social security, and employment-related programs to establish a guaranteed income threshold.

Adaptation options such as social protection and risk financing can play an important role in increasing adaptive capacity and address poverty issues. Investing in adaptive social protection not only protects households and promotes social inclusion but can also contribute to long-term economic growth. Affirmative action measures, which include targets and quotas to improve access to livelihood opportunities, assets, services, and political representation among women and disadvantaged groups, are required to address socio-structural vulnerabilities. In addition, targeted programs that help climate-vulnerable marginal farmers to adapt to a changing climate can reduce their exposure to losses from agricultural shocks. Specific risk management instruments, such as disaster risk insurance, can cover losses from agricultural shocks specific to a particular crop or region.

Recommendations: The data gap posed a major challenge in this study. The dataset required for socio-economic, livelihood/governance, and GESI analysis lacked consistency and quality. For most datasets, multiple sources having different scales, timelines and units had to be used. Although the indicators were carefully selected based on a review of academic literature, empirically proven evidence, and expert consultations, many important indicators had to be dropped because of unavailability, inconsistent quality, and incompleteness of the dataset based on scale and time.
Specific recommendations from the assessment are as follows:

- Institutionalize mechanisms for collection, processing, and dissemination of gender-disaggregated data at all levels with enhanced monitoring and evaluation systems.
- Conduct large-scale qualitative and quantitative surveys and develop disaggregated data banks. It is essential to maintain breakdown data of social groups to understand the specific vulnerabilities of groups like IPs, Dalits, Madhesis, Muslims, and different ages and genders.
- VRA process should ensure a mix of bio-physical as well as socio-structural components. Projections should be based on both climate change and socio-economic trends and scenarios.

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Chapter 1

Background and Sectoral Context

1.1 Socioeconomic Context

Nepal is a multi-ethnic, multi-lingual and multi-religious country with 126 castes/ethnic groups, ten religious categories, and 123 languages that are spoken as a mother tongue (CBS, 2012a). This diversity has made the country one of the more socio-structurally diverse countries in the world. The country has a total population of 28.6 million, which is increasing at an average annual rate of 1.35% (CBS, 2012a; World Bank, 2020). The population is expected to increase to around 35 million, 40 million, and 46 million by the years 2020, 2030, and 2050 respectively (IDS-Nepal, 2014). Out of the total population, 20.7 million (71.5%) are economically active (CBS, 2019). Females comprise 55.6% of the total labour force in Nepal (CBS, 2019).

Nepal's GDP is 30.6 billion and the annual growth rate was 7% in FY 2018/19 (World Bank, 2020). Agriculture share in the GDP has declined over time, from 41% in FY 1996 to 28.1% in FY 2017/18, with a corresponding increase in the non-agricultural sectors—such as service sectors (mostly wholesale and retail trade, real estate transport, communication, financial intermediation, and other related services) and industrial sectors—from 36% to 71.9% during the same period (MoF, 2018a). Among the non-agriculture sectors, the GDP share of the industrial sector, including manufacturing, has declined from 23% to 15%, whereas service sectors such as hotels and restaurants, transport and communications, and health and education services have shown significant growth (MoF, 2018a).

The poverty headcount ratio was 41.8%, 31%, and 25.2% in the years 1996, 2005, and 2010 respectively (NPC, 2018), whereas the recent Multidimensional Poverty Index (MPI) measurement showed 28.6% population as multi-dimensionally poor, which implies that individuals living above the income poverty line could still suffer deprivations in health, education, and/or standard

of living (NPC, 2018). The unemployment rate in Nepal is relatively low, i.e., 1.5% in comparison to the global average of 5.42%; however, 24% of the total employment accounts for wage labour, which is highly sensitive to the external environment, including climate change (World Bank, 2020). There are also significant gender and other socio-economic disparities among different groups and unequal distribution of income and productive capital assets resulting from exclusionary growth-oriented development processes. These disparities have contributed to increasing the sensitivity of certain groups, making them more vulnerable to climatic and non-climatic changes.

Migration is becoming vital in the national economy with two million labour migrants working abroad. Nepal received 6.9 billion USD in FY 2018/19 from remittance, equivalent to 27% of national GDP (IOM, 2019; World Bank, 2020). There is little documentation of seasonal labour migration to India and the corresponding remittance flow. Still, it should be noted that the number of migrants and remittance figures is likely much higher than the formal documentation shows. The remittance figure was 55 million USD during the 1990s and it has increased 126 times in the last three decades (World Bank, 2020). As more men migrate than women, there is an increase in female-headed households, from 13.6% in FY 1995/96 to 19.6% in FY 2003/04 and 26.6% in FY 2010/2011. This phenomenon is particularly acute in rural areas (UNDP, 2014). In addition, there is internal migration accounting for a larger share of total migration in Nepal. The country's rural to urban migration rate is estimated at approximately 3% per year (CIA, 2015). Migration from one municipality to another or from rural to urban areas (within Nepal) is 91.9% while immigration is 8.1%. Adverse impacts of climate change have been identified as one of the major drivers of migration. These migration patterns have resulted in the growth of urban centers, with a proliferation of squatter settlements in urban areas (CBS, 2019).

Progress in reducing income inequality in Nepal has been slower than that of poverty reduction. While the income poverty rate fell from 41.8% in 1996 to 18.7% in 2018, and non-income poverty as measured by the MPI fell by more than half between 1996 and 2014, per capita consumption-based inequality as measured by the Gini coefficient dropped only from 0.35 in 1995 to 0.30 in 2014 (UNDP, 2014; UNDP, 2020).

1.2 Gender Equality and Social Inclusion (GESI)

There has been notable progress[1] in human development indicators in Nepal, but persisting disparities across gender, region, and local groups continue to manifest in various forms. Nepal's national HDI score was 0.587 in 2019, with a score for urban areas (0.647) surpassing that of rural areas (0.561), and a Gender Development Index (GDI)[2] value of 0.886. Within provinces, there are differences in human development and gender inequality indicators (UNDP, 2020). For example, HDI values for females and males are (0.549) and (0.619) respectively. Likewise, the GII value is 0.479 with differing values for provinces. Gender inequality is highest in

1 Between 1990 and 2018, Nepal's HDI value increased from 0.378 to 0.579, a rise of 53%. During this period, life expectancy at birth increased by 16.3 years, mean years of schooling increased by 2.9 years, and expected years of schooling by 5.2 years. The average multidimensional and consumption poverty levels fell to 28.6 in 2014 from 39.1 in 2011 (UNDP, 2020). Nepal has made successful strides in reducing poverty from 25.2 percent in 2011 to 21.6 percent in 2015 (NPC, 2018; UNDP, 2020).

2 The GDI measures gender inequalities in achievement in three basic dimensions of human development: health (measured by female and male life expectancy at birth), education (measured by female and male expected years of schooling for children and mean years for adults aged 25 years and older), and command over economic resources (measured by female and male estimated GNI per capita).

Karnali Province and Province 2, with Gender Inequality Index (GII)[3] values of 0.558 and 0.503 respectively. Human development inequalities along the lines of caste and ethnicity are quite stark. HDI scores for the majority of castes and ethnic clusters are significantly higher than those of lower castes and minorities.

Table 1 below highlights provincial disparities in the human development indices and shows the ranking by province on the HDI, IHDI, GDI, GII, and MPI. Bagmati ranks at the top of all composite indices while Karnali Province and Province 2 rank the lowest. These indices below indicate the uneven distribution of development outcomes across different parts of the country.

Table 1: Provincial disparities on human development indices

Province	HDI (2019)		GDI (2019)		GII (2019)		MPI (2014)	
	Value	Rank	value	Rank	Value	Rank	Value	Rank
Province 1	0.58	3	0.901	4	0.459	2	19.7	3
Province 2	0.51	7	0.786	7	0.503	5	47.9	6
Bagmati	0.661	1	0.929	1	0.457	1	12.2	1
Gandaki	0.618	2	0.896	6	0.460	3	14.2	2
Lumbini	0.563	4	0.901	5	0.474	4	29.9	4
Karnali	0.538	6	0.902	3	0.558	7	51.2	7
Sudhurpaschim	0.547	5	0.903	2	0.522	6	33.6	5

Source: UNDP, 2020

Note: Ranking Number 1 denotes the top performer and 7 the worst

Gender and social factors play a major role in levels of vulnerability among the population. Marginalized groups are more vulnerable than others and are deprived of personal and institutional safety nets. Aspects of marginalization include ethnic, linguistic, or religious discrimination; poverty; living in marginal and fragile environments; having limited access to social, material, economic and political resources, skills, and technologies; disabilities; and age. Marginalization limits these groups' participation in broader economic and political spaces (Goodrich et al., 2017).

Environment and climate change stressors aggravate gender disparity. The experience of climate change is different for men and women due to the existing gender division of labour and roles based on social norms. Due to socio-structural inequalities, there are differences in terms of access to information, technologies, services, and support that put women at a disadvantage (Lambrou & Nelson, 2010). Their role as primary caregivers leads women to feel the effects of climate change more acutely in numerous ways, e.g., having to walk further to collect food and water due to climate-related resource scarcity, having to care for family members impacted by climate-related diseases or disasters, and taking on extra burdens in the aftermath of extreme climate events. Higher rates of illiteracy and a lack of access to information about climate change contribute to their inability to respond.

Similarly, gender inequalities in the distribution of assets and limited access to financial capital make it difficult for women to diversify their livelihoods (Skinner, 2011). There is also evidence

3 GII reflects the gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity. Reproductive health is measured by maternal mortality and adolescent birth rates; empowerment is measured by the share of parliamentary seats held by women and attainment in secondary and higher education by each gender; and economic activity is measured by the labour market participation rate for women and men. The GII can be interpreted as the loss in human development due to inequality between female and male achievements in the three GII dimensions.

of the differential impact of climate change on health (WHO, 2014). Women face an increased risk of sexual violence and experience increased workload during and post-disaster (Plan International, 2011). Women and girls have a critical role in adaptation, owing in particular to their expert and distinctive knowledge of natural resources, regardless of being among the groups most vulnerable to climate change, and being broadly excluded from international and national climate change policy (UNDP, 2009a).

The sub-sections below elaborate on the various categories related to GESI that influence the sensitivity as well as the adaptive capacity of a diverse population and determine their vulnerability to climate change.

1.2.1 Access and Control Over Resources

Women constitute 72.8% of the agricultural labour force in Nepal (CBS, 2019). The paradox here is that regardless of their substantive engagement in the sector, women do not have the same access to productive assets like land, water, seeds, training, credit, and markets as men do, which restricts their capacity for livelihood diversification and income security. Only 10% of farms in Nepal are owned by women or jointly owned by men and women (NDHS, 2016). Women account for only 6% of total landowners and hold a combined share of only 4% of arable land. Besides, female-headed households have an average of 0.50ha of farmland, compared to 0.78ha for male-headed households. Women's land ownership varies across the country: 21% of households in the eastern region, 25.5% in the Terai's mid-west region, and over 30% in urban areas (Wily et al., 2009). Female-headed households, especially those with low educational level/awareness and less access to basic services and early warning systems (EWS), are more vulnerable to climate change impacts.

Access to productive resources like land, credit, and education provides women with tools, skills, and preparation to effectively engage in environmental decision-making (IUCN, 2013), while a lack of access to these resources inhibits their participation and influence in decision-making processes. Likewise, restricted rights and little or no voice in decision-making make them extremely vulnerable to climate shocks (Aguilar, 2009).

In terms of legal rights, the Constitution of Nepal 2015 calls for an end to discrimination based on sex, caste, geographic region, language, or religion. It guarantees women's rights as a fundamental right, reaffirms the right to safe motherhood and reproductive health, education, health, employment, equal pay, social security and property rights, and the inclusive participation of women in state bodies (GoN, 2015). Although the Constitution has recognized equal rights, it has not effectively materialized in practice due to deep rooted social and structural discriminatory practices that reinforce gender roles and stereotypes. Women still lack legal and property rights, access to finance, and modern business practices to enhance their livelihoods and assets, due to which they continue to face barriers in livelihood recovery after environmental shocks.

Indigenous communities in remote rural areas of Nepal have been using their traditional knowledge to adapt to both climatic and non-climatic changes for centuries (Helvetas, 2011), and women's distinctive knowledge and expertise have supported communities to adapt to changing climatic conditions (UN Women Watch, 2020). At the same time, women and other excluded groups may experience challenges based on caste and other discriminatory

and harmful practices (e.g., menstrual restrictions, accusations of witchcraft, dowry practices, caste-based discrimination, and child marriage among others) (UNFPA, 2020). These harmful practices restrict their ownership of land, their employment, and their access to key resources, putting women at a further disadvantage in times of climate stress (Jones, 2009).

1.2.2 Gender Division of Labour

Women spend most of their time in unpaid household and agricultural activities and are mainly involved in care work, predominantly their reproductive work of bearing, rearing, and nurturing children, and household maintenance (Helvetas, 2015). Limited influence over adaptation decisions and lack of control over livelihood resources can increase gender inequalities and women's workloads. NAPA 2010 has stated that a decrease in women's access to water resources would increase their workload, with detrimental effects on their reproductive health. An alarming health issue for rural women in Nepal is uterine prolapse due to heavy workload and inequitable gender division of labour. An increase in women's workload may mean that women have to forego opportunities for economic empowerment, such as education, training, and income-generating activities. They may be forced to take their daughters out of school to assist in farm and household work, which has long-term detrimental effects on the empowerment of girls. Gender dynamics in labour division, decision-making power, and access to public spaces and service needs are often overlooked in the adaptation planning process (IUCN, 2013).

1.2.3 Participation in Decision-Making

Women's decision-making role and control over resources are insignificant in most households. Issues concerning property, marriage, expenditure, and education are considered as 'men's business'; women can exert little or no influence over the outcomes (Xheneti et al., 2019). According to NDHS 2016, only about half of currently married women (52%) with cash earnings decide independently on how their earnings should be used. More than half of currently married women participated, either by themselves or jointly with their husband, in decisions regarding (i) their health care, (ii) making major household purchases, and (iii) visits to their family or relatives. 38% of women participated in all three of the above-mentioned decisions, while 28% did not participate in any (NDHS, 2016).

Regarding political representation, women and marginalized groups make up over one-third of elected positions across all three levels of government. Women (including those from *Dalits*, IPs, *Madhesi*, and *Muslim* groups) constitute 34% of the Federal Parliament[4], 34% of the seven provincial assemblies[5], and 41% of the 753 local governments (Election Commission of Nepal, 2017). In urban and rural municipalities (753 local governments), women constitute 91% of all deputy mayors/deputy chairs (UNHCR, 2019) **(Annex 1).** Despite the historic levels of representation of women at all three levels of government, women are mostly excluded

4 Of the total 272 federal level House of Representative members, 90 are women (33%). Similarly, 22 out of 59 members (37.28%) of the National Assembly and 112 of 331 members (33.84%) of the Federal Parliament are women. (Data from official website of the national assembly and House of Representatives (http://hr.parliament.gov.np/np/members)

5 There are 31 women in the 93-member Provincial Assembly (PA) in Province 1; 35 women in the 107-member PA in Province 2; 36 women in the 110 member PA in Province 3; 20 women in the 60-member PA in Province 4; 20 women in the 87-member PA in Province 5; 13 women in the 40-member PA in Province 6 and; 17 women in the 53-member PA in Province 7 (Speech delivered by Justice Anup Raj Sharma, Hon. Chairperson, National Human Rights Commission (NHRC), Nepal as a Co-Speaker for "Gender Equality: Bridging the Gap" in Regional Conference organized by Honorary Consular Corps Nepal and World Federation of Consuls (HCCN –FICAC), Kathmandu, 13 November 2019 (NHRC Chairperson's Speech, 2019)

from top positions. At the local level, men continue to outnumber women as heads of local governments – with 97% of Mayor/Chair or Ward Chair positions being held by men and 91% of deputy positions (Deputy Mayors and Vice-Chairpersons) held by women, reflecting the low number of women fielded as candidates for the Mayor/Chair positions by political parties (UN Women, 2020). Women also continue to be underrepresented at the community level and in international negotiations on climate change.

Ensuring women's representation in decision-making on all aspects of the environment and climate-related decisions is important for efficient and equitable allocation of resources (Aguilar et al., 2015). Women's participation in climate change decision-making processes brings the unique needs, experiences, expertise, and capacities of diverse women to the climate adaptation process. Furthermore, women's leadership delivers environmental results: the higher the representation of women in parliament, the more likely that environmental agreements are ratified (UNDP, 2011). Even more importantly, research has shown that women are often considered better leaders in times of crisis, mainly due to their ability to foster, achieve consensus, and manage risk (Enarson & Chakrabarti, 2009; Lagarde, 2014; Leader-Chivee, 2014).

1.2.4 Intersectional Issues

Women and men cannot be homogenized, as their roles, responsibilities, and entitlements are not only shaped by gender but also by various other social stratifications and differences, including class, caste, ethnicity/race, religion, age, etc. Hence, it is crucial to take into consideration how different factors of differentiation (e.g., ethnicity, race, age, social class, economic status, sexual orientation) and cultural barriers (such as attitudes, customs, and practices) intersect and interact while recognizing that individuals who find themselves at the intersection of several discriminations might be susceptible to experiencing poverty and exclusion and the impacts of climate change (Goodrich et al., 2017). Intersecting inequalities – such as low income, migrant status, ethnic background, age, (dis)ability, and/or gender identity undermine people's benefits, assets, opportunities, and adaptive capacities to climate change (Resurrección et al., 2019).

1.3 Livelihood and Governance

The agriculture and forestry sectors employ 65% of the economically active population, form the major source of livelihoods, and account for a large share of Nepal's export goods. Industrial sectors employ 15% of the economically active population and the remaining population is engaged by other sectors including foreign employment (CBS, 2019). One in five people in Nepal is employed in agriculture, forestry, and fishing (CBS, 2019). In 2017/18, 84.6% of those in employment were informally employed. Females are overrepresented in informal jobs compared to men (90.5% compared to 81.1%) (CBS, 2019). (Figure 1).

The main contributor to employment was the informal non-agriculture sector, accounting for

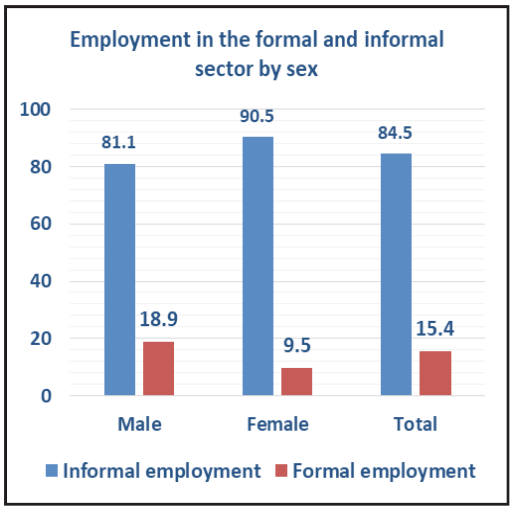

Figure 1: Employment in the formal and informal sector by sex (Source: CBS, 2019)

Table 2: Employment by sectors

Sector	Male	Female
Formal agriculture	1.3	1.2
Formal non-agriculture	39	32.3
Informal agriculture	13.4	31.8
Informal non-agriculture	45.8	32.9
Private households	0.6	1.8
Source: CBS, 2019		

41% of all jobs. The formal non-agriculture sector accounted for 36.5% of total employment. Informal agriculture accounted for 20.2% of the total employment, formal agriculture accounted for 1.3%, and private households accounted for 1% of total employment. Males were mostly employed in the informal non-agriculture sector with 45.8%, followed by the formal non-agriculture sector with 39%. Females were almost evenly distributed across the formal non-agriculture sector, informal agriculture sector, and informal non-agriculture sector with a share of 32.3%, 31.8%, and 32.9%, respectively. Fewer than 2% of females were employed in private households, compared to 0.6% of their male counterparts (CBS, 2019). (Table 2) Women are mostly concentrated in informal agricultural sectors with very limited participation in the industrial, trade, and transport sectors (Annex 16 & 17).

The source of household income has changed over time in all physiographic regions and the wealth quintile. The share of agriculture has significantly decreased. In 1995/96 the share of agricultural income in the mountain region was 62%, 58% in the hill region, and 64% in the Terai, which declined to 49% in the mountains, 28.3% in the hills, and 25.7% in the Terai in 2010/11. The share of remittance has increased significantly in recent years in all physiographic regions while the share of agriculture has significantly decreased. In 1995/96 the share of agricultural income for wealth quintile 1 (Q1) was 69% and for wealth quintile 5 (Q5) it was 47%, which declined to 36% for Q1 and 16.5% for Q5 in 2010/11 (Figure 3).

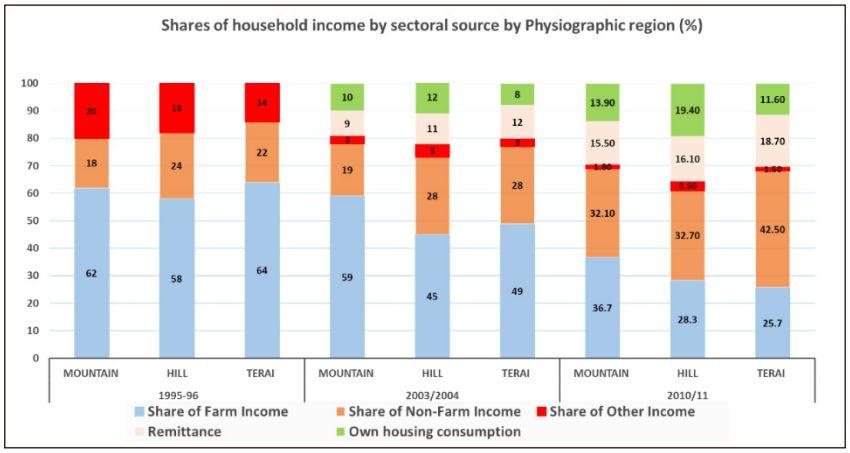

Figure 2: Shares of household income by sectoral source by physiographic region

Sources: CBS, 1996; CBS 2004; CBS 2012c

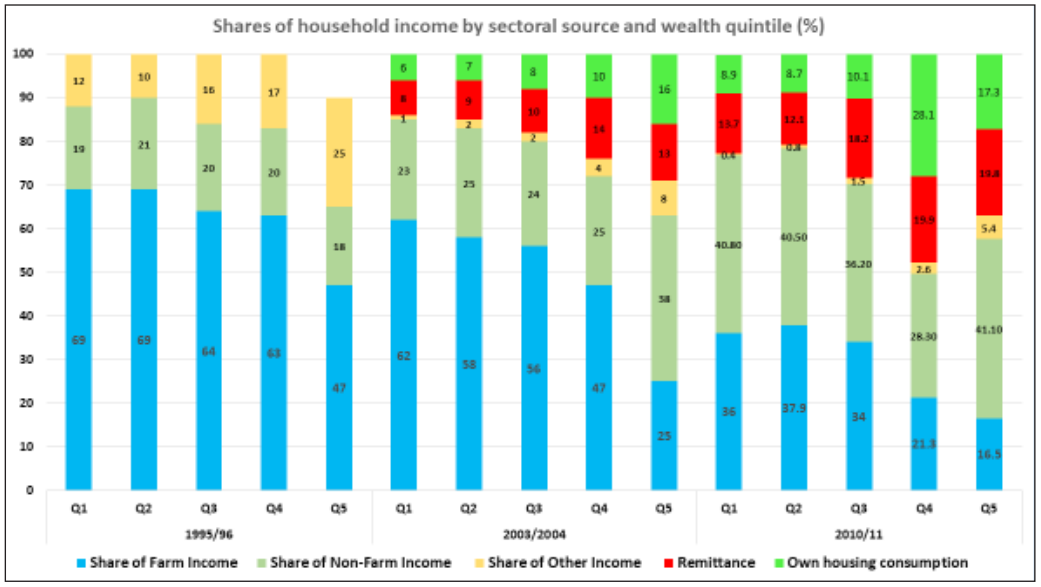

Figure 3: Share of household income by sectoral source and wealth quintile

Sources: CBS, 1996; CBS 2004; CBS 2012c

Climate extreme events may lead to loss of human, physical, and social capital and have a direct or indirect impact on the national economy. Population dynamics and land-use change can intensify the impact of climate change on livelihoods, especially for people living in poverty (ICIMOD, 2011; IPCC, 2014), and increase displacement due to a lack of resources for planned migration (Norwegian Red Cross, 2019). Climate-related shocks (e.g., recurrent floods and droughts) and structural issues, such as the technological limitations of farmers, particularly the limited availability of high-yield seeds and agro-chemicals and the relative scarcity of irrigation infrastructure, disturb the food system from production to consumption, particularly for key grain crops, increasing food prices and food insecurity for women, children, marginalized farmers and the urban poor (IPCC, 2014).

Effective adaptation responses will depend on policies and measures across multiple scales: international, regional, national, and sub-national. Good governance incorporates climate considerations to be transparent, legitimate, inclusive, accountable, equitable, efficient, and effective (WRI online data). In Nepal, the transition from a unitary to a federal system of governance remains a challenge, with numerous laws, institutional arrangements, and policies and guidelines yet to be prepared at all levels.

The agencies governing climate finance in Nepal are the National Planning Commission (NPC), the Ministry of Forest and Environment (MoFE) (previously MoPE), the Ministry of Federal Affairs and General Administration (MoFAGA) (previously MoFALD), the sectoral ministries, provincial and local governments, the Office of the Auditor General (OAG), and civil society organizations (CSOs).

There have been some progressive achievements in recent times such as the institutionalization of gender-responsive budgeting (GRB), which has increased gender-related budgetary allocations from 11.3% in (2007/08) to 38.17% in (2019/2020) (GoN, 2019) **(Annexes 2 and 3).** Likewise, there has been incremental progress in climate change related budget allocation at the national level from 4.45% in (2012/13) to 5.21% in (2019/20). There has also been a similar increment in budget allocation at provincial levels for directly responsive GRB and highly relevant CC budgets **(Annexes 4 and 5)**.

Chapter 2

Objectives and Scope of the Assessment

2.1 Objectives and Rationale of the Assessment

The overall objective of this assignment was to assist Nepal's NAP process in assessing climate-related hazards and vulnerabilities and socio-structural vulnerability to identify practical adaptation options at the sectoral, local, provincial, and national levels.

Specific objectives

- Assessing risks and vulnerability to climate impacts across Gender/Social Inclusion, Livelihood/Governance sector, and physiographic regions through applicable frameworks, and ranking/categorizing associated climate risks and vulnerabilities.
- Identifying adaptation options to these risks at multiple scales (district, province, physiographic regions) to address priority climate risks and vulnerabilities.
- Integrating GESI and Livelihood/Governance components in the 8 thematic sectors and identifying adaptation options.

The rationale of the assessment

The conventional vulnerability assessment or top-down/end-point approach considered biophysical science and viewed vulnerability in terms of the likelihood of occurrence and impact of climate-related events (Green et al., 2012). The approach did not identify specific vulnerabilities nor adaptation options to cope with those vulnerabilities. The focus on human systems as the primary domain of vulnerability was brought in by the Fifth Assessment Report that defined vulnerability as: ''the propensity or predisposition to be adversely affected'' and encompassed a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to adapt. As the socio-economic and structural aspects determine who has access to resources, who participates in decision-making processes, and what gendered practices are exacerbated during climate stresses, a more comprehensive assessment of the impact of climate change was deemed necessary, combining both the bio-physical and socio-economic approach (Fireman et al., 2011; Green et al., 2012; Harrison et al., 2016).

Chapter 3

Methodology

3.1 Framework

The vulnerability and risk assessment framework and the methodological process are aligned with the VRA framework of Nepal, 2017 which is based on the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and the NAP guidelines. **(Figure 4)** The IPCC framework considers risk as a function of hazard, exposure, and vulnerability. The proposed framework unpacks the elements of risk and customizes them to the 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 socioeconomic processes (including governance and adaptation and mitigation actions) are drivers of hazards, exposure, and vulnerability (IPCC, 2018).

Socio-economic factors are closely linked with sensitivity and adaptive capacity, which influence the vulnerability components of climate change, whereas hazards are more linked with physical factors, which influence the risk of climate change. Future changes in socio-economic drivers may affect sensitivity and adaptive capacity. The dynamic nature of socio-economic factors makes adaptive capacity uncertain, which means that strategies considered effective today may fail to cope with climate change vulnerability in the future (Adger & Vincent, 2005). Therefore, it is very important to consider socio-economic pathways and scenarios in the climate change vulnerability and risk assessment framework (**Figure 4**). In this analytical framework, socio-economic indicators which are closely linked with either sensitivity or adaptive capacities, such as population dynamics, urbanization, migration, poverty, female-headed households, and HDI, were considered.

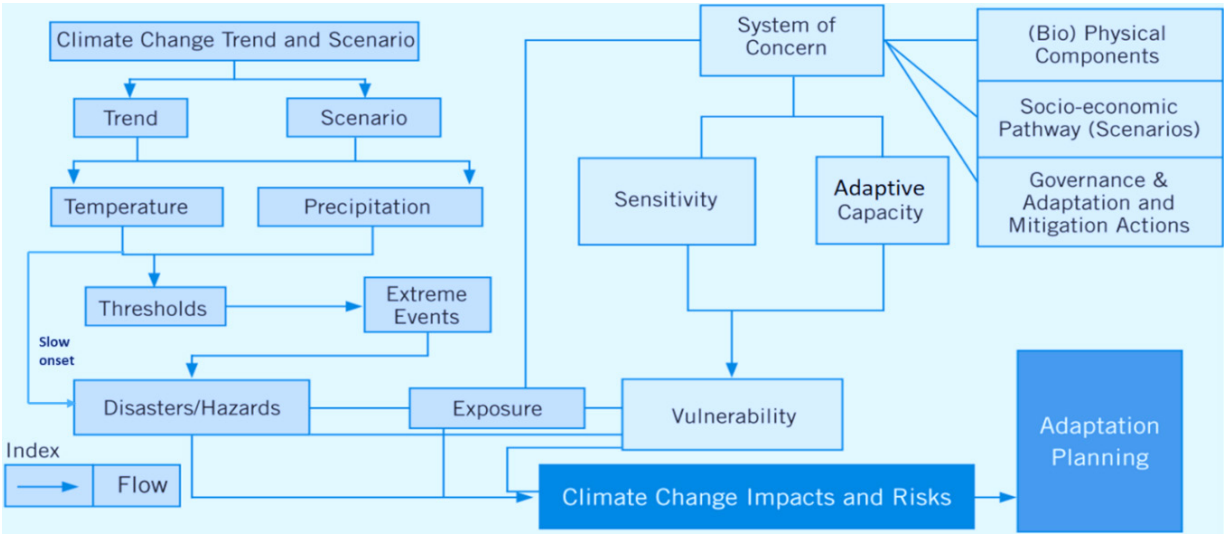

Figure 4: Climate change vulnerability and risk assessment framework
(Source: MoPE, 2017)

Although there are various ways of interpreting 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, along with the way those risks are expected to change with investment in adaptive infrastructure, ecosystems, and human settlements. For both past impact and future risk, a core focus of the assessment depends on characterizing vulnerability, disasters/hazards, and exposure. In this assessment, climate trends, scenario analyses, and socio-economic pathways available from national, regional, and international research centers have been used to characterize broad future climate risk and level of uncertainty, as well as differential impacts of climate change. Risks are unevenly distributed and are usually greater for disadvantaged people and communities in countries at all levels of development (IPCC, 2014).

3.2 Approach

Socio-structural vulnerability is a set of socio-economic, biophysical, and institutional factors that determine people's ability to cope with stress or change (Adger et al., 2005). The assessment takes into account biophysical and socio-structural vulnerabilities leading to a differential impact on the population due to long-standing social, economic, cultural, and geographic inequalities. Studies have shown that communities that depend on natural resources (Gentle & Maraseni, 2012), live in geographically remote areas (Kohler et al., 2010), are poor in a stratified society (Mirza, 2011), along with women and households based on gender differences (Terry, 2009), are disproportionately impacted (Schellnhuber et al., 2016), further perpetuating existing inequalities.

The study looked into 'who' is mostly affected by climate-related impacts, and 'why', and attempted to identify the drivers of uneven vulnerability across social differences. It examined how micro and macro socio-economic trends and scenarios, e.g., population growth or decline; changes in age distribution and education; social and spatial mobility (migration); poverty; participation; culture, etc., impact different populations and their experiences of climate change, as well as their adaptive capacity. Incorporating socio-economic parameters into vulnerability assessments assists in identifying specific adaptation options.

Assessment approaches are mostly characterized by top-down or bottom-up approaches, initially to indicate the motivation of the methods used. A mixed assessment approach has been applied to the assessment process **(Figure 5)**. The top-down approach usually refers to scenario-driven assessments that apply global, regional, or national climate change modeling and projections to assess potential impacts on the particular sector (Kelly & Adger, 2000)**.** In a bottom-up approach, the unit of analysis is typically smaller and more localized, such as households or communities, which the top-down approach cannot capture. The bottom-up approach also aims to empower local and provincial government and stakeholders, including communities, by encouraging self-assessment of climate impacts methods (Van Aalst et al., 2008). This approach is also useful for triangulating and validating information derived from top-down approaches.

This assessment followed a mixed approach as risks associated with socio-structural vulnerability is specific to particular societies and people, which requires a bottom-up approach as well as a top-down quantitative analysis as climate change vulnerability is multifaceted. Changes in the climate system (trends and scenarios), as well as socio-economic (trends and scenarios), have been analyzed to understand the underlying causes of vulnerability and risks of climate change impacting women and vulnerable groups. To operationalize the bottom-up approach, preliminary results and findings of the VRA were shared with relevant stakeholders at the provincial consultations. Several FGDs were organized with local communities where climate change issues and scenarios were discussed. Separate FGDs were organized with vulnerable communities like *Mushar, Dalits, Madhesis, Muslims,* and IPs to understand the differential impact of climate change on these groups. Their experience on local level adaptation was also collected and incorporated into the analysis.

The top-down approach helps to understand the impact of climate change through climate change models and the future scenario whereas the bottom-up approach is needed to understand the vulnerability and threshold of the community. The down-scaled models and scenarios are helpful to interpret the impact on the ground. Therefore, we adopted a customized and balanced approach of top-down and bottom-up approaches while analysing the VRA of the socio-structural sector (**Figure 5**).

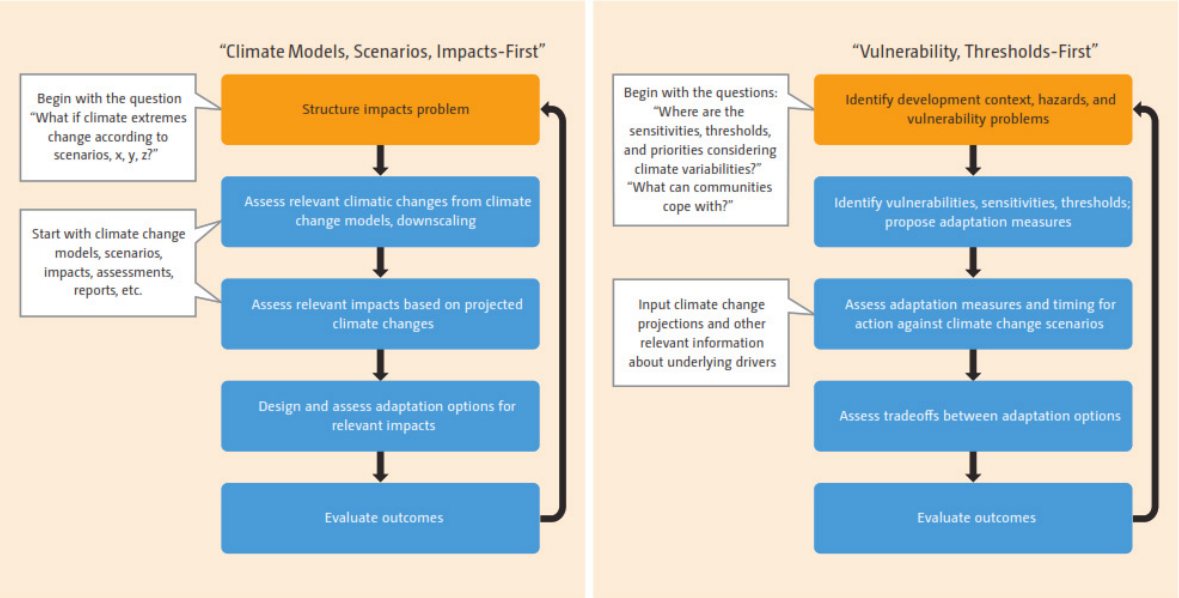

Figure 5: Top-down and bottom-up models

Source: Van Aalst et al., 2008

The assessment process considered the pre-existing deep social structures and positioning of the diverse groups and their specificities that led to differential impacts of hazard through a combination of top-down and bottom approaches. As resilience to climate change is highly impacted by local power structures, including political power, power relations between men, women, and diverse social groups, and allocation of local resources and budgets, these aspects were thoroughly considered throughout the process at all levels. The combination of the two approaches was useful in ground-truthing and validating information derived from top-down approaches. Additionally, GESI analysis[6] and policy review helped identify gaps in policy and practice of climate change commitments at various levels. These findings have also been validated through consultations carried out with diverse stakeholders including political and government leaders, community representatives, and experts from various fields.

To ensure cross-cutting integration in the assessment, a thorough literature review, sectoral analysis, and review of related policies, plans, and budgets were carried out. This was useful to understand for the formulation of indicators. Cross-cutting integration was ensured by closely working with all the sectors and monitoring the process through the development of a checklist that guided each step of the assessment process. Disaggregated data was collected and analysed as available and inclusive participation of stakeholders was ensured throughout the process **(Annex 17)**. The identification of adaptation options and the recommendations also ensured the cross priorities based on the quantitative analysis and the field consultations. Cross-cutting sector integration has been ensured throughout the assessment process as indicated below **(Figure 6).**

Figure 6: Crosscutting sector integration process

6 GESI analysis refers to the variety of methods used to understand the relationships between men and women based on their intersectionality – caste, ethnicity, geographical location, etc. – in terms of division of labour, roles and responsibilities, access to and control over resources, and their participation and relative position in society. It also involves analysing social norms and practices which privileges or places them at a disadvantage.

3.3 Methodological steps

The assessment followed a step-wise methodological process to analyze climate vulnerability and risk and identify adaptation options at multiple scales **(Figure 7).** As shown in the figure, scoping of vulnerability and risk and revisiting and refining the VRA framework were undertaken initially in the assessment process. This was followed by the selection of relevant indicators for exposure, sensitivity, and adaptive capacity for socio-structural vulnerability, using both biophysical (intrinsic), socio-economic, and governance dimensions as shown in **Table 3.**

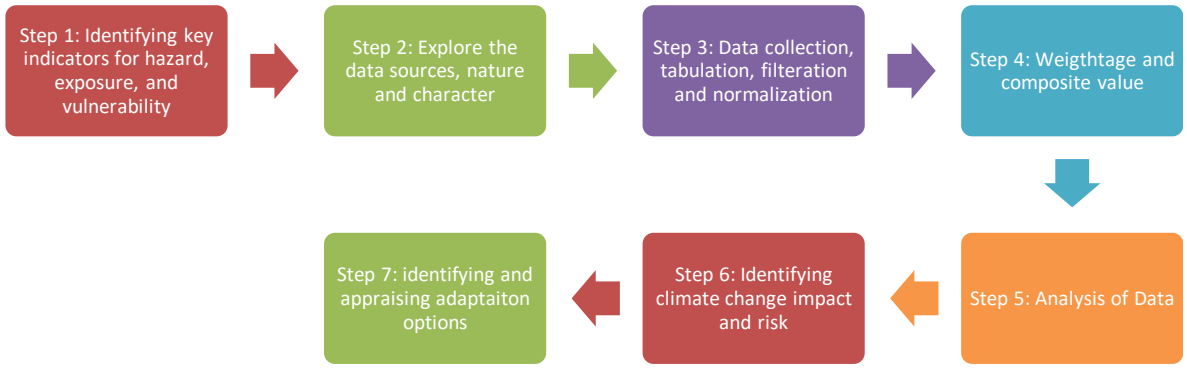

Figure 7: Steps of socio-structural vulnerability and Risk Assessment

Step 1 – Identifying Key Indicators for Hazard, Exposure, and Vulnerability for cross-cutting areas

The main purpose of this step was 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 quantitative and qualitative indicators for exposure, sensitivity and adaptive capacity were selected based on the VRA framework of Nepal, 2017. The indicators were selected 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, programs, and activities in a coherent manner. The GESI indicators selection was based on access and control over resources; participation in decision making; gender division of labour, intersectional discrimination; indigenous knowledge, perception, beliefs, and legal rights and status. These factors had determined the sensitivity and adaptive capacity of individuals and the community. The relevant indicators were identified from the desk review, which was shared with the thematic working group (TWG) members and experts for their inputs, comments, and suggestions. Indicators were revised and refined with the inputs from TWGs and experts.

Table 3: Key considerations adopted in the selection of indicators

Population and resources	
Exposure	Socio-demographic - disaggregated population Resources - an area of the district
Sensitivity	Socio-Demographic – population density, age, disability, sex Caste/ethnicity – *Dalit, Janjati*
	Labour force participation-economically not active, employment in natural resource base sector
	Poverty, unemployment, corruption, and migration
	Limited access to resources- ownership inland house, financial/natural
Adaptive Capacity	Human capital - knowledge and skills, years of schooling
	Socio-economic (macro) - HDI, GDI, GDP
	Socio-economic (micro) – Insurance, savings accounts, women's income share, income from non-agriculture
	Natural Capital (Access to Resources) – average land holding, per capita forest area, ownership of house and land
	Technology/infrastructure – access to communication, road networks
	Social capital – No. of cooperatives, Representation in user committees
	Governance – Political representation, environment-related actors and agencies; Institutional and governance dimensions – policy, plans, and strategies, participatory and inclusive decision-making processes

Step 2 - Exploring Data Sources, Nature, and Character:
Quantitative data were collected from major sources like CBS, NDHS, NLSS, MPI, UNDP, relevant ministries, published and unpublished reports, and journal articles. The secondary datasets were validated through consultations in all seven provinces and at the national level. To ensure data quality and authenticity, sector-specific data were derived from relevant government agencies and institutions. The secondary datasets were validated through participatory methods consisting of focus group discussions (FGDs), interviews with key informants, informal conversations, and field observations with key stakeholders at provincial and national levels.

3.4 Indicators, Weightage, and Analysis

The assessment was focused on looking at climate change impacts in eight major thematic sectors including GESI, Livelihood, and Governance across 77 districts, 5 provinces, and physiographic regions. This assessment does not, however, consider all the palikas because of the limited data available. GESI, livelihood, and governance are a cross-cutting sector integrated with other sectoral assessments, while also separately analyzed by looking into the socio-structural issues impacting vulnerability and risks.

The socio-economic data has been collected from the most reliable and authentic sources which included CBS and international agencies like ICIMOD, WB, ILO, etc. However, limitations in terms of the availability of sex-disaggregated data for all 77 districts have been a major challenge. There was also a limitation on the availability of large-scale research and surveys looking into the socio-economic aspects of climate change and its differential impact on a diverse population. There is inadequate documentation and sharing of the GESI responsive climate-resilient practices which are limited to project-specific and district-focused examples. Further challenges were due to data gaps as per the new federal structure and the COVID

pandemic, which limited the number of face-to-face interactions and field visits. Nevertheless, the availability of secondary data, case studies, and numerous consultations has validated the information in the assessment process. The list of indicators used for analyzing socio-structural risks and vulnerability, their sources, and the unit is presented in **Table 4** below:

Table 4: Indicators with units and weights

Exposure components	Indicators' name	Unit	Sources	Weightage assigned 3 decimal places
Demographic	Male population	No.	CBS, 2012a	0.4666
	Female population	No.	CBS, 2012a	0.5333
Resource and services	District area	Km^2	CBS, 2012a	0.5000
	RCC house	No.	CBS, 2012a	0.2353
	Number of thatched and other houses (kachha house)	No.	CBS, 2012a	0.2647
Total				2.0000
Sensitivity components				
Socio-economic	Proportion of *Dalit* population	%	CBS, 2012a	0.1225
	Proportion of *Janjati* population	%	CBS, 2012a	0.0600
	Population growth (annual)	%	CBS, 2012a	0.1056
	Sex ratio	%	CBS, 2012a	0.0325
	Female-headed households (FHH)	No.	CBS, 2012a	0.0721
	Male migrants	No.	MoLE, 2020	0.1763
	Dependency ratio	%	CBS, 2012a	0.2023
	Poverty incidence	%	CBS, 2012c, CBS, 2013, NPC, 2018	0.1691
	Food poverty incidence	%	CBS (2013)	0.0675
Resource and services	Economically active males in agriculture	%	CBS, 2019	0.1394
	Economically active females in agriculture	%	CBS, 2019	0.1519
	Females without ownership of land and house	%	CBS, 2012a	0.0773
	No. of households which use firewood for cooking	%	CBS, 2012a	0.1488
	No. of households without access to safe drinking water	%	CBS, 2012a	0.1498
	No. of households without toilets	%	CBS, 2012a	0.1518
	Landless HH	No	CBS, 2012b	0.0258
	Households lacking access to agricultural credit	No	CBS, 2012b	0.1548
Total				2.0000
Adaptive capacity components	Years of schooling	Yrs	UNDP, 2014	0.0190

Socio-economic	Economically active population	No	UNDP, 2014, CBS, 2012c	0.0300
	Labour productivity	Ratio	CBS, 2012c	0.0124
	HDI (index)	Index	UNDP, 2014	0.0109
	GDI (index)	Index	UNDP, 2014	0.0103
	GDP	USD	UNDP,2014	0.0897
	Non-agriculture GDP	Nrs (million)	MoF, 2018b	0.1366
	Per capita budget	Nrs per capita	MoF, 2018b	0.1903
	Women's income share	%	UNDP, 2014	0.0411
	Per Capita Income (USD)	USD	UNDP, 2014	0.0595
	No. of holdings the main source of income from non-agriculture	No.	CBS, 2012b	0.0558
	Active male saving account	No.	CBS,2017	0.1634
	Active female saving account	No.	CBS,2017	0.1487
Resources and services	Average holding size	ha	CBS, 2012b	0.0620
	Female ownership with house and land	%	CBS, 2012a	0.1378
	Female ownership with land only	%	CBS, 2012a	0.1378
	Per capita Forest Area	ha/HH	MOFE, 2020	0.1281
	Households with television access	%	CBS, 2012a	0.0422
	Biogas installed	No.	CBS, 2012a	0.0432
	Road density	$km/100km^2$	CBS, 2012a	0.0444
	No. of cooperatives	No.	Dept. of Cooperative 2017	0.0630
	Female membership in a cooperative	No.	Dept. of Cooperative 2017	0.0715
	Male membership in a cooperative	No.	Dept. of Cooperative 2017	0.0648
	Representation in CFUGs	No.	MoFE, 2019	0.0733
	Environment Related I/NGOs	No.	SWC, 2017/18	0.1314
	Total			2.0000

Step 3 - Data Collection, Tabulation, Filtering, and Normalization

The step involved data collection from various sources such as government (federal, provincial, and local), regional and global centres, international and national organizations, and other local/community stakeholders. After the data were collected, it was tabulated, filtered, and normalized. VRA indicators consisted of a wide range of socio-economic variables with different scales and units. The min-max method was adopted for the normalization of the quantitative dataset. The method transformed values between 0 and 1 by subtracting the minimum score and dividing it by the range of indicator values as shown in Equations 1.0 and 2.0. If X has a positive relationship with the resulting component index, then its normalized values are

$$Xij\ (normalized) = \frac{Xij - Min(Xij)}{Max(Xij) - Min(Xij)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1.0)$$

If X has a negative relationship with the resulting component index, then its normalized values are

$$Xij\ (normalized)\ =\ \frac{Maxx\ (Xij)-Xij}{Max(Xij)-Min(Xij)} \quad \text{.....2.0)}$$

Where,
Index $X_{ij\ (normalized)}$ is the normalized value of an indicator,
X_{iij} is the actual value of the same indicator,
Max (X_{ij}) and Min (X_{ij}) are the maximum and minimum values of the same indicators respectively.

Step 4 – Weightage and Composite Value

AHP method was used to assign weightage to the indicators. A total of 21 experts were consulted online for assigning weightage to the indicators. Out of 21 participants, 14 were female (67%) and 7 were male (33%). The selected experts were from a diversified background ranging from an economist, a social scientist, livelihood experts, and GESI experts. Out of 21 experts, 5 experts were from the Thematic Working Group (TWG member), 2 experts were also from Government but non-TWG members, and the other 14 were from research organizations and INGOs working in Nepal, such as ICIMOD, IWMI, UNDP, World Bank, etc. The list of indicators and relative weightage assigned by the experts are summarized in **Table 4.**

Aggregation

The aggregation was performed using the weighted linear summation method which is a linear combination of standardized values using weights as shown in equation (3.0).

$$AC = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} \quad \text{..... 3.0)}$$

Where *AC* is an aggregated indicator, e.g., aggregated adaptive capacity,
x_i is an individual indicatory of the adaptive capacity of a vulnerability component,
w_i is the weight assigned to the corresponding indicator x_i.

The most preferred alternative is that with the minimum value of *AC*. All the components, i.e., exposure, sensitivity, and adaptive capacity, were aggregated in the same manner. Similarly, the vulnerability and risk were computed as shown in Figure 1.

According to the IPCC-AR5, vulnerability is a function of Sensitivity and Adaptive Capacity and risk is a function of Hazard Intensity, Exposure, and Vulnerability as shown in (4.0) and (5.0).

$$V = S - AC \quad \text{..... (4.0)}$$

Where,
V is the composite vulnerability indicator,
S is the sensitivity component of vulnerability,
AC is the adaptive capacity component of vulnerability.

$$R = H_{intensity} \times V \times E \quad \text{..... (5.0)}$$

Where
R is the risk index
$I_{ntensity}$ is the hazard intensity
V is the vulnerability
E is an exposure

Step 5 – Analysis of Data

Data analysis was carried out to identify trends in variables and indices useful to support planning and decision-making. The step also involved characterizing broad future climate risks and levels of uncertainty based on climate and socioeconomic scenarios. Climate data were analyzed in advance and results were produced in different forms such as trend analysis, scenario analysis, and climate pattern. Socioeconomic, demographic, and sector-specific data were analyzed using descriptive analysis and statistical analysis including logistic and non-logistic regression and scenario-based economic modeling to understand which particular category is more exposed to climate change, which one is more sensitive, and which region or population has better adaptive capacity. The result in the form of maps has been produced for the national, provincial, and district levels and is useful to identify key "climate-vulnerable hotspots" from among the 3 ecological zones, 7 provinces, and 77 districts of Nepal.

Since there are a lot of diversities based on the socio-structure and geography of the country, qualitative analysis has been carried out to enrich the findings of VRA and come up with specific realistic recommendations for adaptations. The local and provincial consultations and fieldwork have helped to understand the specific social dimensions of climate change and the underlying social inequalities and gaps which contribute to individual and gender-specific vulnerability, as well as the coping and adaptation capacities. The analysis has looked into communities, women, men, their socioeconomic differences, women and men's roles, activities and power relations, access/control over resources within the household and the community, and how these continue to influence their respective participation, capacities, and actions against climate change impacts. Similarly, current responses, coping and adaptation options to climate risks, and effective strategies for managing climate-related shocks, stresses, and uncertainties have been identified for effective adaptation planning based on the different needs of the most vulnerable groups.

Step 6 – Identifying Climate Change Vulnerability and Risk

The analysis generated products for climate trends and scenarios observed and projected impacts/hazards, risks, and vulnerability. It helped rank climate change impacts and risks at provincial, ecological, and national levels. This ranking was validated through a consultative process with key stakeholders. The calculated sub-sector and sector-wise aggregate vulnerability and risk indices across the districts, provinces, and physiographic regions were ranked into five classes: (a) Very low, (b) Low, (c) Moderate, (d) High, and (e) Very high, based on the Jenks natural breaks method. The result of the risks and vulnerability of different districts, provinces, and physiographic regions has been presented in the form of thematic maps, and the most

vulnerable districts, provinces, and physiographic regions have been identified. This is expected to be useful for the planning and budgetary process for climate adaptation at national, provincial, and local levels.

Step 7 – Identifying and appraising adaptation options

Adaptation options were identified based on the vulnerability ranks of different districts and provinces and the underlying indicators that contributed to high or low vulnerability. Extensive literature reviews also supported identification for specific adaptation options based on local specificities and vulnerabilities based on differential impacts of major climatic events. Additionally, case studies with potential for scaling up distinctive knowledge; increasing efficiency and decreasing workload of women and climate-vulnerable groups; and potential avenues for diversifying income sources through the management and operational strategies, infrastructural changes, inclusive policy adjustments, and capacity-building were identified for different sectors. The assessment considered the distinctive knowledge of women in climate change adaptation as agents of change rather than as vulnerable groups. Efforts were made to ensure that the adaptation options do not reinforce existing discriminatory practices and gendered stereotypes. The most appropriate or relevant adaptation strategies have been identified through a set of criteria that is in line with national goals and targets for sustainable development as well as national policy, sectoral policy, and national development goals relevant to climate change. The priority longlist of adaptation options has been identified based on timing/urgency for action, cost, co-benefits, efficacy, and flexibility, or robustness criteria (UNFCC, 2012).

The process adopted in this assessment included:

- Identifying potential adaptation options based on the impacts, vulnerability, and risk maps and tables generated by the analysis of secondary socio-structural data.
- Identifying a potential list of adaptation options based on literature review, particularly successful adaptation practices, distinctive local knowledge/practices, and climate-smart technologies.
- Consultation with relevant experts to map effective adaptation strategies in the sector and sub-sector
- Consultation at the provincial level to identify adaptation options in the context of the existing risk and vulnerability
- Validation of adaptation options in Thematic Working Groups (TWGs) and Technical Committees
- Finalization of the list of adaptation options with a recommendation for prioritizing costing through NAP.

Chapter 4

Socio-economic Trends and Scenarios

This chapter presents trends and scenarios of key socio-economic indicators at the national, provincial, and district levels. Future climate risks and vulnerability are influenced by socio-economic trends and scenarios in which climatic risks are influenced by natural hazards and socio-economic scenarios influence vulnerabilities. Understanding socio-economic trends and scenarios in association with climatic trends and scenarios are called a shared socio-economic pathway (Birkmann et al., 2015). There is an increasing need of incorporating socio-economic scenarios for climate change analysis which is largely missing currently (Kriegler et al., 2012). Trend analysis helps to understand the socio-economic development path in the past. Basing on past trends and coherent assumptions about how key socio-economic changes occur over time gives a clue as to how to think about future socio-economic developmental pathways.

4.1 Demographic Trends and Scenarios

Based on the population projection of CBS (2014), Nepal's population is expected to reach 34 million by 2031. If the same growth rate continues, it will reach 42 million by 2051. This means 28%, 44%, and 62% more population will be added by 2031, 2041, and 2051 to the base population of the 2011 census. There is a slightly higher female population in Nepal based on the 2011 census and it is expected to reach 21.9 million by 2051, while the male population will reach 20.9 million during the same time. Similarly, there will be an increased urban population in the future with a corresponding reduction in the rural population. If the same growth rate continues, the share of the urban population may reach 53% from the current share of only 17% while the rural population share shrinks to only 56% from the current share of 83% (**Table 5**). An increasing trend of rural-urban migration for economic opportunities, climate change, and disaster-related migration and displacement are some of the reasons for the increasing urban population.

Table 5: Demographic projection at the nation level

Population	2011	2016	2021	2026	2031	2041	2051
Total (million)	26.49	28.46	30.52	32.47	34.18	38.27	42.86
Male (million)	12.84	13.80	14.81	15,77	16,61	18.64	20.92
Female (million)	13,64	14.66	15.71	16,70	17,56	19.63	21.94
Urban population (million)	4.52	5.55	6.93	8,53	10,31	15.30	20.57
Rural population (million)	21.97	22.90	23.59	23,94	23,86	22.96	22.28
Urban population (%)	17.07	20	23	26	30	40	48
Rural population (%)	82.93	80	77	74	70	60	52

Source: Based on CBS (2014) projection

4. 2 Demographic Trends and Scenarios at the Province Level

The following **Figure 8** shows the population trends and projections at the province level. Based on the historical population trend from 1971 to 2011, the future population is projected. The result shows that Province 2 will have a maximum population by 2051 exceeding the population of Bagmati Province. Province 2 had a population of 2.2 million in 1971, which reached 5.4 million in 2011 and is expected to reach 8.7 million by 2051. Bagmati Province is supposed to have a slightly lower population than Province 2 by 2051 though it has a slightly higher population than Province 2 currently. But the higher population growth rate in most of the districts of Province 2 is the contributing factor for this exponential population growth. Among all seven provinces, Karnali Province has the lowest population and will remain the same in the future too. Like the national case, the female population has slightly exceeded the male population in each province and this trend remains the same in the coming years **(Annex 6 & 7**).

It is projected that Bagmati Province will have the highest female population (above 4.5 million) by 2051 whereas Karnali Province will have the lowest female population (0.60 million) by 2051 **(Annex 7).** World Bank has also estimated that the male population contributes 45.60% of the total population while the female population contributes 54.40% in 2019, which was 49% and 51% respectively (World Bank, 2020). This difference is mainly contributed by life expectancy differences along with other factors. The life expectancy rate for females is 67.44 years against 64.94 years for males. As Bagmati Province already holds a higher female population, if the same growth trend continues, it will have the highest female population by 2020. Bagmati Province and Karnali Province have a sparse population where the female population is slightly higher than the male population. If the same population growth pattern continues, Karnali Province will not have a higher population and will keep the lowest female population among all seven provinces of Nepal.

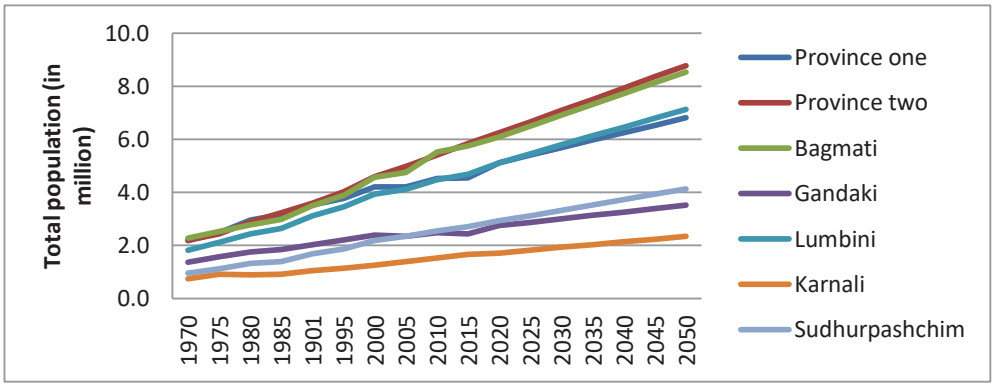

Figure 8: Population (in millions) trends and projections at the provincial level

Sources: CBS (1991), CBS (2001), CBS (2012a)

4.3 Population Density

Population density is a measurement of the population residing per unit area and is measured per square kilometer. It is an important indicator of Vulnerability and Risk Assessment (VRA) as a higher population density at climatic hazard-prone areas is considered sensitive to climatic risks. In the figure in **Annex 8,** the population density of Bagmati Province is higher from 1971 and it will exceed 1200 per square kilometer by 2051 if the same growth rate is followed. Province 2 has the second-highest population density after Bagmati Province and its density will cross 800 persons/square km by 2051 if the growth follows the same trend in the future**.**

Kathmandu Valley in Bagmati Province is the main factor of the unprecedented population growth and higher population density of the province. Based on CBS, 2011, this valley has over 2.5 million population and the annual population growth rate is 4.78% (CBS, 2014), making it the fast-growing metropolitan area in South Asia. Population from peri-urban and different parts of the country migrates here because of its better education, health, and other facilities. The recent national move to federalism is expected to break this chain to some extent.

Unlike Bagmati Province, the increase in population density in Province 2 is contributed by higher population growth and an increasing trend of mountain-Terai migration. The report says that the population of the Terai increased by 1.5 million due to migration (CBS, 2014). Overall, the Terai covers 23% of the total land area but holds about 50% of the total population. Province 2 is the major part of the Terai region, hence the higher population density.

4.4 Labour Migration

Labour migration is the movement of persons from one State to another, or within their own country of residence, for employment (IOM, 2019). Migration, displacement, and refugees are major social issues that have a direct relationship with climate change and natural disasters (Kaczan & Orgill-Meyer, 2020; Kolmannskog & Trebbi, 2010). In Nepal, natural hazards (mainly floods and landslides) are the major driving force inducing labour migration (Jaquet et al., 2019). The majority of the labour force depends on agriculture and this sector is badly impacted by recurrent floods, droughts, and landslides. As a result, the agriculture labour force, particularly the young generation, wants to escape from the agriculture sector as they find a higher shadow price of labour in the labour market abroad. Poverty, one of the major components of sensitivity, also has a strong relationship with labour migration (Sunam & McCarthy, 2016). Migration trends have increased alarmingly in Nepal, with a corresponding increase in remittance. Each year, more than 400,000 labour migrants, mostly agricultural, travel abroad for work, the majority to India and the Gulf (MoLES, 2020). **Annex 9** shows contributions from remittance over time. If the same trend continues, remittance is expected to grow by 128% and 194% by 2020 and 2030 in comparison to the baseline remittance volume of 2017 which was 678 million USD.

The recent data show that the volume of remittance, almost negligible a decade ago, is almost equivalent to agriculture GDP. Remittance is playing a crucial role to supplement household income, education, and other household consumptive use. Out-migration has led to shortages of hired agricultural labour and the increasing feminization of agriculture. 73% of the female

workforce works in agriculture, compared to 56% of men. Male out-migration has left behind the women, children, and elderly in villages. Male labour migration has a multidimensional impact on women's role in agriculture and has forced them to take over the burden of agricultural work due to a shortage of labour (Paudel et al., 2020). Labour migration has created agricultural labor scarcity which has resulted in more fallow land in Nepal and declined production worsening households' food and nutritional security (Neupane, 2011; Bhatta et al., 2019).

4.5 Labour Migration at the Province Level

Using labour migration data from 2009-2018, **Annex 10** shows the trend and projection of male labour migration at the provincial level. It shows that Province 2 has the highest number of labour migrants, which was just 36,000 per year in 2009, increased to 231,000 in 2017/18, and will reach 400,000 per year by 2030 if the same trend continues. Province 2 is followed by Lumbini Province and Province 1. The lowest male labour migration growth rate is observed in Karnali and Sudhurpaschim Provinces, possibly due to lower population pressure in this region and undocumented labour migrants who go to India as seasonal labour. Eastern and central part of Nepal is more impacted by overall natural hazards, such as heavy rainfall, floods, landslides, and thunderbolts, which are also expected to increase in future. It shows that the aggregate hazard index is higher in Province 1, 2, and Bagmati Province at the baseline scenario and will continue to increase significantly through 2030 and 2050 under both RCP 4.5 and 8.5 scenarios **(Figures 11, 12, & 13).** As natural hazard is one of the push factors for incremental labour migration, this indicates that natural hazard-induced labour migration in this region will continue to rise.

Annex 11 shows the number of female labour migrants is much lower than the number of male labour migrants, though the market demand for the female worker is normally higher than male counterparts (Oishi, 2005). There are many plausible reasons for this, such as lower literacy rates, lack of skills, and language barriers. Another reason could be government policy, as many countries are not opened yet for female labour migrants due to security reasons. Thirdly, in the absence of a male counterpart, females typically serve as caregivers for children and the elderly, and it is also socially undesirable for females to leave their homes for a longer period. It is lower for Province 2 where male migrants' number is highest. Male labour migration is highest for Province 1 and Bagmati Province and lowest for the Karnali and Sudhurpaschim Provinces. In Province 1 and Bagmati Province, increasing female literacy rate, GDI, and increasing network are contributing factors for increasing female labour migration. Poor literacy rate and GDI results in a lower female migration rate particularly in Province 2 where male labour migration is excessively high. The prevalence of several religious and social stigmas, such as *gumto pratha* (covering the forehead), menstruation restrictions, etc., prevents women from practicing labour migration. In a relatively close society like the *Madhesi* community, it is socially undesirable for the female to stay outside the home for a longer duration of time.

4.6 Female-headed Households in Nepal

Normally, the woman in the developing world heads a household when she has migrated for a long period; or if she is a widow or divorces; or sometimes, if she is a wife of physically

handicapped men. There are two kinds of household headship, de jure and de facto, and the latter is more prominent in our context. Female-headed households are one of the most vulnerable groups of society that confront many challenges of climate change. Because of their poor access to physical and financial resources, technologies, and skills and low level of awareness and literacy, they are unlikely to take decisions and adaptation options related to climate change in comparison to their male counterparts. The trends of female-headed households in Nepal show that there is a significant increase in number over the past three decades **(Figure 9a).** The positive increasing trends of FHHs are mostly caused by the increasing labour migration for employment in the past two decades.

There were altogether 439,000 female-headed households in Nepal during the 1991 census, which became 621,000 in the 2001 census, over 41% increase from 1991-2001. Then, it jumped to 1.3 million in 2011, showing a 125% increase. If female-headed households follow the same growth trend taken during 1991-2011, they will reach 1.6 million during 2020/21, 2.1 million in 2030/31, 2.6 million in 2040/41, and 3.1 million during 2050/51, double the female-headed households recorded in 2011. **Annex 12** explains the trends and projections of female-headed households at selected districts representing the provinces of Nepal.

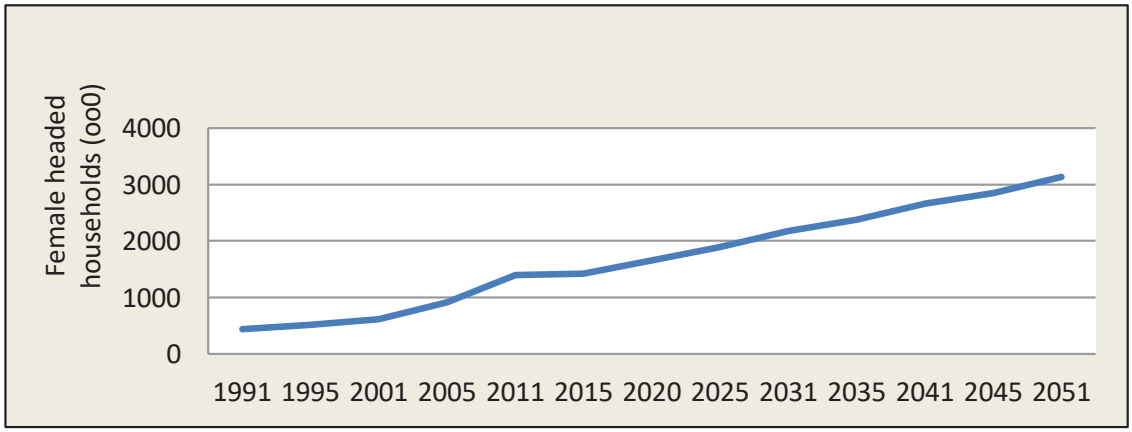

Figure 9a: Trend and projection of female-headed households in Nepal

Sources: Projection based on CBS (1991); CBS (2001); CBS (2012a)

4.7 Human Development Index (HDI)

Human Development Index (HDI) is a composite index that reflects the overall socio-economic dimension of a country or region based on the health of people, their level of educational attainment, and their standard of living. HDI is considered very important for capacity-building and awareness-raising and ultimately building the resilience and adaptive capacity of a society. **Figure 9b** provides a comparison of HDI among the provinces and with the national figure.

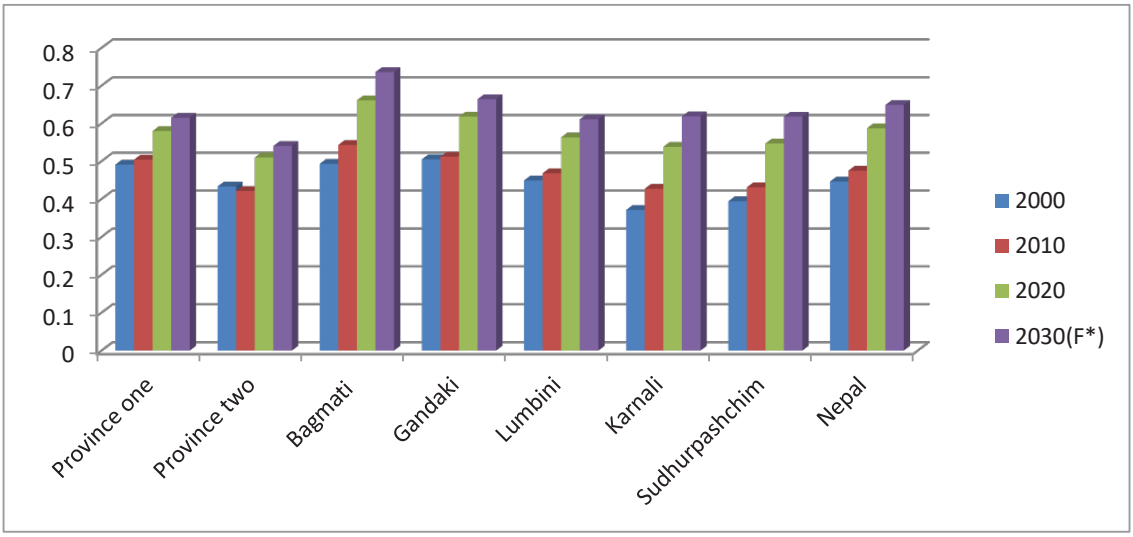

Figure 9b : HDI growth trends and projections at the provincial and national level

Sources: NPC (2018); UNDP (2004); UNDP (2009b); UNDP (2014); UNDP (2020)

Figure 9b shows that Bagmati Province has the highest HDI among all provinces and the national average with an annual growth rate of 1.14%. If it follows the same growth rate, its HDI will cross 0.70 by 2030. Karnali and Sudhurpaschim Provinces have relatively poor HDI but have made significant progress during the last decade (2010-2020) and the HDI growth rate for Karnali is 1.50% and for Sudhurpaschim Province is 1.29%. If the same growth rate is followed, both provinces may follow the pace of the national HDI growth rate by 2030. HDI growth rate of Province 2 was found to be very poor, and it may lag behind the other provinces if the same HDI growth path is followed.

4.8 Poverty Trends

Poverty is a major driver of people's vulnerability to climate-related shocks and stressors. The people interwoven into poverty traps are likely to be affected by climate change quickly (Marotzke et al., 2020). Poverty also induces labour migration directly and indirectly. Therefore, poverty trends and scenarios are important for climate change adaptation planning. Due to different approaches of poverty measurement adapted in the past, it is difficult to calculate the poverty trends and future projections. At the national level, poverty headcount trends show poverty has reduced by 26% between 1995-2003 (CBS, 1996; CBS, 2004), at a rate of 3.2% per year. Later, it has reduced by 18.31% in between 2003 to 2011, at the rate of 2.2% per year (CBS, 2004; CBS, 2006; CBS 2012c; CBS, 2013). Only in 2018, Nepal has conducted a Multi-dimensional Poverty Index (MPI) measurement using 2014 survey data. MPI being the first time poverty measurement in Nepal, it is not possible to estimate trends.

Figure 10 shows a reduction in poverty headcount (absolute poverty rate) between 2011 and 2014 at the province level and its comparison with the national level. The figure reveals that there is an overall reduction in the poverty rate in all provinces. Increasing trends of international labour migration, change in the agrarian system, and the government's poverty reduction interventions could be some of the reasons for this poverty reduction (CBS, 2005; Sunam, & McCarthy; 2016). A higher reduction rate is observed in Bagmati Province, where poverty

has reduced from 27.2% to 12.2% in four years at the rate of over 3% per year. The lowest reduction in poverty is seen in Province 2 and Karnali Province **(Figure 10)**.

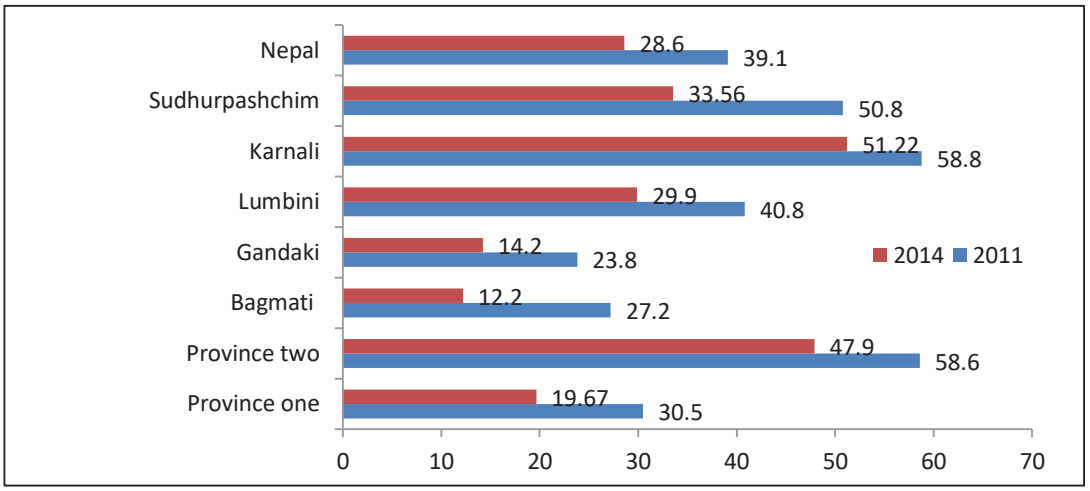

Figure 10: Changes in poverty headcount (%) (2011-2014)

Sources: NPC, 2018; UNDP, 2020

Annex 13 compares the current poverty headcount and MPI at the provincial level. It shows that the poverty headcount is lowest in Bagmati Province (12.2%) and highest in Karnali Province (51.2%). Again, Karnali Province has the highest MPI (23%) and Bagmati has the lowest MPI (5.1%). Province 2 has 21.2% MPI but 35% of the total MPI poor of the country reside there, the most of any province.

Chapter 5

Observed and Projected Climate Change and its Impacts in the Sector

5.1 Climate Change Trends and Scenarios

5.1.1 Climate Change Trends

This subsection gives trends and future scenarios of major climatic parameters based on the study conducted by DHM in 2017 and another study followed by MoFE and ICIMOD in 2019 (DHM, 2017; MoFE & ICIMOD, 2017). Based on the DHM study, trends of two major climatic parameters, i.e. temperature and precipitation are presented in **Table 10.**

There are several studies on trend analysis of climatic parameters that were conducted in the past and different trends were suggested by them. The recent study conducted by DHM during 2017, based on historical data from 1975-2014, suggests an overall positive trend in annual maximum temperature, which is increasing at the rate of 0.056^{0}C/year at the national level (DHM, 2017). Similarly, the minimum temperature trend is increasing at the rate of 0.02^{0}C/year for the whole of Nepal, and the trend is significant only for the monsoon season (Table 10). Unlike temperature, precipitation's trend is less clear; it shows a significant upward trend for the pre-monsoon and monsoon precipitations whereas pre-monsoon precipitation shows a significant negative trend in the high Himalayan region. Interestingly, the number of rainy days is increasing significantly mainly for the north-western districts. Very wet and extremely wet days are decreasing significantly in the northern districts. Trends in warm days and warm nights show a significant increase in the majority of the districts. Similarly, warm spell duration is increasing significantly in the majority of the districts (MoFE & ICIMOD, 2019). The past trends of the climatic parameters have a relationship with the future scenario of climate change stressors and hazards.

Table 6: Observed precipitation and temperature trend of Nepal (1975-2014)

Seasons	Precipitation (mm/yr)	Maximum Temperature (°C/yr)	Minimum Temperature (°C/yr)
Winter	-0.072	0.054**	-0.009
Pre-monsoon	-0.081	0.051**	-0.003
Monsoon	-0.085	0.058**	0.014*
Post-monsoon	-0.324	0.056**	-0.005
Annual	-1.333	0.056**	0.002

* Denotes significant at 95% CL and ** is significant at 99% CL
Source: DHM, 2017

Maximum Temperature trend: DHM study shows that the annual maximum temperature trend is significantly positive and increasing at the rate of 0.056°C/year for the whole of Nepal. The positive temperature trend is highly significant for the majority of districts (> 90% of the districts). At the district level, the highest significant positive trend (0.12°C/year) is observed for the Manang district in the winter season. The trends are found positively correlated with altitude, for instance, a negative trend or a small positive trend is observed for lower altitude districts and a larger positive trend is observed in higher altitude districts.

At the physiographic level, a significant positive trend is observed for all five physiographic regions except Terai in winter and pre-monsoon, and Siwaliks in winter. In High Mountains and the high Himalayas, the highest positive trend is observed in the winter season whereas, in Terai, Siwaliks, and middle mountains, the highest positive trend is observed in the monsoon season.

Minimum temperature trend: In the case of minimum temperature, the DHM study shows that it is also positive (0.002°C/year), but unlike the maximum temperature trend, it is insignificant for the whole of Nepal. At the district level, the highest positive trend (0.046°C/year) was observed in Dolpa in the monsoon, and the greatest negative trend (-0.076°C/year) was observed for Humla district in winter. Similarly, the negative minimum temperature trend is significant in most of the north-western districts in winter and post-monsoon seasons while the positive minimum temperature trend is significant in the majority of southern (Terai to Middle Mountains) districts in Eastern, Central, and Western Nepal for all season. At the physiographic level, Terai and Siwaliks show a significant increasing trend in most of the seasons. Similarly, a significant decreasing trend is observed for High Himalaya only in the winter season.

Precipitation trend: Unlike temperature, the precipitation trend is less clear: shows a significant upward trend for the pre-monsoon and monsoon precipitations whereas pre-monsoon precipitation shows a significant negative trend in the High Himalayan region. Interestingly, the number of rainy days is increasing significantly mainly for the north-western districts.

5.1.2 Future Climatic Scenario

Climatic future scenarios are based on the MOFE and ICIMOD report (MoFE & ICIMOD, 2019). It shows that both the average annual mean temperature and the average annual precipitation are projected to increase until the end of the century. Precipitation could increase by 11–23% and the mean temperature might increase by 1.7–3.60C by 2100. The temperature is projected to increase for all seasons. The highest rates of mean temperature increase are expected for

the post-monsoon season (1.3–1.40C in the medium-term period, and 1.8–2.40C in the long-term period) and the winter season (1.0–1.20C in the medium-term period, and 1.5–2.00C in the long-term period).

In the case of precipitation, in the medium-term period (2030), the average annual precipitation change is projected to increase by 2.1%, whereas for the long-term period (2050), it is likely to increase by 7.9%. However, there is a spatial variation of projected changes in which the central and western regions are likely to be wetter than the eastern. The changes in precipitation are higher in the high mountains than in other physiographic regions for most of the periods. In the medium-term period (2030), the pre-monsoon precipitation is expected to decrease for both RCP 4.5 and RCP 8.5 scenarios. The winter precipitation is projected to decrease for RCP 4.5 but increases for RCP 8.5. Monsoon precipitation is projected to increase for both RCPs. In the long-term period (2050), almost all seasons indicate an increase in precipitation, except the pre-monsoon for RCP 8.5. A maximum precipitation increase is observed during the post-monsoon season followed by the monsoon season. Precipitation is likely to increase in the central and western parts in both the short-term and the long-term periods, whereas there will be a lower increase in precipitation in the eastern part of Nepal.

5.2 Climate Change Impacts

Nepal is extremely vulnerable to climate change given its hydro-meteorological and physiographic extremes such as flash floods, landslides, and GLOFs (Shrestha & Aryal, 2011). Many factors contribute to and compound the impacts of climate change and negatively affect people's ability to cope with climate stresses. Context-specific conditions of marginalization shape multidimensional vulnerability and differential impacts (IPCC, 2014). Different communities and individuals face different risks of hazard, even within the same district or locality. Lack of income, ownership of land/property, access to credit/market, and lack of capacity for diversification of livelihoods, increase the risk further, drastically amplifying the effects of climate change.

There is a strong correlation showing households with fewer years of schooling and lower wealth are considerably more likely to be affected, experience higher casualties, and incur livelihood losses as a result of floods and landslides (Shrestha et al., 2016). Most households exposed to flooding are in the low-lying Terai region where population densities are comparatively higher. The large population in these regions has some exposure to flood water but the intensity of the hazard is lower and household capacity to take action is higher whereas the relative risk of loss of life and livelihood are considerably higher in the other hilly and mountainous regions (World Bank, 2021). A key research finding of disaster risk in Nepal shows that hazards with low absolute impact (but potentially severe impacts for affected households) are very high in frequency (World Bank, 2021).

Climate change impacts are likely to disproportionately affect the poorest groups in society. For instance, heavy manual labour jobs are common among the lowest paid whilst also being most at risk of productivity losses due to heat stress (Kjellstrom et al., 2016). These groups are proportionally most affected by natural hazards (Hallegatte et al., 2016) and are also most sensitive to rising food prices, potentially driving them to extreme poverty (Dunne et al., 2013). As poor households allocate more than 60% of total household consumption of food, they

are highly prone to the effects of climate change when agricultural productivity declines lead to food insecurity (ADB, 2012). Climate change impacts all four dimensions of food security: food availability, food accessibility, food utilization, and food systems stability, by impacting human health, livelihood assets, food production, and distribution channels, as well as changing purchasing power and market flows (Firdaus et al., 2019).

For this assessment, climate change impacts generated from the literature review were validated through provincial consultations and field visits in all seven provinces. Some similar trends were observed; for instance, variation in rainfall patterns and changing precipitation levels were common to all. An increase in forest fires and drying up of springs were observed in most of the Terai regions. Droughts impacted the agricultural productivity of smallholder farmers and women-headed households (Zhu et al., 2020). Land degradation and crop failure with decreased agricultural productivity and food insecurity are common to all provinces. A common finding in all the provincial consultations was that the impact of floods is experienced mostly by marginalized and landless households. Cities, as well as rural settlements, continue to be exposed to recurring rapid-onset natural hazards such as floods and longer-term, slower onset changes such as increased temperature and changing rainfall patterns triggering rural-urban migration (MoPE, 2017; MoFE, 2021). The subsection below discusses specific impacts of climate change and **Table 6** provides a glimpse of the impact on different sectors.

5.2.1 Economic Impact

The estimated direct cost of extreme climatic events is equivalent to 1.5–2% of the GDP/year (approximately US$270–360 million/year in 2013 prices), and is much higher in later years, rising to 5% or more. The economic loss from water-induced disasters is estimated to be around 0.6–1.1% of GDP per year by 2050. Amjath et al., 2019 estimated an annual loss of 27% in crop production in 27 districts of eastern and central Nepal which fall in the Koshi basin. Likewise, the indirect loss caused by climate change due to business disruption, lost wages, inflation, relief and reconstruction costs, etc., is estimated to be around 25–100% of direct costs (IDS-Nepal, 2014).

Economic loss from reduction of water flow is equivalent to 0.1% of GDP per year on average by 2050 and it may reach 0.3% in very dry years. In the agriculture sector, loss due to droughts (for paddy alone) amounted to USD 753 million from 2001 to 2010 (UNDP, 2013). Direct Loss and Damage (L&D) due to disasters in Nepal from 2008-2011 amounted to a total of NRs 792,633 million. The economic costs of major droughts which occurred in 2006 and 2009 (from the lost agricultural output) were equivalent to 1.9% (2006) and 0.4% (2009) of current GDP (IDS-Nepal, 2014).

Table 6 presents direct loss and damage due to disasters in Nepal from 2008 to 2017. It shows that disaster has caused the loss of Nrs 792,633 million during the last decade at the rate of Nrs. 79,263 million per year. It accounts for a minimum of 0.01% and a maximum of 33.20% of the national GDP.

Table 7: Monetary value of damage and losses due to disaster in Nepal

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Loss and Damage (L&D) (NRs. million)	3,774	947	1789	1452	1294	192	15,143	706,893	432	60717	792,633
Proportion of GDP (%)	0.39	0.1	0.15	0.11	0.08	0.01	0.77	33.19	0.02	2.34	

Source: Bhandari et al., 2020

The impact of climate variability on electricity production (and the impact of planned interruptions) indicates that economic costs could be equivalent to 0.1% of GDP per year on average, and 0.3% in very dry years (Bhandari et al., 2020). Nepal also experiences natural hazards in the form of GLOFs. The damage and loss of life from GLOFs are experienced mostly locally and historical events are low (in terms of fatalities and damage costs). Hydroelectric plants are also subject to the risk of damage due to floods and GLOFs in some locations. A multi-million-dollar hydropower facility was lost in 1985 due to a GLOFs event and there has been a more recent loss of micro-hydro plants from floods (Bhandari et al., 2020).

Case Study 1 – Impacts of the 2008 Koshi floods in Nepal

A total of 12 VDCs with a total population of 98,680 were affected by the Koshi flood of August 2008. The monetary value of loss and damage was estimated at NPR 3774 million. Direct damage was caused to about 5,000 ha of agricultural land, and a total of 17 km of the East-West Highway along different stretches. The damage to the highway prevented farmers from taking agricultural produce from the eastern Terai to any point west of the Koshi River, which reduced sales and undermined livelihoods. The flood had a significant impact on demand and supply, increasing the prices of commodities, particularly onions, potatoes, and firewood. Prices of perishable food items such as bananas and vegetables fell sharply in regions east of the Koshi River and rose in markets in central and western Nepal. The inundation also damaged underground optical cables, phone lines, and pylons, disrupting telecommunications. Damage to high-voltage electricity transmission pylons disrupted the supply of electricity from India to the Integrated Nepal Power System (INPS) and increased the duration of power cuts in Nepal, further affecting livelihoods across the country.
Sources: Dixit (2009); IASC (2008); MoHA (2009)

5.2.2 Resources/Livelihoods

The impact of climate change such as flooding and reduced access to water alters livelihood by destroying assets: physical (homes, land, and infrastructure), human (health), social (social networks), cultural (sense of belonging and identity), and financial (savings). Agriculture-based livelihood systems that are already vulnerable to food insecurity face immediate risk of increased crop failure and susceptibility to new types of pests and diseases. The major natural resource-based livelihoods and occupations such as agricultural farming, forest enterprise, fishing, and pastoralism are highly sensitive. Untimely snowfall severely affects the quantity and quality of rangelands impacting fodder productivity for livestock, depleting ecosystems, altering flowering and fruiting of plants, and thus threatening livelihood means of pastoralists, herders, and marginalized groups. Impacts of climate change not only affect biodiversity but the livelihoods of millions of local and indigenous people who depend on it (Chitale et al., 2018).

Table 8: Impact of Climate Change

Impact of Climate Change	
Crop Failure	Increased efforts in food production and economic burden for farmers, increased workload and household burden for women, food and nutritional insecurity
Reduced availability of forest resources	Fuel Shortage – Women have to spend more time collecting fuel and cooking; loss of livelihood and reduced source of traditional food, fiber, and medicines for forest-dependent communities; resource use conflict amplifies existing inequalities
Water scarcity	Drying up of water sources; increased work burden on women and girls, who travel long distances to fetch water; impact on education and economic activities, displacement, waterborne diseases
Climate extreme events/ disasters	Loss of life and livelihoods, economic loss, decreased labour productivity, psychological distress, increased workload and gender-based violence against women, loss of social capital and safety nets; impacts major tourist destinations and income of those dependent on tourism; damage of road and transportation and disruption of services
Health/WASH	Increased burden of care work for women (primary responsibility of children, elderly); impacts on reproductive health and personal hygiene
Displacement	Rural-urban migration, increased urban poverty, loss of livelihood, unemployment; risks of insecurity, and sexual violence against women
Denial of basic human rights	Lack of access to safe drinking water, energy, nutritious food, clean environment, safe housing

Many women collect and sell NTFPs such as grasses and medicinal plants as part of their livelihood income (Gurung & Bisht, 2014). Forest destruction due to the increasing frequency of forest fires and expansion in the distribution of invasive alien plants reduces the sources of traditional food, fiber, and medicines (Table 7). GLOFs directly impact people living in remote areas close to rivers or fragile slopes (Goodrich et al., 2017). Receding snow lines and increased frequency of cloudbursts, floods, and landslides may affect major tourist attractions, mountaineering, trekking, and rafting, which impacts the income of those dependent on tourism as a source of livelihood (MoFE, 2018).

In addition, a shift in the tourist season increases the workload of women and marginalized groups when it overlaps with the cropping calendar. In the provincial consultations, it was highlighted that mountain regions experienced higher melting of snow, avalanche, and GLOFs, which negatively affected local climate in the mountainous region and substantially reduced water supply, and impacted agriculture in the mid-hills (Province 1, Karnali Province, and Sudhurpaschim Province). Shifts in the monsoon season, longer dry periods, and decreased snowfall lead to higher vulnerability for marginalized communities. Floods and droughts adversely affect agricultural production and productivity, resulting in income shortages.

Provincial consultations showed that women, ethnic/indigenous groups dependent on water, agriculture, and forestry, and *Dalit* communities, including those living in squatter settlements and slums, were most impacted **(Case study 1).** Others impacted were urban and rural households, ethnic minorities, the poor, and those without land and proper houses (e.g., *Musahar* communities). Drought severely affected the livelihood of small-scale farmers and herders, threatening their food security (FAO, 2009). Low-income marginalized or indigenous groups, particularly *Majhi, Raute, Chepang,* and *Satar*, are more vulnerable during floods, landslides, and fires (MoFE, 2018) as they keep their savings in the form of livestock and have limited income sources, which are destroyed together with essential infrastructures like roads, bridges, houses, schools, and public buildings.

5.2.3 Social Impact

Deaths, Injuries, Psychological Trauma

Different types of disasters occur annually in Nepal, among them landslides, floods, fires, and epidemics are major in terms of occurrences and human fatalities. Climate variability is projected to increase the frequency and intensity of such disasters. 28,829 deaths have been recorded from 1971-2018 due to different disasters as shown in the table below. Altogether, 16,598 deaths occurred from epidemics, 5,141 from landslides, and 4,628 from floods (MoHA, 2018) (**Table 8**). Psychological distress and mental health issues post-disasters are also common (Shrestha, 2019).

Table 9: Multi-hazard scenario of Nepal 1971-2018

Type of Disaster	No. of Incidents	Human Loss			
		Death	Missing	Injured	Affected Family
Fire	12,694	1,755	0	2,176	265,962
Landslide	3,729	5,141	191	2,053	559,347
Wind storm	298	21	0	95	1,718
Flood	4,368	4,628	87	615	3,726,261
Epidemic	3,474	16,598	0	44,992	5,134,09
Avalanche	3	17	4	7	1
Snow Storm	7	97	7	0	10
Hailstones	134	9	0	24	3,407
Cold Waves	438	563	0	83	2441
Total	25,145	28,829	289	50,045	5,072,556

Source: MoHA, 2018

Differential Impact on women, children, elderly, poor, and indigenous groups

Exposure to climate change impacts is higher among children, girls/women, pregnant women, the elderly, and people with disabilities with increased mortality and morbidity (MoFE, 2018, Regmi et al, 2016). The marginalized or indigenous groups, particularly *Majhi, Raute, Chepang,* and *Satar*, are more vulnerable to food insecurity due to disasters like floods, landslides, and fires. While women are key managers of their environment and carry out a disproportionate amount of agricultural, household, and community work, they are often excluded from climate change-related decision-making and knowledge-sharing platforms. Women's limited access to common property resources (Perez et al., 2015) aggravates their situation during climate-induced disasters which disrupt their security and safety nets. Marital status can also trigger unequal access to resources during droughts, with widows and divorced women having less access to water resources (Goh, 2012).

Increase in the workload of women and girls

Decreased availability of natural resources leads to girls spending longer hours collecting firewood/water, sometimes even resulting in school dropouts (Nellemann et al., 2011). A study from three villages in western Nepal also found that women worked up to 18 hours a day collecting fuel, fodder, and water (Sugden et al., 2014). Similarly, a different study showed that in the hill villages of Nepal, women performed 82% of the fuelwood collection work (Haigh et al., 2010). Another study in Baitadi, Surkhet, and Dailekh districts found that women were traveling long distances to collect water, fuel, and fodder due to the drying of rivers and streams (Gum et al., 2009). When women have to walk long distances to obtain water and fuelwood, they

become prone to injuries, harassment, or sexual assault (Leduc & Bhattarai, 2008), adversely impacting their reproductive health and making them prone to uterine prolapse (Dhimal, 2015). A lack of clean water and sanitation poses serious health challenges to women, especially during menstruation and pregnancy (Birch et al., 2012).

In Nepal, women are the primary agricultural producers, responsible for the provision of 60–80% of all food, but their livelihood and nutritional status are threatened when changing climatic conditions decrease agricultural yields. Even though women produce most food, less than 10% of female farmers are landowners, and barely 2% of owners have proper paperwork for their land (German Development Institute, 2017). In the hill-villages of Nepal, women perform 82% of the fuelwood collection, and with climate change, reduced availability of fuelwood has increased women's workload (WEN, 2010). Evidence from studies shows that female-headed households are more vulnerable to climate shocks as they grow fewer crop types (Gentle et al., 2014) and have restricted mobility because of their care burden. Men, who have more control over cropping choices, choose to plant highly nutritious but labour-intensive crops such as buckwheat, which increases women's workload and leaves them less time for other livelihood activities (Onta & Resurreccion, 2011). Many times, the loss of seed preserved by women makes them more vulnerable.

Increase in Gender-based Violence

Climate-induced resource conflicts increase gender-based violence, sexual harassment, rape, and even organized trafficking (Nishant & Rahman, 2017). Early marriage was found to be relatively high in drought-prone areas, where there was chronic poverty due to crop loss and generally low levels of education (World Bank, 2010). The lack of timely information may lead to women suffering more in disasters (Khan et al., 2010). An ODI study in Nepal also found that rural women's and girls' clothing was not suitable for swimming, making them more vulnerable to floods and impairing their adaptive capacity (Jones, 2010). It is also reported that during natural disasters, women and girls are frequently subjected to intimidation, harassment, and gender-based violence (Nellemann et al., 2011), notably when traveling long distances in search of resources like fuelwood and water. Issues of social disharmony and an increase in gender-based violence were common in all provinces.

Increase in poverty and migration

Many empirical findings in Nepal have found a strong relationship between climate change and poverty (Gentle et al., 2014; Joshi 2011). Migration is not a new phenomenon in Nepal and has been one of the adaption strategies against climate change. People have migrated historically due to change in climate conditions and for better livelihood options. **Table 9** shows the possible causes for migration and the livelihood options in different places of Mustang district in historical times in Nepal.

In recent times, climate change has also been a push factor for migration with an increase in men seeking employment overseas leaving behind women in rural areas (Dhimal et al., 2017). The need for livelihood diversification has triggered outmigration (predominantly men, with 12% women migrant workers). In many parts of western Nepal when men and boys migrate to neighbouring countries such as India after completing the plantation of crops, women are left to carry out all farming and household responsibilities (Raney et al., 2011; Gartaula et al., 2010). Migration indirectly affects production patterns and the division and availability of labour

resources, making women more vulnerable by limiting their mobility and compelling them to stay back in the affected area to take care of the family and household. As livelihood becomes less reliable due to unpredictable and changing weather patterns, men are extending their stays in India as well as seeking new migration destinations, including different cities within Nepal and Gulf countries (Shrestha, 2017). Although migration of men leads to women's comparative control over income and household activities, they are particularly vulnerable to natural disasters such as floods, due to loss of family support networks and increased responsibilities at home. There is also an increase in internal migration and a large influx of unplanned migration, which creates additional pressure on the availability of basic services and infrastructure and increases urban poverty.

Table 10: Possible causes for migration in different places and their livelihood options

Migrated from	Approx. time (years before)	Distance from Dhye	Livelihood options	Reasons for migration (from/to)
Ghayu to Jhong	500-1000 years	9.29 km	Livestock, cultivation, and hunting	Soil erosion, weather, deficient agricultural land, no irrigation due to soil erosion, avalanche, and safety
Jhong to Dhye		0.87 km	Livestock and cultivation	Enough agricultural land, water availability, enough irrigation, and pasture land
Dhyey to Thangchung Chawale	350 -400 years	8.6 km	Livestock and cultivation	Decrease in agricultural production due to drought, deficiency of water, lack of health facilities, inadequate education

Source: Sherchan, 2019

Provincial consultations also confirmed that displacement of settlements due to drying up of water sources and unplanned migration in search of livelihood opportunities and employment was experienced in all provinces, particularly Bagmati and Gandaki Provinces. Damage to physical infrastructure, loss of livelihood assets, and disruption in the education sector were reported from all provinces, but were significant in Karnali and Sudhurpaschim Provinces. Extreme weather impacted transport infrastructures, such as roads, bridges, trails, airports, runways, etc., and created difficulty for women and marginalized populations due to the existing socio-structural inequalities. These events also lead to indirect effects – e.g. business disruption, lost wages, and macro-economic costs – from the effects of major disasters on consumption, inflation, and the shift of resources to relief and reconstruction.

Impact on Health

Studies have found that changes in climatic conditions are likely to alter the distribution and prevalence of vector-borne diseases like malaria, putting pregnant women more at risk of severe malaria, which is three times as high as that of non-pregnant women (Rijken et al., 2012). Human health impacts, including vector-borne diseases and extreme weather events (heat waves and cold waves), were common in almost all of the Terai regions. Heat and cold waves impacted those working outside, the poor, women, children, and the elderly (Province 1, Province 2). Vector- and waterborne disease led to health and WASH challenges and mainly impacted marginalized populations which included *Mushar, Tharu, Dalit,* poor farmers (landless, groups with smaller landholding size, and those living near riversides), and indigenous people (whose livelihood depended on fishing, NTFPs collection, etc.).

Extreme climatic events such as droughts and floods increased the prevalence of water-borne diseases like typhoid, cholera, and other diarrhoeal diseases which mostly impacted children below the age of 5 years (Eriksson et al., 2008). A study in Nepal showed that flood-related fatalities were 13.3 per 1000 girls aged 2–9 years, 9.4 per 1000 boys aged 2–9 years, 6.1 per 1000 adult women, and 4.1 per 1000 adult men (Bartlett et al., 2008). Health issues were mostly seen in pregnant women, infants, and the elderly (Province 1 and Province 2). Floods were the most frequent type of natural disaster in the Terai regions. In Lumbini Province, major climatic events included irregular rainfall, high rainfall during monsoons, and low rainfall during winters leading to flooding, inundation, and droughts. It further led to food insecurity and nutritional challenges for women and children. Girls and women were more susceptible to health issues as the distribution of food within households was highly gender-biased, which gets exacerbated during food scarcity.

Violation of human rights

Along with environmental degradation, economic and social issues like poverty, population growth, and migration lead to human rights violations against women. The Constitutional commitments of achieving equality, the right to a clean environment, and wider economic growth have been inhibited by a range of socio-political factors. Although the constitution has mandated a new federal structure for environmental management and protection of biodiversity, a lot remains to be done (Nepal, 2019). Climate change remains a growing threat to development and threatens the lives and livelihoods of people and denies them their basic human rights (Human Rights and Climate Change, 2017).

Nepal is one of the global "hot spots" for natural disasters in terms of mortality rate (Dilley et al., 2005). The hilly areas of Nepal are prone to landslides and the Terai plains are prone to floods, while the higher Himalayas, high mountains, and middle-mountains experience debris flow and glacial lake outburst floods (GLOFs). Droughts affect the entire country while forest fires affect the higher Himalayas. Demographic factors such as rapid population growth, human encroachment into vulnerable lands, poverty, and unsustainable use of natural resources have further worsened the level of disaster risk (Aryal, 2012).

The major hazards in these sectors include increases in heat waves, cold waves, heavy rainfall, landslides, floods, droughts, fire, and lightning strikes, with longer warm spells and, consecutive dry days (**Table 11**). Eight selected climate extreme indices are triggering the above hazards such as a change in warm spell duration, change in consecutive dry days, change in temperature, change in cold spell duration, change in precipitation, change in extreme wet days, and change in the number of rainy days.

Chapter 6

Observed and Projected Climate Change Hazards and Exposure

6.1 Trends and Scenarios of Aggregate Climatic Indices

This section presents the scenario of key hazards and extreme events related to the socio-structural sector. Precipitation and temperature are the two fundamental climatic parameters that induce most of the extreme events and their corresponding indices and trends are presented in **Table 10**. Eight selected indices are triggering the above hazards such as a change in warm spell duration, change in consecutive dry days, change in temperature, change in cold spell duration, change in precipitation, change in extreme wet days, and change in the number of rainy days. These events may increase in magnitude and frequency in the current context of global environmental change. Increasing population and urbanization trigger some of these hazard events, either directly or indirectly. Therefore, understanding the scenarios of climatic hazards under the socio-economic development pathway is important.

For developing hazard scenarios, experts were consulted for providing relative weight for each index based on its relative importance in triggering hazards and extreme events. **Table 11** presents major hazards from a socio-structural perspective, indices triggering those hazards, and their relative weight.

Table 11: Relative weights for hazard indicators associated with the socio-structural sector

Major hazards in the socio-structural sector	Hazard indices	Weight (%)
Increase in heat waves	Change in Warm Spell Duration (%)	5
Cold waves	Change in Consecutive Dry Days (%)	10
Increase in heavy rainfall	Change in Temperature (°C)	25
Increase in landslides	Change in Cold Spell Duration (%)	15
Floods, GLOFs	Change in Precipitation (%)	20
Increase in droughts	Change in Extreme Wet Days (%)	50
Increase in fire	Change in Number of Rainy Days (%)	15
Increase in warm spell duration		
Increase in consecutive dry days		
Thunderbolts		

Source: Stakeholders' consultation, 2020

Figure 11 shows the baseline scenario of the aggregate value of hazard indices. We can infer that hazard mostly occurs in Province 1, Province 2, Bagmati, and Gandaki Provinces, and diminish slowly in the West. Most of the hazards concentrated in the eastern and central parts of Nepal are water-induced: heavy rainfall, flash floods, riverine floods, and landslides. The eastern and central parts of Nepal receive more rainfall than the western region, and therefore also more water-induced hazards. The moderate levels of hazards in the western part of Nepal, particularly the lower part of Lumbini, Karnali, and Sudhurpaschim Provinces, are mostly due to recurrent drought. In terms of physiographic region, the composite value is higher for Terai and hills in comparison to middle mountains and high mountains. Cascading impacts of multiple hazards are more pronounced in Terai (Fang et al., 2020) and, as a result, the aggregate hazard index is higher in this region.

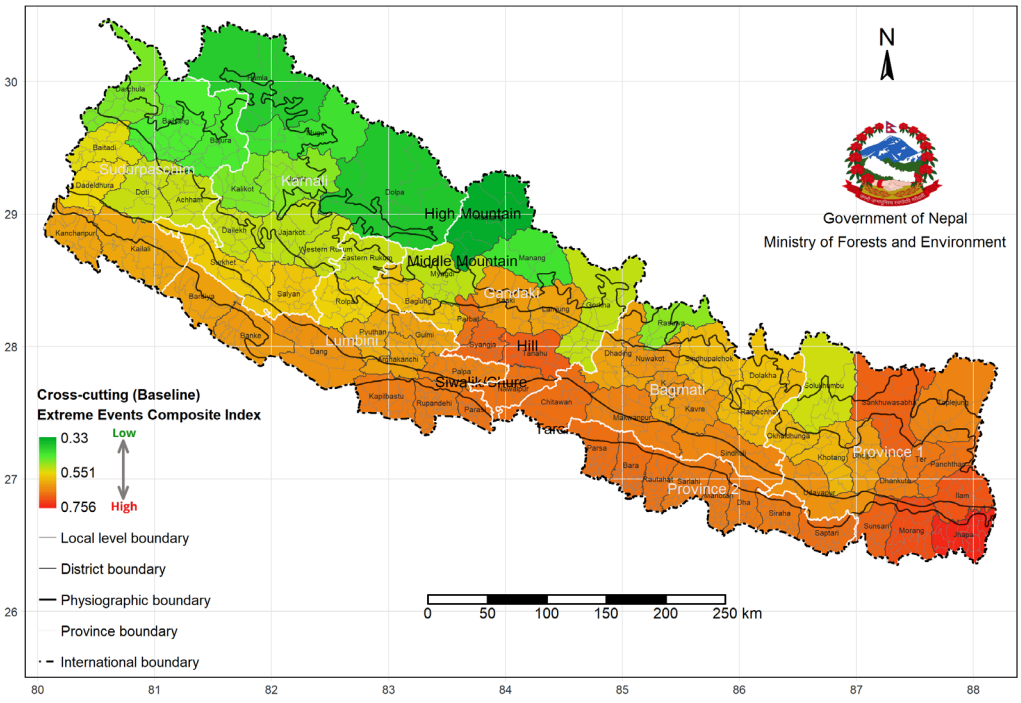

Figure 11: Baseline scenario of aggregate hazards for the socio-structural sector

6.2 Projected Future Scenarios of Climate Change and Extreme Events (2016-2045)

The future status of socioeconomic parameters is further complicated by future climate change and extreme events. For example, the future GDP growth rate is subject to climate change and extreme events regardless of development measures. Population growth will increase exposure to climate change and extreme events in the future where the poor, women and marginalized populations are likely to be particularly affected.

Extreme indices such as extreme wet days, very wet days, the number of warm days and warm nights, and warm spells will increase, whereas the number of rainy days, cold nights and cold days, and cold spells will decrease. Climate-induced hazards such as cold waves and snowstorms are likely to decrease during this period. Heat waves, heavy rainfalls, snowstorms, thunderbolts, windstorms, floods, landslides, GLOFs, fires, avalanches, epidemics, and forest

fires are likely to increase. The projected increases in precipitation, temperature, extreme indices, and climate-induced hazards have significant socio-structural implications.

Figures 12 & 13 show projected scenarios of hazards indices for 2030 and 2050 based on RCP 4.5 and 8.5. The figures clearly show that those indices are likely to increase with the baseline scenario **(Figure 12).** It shows that Province 1, Province 2, Bagmati, and Gandaki Provinces are likely to be more affected. For the 2030 scenario (RCP 4.5), the Jhapa district of Province 1 will experience an increase in climate extreme events in the baseline scenario, and all remaining districts of this province will experience massive to moderate increases in climate extreme events. Similarly, most of the districts from Province 2, Bagmati, and Gandaki Provinces will show increases compared to the baseline scenario. For the same scenario, i.e., 2030 at RCP 8.5, more districts in Province 1 (Ilam, Panchthar, and Morang) and Province 2 (Saptari and Siraha) will experience high to very high increases in extreme events.

The 2030 scenario at RCP 8.5 and the 2050 scenario at RCP 4.5 resemble each other. But in the 2050 scenario of RCP 8.5, more districts will fall into the very high increase and high increase categories. Except for a few mountain districts of Gandaki, Karnali, and Sudhurpaschim Provinces, the rest of the districts will experience a higher increase to the highest increase of climate extreme events. The 2050 scenario shows that the aggregate impact of hazards starts to move slowly to the Western part of Nepal when compared to the baseline and 2030 scenarios. This is also alarming for provincial and local level policymakers who need to incorporate future hazard scenarios into their long-term adaptation plans.

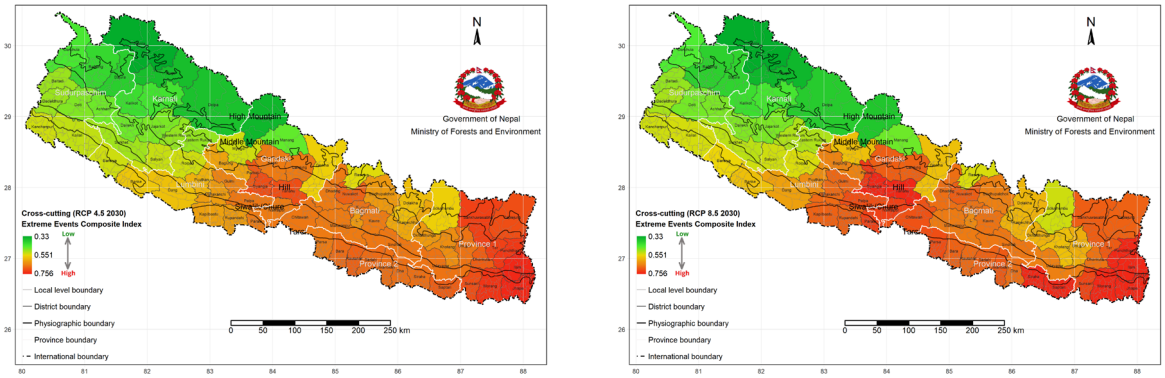

Figure 12 Hazards Scenario of the socio-structural sector for 2030 Horizon RCP 4.5 (L) & RCP 8.5 (R)

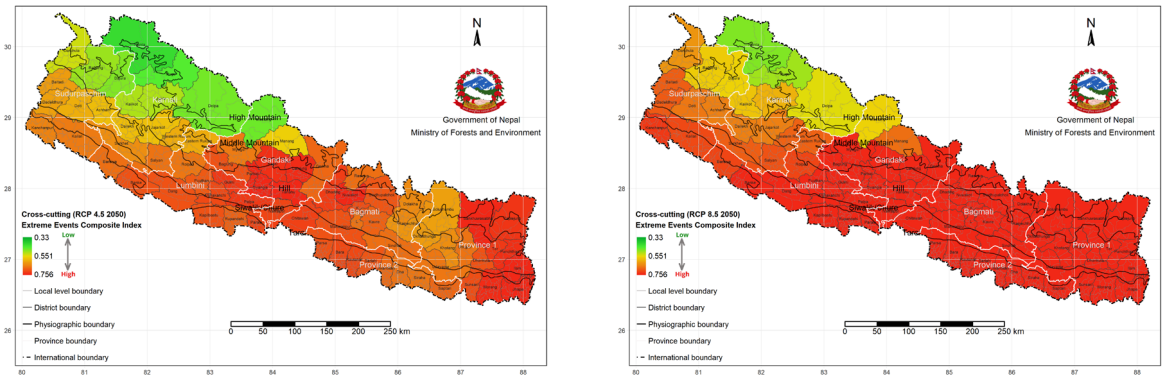

Figure 13 Hazard Scenario of the socio-structural sector for 2050 Horizon RCP 4.5 (L) & RCP 8.5 (R)

Looking into future climate extreme events from a socio-structural point of view, it can be concluded that relatively better-off districts from Province 1, Bagmati, and Gandaki Provinces could be hard hit by climate extreme events, and those provinces have to invest more in climate change adaptation options in the future. Extreme events will slowly expand towards the west in long-term climate scenarios, which implies that provincial governments need to adopt plans and strategies to tackle climatic uncertainties in their long-term adaptation plans.

6.3 Climate Change Exposure

This section presents the exposure of the socio-structural sector by district, province, and physiographic region. The overall exposure ranks, as well as ranks for each sub-sector, are presented. Exposure units are categorized into socioeconomic and resource subsectors. In socio-economic components, demographic parameters (such as disaggregated male and female populations) are considered. Resource components include district area and housing units **(Table 12**). Different categories of the population have different exposure to climate change and extremities. This is a highly dynamic unit and future demographic change in the climate-vulnerable area may increase its exposure in the future.

The district area is an aggregation of agricultural areas, forest areas, water bodies, and settlements, which have direct links with people's livelihoods. Communities whose livelihoods depend on forest-based products are exposed to the impacts of climate change due to pests, disease attacks, changes in rainfall patterns, and rising temperatures leading to forest fires and forest degradation. Housing units are also considered as exposure units because they are livelihoods assets that have greater exposure to environmental change and extremities such as frequent flooding, landslides, heat, and cold waves. However, experts assigned this indicator relatively lower weightage in comparison to the preceding indicators, although this does not mean that the importance of these indicators can be underestimated.

The following **(Figure 14 and Table 12)** presents the overall degree of exposure of the socio-structural system. 6% of districts fall in the very high exposure category, 10% in high, 23% in a moderate level of exposure whereas more than 60% of districts fall on low to very low category. Districts such as Jhapa, Morang, Kathmandu, Rupandehi, and Kailali are showing very high exposure. Several mountain districts from west to east such as Humla, Bajhang, Dolpa, Gorkha, Solukhumbu, and Taplejung show moderate exposure due to their larger district area despite the smaller population size. Districts having lower populations and smaller areas show very low exposure, indicating those districts have either a smaller number of exposed populations or smaller exposed areas. Districts such as Tehrathum, Dhankuta, Okhaldhunga, Rasuwa, Nuwakot, Lamjung, Manang, Myagdi, Parbat, Arghakhanchi, Western Rukum, Eastern Rukum, Kalikot, Jumla, Baitadi, Dadeldhura fall in the lower category **(Figure 15 (a & b) and Table 12).**

Table 12 Districts with different exposure categories

Exposure categories and rank	Districts	Number and Percentage
Very High (0.773 - 1)	Kailali, Rupandehi, Morang, Jhapa, Kathmandu	5 (6%)
High (0.609 - 0.772)	Sunsari, Siraha, Bara, Chitawan, Dhanusha, Dang, Sarlahi, Saptari	8 (10%)
Moderate (0.410 - 0.608)	Makawanpur, Humla, Kapilbastu, Sankhuwasabha, Rautahat, Bardiya, Gorkha, Udayapur, Banke, Dolpa, Surkhet, Sindhuli, Kaski, Kanchanpur, Taplejung, Mahottari, Bajhang, Parsa	18 (23%)

Low (0.273 - 0.409)	Dhading, Rolpa, Mugu, Dolakha, Baglung, Sindhupalchok, Solukhumbu, Lalitpur, Tanahu, Kavrepalanchok, Dailekh, Pyuthan, Darchula, Syangja, Achham, Palpa, Bhojpur, Salyan, Mustang, Doti, Khotang, Bajura, Nawalpur, Panchthar, Jajarkot, Parasi, Gulmi, Ramechhap, Ilam	29 (38%)
Very Low (0.137 - 0.272)	Rasuwa, Myagdi, Lamjung, Dhankuta, Terhathum, Nuwakot, Western Rukum, Bhaktapur, Parbat, Arghakhanchi, Baitadi, Manang, Eastern Rukum, Okhaldhunga, Kalikot, Jumla, Dadeldhura	17 (22%)

Sub-sector-wise exposure results show that districts with a higher population are showing demographic exposure (**Figure 15a**). In Province 1, Morang falls in the very high exposure category, whereas Jhapa and Sunsari fall in the high exposure category, while the exposure of the rest of the districts of Province 1 ranges from very low to low categories. As mentioned earlier, the total population of the particular district is contributing to these exposure components. Morang has a population of 0.9 million, higher than adjoining districts such as Jhapa and Sunsari. The latter two districts have a population of 0.8 million and 0.7 million respectively and are categorized as high exposure districts. Districts such as Solukhumbu, Sankhuwasabha, or Taplejung are very low exposure districts, and their population is 0.10, 0.15, and 0.13 million respectively, significantly lower than highly exposed districts. In Bagmati Province, Kathmandu has very high exposure because it has a population of 1.7 million which is much higher than the adjoining districts, Lalitpur (0.4 million) and Bhaktapur (0.3 million). Lalitpur, Kavrepalanchok, Makwanpur, and Chitwan are categorized as moderately exposed, and the rest of the districts vary from very low to low exposure with corresponding lower populations.

Exposure of all the districts from Gandaki Province varies from very low to low, except Kaski which has a population of 0.6 million, much higher than the rest of the districts. In Lumbini Province, Rupandehi has a much higher exposure as it has a 0.8 million population, much higher than adjoining district Palpa which has just a 0.2 million population. Other Terai districts of Karnali Province, such as Kapilbastu, Dang, Bake, and Bardiya, are showing a moderate level of exposure. The socioeconomic exposure of the districts of Karnali Province varies from very low to low as this whole province is a sparsely populated area. In Sudhurpaschim Province, Kailali, which has a population of 0.7 million, has high exposure, whereas Kanchanpur is moderately exposed with a total population of 0.7 million. The rest of the districts vary between very low to low exposures.

The exposure in these districts is mainly determined by demographic characteristics, which are, however, highly dynamic and may change in the future. Recent rural to urban migration trends may increase the exposure of urban centers. For example, the population of Province 2 and Bagmati Province is expected to cross 9 million in each province by 2051, increasing their exposure rating. Similarly, the highly populated district of Kathmandu will reach 2.7 million by 2031 from the current 1.7 million base population of 2011, an increase of 1 million (CBS, 2011 estimates). Similarly, Jhapa, Morang, and Sunsari are the most densely populated districts of Province 1, and while each currently has less than 0.9 million population, CBS medium variant projection shows each district will hold above 1 million by 2031. The rapid increase of population in those districts will expose more population to climate change in the future.

The resource sector of exposure portrays a different picture than demographic exposure. In Province 1, Sankhuwasabha, Taplejung, and Morang fall under the very high exposure category. The exposure of the former two districts is contributed by the larger district land area whereas the exposure of Morang district is contributed by district area and household units. Unplanned

use of land, forest, and water resources, which are also the basis of livelihoods, will increase the resource exposure of the districts which fall in this category. **Figures 14 (a & b)** show sub-sector-wise exposure components, i.e., socio-economic and resources and services. Their indicators are listed in **Table 4** in **Chapter 3**.

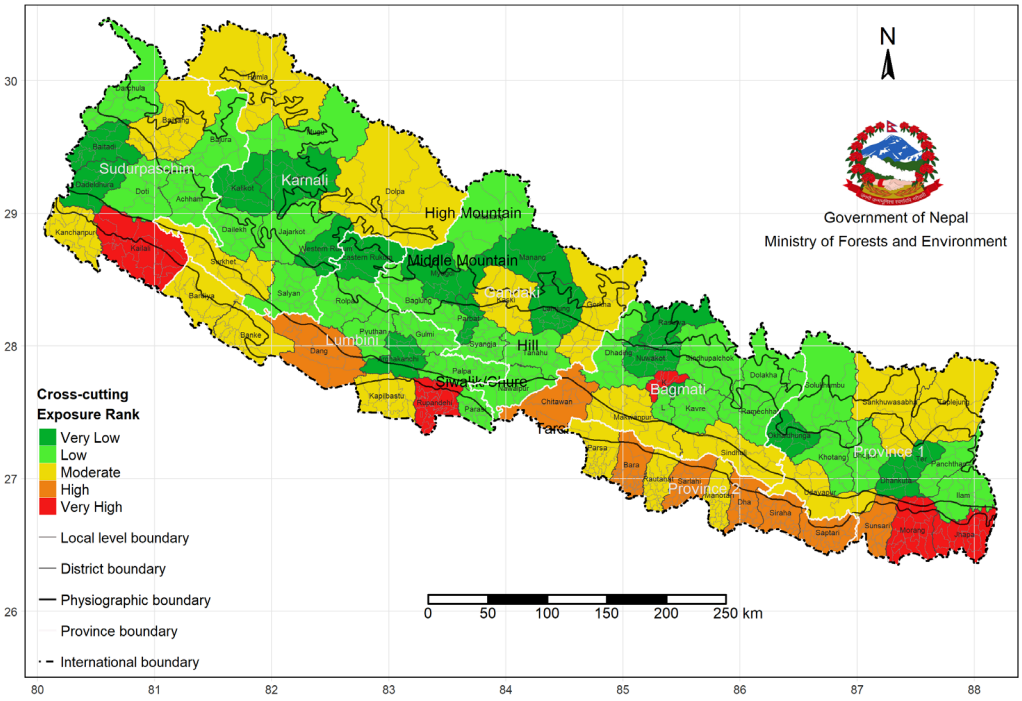

Figure 14: Socio-structural Exposure Rank

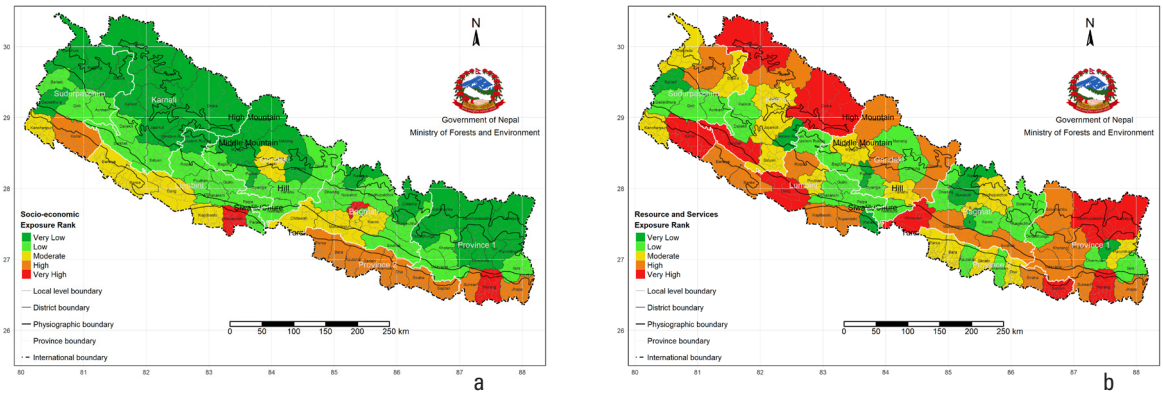

Figure 15: Exposure of sub-sectors: (a) socio-economic and (b) resource and services

The result shows that highly populated districts and districts with larger land areas have high exposure while the less populated districts and districts with smaller land areas have lower exposure. In exposure indicators, district area is a static variable whereas the population is a dynamic variable. Our scenario analysis shows that there will be a sharp increase in population, particularly in Province 2 and Bagmati Province. Each province is expected to cross 10 million population by 2051 **(Figure 8, Chapter 4)**, indicating more population will be exposed to climate change risks and vulnerabilities in the future, particularly the elderly, children, the poor, and marginalized communities (Bartlett, 2008).

Chapter 7

Observed Climate Change Vulnerability and Risks

7.1 Sensitivity of the Socio-structural Sector

This section presents the sensitivity of the socio-structural sector, its indicators and selection process, and its index value. The sensitivity index is presented at district, provincial and physiographic regions. Both overall and sector-wise sensitivity are presented.

Sensitivity is defined as the predisposition of society and ecosystems to suffer harm as a consequence of intrinsic and extrinsic conditions and their propensity to collapse under the stress of a hazardous event. The social and cultural characteristics of people shape their vulnerability and capacity to adapt to the impacts of climate change. For example, children, pregnant women, and those with compromised health are more sensitive to contaminated water sources. Similarly, women-headed households and those with limited access to modern agricultural inputs, infrastructure, and education are more sensitive to the impacts of extreme events on food security. It is therefore important to identify specific vulnerabilities, risks, and impacts of climate change on women and marginalized groups to help in designing gender and social inclusion, responsive adaptation plans, and strategies for specific thematic sectors.

Sensitivity indicators are selected and screened carefully based on the literature and expert consultations. These indicators include high rates of population growth (especially in hazard-prone areas); higher dependency ratios and food insecurity; high levels of poverty; and high dependency on natural resources (IPCC 2007a; IPCC, 2007b). Lack of access to services and weak institutional frameworks, policies, and governing systems, combined with poor socioeconomic parameters, increase the sensitivity of systems.

Sensitivity indicators refer to two domains: the socioeconomic sector and the resources and services sector. The former reflects sensitivity at the level of individuals and households, with factors such as high dependency rates, low

income levels, and poverty, while the latter reflects sensitivity at the institutional level. There are nine socioeconomic indicators: proportion of *Dalit* population, the proportion of *Janjati* population, population of Indigenous Peoples (IPs), annual population growth, sex ratio, dependency ratio, female-headed households, number of male migrants, poverty incidence, and food poverty incidence.

The indicators in the resources and services sector show the degree to which climate change and extreme events impair access to these resources and services. The indicators are economically active males in agriculture, economically active females in agriculture, females without ownership of land and houses, number of households that use firewood for cooking, number of households without access to safe drinking water, number of households without a toilet, landless households, and households lacking access to agricultural land. All the sensitivity indicators are assumed to have a direct relationship with the sensitivity of the sector, i.e., increasing the value of the indicators increases the sensitivity.

The results of overall sensitivity analysis show that 20 districts (26%) out of 77 districts fall in the category of very high, 21 districts (29%) in high, 22 districts (27%) in moderate, and the remaining 14% in low and very low category (**Table 13**). The analysis indicates that above 55% of districts in Nepal are already in the very high and high categories of sensitivity and very few (< 15%) districts are in the category of low and very low sensitivity districts.

Table 13: Districts by the overall sensitivity level

Sensitivity categories and rank	Districts	Number and Percentage
Very High (0.823 - 1)	Rolpa, Makawanpur, Dailekh, Kailali, Achham, Siraha, Baitadi, Sindhuli, Salyan, Doti, Eastern Rukum, Dhanusha, Bajura, Dang, Kalikot, Jajarkot, Sarlahi, Mahottari, Bajhang, Saptari	20 (26%)
High (0.718 - 0.822)	Humla, Kapilbastu, Mugu, Rautahat, Baglung, Western Rukum, Sindhupalchok, Bardiya, Gorkha, Udayapur, Pyuthan, Dolpa, Surkhet, Arghakhanchi, Bhojpur, Morang, Bara, Khotang, Kanchanpur, Jhapa, Dadeldhura	21 (29%)
Moderate (0.626 - 0.717)	Dhading, Myagdi, Sunsari, Dolakha, Nuwakot, Sankhuwasabha, Tanahu, Kavrepalanchok, Darchula, Syangja, Banke, Rupandehi, Palpa, Okhaldhunga, Chitawan, Nawalpur, Panchthar, Jumla, Parasi, Parsa, Gulmi, Ramechhap	22 (27%)
Low (0.525 - 0.625)	Rasuwa, Lamjung, Dhankuta, Terhathum, Solukhumbu, Parbat, Mustang, Taplejung, Ilam	9 (12%)
Very Low (0.394 - 0.524)	Lalitpur, Bhaktapur, Manang, Kaski, Kathmandu	5 (6%)

At the province level, the findings show that overall sensitivity is very high in Sudhurpaschim Province (six districts), Province 2 (five districts), and Karnali Province (four districts) whereas there are two districts in Bagmati Province and only one district in Gandaki Province showing very high sensitivity and there is no district that falls into the rank of very high sensitivity in Province 1 (**Figure 16**)

In Sudhurpaschim Province, six districts, Doti, Kailali, Baitadi, Bajura, Achham, and Bajlung, have very high sensitivity. The higher prevalence of *Dalit* and *Janjati* population, higher population growth rate, poverty incidence, food insecurity, and lack of access to resources are the major contributing factors of the higher level of sensitivity in this region. The former five indicators belong to the socio-economic sub-sector while access to resources is related to the resource and service sub-sector. **Figures 17 (a & b)** show sub-sector-wise sensitivity components, i.e., socio-economic resources and services, and their indicators are listed in **Table 4**. Achham has the highest *Dalit* population (30%) and this figure ranges from 13 to 25% for the other districts in this province. The *Dalit* population is therefore one of the contributing factors for higher

sensitivity for Achham. Kailali has a 46% *Janjati* population and this figure ranges from 0.5 to 5% for the rest of the districts. Secondly, the annual population growth rate for Kailali and Bajura is 2.20% whereas the rest of the district has below 1.5%. Poverty incidence is highest for Bajura (64%) and Bajhang (56%) and it ranges from 33 to 48% for the rest of the districts. Similarly, Bajura and Bajhang have a higher degree of food poverty incidence (above 70%) which ranges from 30 to 58% for the rest of the districts. In all districts, more than 85% of households use firewood for cooking. This figure is highest for Achham, Bajura, and Bajhang, which is 98% for all three districts. 69% of households in Bajhang and 61% of households in Bajura do not have access to toilets. This figure ranges between 50 to 60% for the rest of the districts.

In Karnali Province, four districts, namely Dailekh, Kalikot, Jagarkot, and Salyan, have very high sensitivity. Like Sudhurpaschim Province, the higher prevalence of *Dalit* and *Janjati* population, higher population growth rate, poverty incidence, food insecurity, and lack of access to resources are the major contributing factors for higher sensitivity in this province. For example, 48% of households in Dailekh have no access to safe drinking water, more than any other district. Kalikot has the highest poverty incidence (57%), significantly higher even than other high sensitivity districts, which range from 30 to 36%. Food poverty is also highest in Kalikot. The rest of the districts have 30 to 40% food poverty. Jajarkot has the highest *Dalit* population (29%). In Salyan, 70% of the population has no access to toilets.

Lumbini Province has only three districts with very high sensitivity: Rolpa, Eastern Rukum, and Dang. Poverty incidence, *Dalit* and *Janjati* population, and prevalence of female-headed households were the major contributing factors for higher sensitivity in this province. Rolpa has the highest incidence of food poverty (35%). The poverty figure is similar for all four districts (Rolpa, Eastern Rukum, Dang, and Banke), ranging from 25 to 26%. The percentage of female-headed households is highest for Rolpa (33%); the other districts have less than 30%, with the lowest rate for Banke (22%). Eastern Rukum has 33% *Dalit* and 56% Janjati population. In the rest of the districts, the *Dalit* population ranges from 11 to 15% and the *Janjati* population ranges from 24 to 46%, with Banke having the lowest.

In Gandaki Province, Gorkha is the only district that has very high sensitivity. The higher *Dalit* population, higher rate of labour migration, higher number of female-headed households, and the lack of access to land resources are major contributing factors to a higher level of sensitivity in this district. Gorkha's *Dalit* population is 16.23% of the total population whereas its adjoining district, Manang, with low sensitivity, has only 5.14% *Dalit* population. Gorkha has also a higher labour migration rate. Above 4,324 labourers migrate annually from Gorkha district, and this figure is 21 for Manang. Gorkha has 37% female-headed households whereas it is 24% for Manang. Over 55,000 thousand females have no ownership of land and house in Gorkha, and this figure is only 1,150 for Manang.

In Bagmati Province, two districts, namely Makwanpur and Sindhuli, have a very high degree of sensitivity. Poverty incidence, *Dalit* and *Janjati* populations, and lack of access to resources are the main contributing factors for higher sensitivity in this province. Sindhuli has a higher *Dalit* population (12% of total) in comparison to adjoining districts Kavre (6%), Ramechhap (9%), and Lalitpur (3.3%). Similarly, both districts have a higher *Janjati* population which is 68% for Makwanpur and 64% for Sindhuli whereas the adjoining district Kavre has 56% *Janjati* and Ramechhap have 58%. Households without access to toilets are higher for Sindhuli (68%) and Makwanpur (40%) and this figure is lower for adjoining districts such as Kavre (27%), Ramechhap (37%), and Lalitpur (4%).

Province 2 has five districts showing very high sensitivity: Saptari, Siraha, Dhanusha, Mahottari, and Sarlahi **(Figure 16).** This higher sensitivity is caused by higher population growth, higher dependency ratio, higher incidence of poverty, and higher labour migration. These districts also have a higher population of *Dalit* and *Janjati*. The poverty incidence of Saptari is 39% and 34 % in Siraha whereas it is only 23% in Dhanusha, 26% in Mahottari, and 17% in Sarlahi. Poverty has contributed significantly to sensitivity for Saptari and Siraha districts whereas other factors besides poverty have contributed to the three very highly sensitive districts (Dhanusha, Mahottari, and Sarlahi) of Province 2. Rautahat and Bara (high sensitivity) and Parsa (moderate sensitivity) have 29% poverty incidence. The *Dalit* population is also high in Saptari (26% of the total population) and Siraha (24% of the total population), whereas in the other three districts (Dhanusha, Mahottari, and Sarlahi) with higher sensitivity *Dalit* population is between 14-20% of the total population. Female-headed households also contribute to higher sensitivity for Siraha, Dhanusha, and Mahottari with 20% of the total households being female-headed. In the other districts (Saptari, Sarlahi, Rautahat, Bara, and Parsa) this ranges from 5.65 to 15%. Dependency ratio is the contributing factor to sensitivity particularly in Mahottari (0.63) and Saptari (0.57). The rest of the districts of Province 2 have a dependency ratio between 0.24 and 0.55. Male labour migration is contributing to higher sensitivity in Dhanusha with 22,000 labour migrants, whereas this number is 5,000 to 16,000 in other districts.

According to consultation in Bagmati Province, the key issues contributing to sensitivity in this province are migration due to lack of water, increased poverty and unemployment, high dependency ratios, and a greater number of vulnerable or marginalized groups, such as indigenous people, *Dalits,* smallholders, squatters, and landless people. Similarly, consultation in Province 2 indicates that poor ethnic minorities and those without land and proper houses (e.g., *Musahar* communities) are more sensitive to climate change. Food insecurity, lack of shelter, lack of access to safe drinking water, disruption of transport and communication are aggravating the sensitivity in this province.

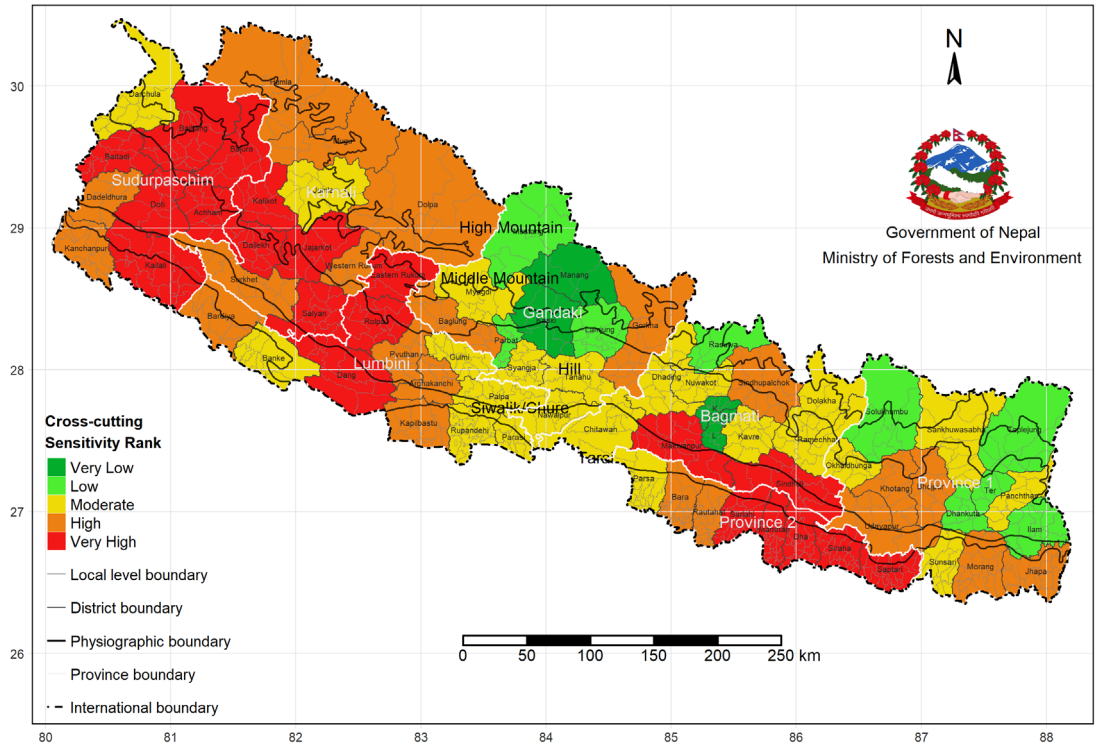

Figure 16: Socio-structural Sensitivity Rank

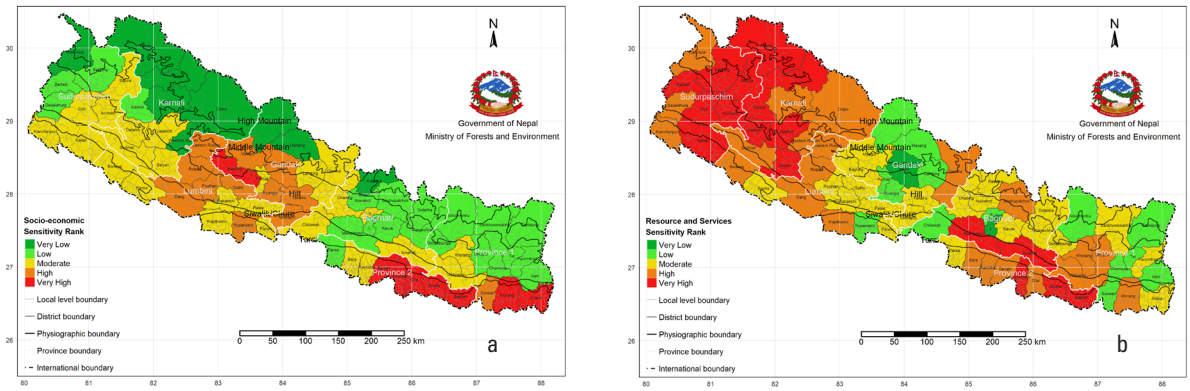

Figure 17: Sensitivity components: (a) socioeconomic and (b) resource and service

The sensitivity of the socio-structural system is determined by underlying intrinsic socio-economic conditions and access to essential resources and services (**Figure 16**). Higher poverty incidence, higher population growth, higher dependency ratio, caste and gender (*Dalit/Janjati*, female-headed households), the higher rate of labour migration, inequalities in access to basic resources and services (land resources, drinking water, toilets, etc.) are key factors contributing to sensitivity. Sensitivity in western Nepal is mostly due to the higher incidence of poverty, lower GDP, higher incidence of food poverty, a higher proportion of the *Dalit* population, and lack of access to essential services. The sensitivity of central and eastern Nepal is caused by the higher population growth rate, higher dependency ratio, higher rate of labour migration, and higher incidence of poverty (particularly in Province 2). In highly populated areas, higher dependency is one of the major sensitivity factors. Women, children, and the elderly were found more sensitive to climate change and disasters because the elderly often have less education, have fewer financial resources, and are frequently dependent on others for survival.

The provincial consultations also helped to validate the indicators of sensitivity. Besides, the consultations showed that women, ethnic/indigenous groups dependent on water, agriculture, and forestry, and *Dalit* communities including those living in squatters and slums were highly sensitive. Sensitivity was also attributed to poverty as seen in urban and rural households with the poor, ethnic minorities, women, and those without land and proper houses (e.g., *Musahar* communities) who bore the brunt of climatic impacts. The sensitivity component is mainly contributed by socio-economic indicators and future changes in socio-economic parameters may drive sensitivity of this sector in both directions. For example, labour migration, female-headed households (FHHs), poverty incidences are very dynamic socio-economic parameters and have a significant contribution to sensitivity components.

Labour migration is highest in Province 2 where it has increased from 36,000 per year in 2009 to 231,000 in 2017/18 and is projected to reach 400,000 per year by 2030 if this trend continues. Similarly, female-headed households increased by 125% from 2001 to 2011, and there are now 1.3 million FHHs in Nepal (**Figure 9, Chapter 4**).

If the same trend continues, Nepal will have 3.1 million FHH by 2051, more than double as compared to 2011. Therefore, the sensitivity of those districts which have a higher proportion of FHHs such as Achham, Baglung, Banke, Chitwan, etc., may be exaggerated in the future. In the case of poverty incidence, there is an overall decrease at the national level.

However, the rate of poverty reduction is slower in urban than in rural areas due to rural to urban migration, increasing slum dwellers in slum areas, which might increase the sensitivity of urban areas in the future.

As indicated in **Table 13**, there are 27% of districts in the moderate category of sensitivity, which means they are particularly dynamic and responsive to change.

7.2 Adaptive Capacity

This section presents the adaptive capacity of the sector, both overall and in terms of sub-sectors, and at all scales, from individuals to communities. The effectiveness of adaptive responses will be influenced by (1) the operating context within which responses occur (e.g. the policy and governance setting); (2) the availability of effective adaptation options; and (3) the capacity of individuals to access support and implement adaptation options.

Adaptive capacity includes a broad range of indicators ranging from socio-economic (such as HDI, GDI, GDP, per capita income) access to physical and natural resources, policy- and governance-related indicators such as representation in decision-making processes and institutional structures including GESI and climate change policy, plans, programs, budgets, and accountability and transparency mechanisms. Those indicators of adaptive capacity widely available in the literature are broadly divided into two categories: the socio-economic subsector and resource and services subsector and operationalized while calculating adaptive capacity in this analysis. Indicators included in the socioeconomic subsector are years of schooling, economically active population, labour productivity, HDI, GDI, GDP, non-agriculture GDP, per capita budget, women's income share, and non-agriculture-based income. Indicators considered in the resource and services subsector of adaptive capacity are active male savings accounts, active female savings accounts, average holding size, female ownership with house and land, female ownership with land only, and per capita forest area **(Table 4, Chapter 3).**

Table 14 presents the adaptive capacity index at the district level. It shows that only 9 districts (12%) have high or higher adaptive capacity. The next 18 districts (23%) have a moderate range of adaptive capacity and the majority of districts (64%) have poor adaptive capacity.

Table 14: Districts in order of adaptive capacity

Adaptive capacity categories and rank	Districts	Number & Percentage
Very High (0.662 - 1)	Morang, Kathmandu	2 (3%)
High (0.419 - 0.661)	Sunsari, Lalitpur, Rupandehi, Chitawan, Dang, Kaski, Jhapa	7 (9%)
Moderate (0.268 - 0.418)	Makawanpur, Kapilbastu, Bardiya, Tanahu, Kavrepalanchok, Bhaktapur, Banke, Kailali, Surkhet, Siraha, Bara, Manang, Dhanusha, Kanchanpur, Sarlahi, Mahottari, Parsa, Saptari	18 (23%)
Low (0.178 - 0.267)	Dhading, Humla, Mugu, Rasuwa, Myagdi, Lamjung, Dolakha, Dhankuta, Terhathum, Nuwakot, Sankhuwasabha, Rautahat, Baglung, Sindhupalchok, Gorkha, Solukhumbu, Udayapur, Parbat, Pyuthan, Syangja, Dolpa, Arghakhanchi, Palpa, Bhojpur, Sindhuli, Mustang, Khotang, Okhaldhunga, Nawalpur, Taplejung, Panchthar, Parasi, Gulmi, Ramechhap, Ilam	35 (45%)
Very Low (0.121 - 0.177)	Rolpa, Western Rukum, Dailekh, Darchula, Achham, Baitadi, Salyan, Doti, Eastern Rukum, Bajura, Kalikot, Jajarkot, Jumla, Bajhang, Dadeldhura	15 (19%)

The province-wise analysis shows that three districts from Province 1 fall into very high (Morang) and high (Jhapa and Sunsari) rank of adaptive capacity. No district in Province 2 falls into the above two categories. In Bagmati Province, Kathmandu falls into the very high category, Lalitpur and Chitwan fall into the high category. In Gandaki Province, only Kaski district falls into high adaptive capacity rank whereas Rupandehi and Dang fall into the same category from Lumbini Province. There are no districts that fall into the above categories from Karnali and Sudhurpaschim Provinces (**Figure 18**).

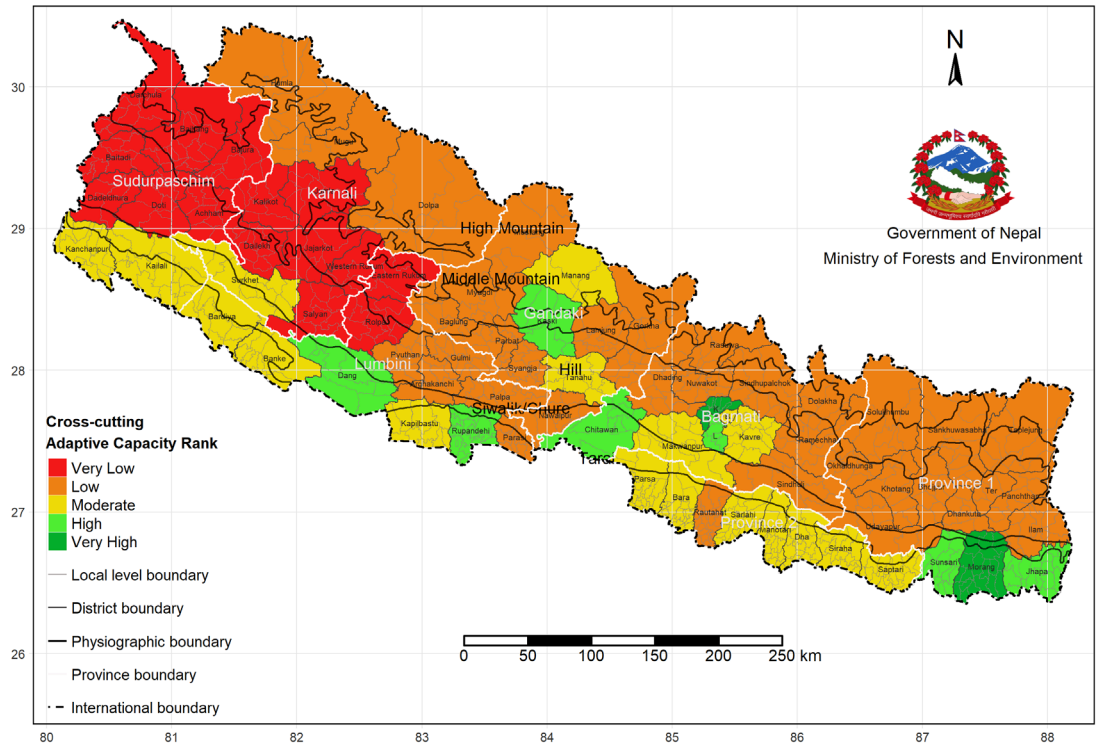

Figure 18: Overall socio-structural adaptive capacities

In Province 1, Morang district has a very high adaptive capacity, and two other adjoining districts, Jhapa and Sunsari, also fall into the category of high adaptive capacity. Economically active population, labour productivity, and per-capita income are the major contributing factors to enhance the adaptive capacity of those districts in comparison to adjoining districts. Morang has a higher economically active population (377,000) compared to 329,000 for Jhapa and 268,000 for Sunsari. Labour productivity for Morang is 129,000 compared to 122,000 for Jhapa and 127,000 for Sunsari. Per capita income is 1,250 USD for Morang, 1,226 USD for Jhapa, and 1,150 USD for Sunsari.

In Bagmati Province, Kathmandu falls into a very high adaptive capacity rank whereas Lalitpur and Chitwan fall into a higher adaptive capacity rank. School enrolment, higher HDI and GDI, a higher number of the economically active population, higher labour productivity, and higher per capita income are contributing to higher adaptive capacity in this province. For example, Kathmandu has higher years of schooling (7.05 years) than Lalitpur (6.47 years) and Bhaktapur (6.19 years). Similarly, Kathmandu has also a higher HDI (0.63) than Lalitpur (0.60) and Bhaktapur (0.57). This district also has a higher economically active population (614,000) than Lalitpur (190,000) and Bhaktapur (129,000). Finally, the per capita income of Kathmandu is 2,764 USD,

much higher than Lalitpur (1,894 USD) and Bhaktapur (1,379). In the case of Chitwan, it has higher years of schooling (5.01 yrs) than the adjoining district Makwanpur (3.63). This district also has a higher HDI (0.55) than Makwanpur (0.49). Similarly, it has a higher economically active population (244,000) and per capita income (1,537 USD) compared to 195,000, and 1,410 USD respectively for Makwanpur.

In Gandaki Province, Kaski shows a high degree of adaptive capacity. Years of schooling, labour productivity, HDI, GDI, and per capita income are contributing to improving adaptive capacity in this province. For example, the years of schooling for Kaski (5.76 years) is higher than its adjoining districts Tanahu (4.17 years) and Lamjung (4 years). Similarly, labour productivity for Kaski is 180,000, much higher than Tanahu (105,000) and Lamjung (103,000). HDI and GDI for Kaski are also higher.

In Lumbini Province, Rupandehi and Dang have high adaptive capacity. Economically active population, per capita income and access to land and housing are the major contributing factors for high adaptive capacity in this province. For example, the economically active population for Rupandehi is higher (300,000) than its adjoining district Kapilbastu (200,000). About 24,000 females in Rupandehi have access to both land and house compared to 8,000 for Kapilbastu. The per capita income for Rupandehi is 1,123 USD, which is higher than Kapilbastu at 990 USD. Like Rupandehi, Dang also has a higher economically active population (230,000) much higher than its adjoining district Rolpa which has an economically active population of 94,000. Labour productivity for Dang is 109,000 which is just 61,000 for Rolpa. HDI and GDI for Dang are 0.48 and 0.47 respectively compared to 0.39 and 0.42 for Rolpa. Finally, the per capita income for Dang is 1,127 USD compared to 643 USD for Rolpa.

No district from Karnali and Sudhurpaschim possesses very high or high adaptive capacity. 15 districts are categorized into very low adaptive capacity. Out of 15 districts in this category, 13 districts come from the above two provinces: Jajarkot, Dailekh, Jumla, Kalikot, Salyan, and Western Rukum in Karnali Province, and Achham, Baitadi, Bajhang, Bajura, Dadeldhura, Darchula, and Doti in Sudhurpaschim Province. These districts have low HDI, low GDI, poor per capita income, limited access to financial institutions for both females and males, a lower economically active population, and low labour productivity. Similarly, education (years of schooling), female ownership to fixed assets such as land and house, and women in professional jobs are low in these districts. Comparison of sector-wise adaptive capacity shows that low adaptive capacity is amplified more by the resource and service constraints than the pure socio-economic attributes as shown in **Figure 19 (a & b)**. During the recent provincial consultations and FGDs, similar elements contributing to adaptive capacity were discussed and similar issues were identified by the participants and community members.

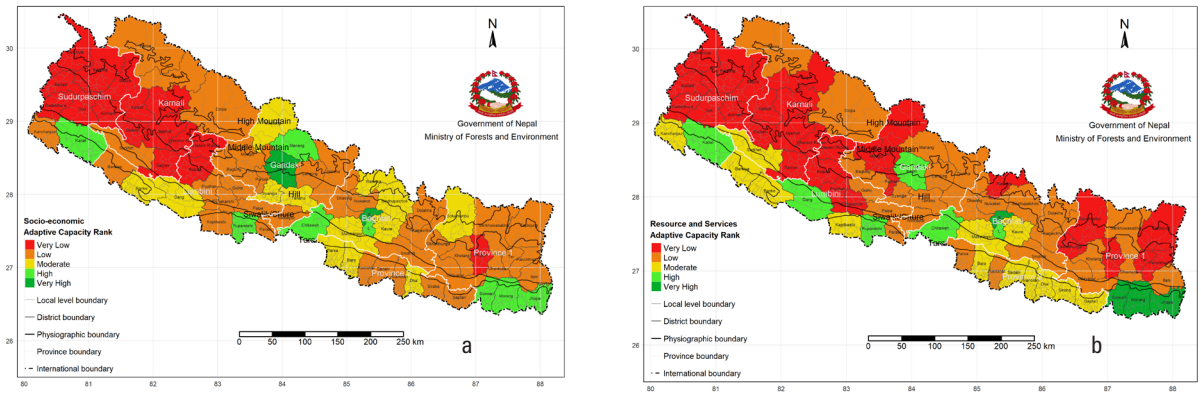

Figure 19: Adaptive capacity: (a) Socioeconomic, (b) Resource and services

7.3 Vulnerability

This chapter presents the vulnerability of the sector by district, province, and physiographic region. Socio-economic resources and services are the two sub-sectors of vulnerability. The former represents the socio-economic characteristics (micro and macro) that cause vulnerability and the latter represents the failure to provide resources and services. Vulnerability to climate change is context-specific and differs for each segment of society. It is influenced by a range of conditions, including their degree of exposure and dependency upon weather patterns for livelihoods, and on their adaptation capacities, which are influenced by gender, social status, economic poverty, power, access, and control, and ownership over resources.

In the assessment, higher adaptive capacity was attributed to better education, access to financial institutions and livelihood opportunities for diversification, and female ownership of fixed assets such as land and housing. Higher sensitivity was due to higher poverty incidence, food insecurity (food poverty), low income, and lower HDI and GDI. Other factors that contributed to vulnerability were limited access to services and weak institutional frameworks, policies, and governing systems, combined with socio-economic parameters that affected the capacity to manage climate risk.

Table 15 and **Figure 20** present the vulnerability index at the district level. It shows that 27 districts (35%) fall into the high to the very high category of vulnerability. The next 21 districts (27%) fall into moderately vulnerable and the other 29 districts (38%) into the low to very low category. The moderately vulnerable districts are transitional districts that can quickly shift to the lower category or higher based on future socio-economic development, government interventions, and the future impact of climate change.

7 Vulnerability at provincial level shows the vulnerability of the districts which fall within a province irrespective of the other districts outside the province. As vulnerability is a relative measurement, therefore vulnerability ranks of certain districts are slightly changed in the provincial maps.

Table 15 Districts in order of vulnerability

Vulnerability categories and rank	Districts	Number & Percentage
Very High (0.780 - 1)	Rolpa, Western Rukum, Dailekh, Achham, Baitadi, Salyan, Doti, Eastern Rukum, Bajura, Kalikot, Jajarkot, Mahottari, Bajhang, Dadeldhura	14 (18%)
High (0.609 - 0.779)	Humla, Mugu, Gorkha, Udayapur, Pyuthan, Darchula, Siraha, Arghakhanchi, Bhojpur, Sindhuli, Khotang, Jumla, Saptari	13 (17%)
Moderate (0.468 - 0.608)	Makawanpur, Kapilbastu, Myagdi, Dolakha, Nuwakot, Sankhuwasabha, Rautahat, Baglung, Sindhupalchok, Bardiya, Dolpa, Surkhet, Bara, Okhaldhunga, Dhanusha, Nawalpur, Kanchanpur, Panchthar, Sarlahi, Gulmi, Ramechhap	21 (27%)
Low (0.082 - 0.467)	Dhading, Rasuwa, Lamjung, Dhankuta, Terhathum, Solukhumbu, Tanahu, Kavrepalanchok, Parbat, Syangja, Banke, Kailali, Palpa, Mustang, Manang, Dang, Taplejung, Parasi, Parsa, Ilam	20 (26%)
Very Low (0 - 0.081)	Sunsari, Lalitpur, Bhaktapur, Rupandehi, Morang, Chitawan, Kaski, Jhapa, Kathmandu	9 (12%)

Table 15 and Figure 20 show that six districts from Sudhurpaschim (Achham, Bajura, Baitadi, Bajhang, Doti, Dadeldhura), five from Karnali (Kalikot, Dailekh, Jajarkot, Western Rukum, Salyan), two from Lumbini (Eastern Rukum and Rolpa), and one from Province 2 (Mahottari) are ranked as highly vulnerable. There are no districts from Gandaki, Bagmati, and Province 1 falling into this category. The districts from Sudhurpaschim, Karnali, and Lumbini Provinces are characterized by high sensitivity and very low adaptive capacity leading to persistent vulnerability. Higher sensitivity is attributed to higher poverty incidence, food insecurity (food poverty), low income, and lower HDI and GDI. As vulnerability is determined by both adaptive capacity and sensitivity, some districts with higher sensitivity were ranked as low vulnerability due to their higher adaptive capacity (e.g., Dang).

In Province 2 **(Figure 20),** only Mahottari district is ranked as a highly vulnerable district. The lower HDI (0.388) and higher dependency ratio (0.63) have made the Mahottari district more vulnerable than the other districts of Province 2o. Similarly, Sindhuli and Makwanpur of Bagmati Province have higher sensitivity, but both have relatively better adaptive capacity and are ranked in the high to moderate vulnerability category. Most of the districts in mountains and hills had low to moderate adaptive capacity and very low sensitivity, resulting in low to moderate vulnerability **(Figure 21).**

Analysis of vulnerability at the provincial level shows that four districts in Sudhurpaschim (Achham, Bajura, Bajhang, and Doti) show very high vulnerability, and two districts (Baitadi and Dadeldhura) are ranked as highly vulnerable **(Annex 22).** Two districts from Karnali Province, namely Kalikot and Dailekh, are very highly vulnerable, while Jajarkot and Salyan are highly vulnerable **(Annex 23)**. Three districts from Lumbini Province, Eastern Rukum, Rolpa, and Pyuthan, are very high vulnerable whereas Gulmi, Arghakanchi, and Kapilbastu are in high rank **(Annex 24)**. Four districts from Gandaki Province (Myagdi, Baglung, Gorkha, and Nawalpur) are in very high vulnerability rank and only one district (Tanuhu) is in high rank (**Annex 25**). In Bagmati Province, Makwanpur and Sindhuli are in very high rank whereas Nuwakot, Sindhupalchowk, and Ramechhap are in high rank **(Annex 26)**. Two districts from Province 2 **(Annex 27),** namely Mahottari and Siraha, are very highly vulnerable and another two districts, Rautahat and Saptari, are categorized into high rank. In Province 1, four districts (Okhaldhunga, Khotang, Udayapur, and Bhojpur) are ranked as very high vulnerability, whereas three districts, (Sankhuwasabha, Taplejung, and Panchthar) were ranked into the high category **(Annex 28)**. The vulnerability

result of Province 2 is consistent with the vulnerability analysis conducted by Neupane et al., 2013 which also shows the persistent nature of vulnerability due to poor socio-economic development of the region (Neupane et al., 2013).

Poverty has been a determining factor for vulnerability as evidenced by the data analysis. Districts with high poverty incidence, such as Kalikot (0.579) and Bajura (0.641), fall in the very high vulnerability ranks, whereas Kathmandu and Lalitpur with a poverty incidence of (0.076) and (0.076) respectively fall in the low vulnerability rank. Food poverty for Kathmandu (0.200), Lalitpur (0.145), Kalikot (0.550), and Bajura (0.750) also influenced their vulnerability. Districts having better GDP and non-agricultural GDP values were also ranked as less vulnerable.

With more than 66% of people dependant on land for livelihoods, unequal distribution of land ownership has been one of the most fundamental types of wealth inequality (Dilley et al., 2005). The findings show that the districts with low vulnerability have a higher number of female ownerships in fixed assets such as land and house; for example, Chitwan and Jhapa have 22,655 and 32,629 women respectively who have ownership over both land and house, which is much higher than the average national value of 7,542. Further, as we move toward the western region, female ownership in fixed assets decreases, leading to higher vulnerability. In Western Rukum (445) and Kalikot (281), female ownership in fixed assets was much lower than the average mean value (7,542). Access to a financial institution through cooperatives and population (both male and female) with active savings accounts and access to television were higher in districts with lower vulnerability.

Districts from Sudhurpaschim Province and Karnali Province, such as Kalikot, Achham, Bajhang, Bajura, and Jajarkot, that ranked in very high vulnerability had low labour productivity and per capita income. Whereas districts from Bagmati and Gandaki Provinces, such as Chitwan, Bhaktapur, Kathmandu, and Lalitpur, that ranked in very low vulnerability, had high labour productivity and per capita income. Manang and Mustang were also found to have higher per capita income and labour productivity even though the districts were ranked in low vulnerability and thus ranked better than their adjoining districts.

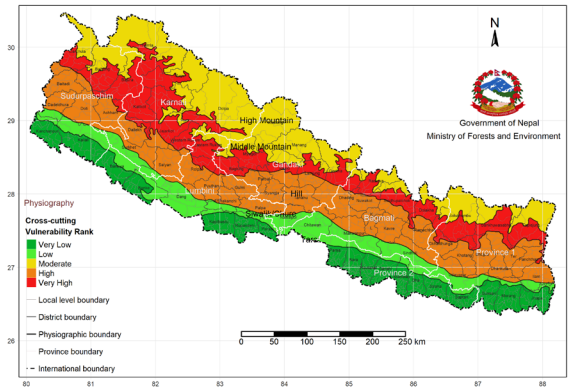

Figure 20: Overall socio-structural vulnerability by physiographic region

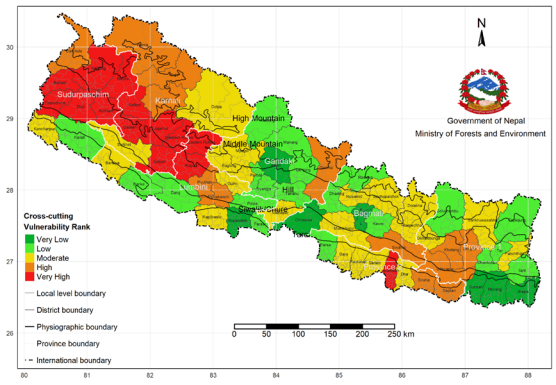

Figure 21: Overall socio-structural vulnerability by district

According to the Human Development Report (HDR, 2020), unequal access to education, health, and income has resulted in an average loss of 25.6% on the HDI due to inequality, despite significant progress in human development overall (UNDP, 2020). The data analysis

also showed that districts with low vulnerability had a comparatively higher population with higher years of schooling, a higher number of women in professional jobs, and people having diversified (agriculture and non-agricultural income) livelihood options as well as higher labour productivity and per capita income.

According to the 2014 MICS data, poverty incidence differs significantly by gender and social groups, rural and urban areas, ecological belt, and province. The provincial analysis of the MPI shows the highest incidence in Karnali Province (57%) and Province 2 (48%), both of which experienced the slowest progress in poverty reduction between 2011 and 2014. Provinces with higher multidimensional headcount poverty also have consistently more deprivation. Deprivation in years of schooling contributes the most (20%) to the MPI in Province 2 followed by nutrition (17.4%). In Karnali Province, deprivation in child mortality contributes the most (16%), followed by nutrition (15.1%). Province 2 has over 1 million more people in multidimensional poverty than any other province. Karnali Province has 0.6 million people in multidimensional poverty. Among the three dimensions of human development, the standard of living makes the highest contribution to multidimensional poverty in Nepal at 45%, followed by health at 28.3%, and education at 27.3%. Among the MPI indicators, the largest contributions to national poverty are deprivations in years of schooling (17.7%), followed by nutrition (15.9%). The climate change vulnerability attributes are further aggravated by these dimensions.

In addition to vertical inequality, horizontal inequality among different ethnic groups as a result of exclusionary development processes has caused instability. Inequalities in assets and opportunities and spatial, gender, and other socioeconomic disparities in health and education thus make the situation much worse in districts having a higher vulnerability to climate change. In the country, while most poverty reduction has resulted from the massive outmigration of labour leading to an increase in private remittances, remittances have also increased income inequality (UNDP, 2020). Male migration has increased female-headed households, further increasing women's workload. Thus, it is important to promote gender-friendly and climate-smart technologies to reduce their workload and increase productivity.

Analysis of vulnerability in terms of sub-sectors shows that vulnerability in Province 2 is more related to socioeconomic indicators, whereas the vulnerability of Sudhurpaschim Province and Karnali Province is more related to resource and services and is further complicated by their socio-economic attributes **Figure 22 (a & b)**.

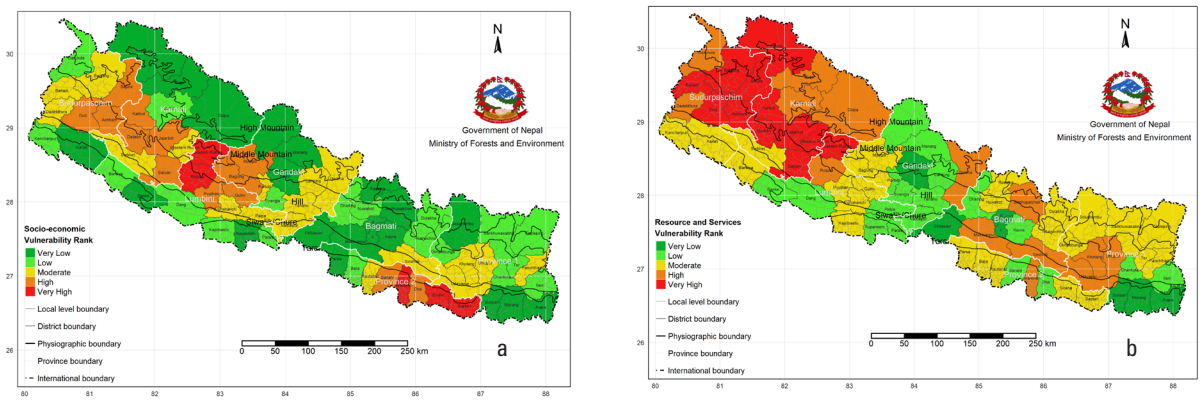

Figure 22: Subsector-wise vulnerability: (a) Socioeconomic and (b) Resource and services

The above analysis infers that different pattern of vulnerabilities exist in different districts. Vulnerability in the western region is different than in the eastern, and vulnerability in rural areas is different than in urban areas. Vulnerability in the western region has resulted from higher sensitivity due to higher poverty incidence, issue of food insecurity, low income, and lower HDI and GDI, accompanied by low adaptive capacity. Such vulnerability resulting from higher sensitivity and very low adaptive capacity indicates persistent vulnerability where the population is already trapped in the vicious cycle of poverty. There are also a few very sensitive districts that, due to their higher adaptive capacity, have been ranked into lower vulnerability. The overall vulnerability results reveal vulnerabilities are diverse and call for different policy responses based on nature and degree of vulnerabilities.

In the stakeholders' consultation and FGDs, this study tried to identify and characterize vulnerability at the local level. FGDs were conducted with marginalized communities such as the Mushar community in Biratnagar. It is found that they are ultra-poor households living in poor housing facilities, have poor nutrition, often live near rivers on public land, and lack land rights. There is also an increasing trend of labour migration to India and the Gulf, creating more female-headed households. Considering their socio-economic condition, they are more sensitive to climatic hazards such as cold waves in winter, heat waves in summer, and being near rivers means they are vulnerable to flood risks.

7.4 Future Climate Change Risks

This section describes the climate change risks at the level of districts, provinces, and physiographic regions. Current risks are presented and future scenarios of climate risks have been projected for 2030 and 2050 time horizons under RCP 4.5 and 8.5 assumptions. Along with climate change risks, future socioeconomic scenarios are discussed.

Risks are determined by the exposure, hazards, and vulnerability which are described in detail in the above chapter. Result **(Table 16 & Figure 23**) shows that 9 districts (12%) fall into the category of higher risks. Those nine districts are Morang, Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, Bara, Dang, and Kailali. All nine districts belong to the Terai physiographic region. There is only one district in Province 1 (Morang) in this category. There are six districts from Province 2 (Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, and Bara). In Lumbini and Sudhurpaschim Provinces, there are two districts, one in each province, namely Dang and Kailali respectively, which fall into the high risk category. Looking into their exposure and vulnerability characteristics, it shows that these districts are commonly characterized by high to very high exposure, high to very high vulnerability, and mostly high to low adaptive capacity.

For instance, Morang district has very high exposure. The vulnerability shows Morang as high sensitivity district and with higher adaptive capacity resulting in lower vulnerability. At the same time, it falls on the higher side of extreme events. Hence, two risk factors, exposure, and hazards, are triggering risks in this district irrespective of low vulnerability. This district has a very high adaptive capacity despite higher sensitivity, which means the district may recover relatively quickly.

Coming to high risky six districts of Province 2, all six fall at the higher rank of hazards occurrence **(Figure 11)**. Exposure and vulnerability vary slightly from district to district. For instance, both

Saptari and Siraha are also adjoining districts of Province 2 and both have high exposure (**Table 12**). In the vulnerability component, both have very high sensitivity but moderate adaptive capacity resulted in high vulnerability (**Tables 13, 14, and 15**). Hence, the overall risks of those districts are very high. Dhanusha, Bara, and Sarlahi possess similar characteristics, i.e., high exposure, high sensitivity, and moderate adaptive capacity, resulting in moderate vulnerability. In the case of Mohattari, exposure is moderate, but it has very high sensitivity, resulting in very high vulnerability. In all districts of Province 2, exposure, vulnerability, and hazards are playing simultaneously for these higher risks. Unlike in Morang district, here the risk is triggered by all three components and it may show lower resiliency to overcome climatic risks.

Dang district from Lumbini Province has high exposure, very high sensitivity, and high adaptive capacity which resulted in low vulnerability. Similarly, Kailali of Sudhurpaschim Province has very high exposure, very high sensitivity with a moderate adaptive capacity which resulted in low vulnerability. Here, the risk is triggered by high exposure with high hazards.

Fourteen districts fall into the high-risk category; four from Province 1 (Jhapa, Sunsari, Sankhuwasabha, and Udayapur); two from Province 2 (Rautahat and Parsa); three from Bagmati Province (Sindhuli, Makawanpur, and Chitawan); two from Lumbini Province (Rupandehi and Kapilbastu); and three from Karnali Province (Banke, Bardiya, and Surkhet). Most of the plains districts, Sankhuwasabha excepted, fall into this category.

Districts from Province 1 exhibit moderate to high exposure and moderate to low vulnerability, but higher hazards, resulting in the high risks category. Districts from Province 2 possess high exposure, moderate to high vulnerability, and high hazards, resulting in high risks. All three risk components are amplified here. Similarly, districts from Bagmati Province possess moderate to high exposure, lower to moderate vulnerability, and higher hazards, resulting in high risks. Similarly, districts from Lumbini Province exhibit high exposure, lower to moderate vulnerability accompanied by higher hazards, resulting in higher risks. Two risk components, i.e., exposure and hazards are amplified here. In the case of Karnali Province, districts have moderate exposure, higher vulnerability, and moderate to higher level hazards, resulting in high risks.

Interestingly, the overall vulnerability is higher in the western part but most of the districts in this category are from the eastern and central parts with some exceptions. This shows hazards are more dominating factors for risks than socio-economic factors. However, given the changes in socio-economic parameters, the risk will be higher even in the western region of Nepal. 25 districts fall into the moderate risk category and, as mentioned earlier, those transitional districts can swiftly switch to higher or lower risk categories in response to future extremities and socio-economic changes. Most of the districts from Sudhurpachim and Karnali Provinces fall into this category. Despite higher vulnerability, these districts have low exposure and hazards which resulted in a moderate category of risks. There are 29 districts (38%) that fall into the lower and very low categories. These districts are relatively safe, at least in the baseline scenario. Interestingly, most of the mountain and mid-hill districts fall into this category. This does not imply, however, that these districts are not at risk from climate change.

Seven districts fall in the very low-risk category: Rasuwa, Terhathum, Bhaktapur, Parbat, Mustang, Manang, and Kathmandu. Unlike the other six districts, Kathmandu presents unique characteristics of risk components. It has very high exposure and a moderate level of hazards.

But it has low sensitivity and very high adaptive capacity, resulting in very low vulnerability. This district resembles the characteristics of Morang for two risk components, very high exposure, and very low vulnerability. However, hazards are higher in Morang and moderate in Kathmandu, which resulted in Morang district falling into the high-risk category while Kathmandu is in the very low category. For the other low risk districts, such as Rasuwa, Terhathum, Bhaktapur, Parbat, Mustang, and Manang, their exposure, vulnerability, and hazards range between moderate to low.

Table 16 Risk categories of districts in baseline scenario

Risk categories and rank	Districts	Number & Percentage
Very High (0.511 - 0.691)	Kailali, Siraha, Morang, Bara, Dhanusha, Dang, Sarlahi, Mahottari, Saptari	9 (12%)
High (0.365 - 0.510)	Makawanpur, Kapilbastu, Sunsari, Sankhuwasabha, Rautahat, Bardiya, Udayapur, Banke, Surkhet, Rupandehi, Sindhuli, Chitawan, Jhapa, Parsa	14 (18%)
Moderate (0.246 - 0.364)	Dhading, Rolpa, Humla, Baglung, Sindhupalchok, Gorkha, Tanahu, Kavrepalanchok, Dailekh, Pyuthan, Syangja, Achham, Palpa, Bhojpur, Salyan, Doti, Khotang, Nawalpur, Kanchanpur, Taplejung, Panchthar, Jajarkot, Bajhang, Gulmi, Ilam	25 (32%)
Low (0.134 - 0.245)	Mugu, Myagdi, Lamjung, Dolakha, Dhankuta, Nuwakot, Western Rukum, Solukhumbu, Lalitpur, Darchula, Dolpa, Arghakhanchi, Baitadi, Eastern Rukum, Okhaldhunga, Bajura, Kalikot, Kaski, Jumla, Parasi, Ramechhap, Dadeldhura	22 (29%)
Very Low (0.011 - 0.133)	Rasuwa, Terhathum, Bhaktapur, Parbat, Mustang, Manang, Kathmandu	7 (9%)

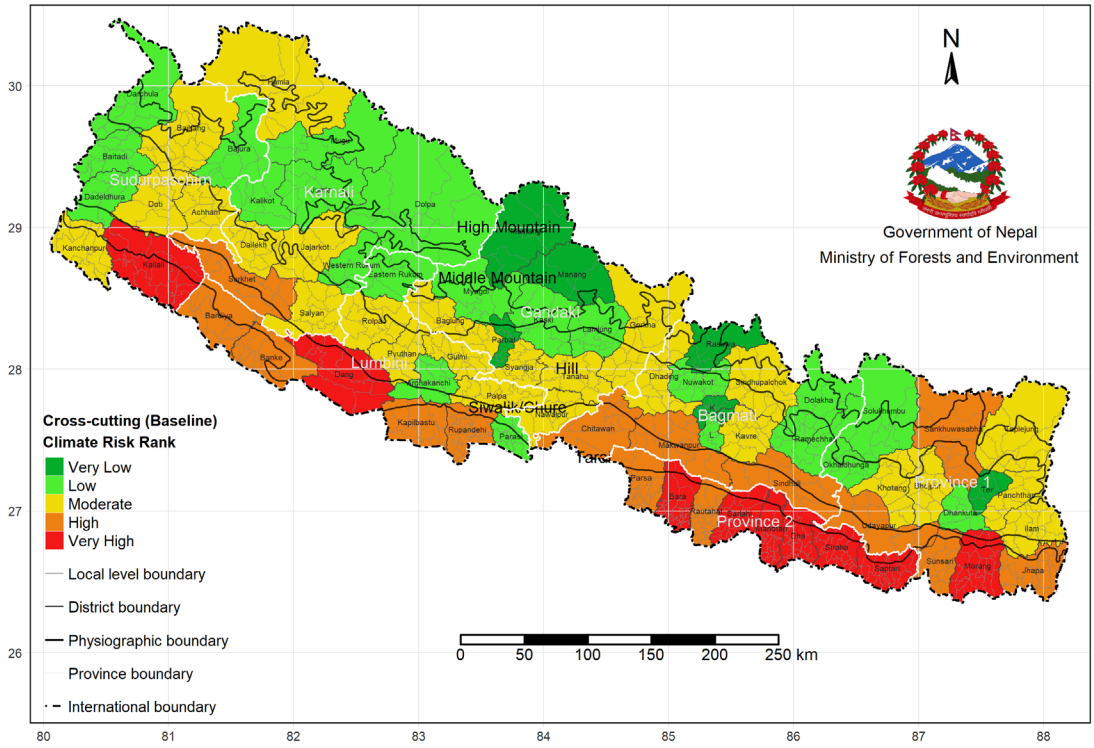

Figure 23: Climate change risks (baseline scenario) by district

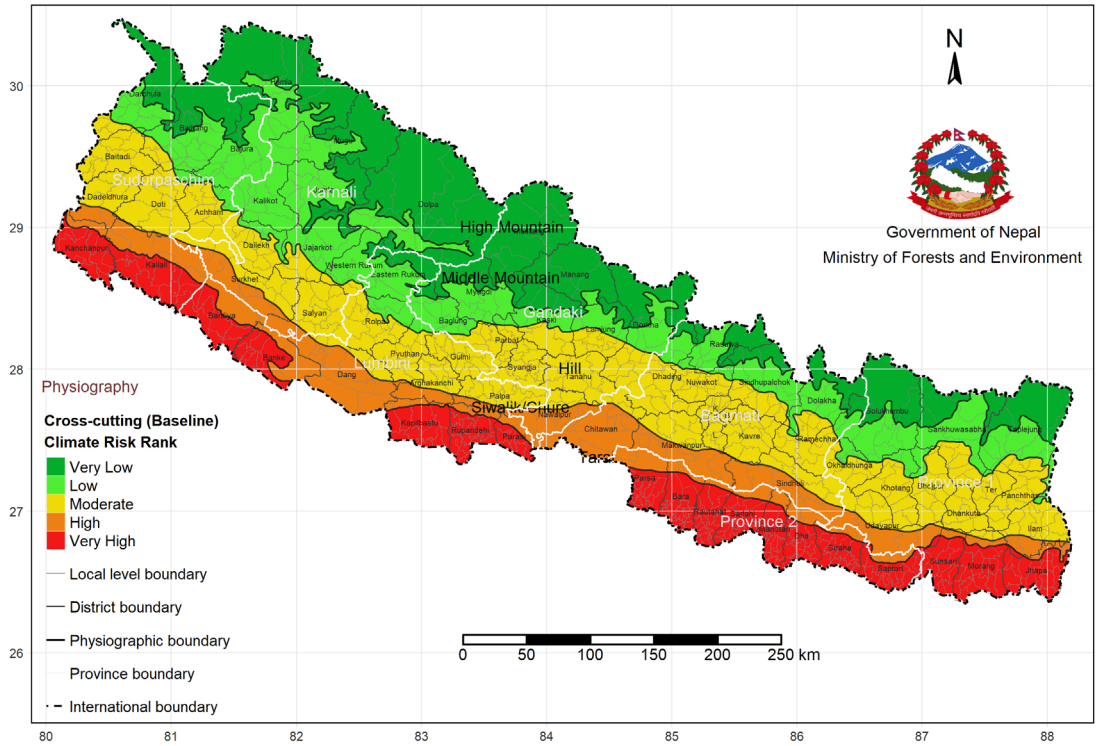

Figure 24: Climate change risks by physiographic region

Table 17 and **Figures 25 & 26** present the future scenario of risks. It indicates that districts falling into the high and very high category will increase abruptly in the future. For instance, there are 9 districts under the very high category of risks which will adjust to 10 districts (RCP 4.5) or 11 districts (RCP 8.5) in 2030 and it will reach 12 districts (RCP 4.5) and even 20 districts in the worst scenario (RCP 8.5) in 2050. A similar trend is observed for the districts falling into the high category. Interestingly, the number of districts in the moderate category remains almost the same. Unlike the above category, the number of districts falling into low and very low is already low and will drop abruptly in the future scenario. This means most of the districts from this category turn into moderate or higher risk categories. This is quite a worrisome scenario of future risks which will have major implications for the sector.

Table 17 Socio-structural risks (baseline and future scenario)

Risks categories	Baseline	2030 (RCP 4.5)	2030 (RCP 8.5)	2050 (RCP 4.5)	2050 (RCP 8.5)
Very high	9	10	11	12	20
High	14	13	14	16	19
Moderate	25	23	22	27	24
Low	22	2	24	18	12
Very low	7	6	6	4	2

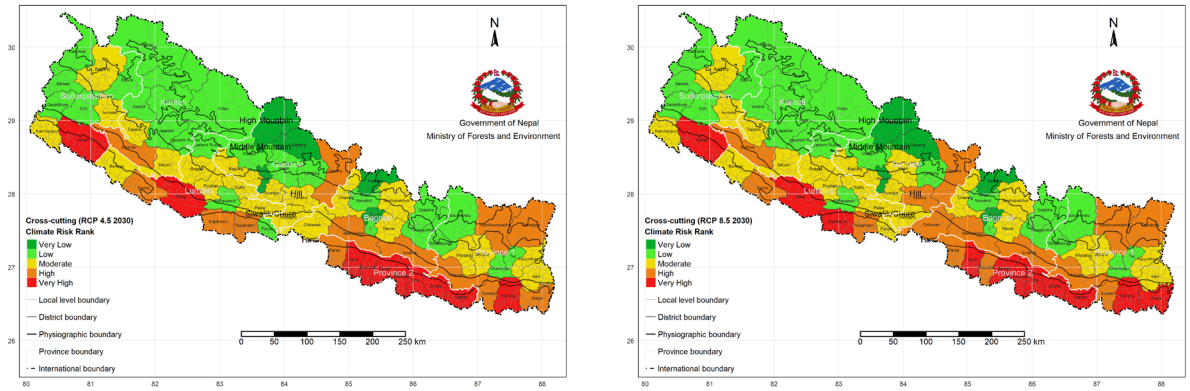

Figure 25: Climate change risks scenario 2030 (RCP 4.5 (L) and 8.5 (R)

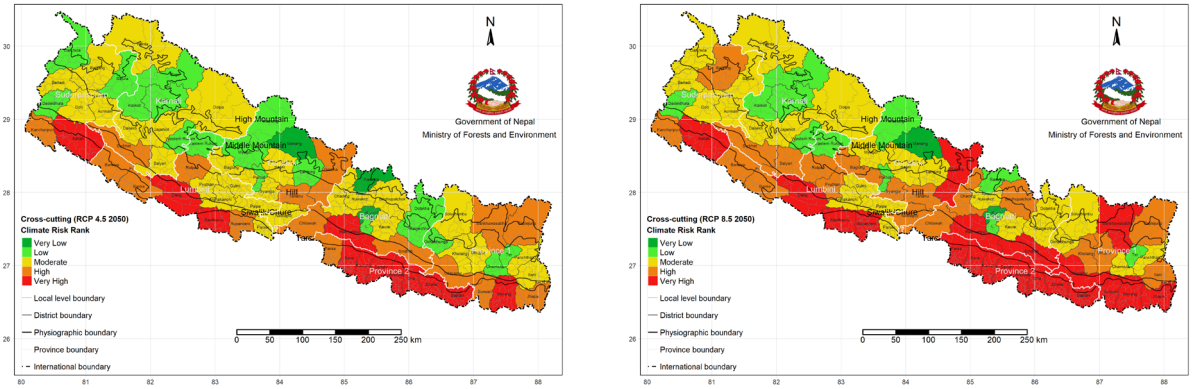

Figure 26: Climate change risks scenario 2050 (RCP 4.5 (L) and 8.5 (R)

The analysis shows that higher risks are seen in vulnerable pockets, which means they are amplified by hazards. Those districts which have poor socio-economic conditions have higher risks of climate change. For example, risk also seems higher in the Terai region as it is densely populated with higher population growth. **(Figure 24)** This means socio-economic and climatic variables are both important in determining the risks. In the absence of a timely adaptation response, a much larger population of this region will have to face climatic risks in near future. On the other hand, the future hazards scenario shows it is expanding to the western part in the future which is socio-economically poor and already in the rank of higher vulnerability. As risks are latent, it is uncertain and invisible and it can be amplified in future at any time in an unexpected location.

The risk scenarios are only based on future hazard scenarios and do not incorporate the socio-economic trends and scenarios. However, future socio-economic development can push risks in both directions. For example, our scenario analysis shows that there will be a sharp increase in population, particularly in Province 2 and Bagmati Province. Each province is expected to cross 10 million population by 2051 **(Figure 8, Chapter 4)** which will increase the exposure of the population, particularly the elderly, children, the poor, and marginalized communities. Almost half of the population will be in urban areas by 2051 which indicates there is a likelihood of an increase in the number of urban poor and slum dwellers and this section of society will be more exposed to climate risks. Similarly, there is an increasing trend of female-headed households, dependency ratio, poverty incidence, and labour migration, which will increase the sensitivity of

society, resulting in higher vulnerability. This situation is likely to happen in Province 2, Karnali, and Sudhurpaschim Provinces.

Some governmental interventions may decrease future vulnerability. For example, the recent Progress Assessment Report of SDGs (NPC, 2020) shows Nepal has done remarkable progress in poverty reduction (SDG1). Population living below USD 1.9 is 15%, MPI Index has dropped to 28.6%, and national poverty line stands at 18.6%. Similarly, Nepal has achieved remarkable progress in terms of drinking water and sanitation. There is satisfactory progress in reducing food poverty and food insecurity, and Nepal is committed to reducing food insecurity by 2030 (SDG 2). There is also remarkable progress in water supply coverage which has increased to 88%, and 85% of the population are using toilets (SDG 7). The current trend of the progress of SDGs directly strengthens adaptive capacity and reduces vulnerability, which may reduce Nepal's risk in the future.

Chapter 8

Adaptation Opportunities

The assessment process has indicated that adaptation measures must be targeted to reduce both socio-structural and biophysical vulnerability related to climate change through proper coordination between different sectors and at different scales (local, national, and regional). Unless the socio-structural aspects are taken into account, the adaptation response would be incomplete and unsuccessful to build climate resilience. Inequalities in assets and opportunities and other socioeconomic disparities make the situation much worse in districts having a higher vulnerability to climate change.

The findings from the assessment show that higher poverty incidence, lower access to resources, limited access to infrastructures and services, and limited livelihood opportunities have been the determining factors for vulnerability. Although there have been progressive achievements in the promotion of women's rights and gender equality, deeply rooted socio-cultural norms continue to perpetuate discrimination. Districts ranked as having very high vulnerability are found in provinces with higher gender inequality and low GDI. For example, Province 2 and Karnali Province both have high GII values. The data analysis also showed that districts with low vulnerability had a comparatively higher population with higher years of schooling, a higher number of women in professional jobs, and more people having diversified (agriculture and non-agricultural income source) livelihood options as well as higher labour productivity and per capita income.

Comprehensive adaptation planning should focus on reducing inequality and underlying drivers, across economic, social, and structural dimensions among individuals and different social groups. Affirmative action, which includes targets, quotas, and positive actions to improve access to livelihood opportunities, assets, services, and political representation among women and disadvantaged groups, is required to address the structural drivers behind persistent inequality and socio-structural vulnerabilities. The adaptation must promote GESI responsive and climate-smart measures in policies, programs, and budgets. It

should integrate holistic measures to enhance access of women and marginalized communities to quality education, employment, and credit, especially for poorer households and those in remote areas. Access to better water management techniques can also help reduce the work drudgery of women and girls (as evident from Case study 2 & 3).

Case 2 – Rain water collection tank

According to Man Kumari Khanal from Dailekh, ward no. 2, Koldada, prior to prolonged drought, water used to be available all year round, but nowadays water sources completely dry up by Magh, increasing water disputes in the community. However, NCCSP under LAPA contributed to the construction of a rain water collection tank. Prior to the construction of the tank, women and girls had to spend two hours daily in collecting 10 litres. The construction of the rain water collection tank has saved around 1,200 hours of their time which is now used for productive income generation activity.
Source: MoFE (2017)

Case 3 – Drinking water project in Tanahu

Residents of Huslangkot, Dharampani, in Tanahun district, faced acute water scarcity since their water source began shrinking. As the community was located high in the hills, women and children of the 31 households had to walk over three hours a day to collect water. Kotle Khola Rural Solar Drinking Water Project installed a solar-powered pump to lift water to a reservoir, then to the taps in the community, after which women's collection time reduced and their consumption of greens increased. The project also formed a farmers group for commercial vegetable farming, tackling other climate vulnerabilities and conserving biodiversity by improving sanitation, controlling forest fires, and planting and stabilizing degraded land.
Source: WWF Nepal (2017)

Social protection plays an important role in addressing structurally generated poverty and vulnerability. It should be properly designed and implemented to reach and reduce the drivers of social exclusion, to build a resilient society capable of sustainable change. Adaptive social protection programming, including cash transfer mechanisms, should reach economically and socially vulnerable groups, such as single mothers, children, and people with disabilities. It should be well integrated with disaster risk management strategies for achieving greater resilience to shocks and disasters.

To reduce vulnerabilities, especially among the most disadvantaged people, the focus should be on balanced economic growth across provinces with a comprehensive strategy integrating social protection, social security, and employment-related programs to establish a guaranteed income threshold (as seen in Case Study 4). Access to information and communication technology and advancement in early warning systems with preparedness for disaster risk will increase capacity to cope with climate change stressors (as evident from Case Study 5).

Case 4 – Mushroom farming as a cash crop

Rama Bhandari, a resident of Patmara, Urthu Chautara, of Jumla district, belongs to a deprived community whose source of livelihood was subsistence farming and a small hotel. Decrease in rainfall, heavy snowfall, and hailstorms were causing damage to crops and underproduction of vegetables and fruits. Rama's life took a different turn when she received a small financial support and a three-day training on mushroom farming. She began farming mushrooms as a profitable business, as it is a cash crop and requires very little space to grow, for instance, it could be cultivated in a small room inside her house. Her hotel business started flourishing along with increasing demand for mushrooms. She expanded her hotel business and made savings which she was able to invest in the education of her children and for household use.
Source: MoFE (2017)

Case 5 – Flood Early Warning System

Poor quality houses, unscientific agricultural practices, lack of land use planning, and the frequently changing river course, among others, had made Holiya village in Banke district vulnerable to floods. A community vulnerability assessment showed poverty, unequal access to resources, lack of meaningful participation of women in early warning systems, and traditional beliefs to be among the key underlying causes of the higher vulnerability and flood risk in the community. When an early warning system was put in place, it helped the community monitor flood levels and disseminate flood warnings and alerts, and increased community awareness of response activities. The rain gauge station was also installed by DHM in the Kusum River, which informed the community, Chief District Officer (CDO), police, and FM station when the level of the river rose above 4.5m. A local disaster management committee (LDMC), which took responsibility for the early warning system and for operating the river gauge at Kusum. The system was people-centered as it covered the majority of households, was low cost, used locally available technology, was affordable, and was managed by the local community. Unfortunately, women's participation in the meetings and decision-making processes related to the early warning system was limited by the community's perception that such "technical" work could only be done by men. This leads to the warning information transmitted by sirens or loudspeakers to reach mostly men in public places which were less frequented by women.
Source: Shrestha et al., 2014

An effective adaptation process will require both top-down strategies, involving adjustments in policies, institutions, and attitudes, and bottom-up activities, through a community-centered approach that is integrated and holistic, with consideration or coordination of cross-sectoral interactions among key climate-sensitive sectors. Without proper integration across different sectors, adaptation strategies may increase vulnerability or undermine net resilience by decreasing capacity or increasing risks in another sector which could result in maladaptation. Climate change brings multiple stresses, and adaptation requires proactive and comprehensive approaches and coordination between different sectors and at different scales (local, national, and regional).

Table 18: Socio-structural adaptation options

Area	Priority Activities	Short	Medium	Long
System strengthening for climate change adaptation	Establish a mechanism for multi-sectoral coordination and integration of climate change adaptation commitments in sectoral development plans at levels. (Integrate GESI in multi-sectoral plans, policies, strategies, and budgets.)- Increase allocation of 'directly gender responsible' and 'climate responsive' budget at all levels.			
	Devise affirmative measures for gender equality and empowerment of women by challenging discriminatory norms, values, and practices that intensify vulnerability.			
	Ensure meaningful representation of women in a leadership role in climate adaptation planning and implementation (build women's capacity for effective participation in key policymaking positions)			
	Establish and strengthen reliable/accessible weather forecasting and surveillance systems; increase access to preparedness-related information (early warning system, lifesaving technique, knowledge and skills of a vulnerable population (PWDs, senior citizens, single women). Develop rescue plans, information communication, and technology for the tourists and those involved in the tourism sector.			
	Develop a mechanism for fair and equitable sharing of carbon and non-carbon benefits from forests for rights holders, women, Indigenous groups, *Madhesis, Dalits*, and forest-dependent population.			
	Develop standards for housing structure and construction materials for people living in squatters and risk-prone areas which can withstand extreme climatic events.			

Area	Priority Activities	Short	Medium	Long
	Establish institutional mechanisms at all levels for emergency preparedness and disaster response to prevent/respond to Gender-Based Violence (GBV) (during a disaster,re-location, and rehabilitation) with gender-responsive recovery measures.			
	Establish GESI responsive public health services/health insurance coverage to address differential health impacts of climate change.			
	Increase the coverage of allowance/grants/incentives for senior citizens, single women, widows, people/children with disabilities, the population covered by endangered people's allowance reservations, and special privileges.			
	Support community-based natural resource management for the collective use, ownership, and management of natural resources focusing on participation and empowerment of women and local communities.			
	Ensure GESI responsive livelihood planning and adequate institutional and financial provisions in CCA/DRR multi-sectoral plans, policies, strategies, and budgets. Prioritize livelihood recovery plan (e.g. unconditional /conditional cash transfers, emergency fund, food and in-kind transfers, school feeding programs) in DRR and CCA planning at all levels.			
	Promote climate change knowledge/information on differential impacts and adaptation measures through the formal and informal education system.			
	Implement sectoral priorities identified in NAP and LAPAs through participatory, transparent, and gender and socially inclusive approaches.			
Access to resources and livelihood options	Increase women's access to productive resources (joint land ownership, seed, fertilizer, credit, equipment); agricultural information, climate-resilient technology, and tools (efficient water use, soil management, soil and pest management, seed banks). Promote women's participation in local institutions and organizations, and explore innovative solutions for generating income locally through climate-smart practices.			
	Promote livelihood diversification (farm/non-farm) for women/youth and vulnerable populations through increased access to skills and formal markets to bridge the gap between production and productivity.			
	Promote public-private partnerships for creating opportunities in nature-based solutions and decent employment in the formal sector focusing on women and marginalized communities.			
	Improve equitable access to safe and affordable drinking water, sanitation, and hygiene for women and marginalized populations including slum dwellers and other vulnerable groups.			
	Build resilience of women and small-scale producers in the livelihood diversification/ employment generation, value chain; enhance business/ leadership skills, negotiation powers, and understanding of market dynamics.			
	Increase access of women and climate-vulnerable populations to public works schemes, such as the Prime Minister's Employment Program.			
Capacity building and empowerment	Increase awareness on climate change at the community level and understanding of local specificity and technical capacity of policymakers and other stakeholders. (As individuals and household decisions about livelihood strategies and investments (e.g. crop selection, equipment purchase, skills training, and contingency planning) represent real-life practices, their alignment into policies are useful for policymakers and practitioners for monitoring and scaling up).			
	Build capacity on climate-smart technologies for production, commercialization (e.g. food processing) to enhance the livelihood of women and marginalized groups based on local/cultural specificity to reduce drudgery and time poverty. (saved time to be used for education, personal growth, and economic activities)			
	Build capacity of women from diverse backgrounds to maximize their voice, confidence, and negotiation skills on climate-related decisions and intersectional issues.			

Area	Priority Activities	Short	Medium	Long
	Enhance the capacity of women, women's organizations, and key government officials to advocate on gender issues in international negotiation processes.			
	Integrate distinctive knowledge of women and indigenous groups into programs or policies to strengthen climate resilience (coping and adaptation practices, conservation, food security, and livestock farming practices, etc.) and facilitate the process of building their 'agency' through GESI responsive climate measures and actions. (removing legal barriers by promoting effective implementation of progressive policies related to property ownership, equal inheritance, and decent work that builds women's adaptive capacity)			
	Enhance technical and institutional capacity on climate change at local and provincial levels. (accountability, and transparency for climate adaption priorities in programs/budget)			
Reducing structural poverty inequality and norm change	Mainstream socio-structural priorities (poverty, inequalities, food security, employment, etc.) in climate change adaptation planning through a holistic and integrated approach.			
	Invest in adaptive social protection to reach economically and socially vulnerable groups, such as single mothers, children, and people with disabilities.			
	Increase women's access to financial resources to increase their engagement in economic activities. (e.g. credit, loan, insurance, etc.)			
	Promote women's participation in non-gender stereotypical jobs (e.g. transport, industry, technology, and tourism) to enhance their adaptive capacity.			
The targeted and accessible need-based program Monitoring and Evaluation	Target 'hot-spots' districts and populations with greater vulnerability (women, children and the elderly, etc.) through livelihood enhancement/skill-building programs, employment opportunities.			
	Generate information through large-scale qualitative and quantitative surveys and participatory research for understanding the differential impact of climate change.			
	Establish disaggregated data bank for assessing vulnerability for all types of slow and rapid onset disasters based on their differential impacts.			
	Carry out GESI analysis and auditing as a mandatory step for gender-responsive adaptation in all sectoral plans and programs.			
Climate-Smart Technologies	Increase access of women and marginalized to clean, efficient and affordable energy for household use and livelihood promotion activities e.g. agricultural processing, micro-enterprises targeting climate-vulnerable women and marginalized.			
	Promote gender-responsive and climate-smart innovative agricultural technologies and practices; such as those related to drudgery and time poverty. (e.g. water conservation technology for efficient and multiple uses of water, agroforestry system and agricultural waste management for meeting the shortage of fuel and fodder)			

Chapter 9

Conclusion and Recommendations

9.1 Conclusion

The dimensions of climate change go beyond biophysical impacts and relate to the social and structural factors that influence vulnerability and risk. This assessment delved into the socio-structural factors contributing to differential vulnerability. Hazards such as floods, landslides, droughts, heat waves, cold waves, and forest fires have a direct link with socio-structural risks and vulnerability which impacts individuals, groups, society, and institutions differently over short- and long-term periods. The short-term impacts include loss or damage of property, injuries or loss of life, livelihood options, loss or damage of public services and utilities, and disruption of supply chains, communication channels, and transportation networks. The long-term impacts include changes in demography and livelihood options, which further add to socio-structural vulnerability.

There are significant regional disparities in development progress, with the mountain regions lagging and significant development gaps between rural and urban areas, that have been attributed to discrepancies in income, education, and access to infrastructure and services. Apart from these regional disparities, human development inequalities along the lines of caste and ethnicity are also significant. Nepal's rural to urban migration rate has resulted in the growth of urban centers with an increase in squatter settlements in urban locations. Both urban and rural districts experience poverty-related challenges and trends. Lower-income groups are hit hardest by the combination of greater exposure to climate hazards (e.g. those living in makeshift housing, unsafe and/or remote sites), less capacity to cope (e.g. lack of assets and insurance), less adaptive capacity, and limited access to social security measures. Gender inequality also plays a role, with women and girls having consistently fewer resources, which undermines their capacity to adapt to existing and future impacts of climate change.

Socio-economic trend analysis shows an increasing trend of key demographic characteristics such as population dynamics (male and female population, its growth and density), female-headed households, and urbanization trends. These demographic characteristics are linked with exposure, sensitivity, and vulnerability to climate change, and thereby to the associated risks, which means our society will encounter more climatic risks in the future and there will be a more exposed population than the baseline scenario. Trend analysis also presents rapidly increasing labour migration, especially in Province 2, Bagmati, and Lumbini Provinces. The migration of young household members in a family increases the sensitivity of those left behind (elderly, children, and women), which is one of the causes of the increasing number of women-headed households in the country.

Besides the demographic indicators, trend analysis also shows there is a gradual improvement in HDI over time, indicating an overall improvement in educational level, health status, and income, and people having more access to information, resources, and technology. This improvement in socio-economic indicators contributes positively to the future adaptive capacity of Nepal. However, one major concern is the rapid growth of the population which has manifested in many parts of the country, notably through the change in land use pattern and degradation or loss of forests and agricultural productivity. However, it is important to note the rural-urban differences in population growth have been negative in many of the mountain districts whereas reverse trends can be found in the urban areas. Some urban districts and highly populated districts of the Terai also exhibit a higher degree of exposure due to the larger population. Similarly, some mountain districts with larger district areas also exhibit higher exposure. Districts having lower populations and smaller areas are in low exposure rank as compared to the districts with a larger area and population size.

The findings show that there are fourteen districts under a very high vulnerability rank. The majority of these districts are from Sudhurpaschim Province and Karnali Province. These districts have high sensitivity and low adaptive capacity. Sensitivity is mostly contributed by poor socio-economic performance, higher poverty incidence, food poverty, low income, lower HDI, and lower GDI combined with lack of resources and services such as access to clean drinking water, sanitation, etc. Alongside poverty and existing inequality, vulnerability is heavily shaped by social, demographic, and institutional factors such as gender, age, culture, education, ethnicity, and governance system. Similarly, limited access to productive resources, financial assets, infrastructure, and social safety nets determines the vulnerability of a particular section of the population.

The findings also reiterate the fact that the impacts of climate change are experienced differently by women, Indigenous Peoples (IPs), disabled people, and marginalized populations due to their historical marginalization leading to social, economic, cultural, and political inequalities. In addition, they often lack the resources and capacity necessary to adequately respond to these challenges. Gender inequalities associated with socially constructed gender roles, responsibilities, and expectations determine social space and the availability or non-availability of opportunities to women and men, and their ability to prepare, respond, and recover at times of disaster. The impact of climate change is higher for socially and geographically marginalized and excluded groups like *Dalits, Madhesi, Muslims, Aadibasi,* and *Janajati*, people with disabilities, children, the elderly, and others. When different discriminations interact and intersect (e.g. discriminations based on gender, race, class, ethnicity, age, language, disability) it contributes to intersectional discrimination which further increases their vulnerabilities.

The assessment found that nine districts fall into the high risk category, the majority in Province 2. All the high-risk districts fall in Terai physiographic region. Unlike vulnerability, the risk is more concentrated in the eastern and central parts of Nepal mostly due to the high occurrence of climatic hazards. The scenario projects the increasing trend of risk extending toward the western region including the hills and mountains. The findings show that increasing access to financial institutions through membership in cooperatives, active saving accounts, years of schooling, female ownership of fixed assets such as land and house, a higher number of women in professional jobs, and diversified (agricultural and non-agricultural income) livelihood options, higher labour productivity, and higher per capita income increase adaptive capacity. Likewise, women's participation in resource management and decision-making processes increases their influence on prioritizing their adaptation needs. For example, in community forestry groups and WASH user committees, there has been good progress in increasing women's participation in effective resource use and achieving greater implementation outcomes. However, a large number of women, poor, and marginalized caste and ethnic groups are still excluded from these institutional processes. Although the share of the directly gender-responsive budget and highly climate-relevant budget has increased, this has not removed entrenched structural inequalities, as evident from the provincial consultation findings.

The methodological approach and the results from this study are important in understanding differentiated impacts among various groups of population and for underscoring and devising appropriate policies and adaptation measures across a range of possible climate scenarios.

9.2 Recommendations

The absence of a GESI perspective in research and the lack of disaggregated data creates a challenge in making informed policy decisions and inclusive adaption planning. GESI and climate change priorities are seldom integrated into sectoral policies, plans, and budgets. Limited institutional capacities at different levels for effective implementation are another area of concern.

In this assessment, the data gap was a major challenge. The dataset required for socio-economic, livelihood/governance, and GESI sectors analysis lacked consistency and quality. The central database maintained by the government ministries and its departments was not up to date. Population census and living standard surveys were the only sources of large-scale datasets available for the analysis. As these surveys were done in long intervals, they could not capture periodic changes, which made trends and projections difficult. For most datasets, multiple sources having different scales, timelines, and units were used. Although the indicators were carefully selected based on a review of academic literature, empirically proven evidence, and expert consultations, many important indicators had to be dropped because of unavailability and inconsistency in quality and incompleteness of dataset based on scale and time.

Specific recommendations from the assessment are as follows:

- Conduct large-scale qualitative and quantitative surveys for maintaining district-level time-series climate-responsive data that can be used for projection and trend analysis and targeted policy and program planning.

- Develop a disaggregated data bank and assess vulnerability for all types of slow and rapid onset disasters based on their differential impacts. Besides gender, it is essential to maintain breakdown data of other social groups such as IPs, Dalits, Madhesis, and Muslims, as well as different age groups.
- Downscale VRA at the municipality level. Relevant information and sectoral database and technical capacity strengthening for maintenance of disaggregated data relevant to climate change would support municipalities in identifying context-specific adaptation options and strategies.
- Involve a wide range of stakeholders, particularly various groups based on gender, age, ethnicity, and geography, to understand context-specific vulnerabilities.
- New census data in 2021 is currently being launched. Vulnerability and risk should be reassessed using the new data to inform policy and planning at various levels.

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Annexes

Annex 1: Details of elected members

Out of a total of 35,041, females comprised 14,352, and males 20,689. At the provincial level, there were 313 males and only 17 females in the first past the post and in the proportional representation, there were 48 males and 172 females. At the federal level, there were 159 males and only 6 females in the first past the post and in the proportional representation, there were 26 males and 84 females.

Sex	Local Level	Provincial Assembly		Federal Parliament		National Assembly	President	Vice President	Total	Percentage
		First past the post	Proportional Representation	First past the post	Proportional Representation					
Male	20689	313	48	159	26	35	0	1	21271	59.21
Female	14352	17	172	6	84	21	1	0	14653	40.79
Total	35041	330	220	165	110	56	1	1	35924	

Source: Election Commission. https://result.election.gov.np/

Annex 2: Gender-responsive budget at the national level (2064-2077)

Fiscal Year	Directly Responsive NPR (in billions)	Percentage	Indirectly Responsive NPR (in billions)	Percentage	Neutral NPR(in billions)	Percentage
2064/65	19.09	11.3	56.03	33.16	93.87	55.54
2065/66	32.91	13.94	83.58	35.41	119.53	50.64
2066/67	49.46	17.3	104.16	36.43	132.32	46.27
2067/68	60.61	17.94	112.65	36.3	154.64	45.76
2068/69	73.33	19.05	176.21	45.78	135.35	35.17
2069/70	87.07	21.51	178.63	44.13	139.11	34.36
2070/71	112.5	21.75	227.3	43.94	177.4	34.31
2071/72	135.56	21.93	278.38	45.04	204.15	33.03
2072/73	182.51	22.27	393.16	47.98	243.97	29.75
2073/74	242.3	23.01	508.2	48.45	298.41	28.45
2074/75	478.5	37.42	417.6	32.66	382.7	29.92
2075/76	508.3	38.65	450.8	34.28	355.9	27.07
2076/77	585.2	38.17	545	35.56	402.7	26.27

Annex 3: Gender-responsive budget at the province level (2019-2021)

		Directly Responsive	Indirectly Responsive	Neutral
Province 1	19/20	not available		
	20/21	14.32	61.85	24.5
Province 2	19/20/	29.74	22.37	47.89
	20/21	40.06	28.1	31.84
Bagmati	19/20/	13.61	28.25	58.14
	20/21	23.74	17.18	59.08
Gandaki	19/20/	66.03	28.54	5.43
	20/21	54.27	36.17	9.56
Lumbini	19/20/	14.28	35.31	50.41
	20/21	21.46	32.73	45.81
Karnali	19/20/	30.1	27.47	42.43
	20/21	36.9	40.77	22.33
Sudhurpaschim	19/20/	51.24	44.23	4.53
	20/21	47.43	46.63	5.94

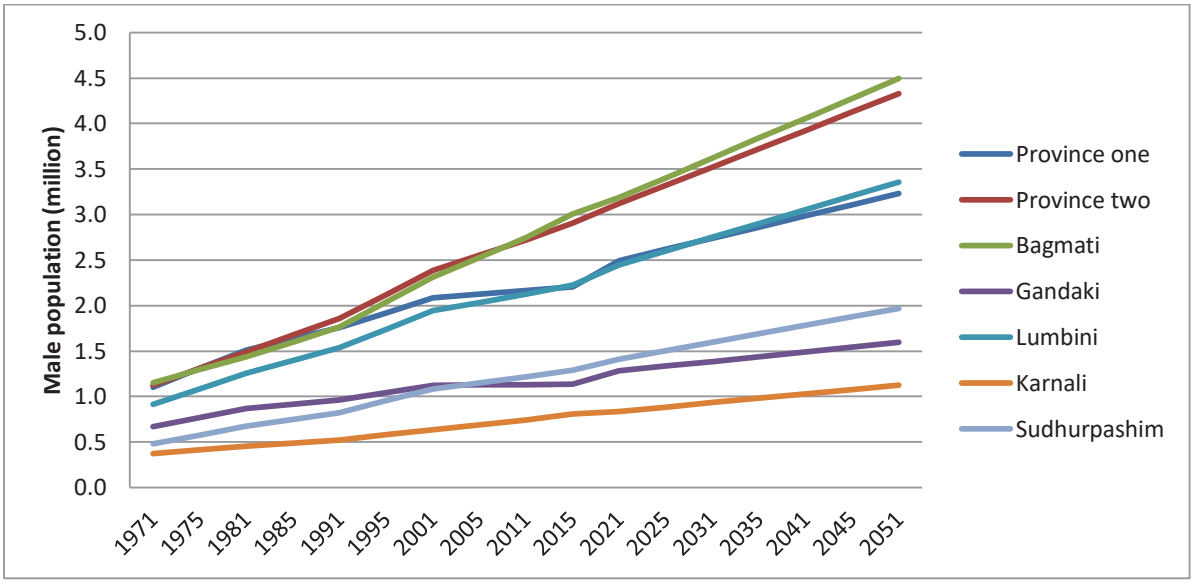
Annex 4: Climate Change Budget at the national level (2012-20)

Fiscal Year	Highly relevant	Relevant	Neutral
12/13	4.45	2.29	93.26
13/14	5.36	4.98	89.66
14/15	5.66	5.07	89.27
15/16	5.66	13.79	80.55
16/17	5.9	13.32	80.78
17/18	4.52	26.24	69.24
18/19	4.41	32.62	62.97
19/20	5.21	25.05	69.74

Annex 5: Climate Change Budget at Province Level (2019-21)

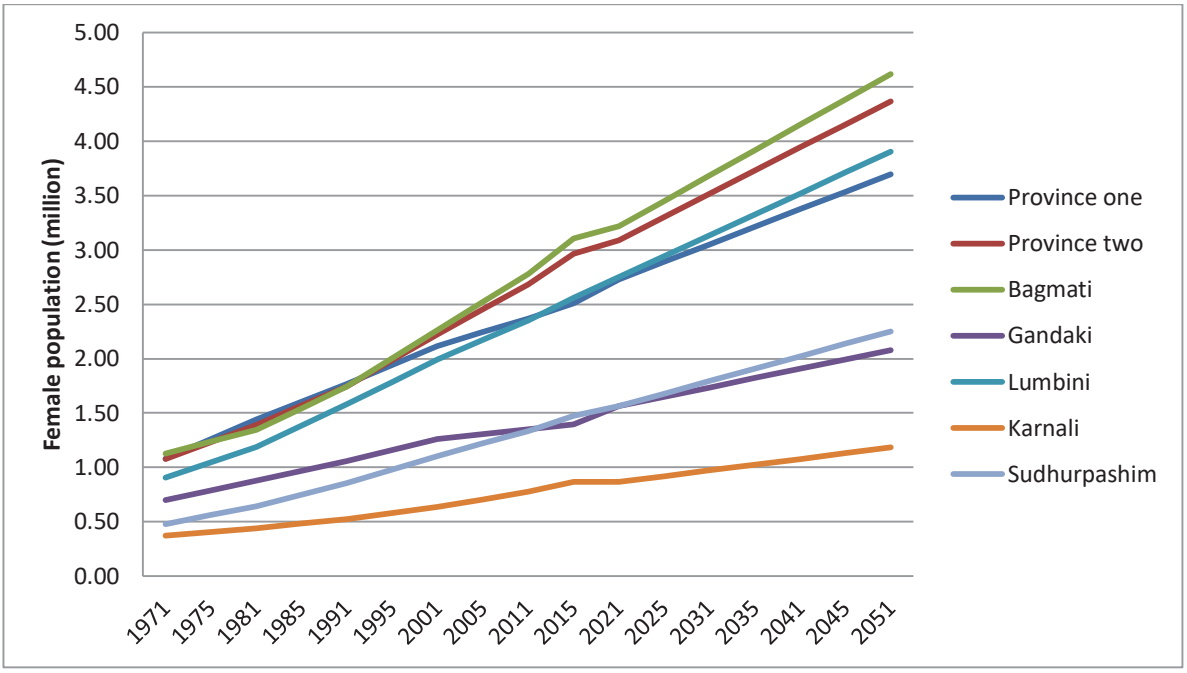
Province	Fiscal Year	Highly relevant	Relevant	Neutral
Province 1	19/20/	Not available		
	20/21	15.8	39.39	44.81
Province 2	19/20/	5.26	8.07	86.67
	20/21	8.27	8.79	82.94
Bagmati	19/20/	9.16	30.69	60.15
	20/21	4.34	31.75	63.92
Gandaki	19/20/	54	21.32	24.67
	20/21	48.55	22.03	29.42
Lumbini	19/20/	Not available		
	20/21	6.02	28.88	65.09
Karnali	19/20/	12.01	19.92	68.07
	20/21	25.93	26.36	47.71
Sudhurpaschim	19/20/	44.43	25.87	29.7
	20/21	46.08	29.92	24

Annex 6: Trend and projection of male population (in millions) by Provinces



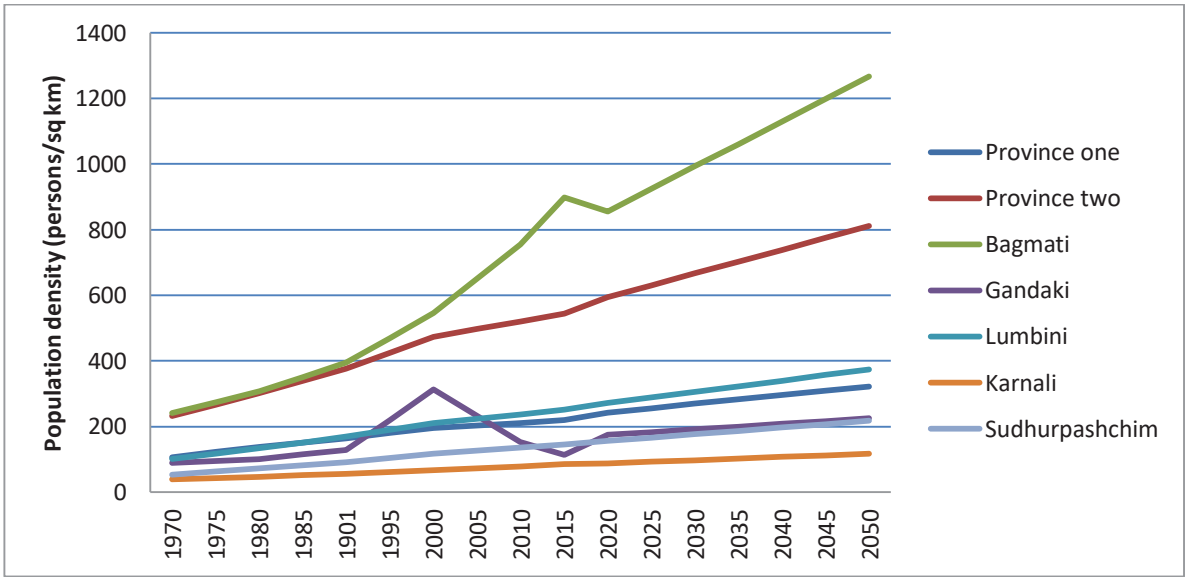
Sources: CBS (1991), CBS (2001), CBS (2012a), Online data portal: https://nepalindata.com/

Annex 7: Trend and projection of female population (in millions) by Province



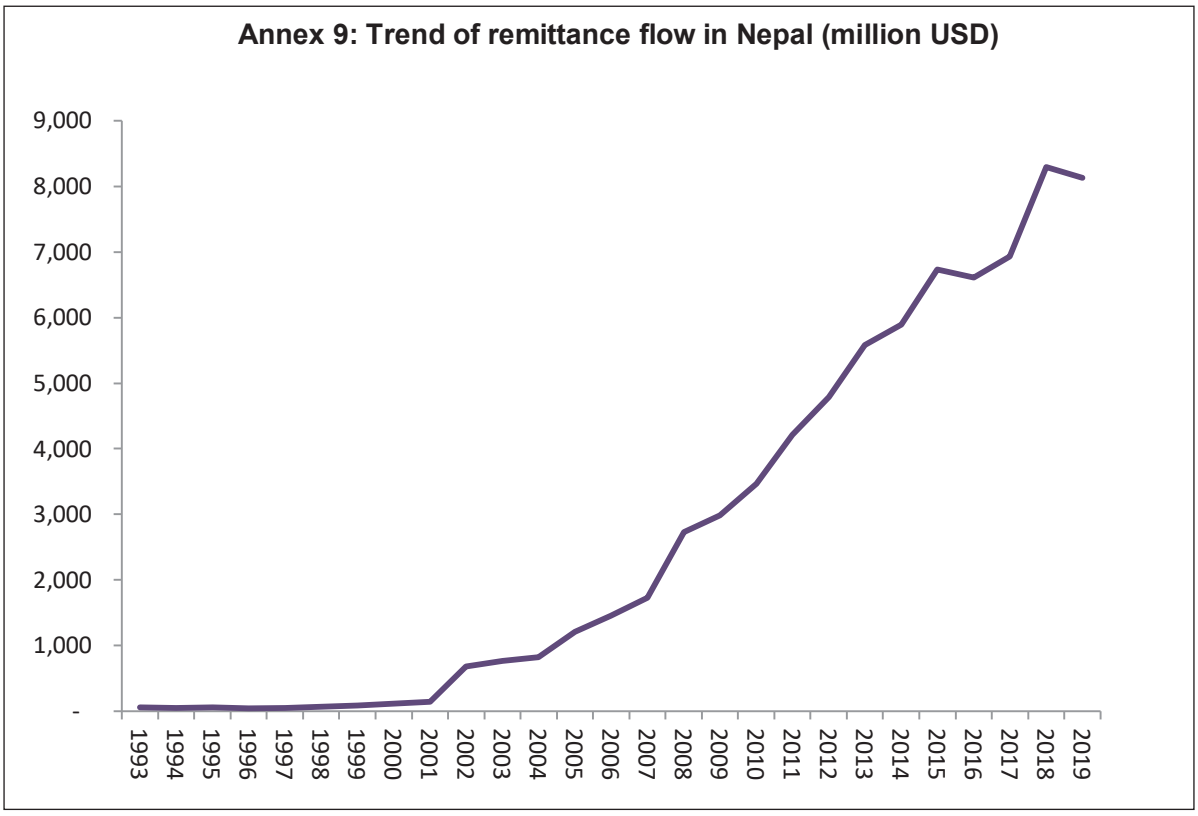
Sources: CBS (1991), CBS (2001), CBS (2012a), Online data portal: https://nepalindata.com/

Annex 8: Trend and projection of population density (persons/sq km) at a provincial level



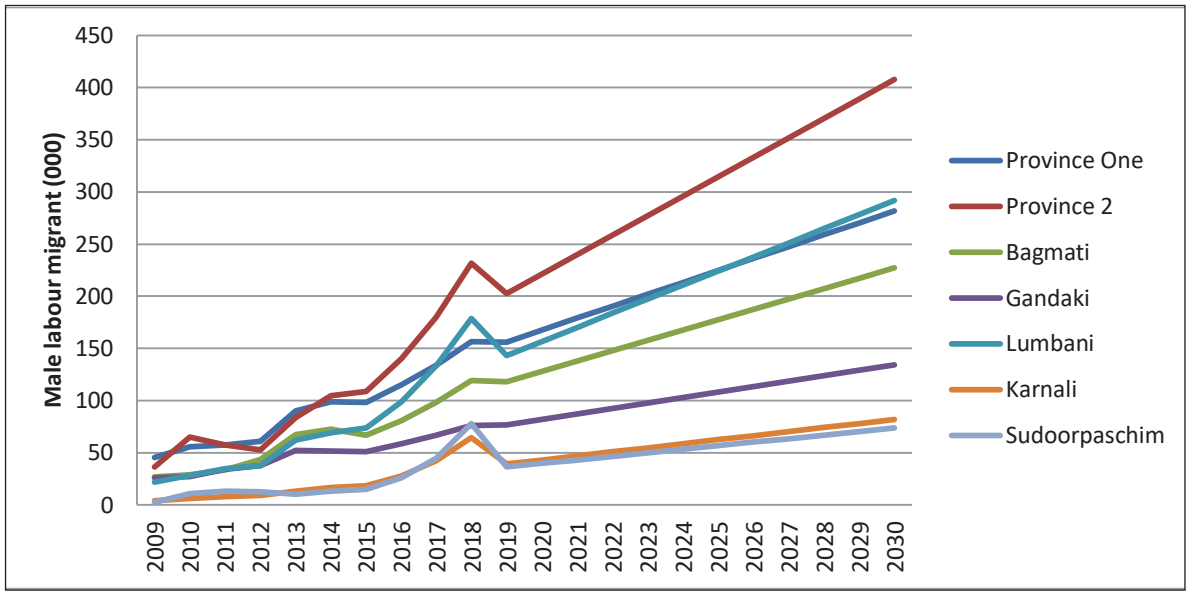
Sources: CBS (1991), CBS (2001), CBS (2012a), Online data portal: https://nepalindata.com/

Annex 9: Trend of remittance flow in Nepal (million USD)



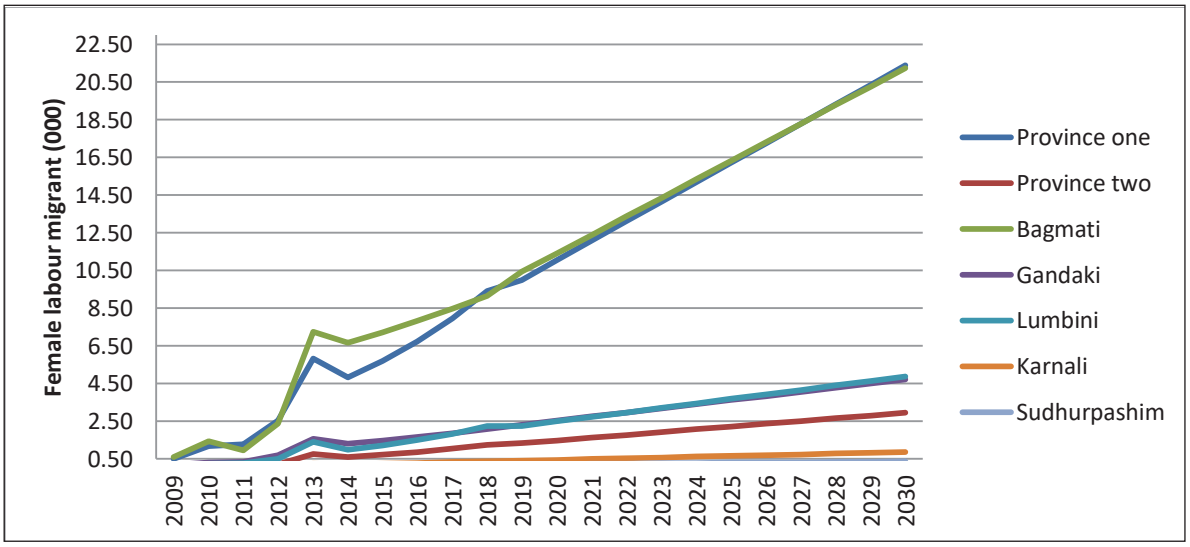
Source: World Bank online database (https://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT?locations=NP)

Annex 10: Trend and projection of male labour migration (000) at a province level



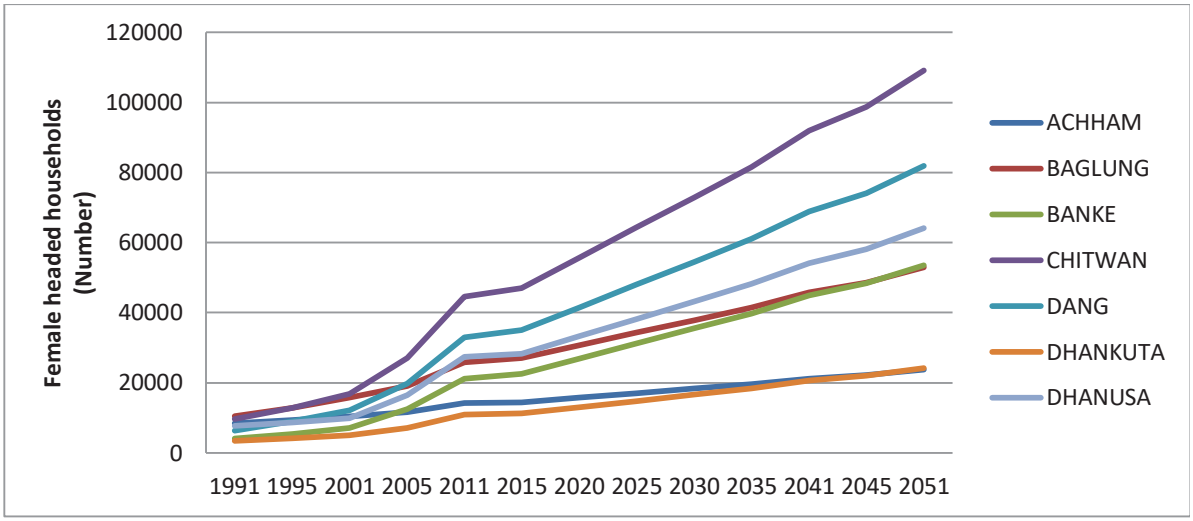
Sources: MoLES (2020); Online data portal: https://nepalindata.com/

Annex 11: Trend and projection of female labour migration (000) at a province level

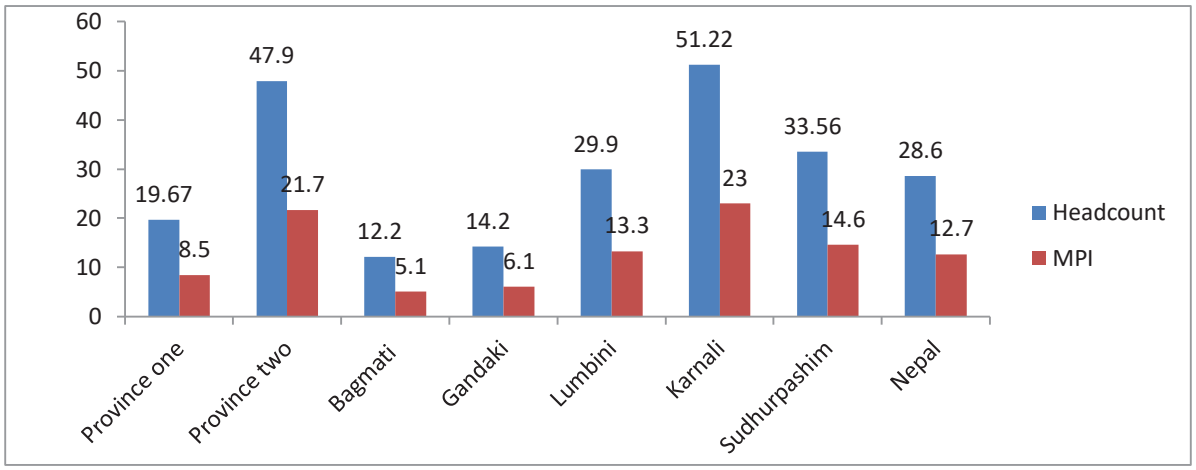


Sources: MoLES (2020); Online data portal: https://nepalindata.com/

Annex 12: Trend and projection of female-headed households in selected districts

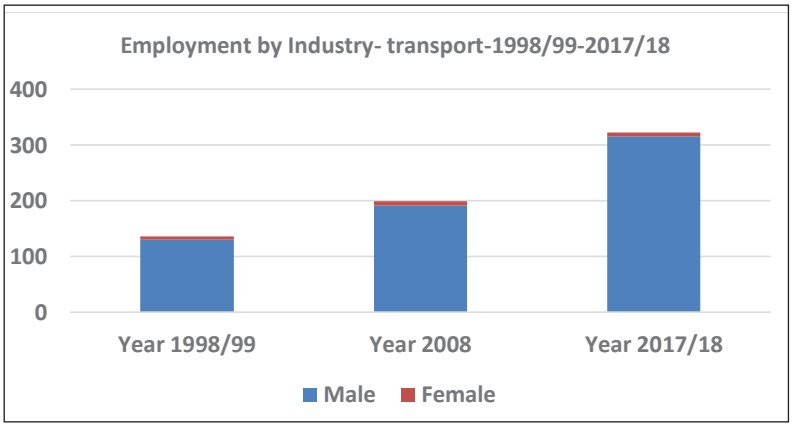


Annex 13: Comparison of poverty headcount and MPI (percent)

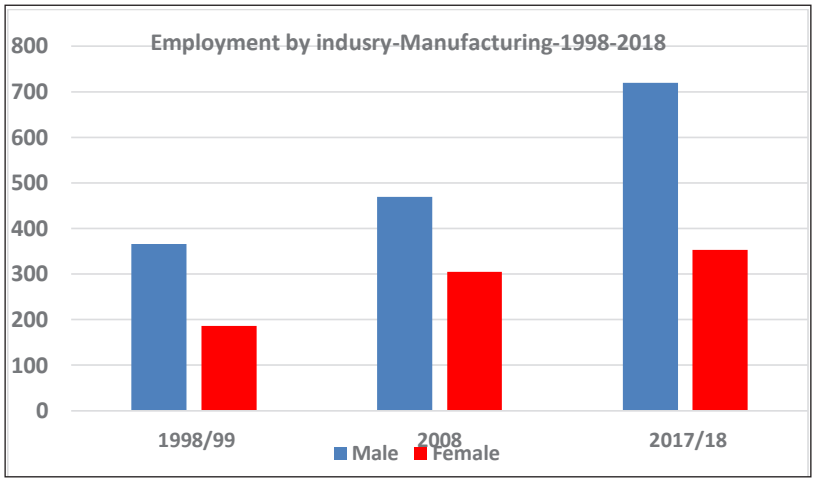


Sources: NPC (2018); UNDP (2020)

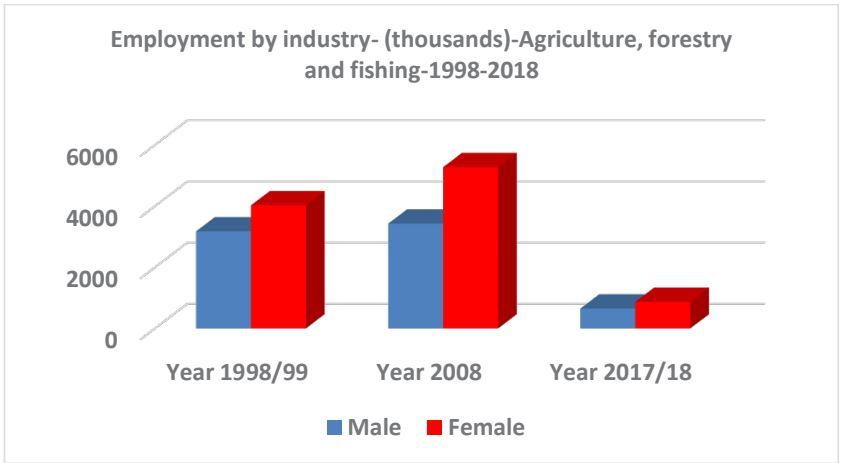
Annex 14: Employment by Industry – Transport – 1998/99-2017/18 (in thousands)



Annex 15: Employment by industry – Manufacturing – 1998-2018 (in thousands)



Annex 16: Employment by industry – Agriculture, forestry, and fishing – 1998-2018 (in thousands)



Annex 17: Checklist to ensure Cross-cutting (GESI, Livelihood, and Governance) integration in VRA process

Reviewed by: ..... (name of thematic lead)

Sector (tick) ☐✓	Steps	Included- 'yes' / 'no'		If 'no' how will it be ensured?	Note
		Yes	No		List of the policy reviewed
☐ Agriculture and Food Security ☐ Forest, Biodiversity, and Watershed ☐ Rural and urban Settlements ☐ Health and WASH ☐ Water Resources and Energy ☐ Transport, Industry and Physical Infrastructure ☐ Tourism, Cultural and Natural Heritage ☐ Disaster Risk Reduction and Management	Sectoral Situation and Policy, Plan, Budget Analysis from GESI and livelihood/governance perspective ***(guidance for situation and policy analysis provided below)***				1. 2. 3. 4. 5.
	Cross-cutting indicators (provided by GESI, livelihood/governance) integrated into sectoral indicators.				
	Disaggregated quantitative data collected.				
	Qualitative Information (case studies)-(include no. of case studies collected)-***case study format attached***				
	Participation of GESI stakeholders (women, marginalized groups, and GESI experts) in consultation processes. ***(provide a disaggregated list)***				
	Identification of adaptation options ensuring cross-cutting priorities.				
	Cross-cutting integration monitored and ensured in the VRA process. (indicator selection, weightage, aggregation, etc.)				

Annex 18: Guidance note for situation analysis and policy review

Situation Analysis	Policy Review
Sex-disaggregated statistics/data on GESI in the literature review of different sectors	Does the policy mention 'gender' or 'inclusion'?
Evidence-based analysis for highlighting existing inequalities and underlying challenges for specific populations, communities, income groups, etc., about climate change.	Does it aim to address gender and other forms of social inequalities?
Qualitative analysis about gender and inclusion.	Does it foster empowerment and participation of women and marginalized groups?
	Is there a budget allocated for gender and inclusion?

Annex 19: Checklist for the case study collection

Case study #/topic	Thematic sector	Area Covered by case study	Tick	Case study (attached/source provided)
		Access and control over resources		
		Participation and decision making		
		Gender division of labour		
		Discriminatory social norms		
		Legal Rights and Status		
		Intersectional discrimination (PWDs, *Dalits,* single, poor, etc.)		
		Knowledge, Beliefs, and Perception		
		Indigenous knowledge and climate-resilient practices		

Annex 20: Guiding questions for the case study collection

Access and control	Who has access to and control over resources, assets, and benefits (access to resources, income, services, employment, information, and benefits). The types of assets or capitals – namely human assets (e.g. health services, education, knowledge, and skills) • natural assets (e.g. land, labour, forest) • social assets (e.g. social networks) • physical assets (transport, communications) • financial assets (capital/income, credit). What are the barriers and constraints? Which of these resources/assets come under the most stress from climate change? How do different hazards affect different groups in the community? Which groups are most vulnerable to which hazards, and why? Within each group, how are women affected by these hazards and how are men affected andwhy? What early warning system is in place? Who (among women, men, boys, and girls in different social situations) has access to them?
Participation and decision making	Who participates in private and public decision-making – community, political and economic spaces? How do the social/gender relations, beliefs, perceptions, knowledge, and norms constrain or provide opportunities for inclusive participation and decision making? How do local planning processes work? Who is involved in or influences decisions at the community level? Whose interests are represented in local decision-making? When climate variability affects people's lives and livelihoods, who makes decisions on resource distribution and practices? Who benefits from these decisions?
Gender division of labour	Who does what? What do women and men do, and where and when do these activities take place? Who is allowed or expected to do certain types of work? What specific sets of opportunities, constraints, and status do these specific types of work mean? How much time do women, men, boys, and girls spend in these activities? What happens to people's roles and time use under changing climatic circumstances?
Discriminatory social norms	What are the discriminatory gender/social norms and hierarchies, such as family/community forms, cultural practices, and religious beliefs that disadvantage certain groups of people? Do women, men, boys, and girls have control over their bodies and sexuality, decisions on marriage, family planning, and freedom from abuse and exploitation? What impacts do climate change and disasters have on this?
Legal Rights and Status	Whether laws and policies are favourable or discriminatory to women and marginalized groups (access to legal documentation such as identification cards, voter registration, and property, as well as rights to inheritance, employment, and representation). Status of men and women before the law: international commitments, the constitution, the civil code, and any other relevant legislative text. Gender Responsive policies and budgets: government budgets, policies, and programs that underlie the needs and interests of individuals that belong to different social groups and gender.
Intersectional discrimination	How different discriminations can interact and intersect (e.g. discriminations based on gender, race, class, ethnicity, age, language, disability, etc.). Who is the better off and worse off in the community? Who are the different wealthy, ethnic, and religious groups? What is their main livelihood option?
Knowledge, Beliefs, and Perceptions	What are different norms and beliefs, ideologies, attitudes that amplify social differences and stereotypes; how does culture define or influence access to/control over resources and decision making? What are the indigenous knowledge and practices? What are gender-related strategic and practical needs?
Indigenous knowledge and climate-resilient practices	What strategies are currently employed to deal with shocks and stresses from climate change? How are women and men in different social situations coping with and managing risk? Who is employing climate-resilient practices?? What are the indigenous knowledge and practices? What distinct knowledge do women and men have? Who has the knowledge, skills, and resources to employ innovative strategies to support adaptation? Who receives institutional support to do so?

Annex 21: Provincial Consultation Findings

Province 1: In the mountain region, droughts, avalanches, and GLOFs have been identified as the major extreme climatic events. Changes in trends were mainly increased in temperature mostly in Sagarmatha and Kanchanjunga regions and a decline in rainfall and short duration of rainfall, leading to flooding. These changes resulted in the drying up of springs, diminished water for irrigation, a decline in agricultural productivity, degradation of habitat of flora and fauna, an increase in forest fires, and decreased production due to snowfall. Mostly the impact was on women and ethnic groups dependent on water, agriculture, and forestry.

In the mid-hills, landslides, droughts, and rainfall variability were identified as the main extreme events. Changes in trends were mainly a rise in temperature and variation in rainfall which led to infrastructure damage and loss of life and property. An increase in a forest fire, drying up of springs, and decrease in agricultural production were observed due to these climate extreme events. Further, there was an increase in male migration resulting in increased women-headed households. The most affected were the ethnic and native communities and the *Dalits,* including those living in squatters and slums.

In the Terai region, floods, heat and cold waves, vector- and water-borne diseases, and lightning were identified as the major extreme climatic events. Additionally, land degradation and crop failure led to decreased agricultural productivity and food insecurity. Heat and cold waves impacted those working outside, the poor, women, children, and the elderly. Vector- and waterborne diseases led to health and WASH challenges. Floods mostly impacted marginalized communities and landless households. Diseases mostly affect the elderly, pregnant women, PWD, and infants.

Province 2: In Province 2, flooding, fires, heat and cold waves, droughts, and forest fires were identified as the main climate extreme events. Flooding resulted in a loss of life and property, food insecurity and lack of shelter, lack of access to safe drinking water, disruption of transport and communication, and outbreaks of water- and vector-borne diseases. Other challenges included snake bites and industrial encroachment. Heat waves impacted labourers and cold waves affected the health of the elderly and children. Others impacted were urban and rural households, mostly poor, ethnic minorities, and those without land and proper houses (e.g. *Musahar* communities). The fires led to the loss of property and livestock, mostly impacting poor and marginalized households. Health issues were mostly seen in pregnant women, infants, and the elderly. Droughts impacted agricultural productivity mainly of smallholder farmers.

Bagmati Province: In Bagmati Province, the extreme events identified were temperature increases leading to avalanches and GLOFs, floods and inundation, landslides and soil erosion, droughts, and health issues. The impact of these events included migration due to lack of water, increased poverty due to loss of jobs, employment and production decline, increase in the workload of women (traveling long distances for water collection), school dropouts, and limited employment opportunities during the disaster and social disintegration due to forced resettlement. The most impacted were women (pregnant, household heads, illiterate, and belonging to ethnic and poor communities), elderly, children and infants with health issues, PWD, poor and marginalized farmers, landless and squatters living in slums and disaster-prone areas, and natural resource-dependent communities: indigenous people, smallholder farmers, ethnic communities, *Dalits.*

Gandaki Province: In Gandaki Province, extreme events were temperature rise, forest fires, droughts, floods, landslides, snowfall, GLOFs, avalanches, and air pollution. The impact of these events included drying of the water source, reduced irrigation potential, and a decline in agricultural productivity. It impacted livelihoods, caused loss of lives and damage to physical infrastructure, and led to unplanned migration. Due to water source contamination, there was an increase in waterborne and vector-borne diseases. The impact was seen mainly on indigenous communities, women, children, poor and marginalized households including PWD, and the elderly.

Lumbini Province: In Lumbini Province, in the mountainous regions, the extreme events were changes in rainfall patterns, increased landslides, flooding, and drying up of springs. The impacts of these extreme events were declining agricultural productivity and damage to livelihood assets. The most affected were children, women (mostly pregnant), elderly, and poor, *Dalits,* and women-headed households.

In the hilly region, changes in temperature, rainfall patterns, forest fires, floods, landslides, and heat and cold waves were the most frequently occurring extreme events. These events resulted in increased loss and damage to assets and human lives, damage to agriculture, forest land, and infrastructure. Disrupted hydrological cycles decreased productivity, increased food security issues, and caused malnutrition. Women and girls were mostly impacted because they had to travel a long distance to fetch water, and children and the elderly faced health challenges. The poor and *Dalits* were disproportionately impacted.

In the Terai region, major events included irregular rainfall and high rainfall during monsoons and low rainfall during winters leading to flooding, inundation, and droughts. Extreme hot (heat wave) and cold (cold wave), changes in the pattern of flood and drought over time increased incidence of water and vector-borne diseases impacted crop production resulting in economic burden to farmers. New vector-borne and water-borne diseases were common and mainly impacted marginalized populations which included *Musahar*, *Tharu*, *Dalits*, and poor farmers (landless, groups with smaller landholding size and those living near riverside), indigenous people (whose livelihood depended on fishing, NTFPs collection, etc.). Women, girls, children, and the elderly were physically and socially highly vulnerable.

Karnali Province: In Karnali Province, the main extreme events included an increase in temperature, extreme weather events, irregular snowfall, changes in rainfall patterns, droughts, avalanches, GLOFs, flood-landslide, epidemics, cold waves, and thunderbolts. Increased melting of snow, depletion of water sources, relocation and migration, river encroachment, drying up of springs, food insecurity, and depletion of groundwater levels. All this led to decreased agricultural productivity, loss of forest resources, increased poaching, and land degradation. Most impacted were women, poor, and ethnically marginalized populations.

Sudhurpaschim Province: In Sudhurpaschim province, the main climate extreme events included change in weather events, avalanches, decrease in snowfall, irregular rainfall, floods, landslides, hailstorms, and droughts. There was a depletion of groundwater leading to low agricultural productivity. There were incidences of forest fires, soil erosion, floods, and inundation. Women are impacted due to the drying up of water resources which has increased their workload. The extreme events led to high loss and damage of physical infrastructure and

disrupted the education sector and livelihood. Groups impacted were mainly pregnant women, the poor, deprived and marginalized people, and ethnic groups. Issues of social disharmony and an increase in gender-based violence were common in all provinces.

Findings from the Focus Group Discussions

Lack of transparency and accountability: There is a lack of participation of the vulnerable communities in decisions related to the program and budgeting of projects and programs on climate change and disaster. Expectations are created by the local government and agencies regarding relief aid, resettlement, and post-disaster support which are not fulfilled or do not reach those most in need of them. There is a lack of transparency and accountability as the communities barely know how much is allocated for relief and how to access the support.

Equality versus equity: Local government programs mostly allocate an equal amount of resources to all the wards. Likewise, most of the development aid is also distributed in the same manner regardless of the need and severity of impact and damages. This often puts the most impacted communities at risk of further marginalization and poverty. The impacted communities like Mushar demand that the aid and relief packages and support should be targeted to the most vulnerable rather than distributed equally to all.

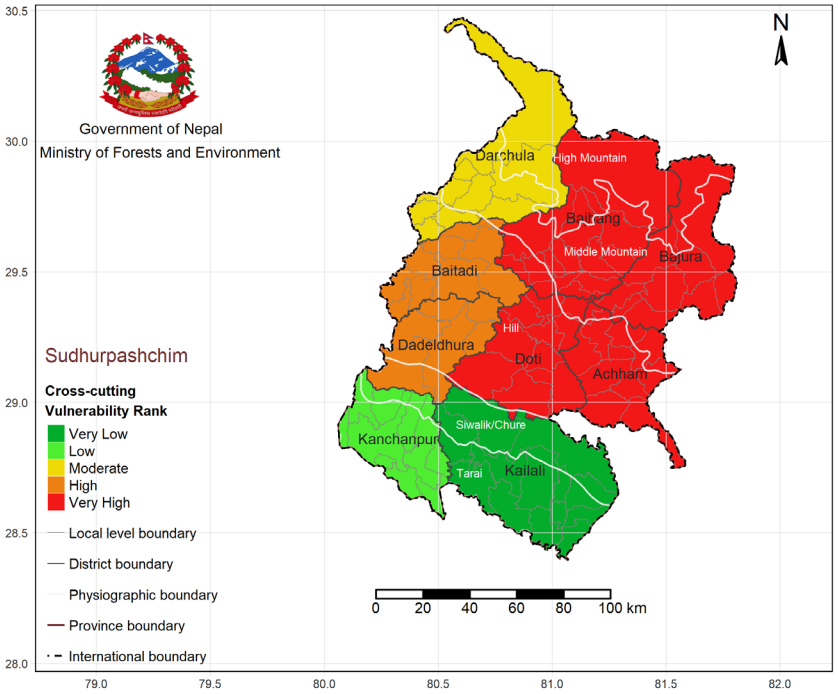
Lack of access to resources and services further adds to climate change vulnerability: The most marginalized and vulnerable groups, such as the Mushar community, are still landless and are often deprived of access to basic services. FGD in the villages of Janakpur and Biratnagar showed that they live in poor settlements and lack access to drinking water, basic health and hygiene, education, and other services. Most impacted are women, the elderly, and children. Being historically marginalized, most of them do not have a formal livelihood and literacy levels are low. Similarly, a large population of the landless and economically marginalized population resides in slums, riverbanks (such as along the Seti, Kamala, and Mohana rivers), and other areas which are highly prone to disasters such as flooding and landslides. Thus, risk and vulnerability were highly contextual and varied across geographical regions and communities.

Development Challenges: Environment and climate change were not a priority for local governments in the areas where the fieldwork was conducted. There is a limited technical capacity for climate change responses at local and provincial levels. The development priorities are mostly focused on infrastructures, such as building roads, culverts, and bridges. Although there is provision of climate change and disaster budget ceiling, allocation (palikas allocate around 3 lakhs NPR), is mostly for disaster relief and not preparedness activities. The resources such as wetlands, rivers, degraded areas, public lands, roads, and infrastructure (wells, pipes, and water sources) were not managed well. The roads and infrastructure are not maintained, repaired, or monitored.

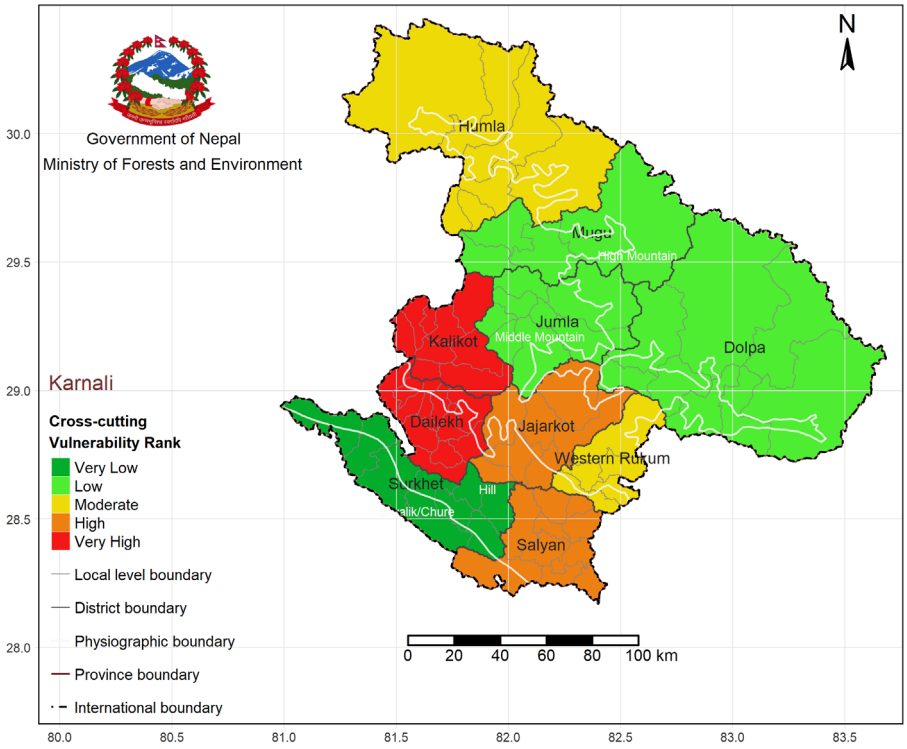
Risk and Vulnerability context: Terai is highly exposed to disasters because of a higher population, with a high degree of sensitivity due to high multi-dimensional poverty and socio-economic marginalization. However, there is also higher adaptive capacity with comparatively better access to roads, communication, drinking water, electricity, etc., than other regions.

Need to build on the successes of disaster risk reduction and management, including nature-based solutions: There is a need to increase proper planning and coordination with all development actors to effectively identify and implement projects to reach the most vulnerable and build on existing sustainability practices. Good practices, such as early warning systems, bioengineering, income generation activities (beehives, coffee plantation), roadside plantation, broom grass plantation, water conservation, species conservation (tree fern), ecosystem services conservation, commercial agriculture practices, social institutions, homestay (nature-based, museum), and eco-tourism, have had great success through various projects.

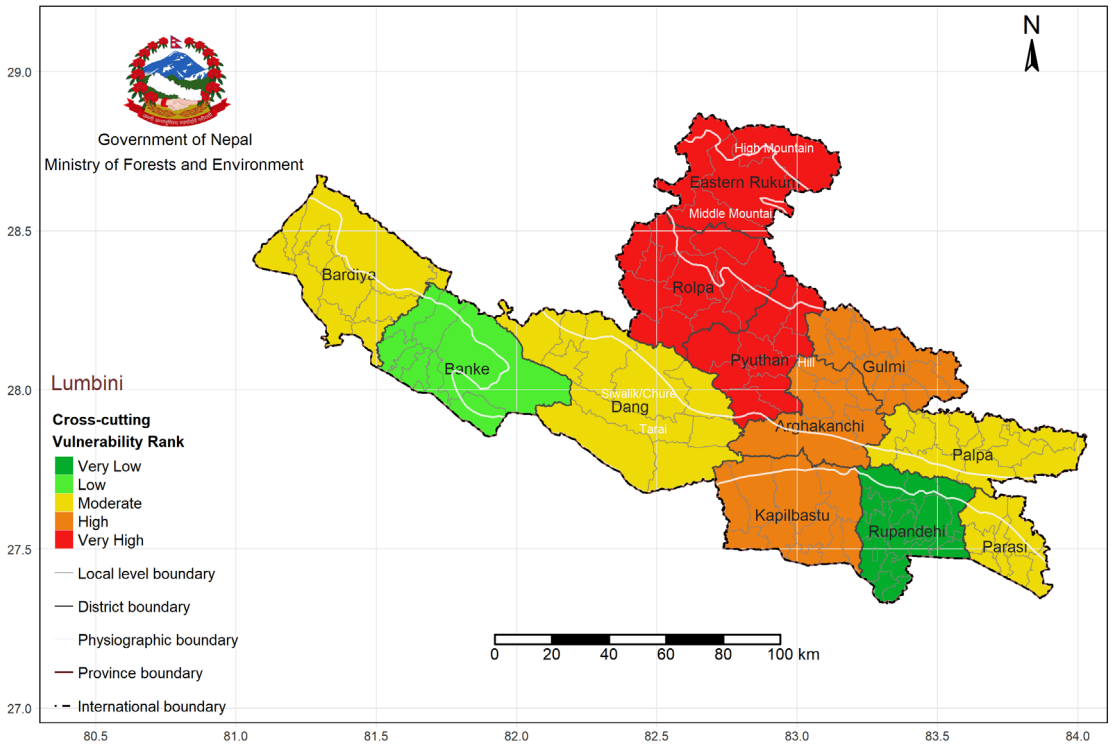
Annex 22: Vulnerability Index Map of Sudhurpaschim Province



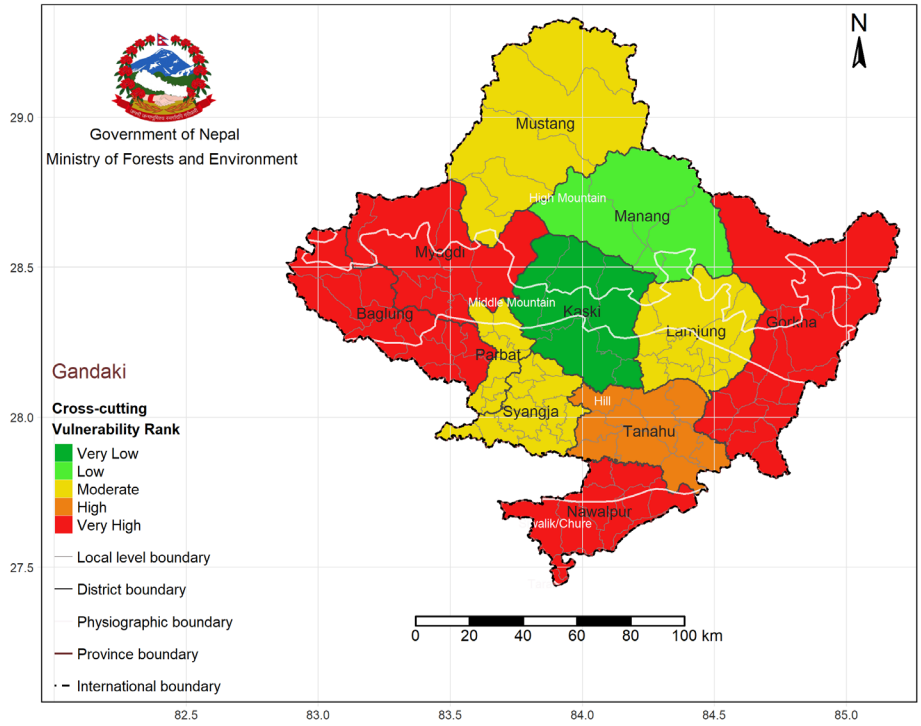
Annex 23: Vulnerability Index Map of Karnali Province



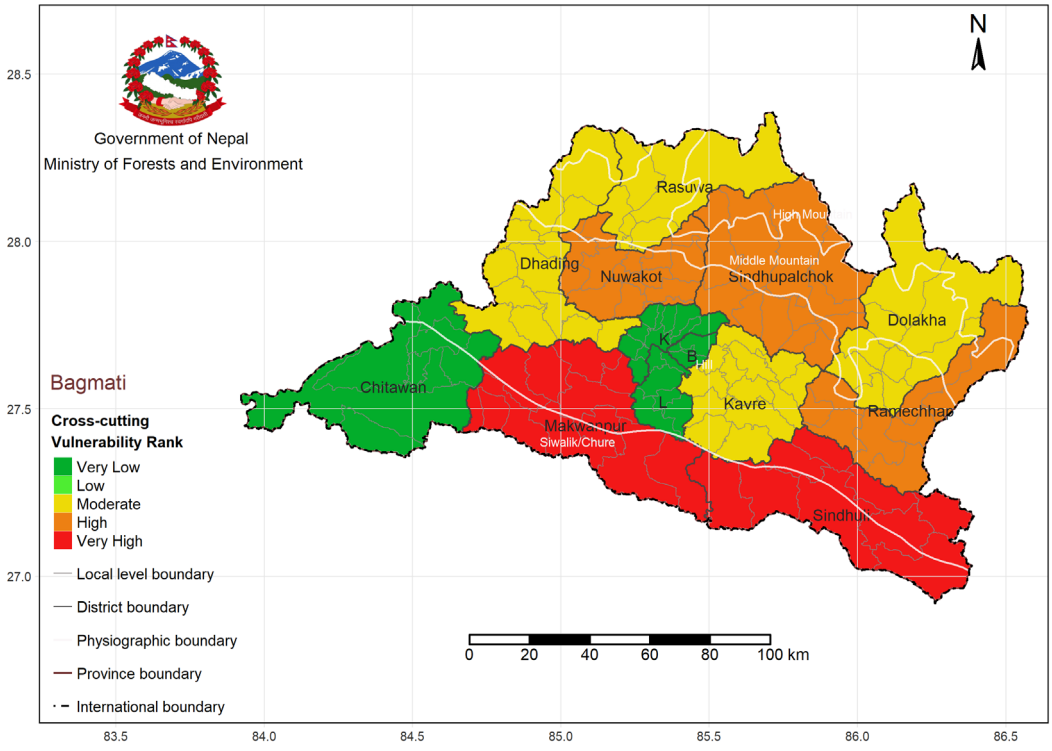
Annex 24: Vulnerability Index Map of Lumbini Province



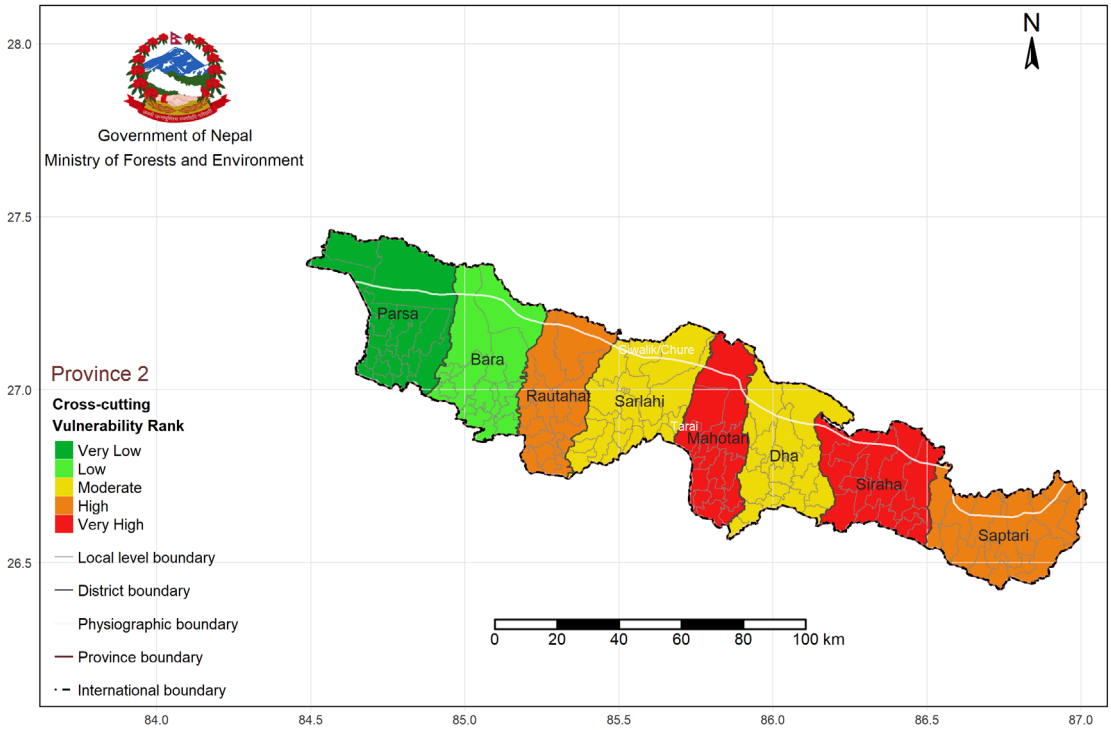
Annex 25: Vulnerability Index Map of Gandaki Province



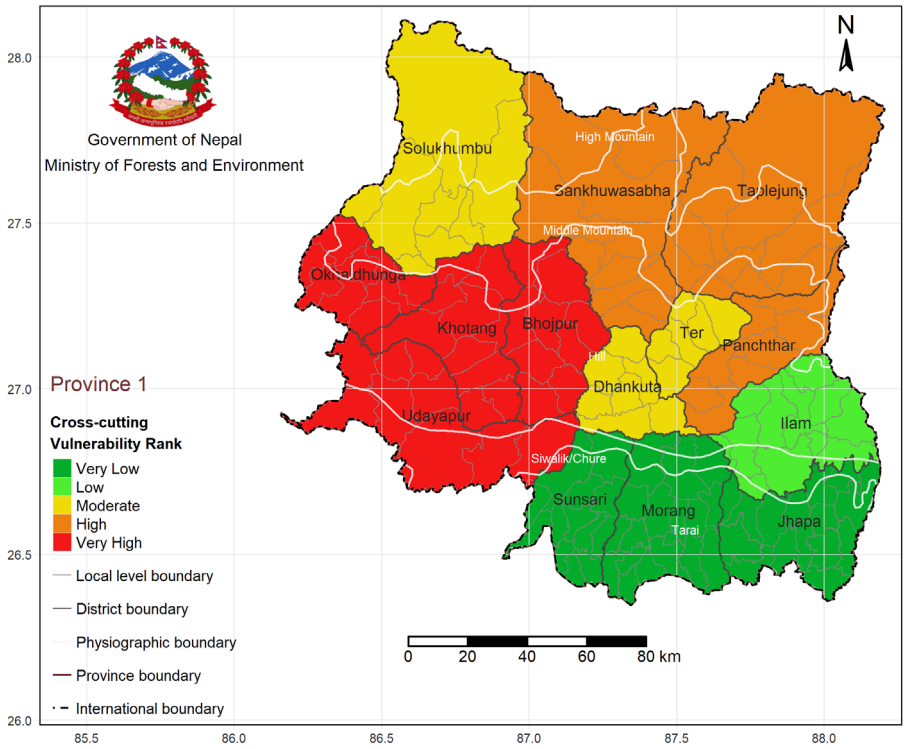
Annex 26: Vulnerability Index Map of Bagmati Province



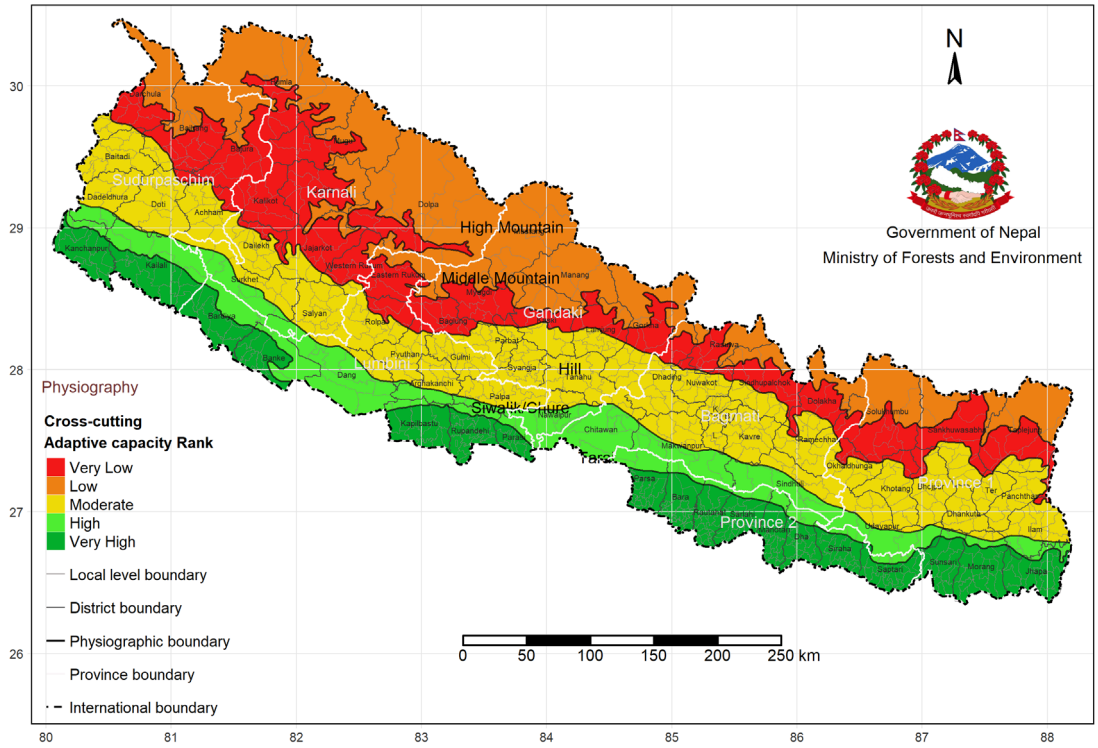
Annex 27: Vulnerability Index Map of Province 2



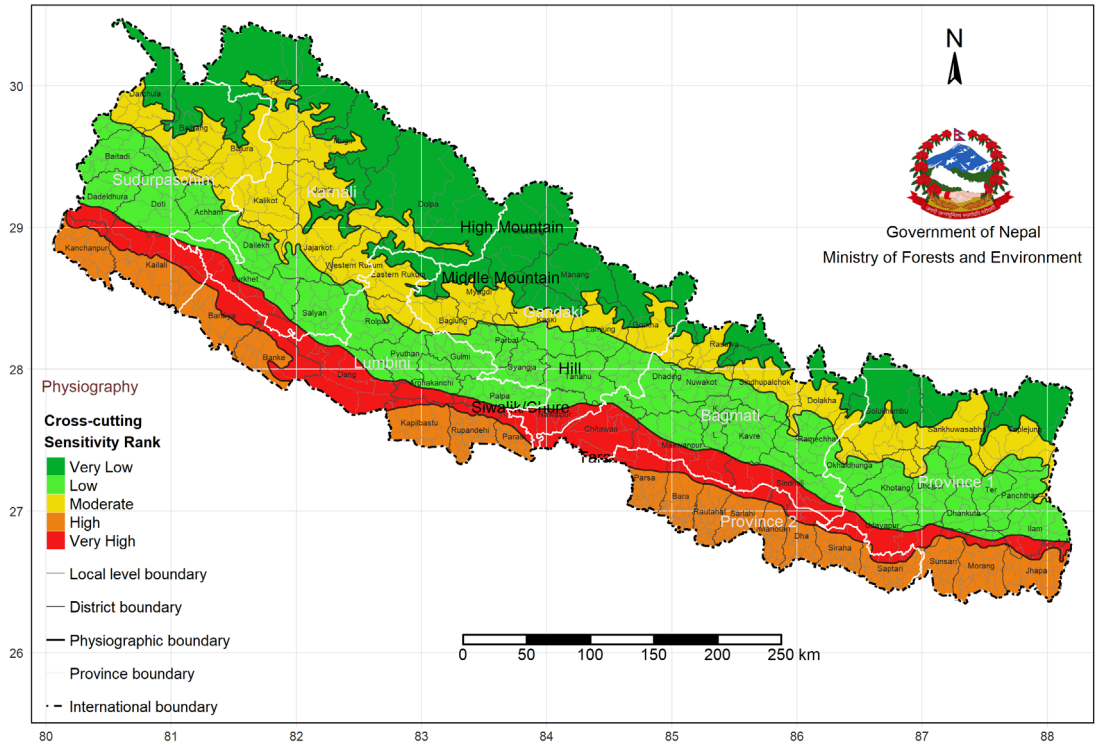
Annex 28: Vulnerability Index Map of Province 1



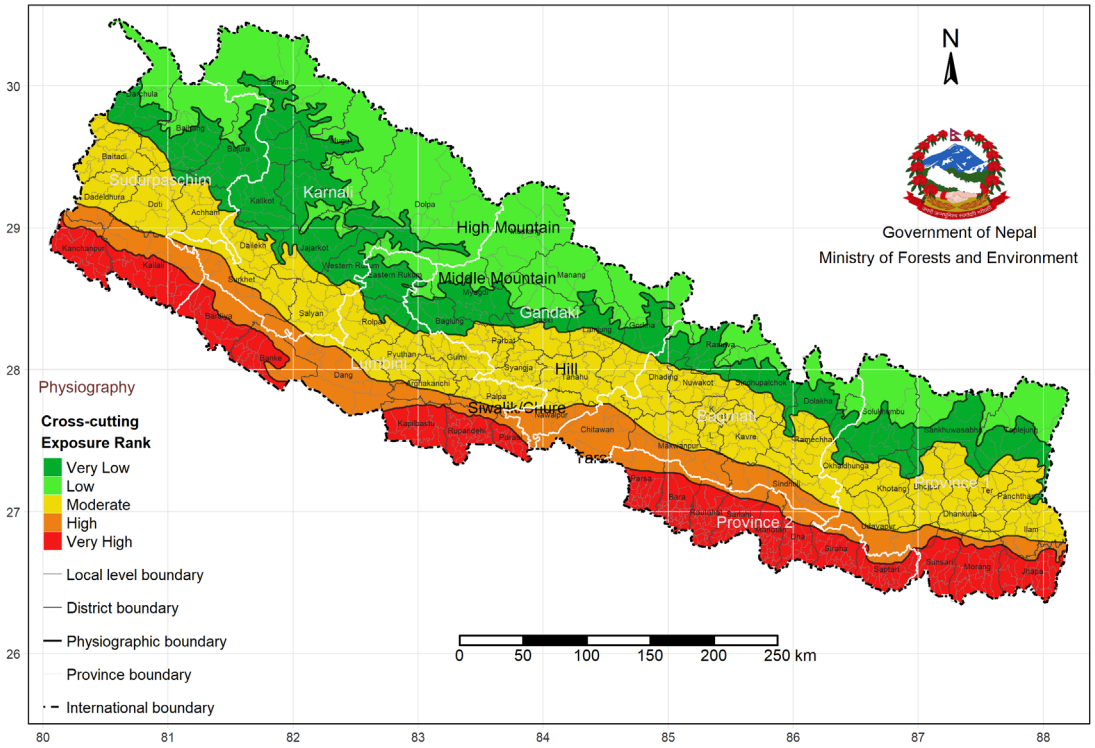
Annex 29: Adaptative capacity Index Map at Physiographic level



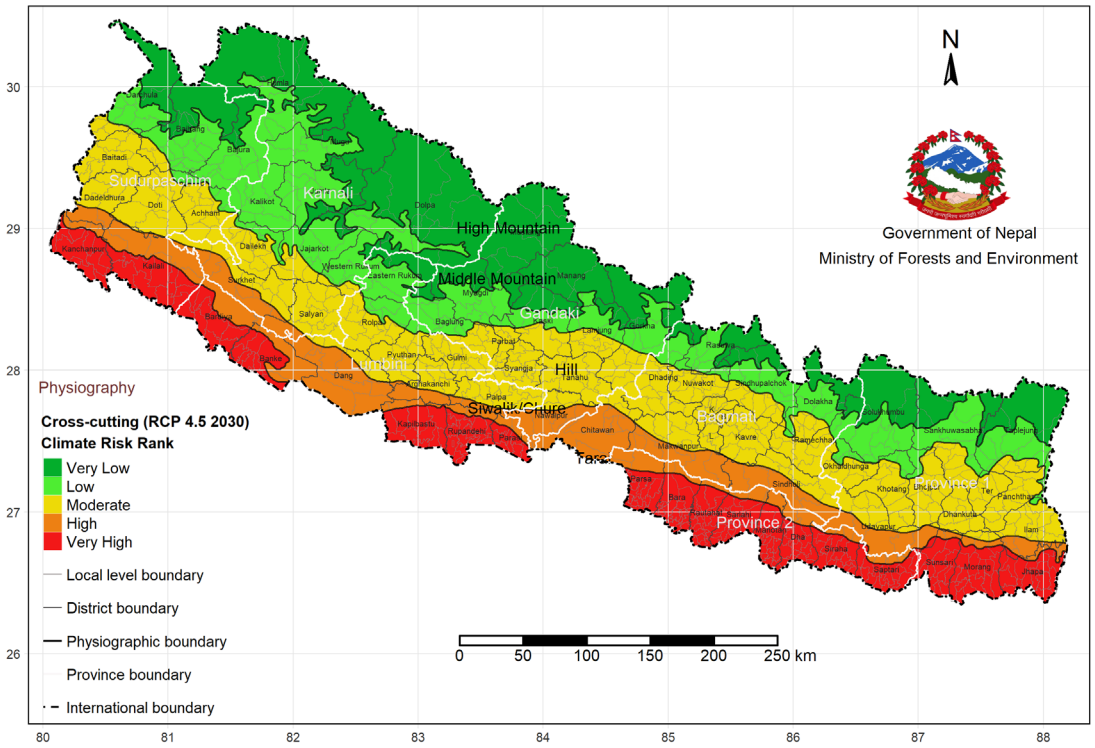
Annex 30: Sensitivity Index Map at Physiographic level



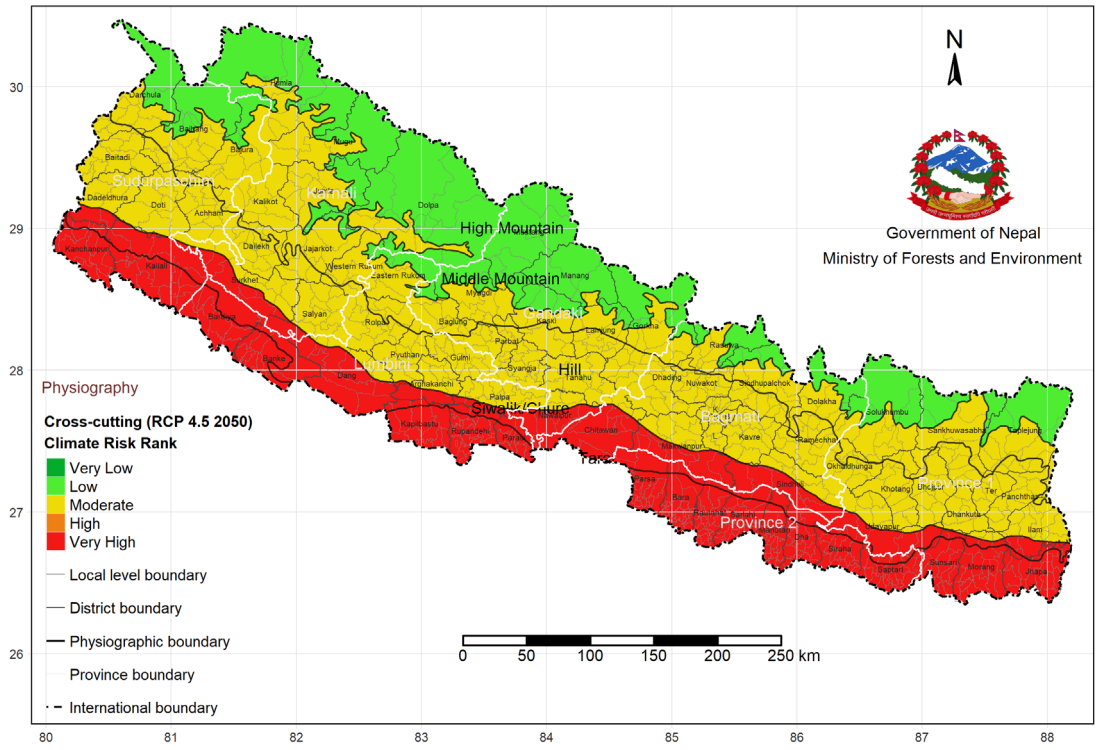
Annex 31: Exposure Index Map at Physiographic level



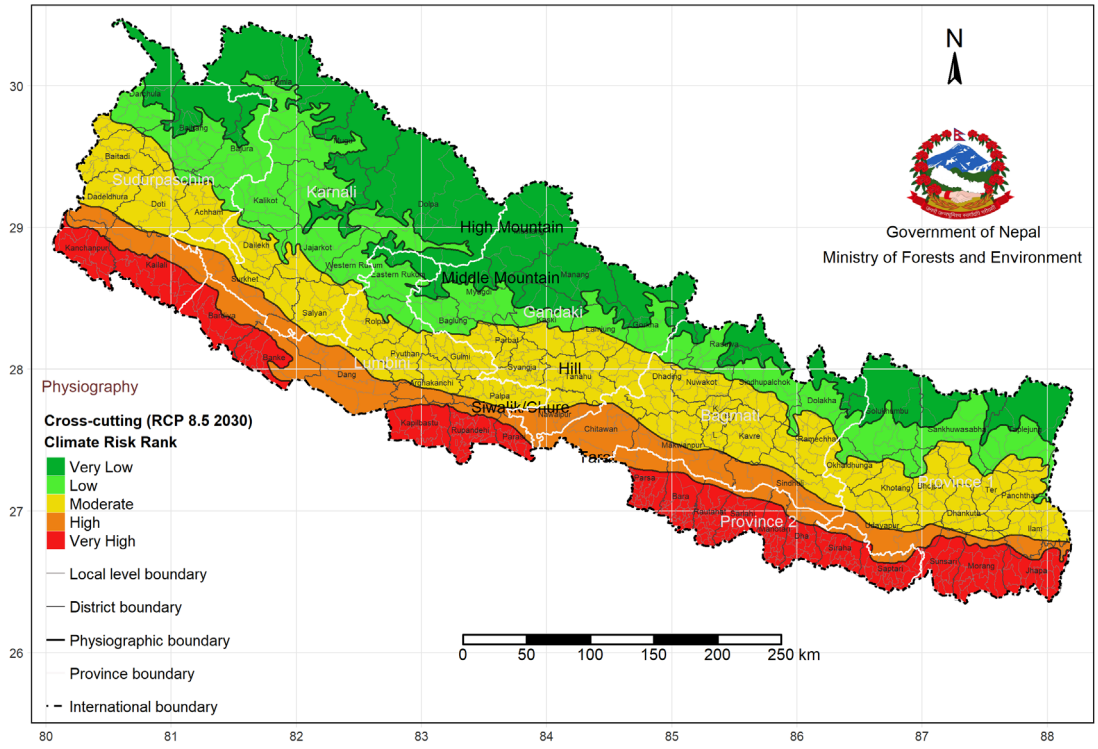
Annex 32: Climate Change Risks Index Map (RCP 4.5 2030) at Physiographic level



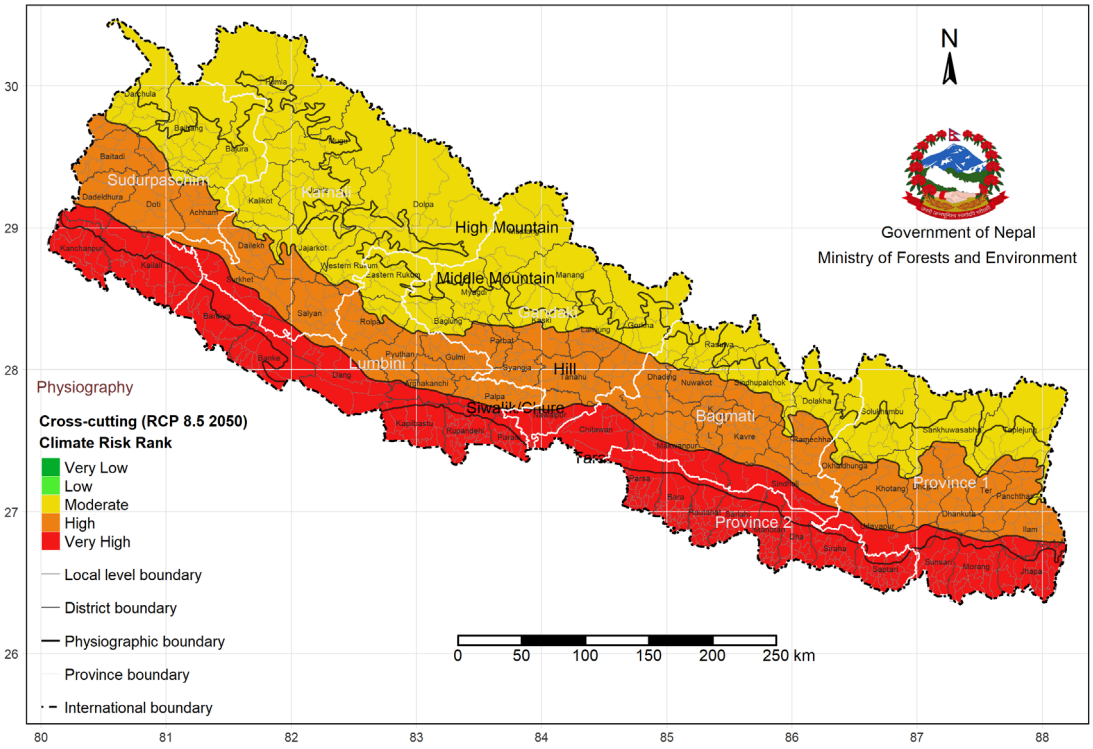
Annex 33: Climate Change Risks Index Map (RCP 4.5 2050) at Physiographic Level



Annex 34: Climate Change Risks Index Map (RCP 8.5 2030) at Physiographic Level



Annex 35: Climate Change Risks Index Map (RCP 8.5 2050) at Physiographic Level



Annex 36: Overall Indices

District	Vulnerability	Exposure	Sensitivity	Adaptive capacity
Achham	1	0.33	0.949	0.158
Arghakhanchi	0.609	0.258	0.718	0.202
Baglung	0.589	0.341	0.732	0.224
Baitadi	0.872	0.266	0.829	0.139
Bajhang	0.944	0.41	0.864	0.125
Bajura	0.978	0.273	0.905	0.136
Banke	0.334	0.588	0.668	0.32
Bara	0.482	0.609	0.769	0.313
Bardiya	0.468	0.513	0.731	0.291
Bhaktapur	0	0.232	0.395	0.382
Bhojpur	0.682	0.358	0.752	0.187
Chitawan	0	0.68	0.646	0.537
Dadeldhura	0.78	0.216	0.787	0.158
Dailekh	0.894	0.33	0.865	0.154
Dang	0.415	0.772	0.859	0.419
Darchula	0.729	0.291	0.711	0.13
Dhading	0.456	0.378	0.683	0.262
Dhankuta	0.444	0.242	0.609	0.212
Dhanusha	0.496	0.675	0.843	0.361
Dolakha	0.482	0.289	0.68	0.245
Dolpa	0.591	0.443	0.735	0.226
Doti	0.919	0.308	0.871	0.144
Eastern Rukum	0.954	0.196	0.868	0.122
Gorkha	0.666	0.482	0.818	0.246
Gulmi	0.577	0.321	0.712	0.216
Humla	0.699	0.451	0.811	0.223
Ilam	0.343	0.343	0.59	0.255
Jajarkot	0.881	0.296	0.843	0.144
Jhapa	0	0.773	0.742	0.635
Jumla	0.669	0.257	0.693	0.15
Kailali	0.39	0.839	0.838	0.417
Kalikot	0.998	0.242	0.913	0.132
Kanchanpur	0.517	0.457	0.754	0.281
Kapilbastu	0.495	0.601	0.742	0.285
Kaski	0	0.562	0.475	0.522
Kathmandu	0	0.93	0.52	1
Kavrepalanchok	0.277	0.378	0.675	0.356
Khotang	0.663	0.383	0.755	0.2
Lalitpur	0	0.394	0.43	0.547
Lamjung	0.406	0.257	0.603	0.23
Mahottari	0.874	0.55	1	0.268
Makawanpur	0.605	0.544	0.889	0.335
Manang	0.082	0.173	0.485	0.322
Morang	0	1	0.798	0.662
Mugu	0.669	0.312	0.759	0.2
Mustang	0.251	0.285	0.525	0.257
Myagdi	0.587	0.252	0.693	0.196
Nawalpur	0.498	0.337	0.716	0.263

District	Vulnerability	Exposure	Sensitivity	Adaptive capacity
Nuwakot	0.49	0.26	0.661	0.226
Okhaldhunga	0.526	0.241	0.655	0.202
Palpa	0.452	0.323	0.683	0.265
Panchthar	0.507	0.302	0.626	0.19
Parasi	0.435	0.291	0.668	0.263
Parbat	0.425	0.138	0.576	0.199
Parsa	0.401	0.578	0.687	0.295
Pyuthan	0.692	0.329	0.748	0.178
Ramechhap	0.527	0.288	0.683	0.222
Rasuwa	0.436	0.139	0.6	0.21
Rautahat	0.559	0.578	0.754	0.258
Rolpa	0.855	0.365	0.823	0.144
Rupandehi	0.019	0.816	0.666	0.495
Salyan	0.854	0.347	0.853	0.167
Sankhuwasabha	0.511	0.468	0.661	0.214
Saptari	0.692	0.733	0.916	0.306
Sarlahi	0.554	0.669	0.861	0.342
Sindhuli	0.718	0.458	0.852	0.243
Sindhupalchok	0.573	0.38	0.749	0.247
Siraha	0.762	0.696	0.946	0.289
Solukhumbu	0.398	0.358	0.595	0.228
Sunsari	0	0.741	0.663	0.528
Surkhet	0.547	0.563	0.796	0.296
Syangja	0.418	0.328	0.662	0.267
Tanahu	0.427	0.393	0.705	0.294
Taplejung	0.457	0.434	0.598	0.197
Terhathum	0.452	0.159	0.593	0.196
Udayapur	0.636	0.472	0.791	0.242
Western Rukum	0.816	0.207	0.766	0.122

Annex 37: Baseline and future scenarios of climate extreme events and risks

District	Baseline context of climate extreme events	Climate extreme events composite (RCP4.5 2030)	Climate extreme events composite (RCP4.5 2050)	Climate extreme events composite (RCP8.5 2030)	Climate extreme events composite (RCP8.5 2050)	Baseline Risk	RCP 4.5 2030 Risk	RCP 4.5 2050 Risk	RCP 8.5 2030 Risk	RCP 8.5 2050 Risk
Achham	0.526	0.461	0.574	0.47	0.631	0.295	0.259	0.323	0.264	0.354
Arghakhanchi	0.598	0.6	0.705	0.656	0.81	0.214	0.215	0.252	0.235	0.29
Baglung	0.573	0.595	0.696	0.627	0.813	0.268	0.278	0.325	0.293	0.38
Baitadi	0.544	0.492	0.6	0.49	0.671	0.231	0.209	0.255	0.208	0.285
Bajhang	0.436	0.404	0.495	0.392	0.561	0.296	0.275	0.337	0.267	0.382
Bajura	0.434	0.388	0.473	0.394	0.555	0.2	0.179	0.218	0.181	0.255
Banke	0.603	0.564	0.695	0.571	0.747	0.412	0.385	0.475	0.39	0.51
Bara	0.654	0.657	0.703	0.665	0.816	0.511	0.513	0.549	0.519	0.637
Bardiya	0.599	0.529	0.651	0.551	0.713	0.39	0.345	0.424	0.359	0.465
Bhaktapur	0.616	0.639	0.686	0.645	0.829	0.11	0.115	0.123	0.116	0.149
Bhojpur	0.601	0.645	0.647	0.586	0.827	0.311	0.333	0.334	0.303	0.428
Chitawan	0.651	0.641	0.715	0.693	0.836	0.365	0.36	0.401	0.389	0.469
Dadeldhura	0.551	0.492	0.599	0.501	0.684	0.181	0.162	0.197	0.165	0.225
Dailekh	0.526	0.461	0.576	0.473	0.63	0.28	0.246	0.307	0.252	0.336
Dang	0.611	0.572	0.694	0.598	0.76	0.58	0.543	0.659	0.567	0.721
Darchula	0.472	0.431	0.531	0.438	0.605	0.204	0.186	0.229	0.189	0.261
Dhading	0.595	0.633	0.722	0.65	0.844	0.284	0.302	0.344	0.31	0.402
Dhankuta	0.63	0.679	0.692	0.647	0.867	0.191	0.205	0.209	0.196	0.262
Dhanusha	0.636	0.652	0.646	0.654	0.837	0.556	0.57	0.564	0.571	0.732
Dolakha	0.571	0.576	0.619	0.581	0.808	0.212	0.214	0.23	0.216	0.3
Dolpa	0.373	0.367	0.465	0.383	0.545	0.227	0.223	0.283	0.233	0.331
Doti	0.526	0.473	0.586	0.465	0.639	0.265	0.238	0.295	0.234	0.322
Eastern Rukum	0.525	0.489	0.589	0.508	0.67	0.171	0.16	0.192	0.166	0.219
Gorkha	0.522	0.559	0.662	0.57	0.768	0.36	0.386	0.457	0.393	0.53
Gulmi	0.599	0.622	0.724	0.662	0.829	0.262	0.272	0.316	0.289	0.362
Humla	0.382	0.331	0.407	0.326	0.477	0.252	0.218	0.268	0.215	0.314
Ilam	0.691	0.765	0.769	0.86	0.946	0.277	0.307	0.309	0.345	0.38
Jajarkot	0.517	0.471	0.573	0.47	0.63	0.246	0.224	0.273	0.224	0.3
Jhapa	0.756	0.817	0.818	0.955	1	0.461	0.498	0.499	0.582	0.61
Jumla	0.478	0.422	0.507	0.425	0.584	0.176	0.156	0.187	0.157	0.215
Kailali	0.592	0.52	0.634	0.537	0.703	0.6	0.527	0.642	0.544	0.712
Kalikot	0.471	0.411	0.505	0.414	0.566	0.194	0.169	0.208	0.17	0.233
Kanchanpur	0.595	0.531	0.626	0.528	0.726	0.357	0.318	0.375	0.316	0.436
Kapilbastu	0.635	0.597	0.692	0.669	0.783	0.493	0.464	0.538	0.52	0.608

District	Baseline context of climate extreme events	Climate extreme events composite (RCP4.5 2030)	Climate extreme events composite (RCP4.5 2050)	Climate extreme events composite (RCP8.5 2030)	Climate extreme events composite (RCP8.5 2050)	Baseline Risk	RCP 4.5 2030 Risk	RCP 4.5 2050 Risk	RCP 8.5 2030 Risk	RCP 8.5 2050 Risk
Kaski	0.602	0.634	0.738	0.678	0.877	0.223	0.235	0.274	0.251	0.325
Kathmandu	0.607	0.648	0.699	0.648	0.828	0.011	0.012	0.013	0.012	0.015
Kavrepalanchok	0.613	0.633	0.669	0.646	0.836	0.259	0.267	0.282	0.273	0.353
Khotang	0.581	0.615	0.614	0.571	0.8	0.319	0.337	0.336	0.313	0.438
Lalitpur	0.592	0.603	0.645	0.617	0.799	0.134	0.136	0.146	0.14	0.181
Lamjung	0.596	0.636	0.743	0.669	0.873	0.187	0.2	0.233	0.21	0.274
Mahottari	0.638	0.65	0.658	0.685	0.83	0.562	0.572	0.579	0.603	0.73
Makawanpur	0.632	0.635	0.693	0.633	0.801	0.475	0.478	0.522	0.476	0.603
Manang	0.422	0.453	0.557	0.462	0.652	0.07	0.075	0.092	0.077	0.108
Morang	0.699	0.734	0.742	0.803	0.907	0.567	0.596	0.602	0.652	0.736
Mugu	0.416	0.361	0.442	0.351	0.499	0.186	0.161	0.198	0.157	0.223
Mustang	0.33	0.349	0.463	0.376	0.554	0.103	0.109	0.145	0.118	0.173
Myagdi	0.518	0.532	0.633	0.571	0.764	0.178	0.183	0.218	0.197	0.263
Nawalpur	0.647	0.634	0.708	0.714	0.85	0.283	0.277	0.309	0.312	0.372
Nuwakot	0.605	0.667	0.755	0.673	0.873	0.202	0.223	0.253	0.226	0.292
Okhaldhunga	0.578	0.604	0.602	0.583	0.796	0.183	0.192	0.191	0.185	0.252
Palpa	0.622	0.643	0.729	0.699	0.847	0.253	0.262	0.297	0.284	0.344
Panchthar	0.648	0.729	0.737	0.757	0.916	0.255	0.287	0.29	0.298	0.36
Parasi	0.647	0.634	0.708	0.714	0.85	0.234	0.23	0.256	0.258	0.308
Parbat	0.645	0.684	0.789	0.727	0.908	0.11	0.117	0.135	0.124	0.155
Parsa	0.654	0.634	0.695	0.701	0.832	0.46	0.447	0.489	0.493	0.586
Pyuthan	0.589	0.583	0.685	0.614	0.779	0.282	0.279	0.328	0.294	0.373
Ramechhap	0.579	0.593	0.607	0.585	0.8	0.22	0.226	0.231	0.222	0.304
Rasuwa	0.486	0.542	0.65	0.539	0.776	0.084	0.094	0.113	0.094	0.135
Rautahat	0.644	0.668	0.707	0.656	0.81	0.501	0.52	0.55	0.51	0.63
Rolpa	0.556	0.531	0.642	0.54	0.711	0.322	0.308	0.372	0.313	0.412
Rupandehi	0.637	0.6	0.665	0.667	0.784	0.471	0.444	0.492	0.494	0.58
Salyan	0.568	0.525	0.644	0.529	0.696	0.313	0.289	0.354	0.291	0.383
Sankhuwasabha	0.67	0.716	0.747	0.672	0.924	0.41	0.438	0.456	0.411	0.565
Saptari	0.65	0.671	0.662	0.902	0.939	0.691	0.714	0.705	0.961	1
Sarlahi	0.636	0.658	0.688	0.67	0.831	0.57	0.59	0.617	0.601	0.746
Sindhuli	0.62	0.642	0.65	0.64	0.831	0.419	0.434	0.439	0.432	0.561
Sindhupalchok	0.577	0.604	0.691	0.631	0.853	0.297	0.311	0.356	0.325	0.439
Siraha	0.637	0.654	0.641	0.802	0.829	0.669	0.687	0.673	0.842	0.87
Solukhumbu	0.532	0.559	0.597	0.529	0.753	0.232	0.243	0.26	0.23	0.328
Sunsari	0.668	0.7	0.7	0.713	0.872	0.423	0.444	0.444	0.452	0.553
Surkhet	0.562	0.499	0.615	0.518	0.678	0.423	0.375	0.462	0.39	0.51

District	Baseline context of climate extreme events	Climate extreme events composite (RCP4.5 2030)	Climate extreme events composite (RCP4.5 2050)	Climate extreme events composite (RCP8.5 2030)	Climate extreme events composite (RCP8.5 2050)	Baseline Risk	RCP 4.5 2030 Risk	RCP 4.5 2050 Risk	RCP 8.5 2030 Risk	RCP 8.5 2050 Risk
Syangja	0.663	0.7	0.806	0.748	0.913	0.268	0.283	0.325	0.302	0.369
Tanahu	0.672	0.702	0.807	0.756	0.909	0.327	0.342	0.393	0.368	0.442
Taplejung	0.626	0.701	0.731	0.667	0.899	0.343	0.384	0.4	0.365	0.492
Terhathum	0.64	0.716	0.727	0.686	0.91	0.128	0.143	0.145	0.137	0.182
Udayapur	0.611	0.646	0.64	0.629	0.828	0.406	0.429	0.426	0.418	0.55
Western Rukum	0.525	0.489	0.589	0.508	0.67	0.168	0.157	0.189	0.163	0.215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