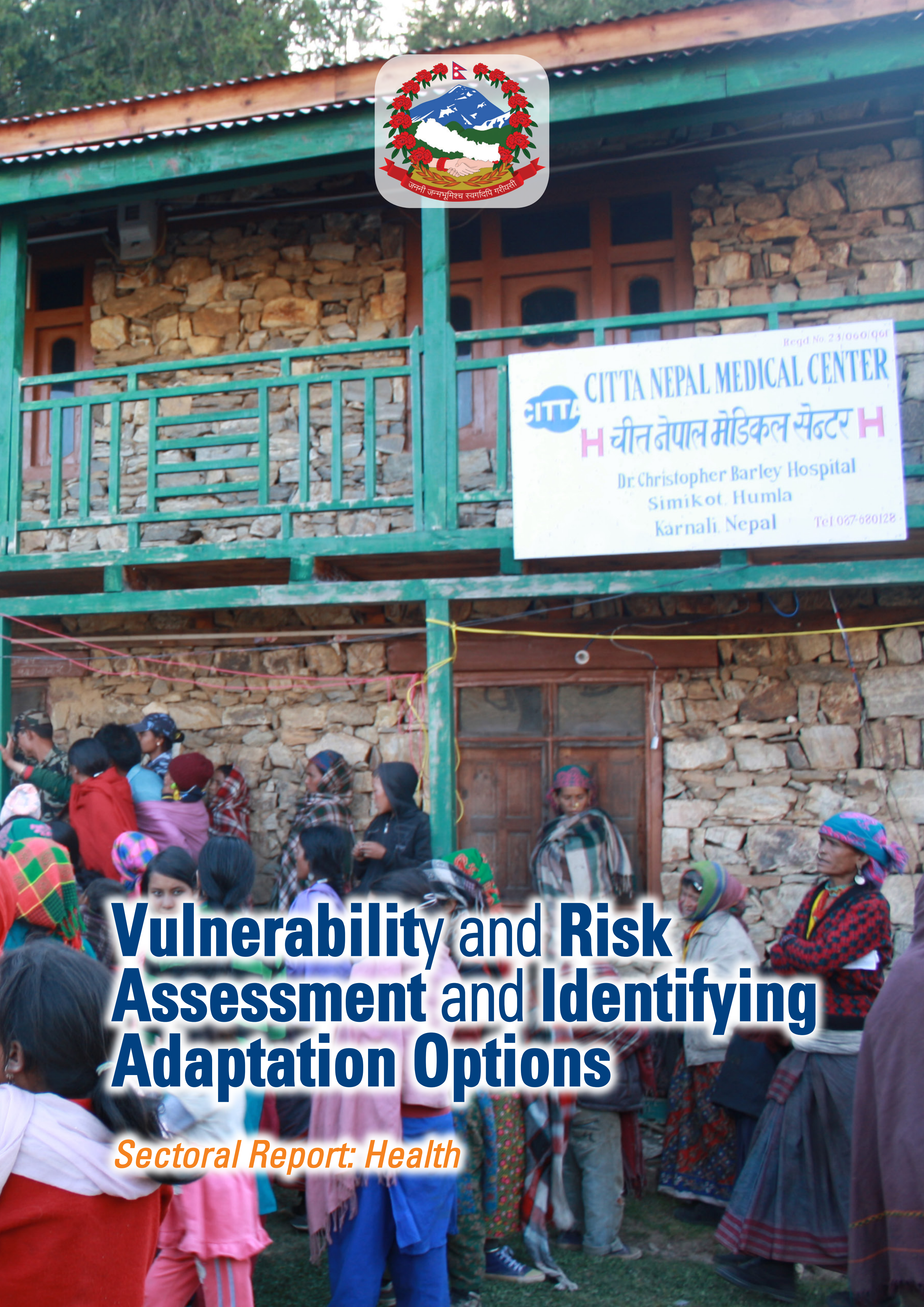

Vulnerability and Risk Assessment and Identifying Adaptation Options

Sectoral Report: Health

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Email: info@mofe.gov.np

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Editorial Team
Dr Yadav Prasad Joshi, Dr Bimal Raj Regmi, Apar Paudyal, Regan Sapkota, and Pratik Ghimire

Technical Committee
Dr Radha Wagle, Dr Arun Prakash Bhatta, Srijana Shrestha, Raju Sapkota, Dr Indira Kadel, Hari Pandey, Gyanendra Karki, and Dr Bimal Raj Regmi

Thematic Working Group (TWG)
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Foreword

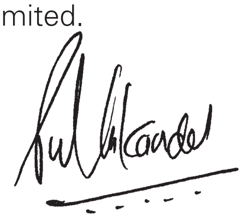
Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. The latest IPCC report confirms that human activities have changed our climate and led to the more frequent heatwaves, floods, droughts, and wildfires that we have seen recently. The 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 the Health sector 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 Health and Population, 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.

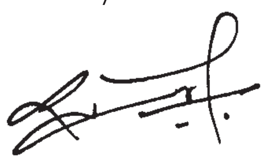
A National Adaptation Plan (NAP) needs to be developed based on a strong scientific foundation and reliable evidence. This includes data and information about how the climate has evolved in the recent past and how it may further change in the future. To realise this, the MoFE has carried out detailed 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 Health and WASH 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 Dr Yadav Prasad Joshi, 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
Ministry of Forests and Environment (MoFE)

List of Acronyms

AR5	Fifth Assessment Report
ARI	Acute Respiratory Infection
CBS	Central Bureau of Statistics
COPD	Chronic Obstructive Pulmonary Disease
DDA	Department of Drug Administration
DHM	Department of Hydrology and Meteorology
DoHS	Department of Health Services
DWSSM	Department of Water Supply and Sewerage Management
EDCD	Epidemiology and Disease Control Division
EPI	Expanded Programme of Immunization
FBD	Food-Borne Diseases
FCHV	Female Community Health Volunteer
FY	Fiscal Year
GIS	Geographic Information System
HP	Health Post
HPI	High Poverty Index
HMIS	Health Management Information System
H-NAP	Health National Adaptation Plan
ICIMOD	International Centre for Integrated Mountain Development
ILO	International Labour Organization
IMR	Infant Mortality Rate
IPCC	Intergovernmental Panel on Climate Change
IVM	Integrated Vector Management
JE	Japanese Encephalitis
LLIN	Long-Lasting Insecticidal Net
MMR	Maternal Mortality Ratio

MoFE	Ministry of Forests and Environment
MoHA	Ministry of Home Affairs
MoHP	Ministry of Health and Population
NAP	National Adaptation Plan
NCD	Noncommunicable Disease
NHP	National Health Policy
NHSS	Nepal Health Sector Strategy
NPRP	Nepal: Preparedness and Response Plan
OCMC	One-Stop Crisis Management Centre
PHCC	Primary Health Care Centre
PHCORC	Primary Health Care Outreach Clinic
SDG	Sustainable Development Goal
VBD	Vector-Borne Diseases
VBDRTC	Vector-Borne Disease Research and Training Centre
VRA	Vulnerability and Risk Assessment
WBD	Water-Borne Diseases
WHO	World Health Organization

Executive Summary

Climate change offers a major risk to all aspects of livelihoods that affect human well-being, with climate variations such as temperature, humidity, precipitation, and extreme weather events contributing to the prevalence of diseases either directly or indirectly. Cases associated with climate-sensitive diseases (VBDs) and the seasonal outbreak of waterborne diseases (WBDs) have been growing over the years.

For the National Adaptation Plan (NAP) process, this study conducted a Vulnerability and Risk Assessment (VRA) of climate change and identified adaptation options in the health sector. The VRA is based on the Ministry of Forests and Environment's (MoFE) national framework. Climate risks, exposures, and vulnerabilities, as well as socioeconomic and spatiotemporal data on climatic, climate-sensitive diseases, and associated infrastructures were assessed in the study, which covered seven provinces and 77 districts. The key methodological steps included identification of key indicators for hazard, exposure, and vulnerability; data sources exploration, data collection, tabulation, filtration, and normalization; weightage and composite value identification; data analysis; and identification of climate change impacts and risks on health. For short, medium, and long-term periods, priority-based adaptation options were listed.

This study found a link between climate change parameters and health outcomes. From 2005 to 2018, the baseline status of climate-sensitive diseases in Nepal showed that cases of heart and respiratory diseases, as well as WBDs, were on the rise, while malnutrition and VBDs were on the decline. It was also discovered that the effects differed amongst different populations and periods. In Dhankuta, Kailali, Dhading, and Kathmandu, annual variations in the number of heart disease patients were positively correlated with maximum temperature. In the Terai, an increase in mean temperature caused an increase in drought events and warm days, which led to a rise in respiratory diseases. In the Hill region, an increase in cold wave events led to an increase in respiratory disease cases. In Achham and Kalikot, rainfall and maximum temperature were both positively linked with WBD cases. For over 13 years, the frequency of drought occurrences was linked to the number of undernutrition cases per 100,000 people. In Kailali and Kanchanpur, the annual variations of VBD cases and maximum temperature were positively related. In Kapilvastu, the yearly sum of undernutrition patients was positively related to the yearly precipitation, while the undernutrition of those from Dolakha, Kanchanpur, Rolpa, and Sarlahi was positively related to the annual mean temperature.

The findings suggest that climatic extreme events and hazards put the population and healthcare infrastructures at risk. Districts with a very high level of exposure, such as Kathmandu and Morang, have a greater population and greater health infrastructure, including medical stores, laboratories, and water supply infrastructure. The very low-exposure districts, on the other hand, have a smaller population and fewer healthcare infrastructures that are directly impacted by climate-induced disasters.

According to a sensitivity index score, Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, and Rautahat districts of Province 2 and Achham of Sudurpaschim Province have very high sensitivity to climate change. These areas have worse climate-sensitive health outcomes, owing to a higher number of mud and thatch buildings, the majority of which are built without facilities, and a high

Human Poverty Index (HPI) score. Most of the districts in Karnali and Sudurpaschim provinces with high climate sensitivity have a larger number of children under the age of five years, as well as greater VBD, WBD, and undernutrition cases.

The adaptable capacity index shows a very low adaptive capacity rank all over the country, especially in the Hill and Mountain districts, suggesting that these two districts are less equipped to cope with and adapt to health outcomes as compared to other districts. This is likewise true of the limitations and constraints of the adaptation options. Kathmandu and Manang have the greatest and lowest adaptive capacity scores, respectively. Lalitpur has a very high adaptation capability, according to the adaptive rank analysis. Sunsari, Chitawan, Makawanpur, and Kavrepalanchok have high adaptation capability. Low and very low adaptive capacity ranks are found all around the country, particularly in Hill and Mountain districts.

The findings show that Makawanpur, Lamjung, Dhankuta, Baglung, Lalitpur, Kavrepalanchok, Bhaktapur, Parbat, Syangja, Rupandehi, Palpa, Manang, Chitawan, Kaski, Panchthar, Gulmi, Kathmandu, and Ilam districts have the lowest vulnerability whereas Humla, Rautahat, Siraha, Dhanusha, Sarlahi, Mahottari, and Saptari have the highest vulnerability. The six districts of Province 2 representing the Terai region of the Eastern cluster, Humla from the Mountain region of Karnali Province, experience a very high vulnerability. Nawalpur representing the Terai region of Gandaki Province also has a high vulnerability. The analysis illustrates that a high vulnerability index is found in almost all the districts of the Hill and Mountain region of Sudurpaschim and Karnali provinces, signifying the provinces' greater vulnerability to health impact due to climate change.

The climate change risk analysis shows that Sunsari, Dhankuta, Terhathum, Sankhuwasabha, Tanahu, Parbat, Syangja, Morang, Taplejung, Panchthar, Jhapa, and Ilam have a very high risk of climate change with regards to its impact on the health sector. The number of districts at very high risk of climate change impact has increased to 9 and 12 in RCP 4.5 for 2030 and 2050 respectively. The analysis also shows that the risk of climate change impact increased to 9 and 13 in RCP 8.5 for 2030 and 2050 scenarios respectively. In the physiographic region, the risk index shows that the Terai and Middle Mountain have very high and high climate change risks respectively. Amongst the provinces, very high climate risk is found in the districts of Gandaki Province which include Parbat, Syangja, Tanahu, and Nawalpur.

Based on the observed impact and analysis of vulnerability and risk due to climate change in the health sector, short-term (5 years), mid-term (up to 10 years), and long-term (up to 30 years) adaptation options were identified. These options should strengthen: i) diseases surveillance including climate-sensitive diseases; ii) infrastructure for healthcare and water services; iii) protection of population; and iv) preparedness of health services. Sensitization about climate and health issues, comprehensive assessment of climate impacts on health, impact assessment and risk assessment of climate-sensitive diseases, and use of early warning systems in the health sector are among the key areas. These activities can help healthcare decision-makers address health risks and strengthen the healthcare system's resilience to climate change.

The assessment suggests bridging the current knowledge and information gap regarding climate change impacts and climate-related health consequences observed during the study. To avoid the immediate and long-term adverse impact of climate change on people's health, appropriate strategies for early planning and strengthening the health system with a focus on climate-sensitive health outcomes are required. The results of this assessment can then be utilized to implement more focused public health actions to strengthen the resilience of the health system and thus the people.

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Chapter 1

Background and Sectoral Context

1.1 Background

The Constitution of Nepal has established basic healthcare as a fundamental right of its citizens. As the country has moved to a federal governance system, it is the responsibility of the state to ensure access to quality health services for all citizens based on the contextual norms of the federal system.

The health sector is one of the largest and has the most potential in areas of employment and service delivery in Nepal. The Ministry of Health and Population (MoHP) has more than 30,000 employees; among them over 24,000 are technical personnel and 6,300 are administrative staff in 4,515 health institutions (DoHS, 2017/18). In fiscal year (FY) 2018/19, 135 public hospitals including other ministries, 2,168 non-public facilities, 196 Primary Health Care Centres (PHCCs), and 3,806 Health Posts (HPs) had delivered basic health services. Additionally, the Primary Health Care Outreach Clinic (PHCORC) provided services in 12,532 sites. The Expanded Programme of Immunization (EPI) clinics provided immunization services in 16,428 sites and were supported by 51,420 Female Community Health Volunteers (FCHVs) working in 77 districts of the country. The Department of Health Services (DoHS) administers the overall public health system, private health facilities and affiliated national and international organizations, and Health Management and Information System (HMIS) as well as documents the accounts on health sector achievement (DoHS, 2018/19).

The government's investment in health, as a share of the gross domestic product, has increased from 1.4 percent in FY 2014/15 to 1.8 percent in FY 2018/19. The health sector budget has been gradually escalating over the years from NPR 37.8 billion in FY 2015/16 to NPR 78.4 billion in FY 2019/20. Most of the health budget goes to the local governments to cover salaries, wages, support services, capacity building, and program activities (MoHP, 2019). The major source of the government's expenditure on health is domestic revenue. The support from foreign governments and entities also contributes to government revenue (DoHS, 2018/19).

The MoHP has implemented different programs and initiatives in the areas of reproductive and maternal health, child health services, communicable diseases and noncommunicable diseases (NCDs), deprived citizen's packages, and emergency health management. The ministry also supports the affected population during emergencies such as disasters, disease outbreaks, trauma system strengthening, E-WASH, and emergency health preparedness and response. It provides nutrition services to the most vulnerable persons as well as counselling, education, vocational skills training, and other livelihood support (DoHS, 2017/18). In the federal system, the provincial and local provincial governments deliver social services including health services (DoHS, 2018/19).

Nepal has made significant improvements in its health status, with the maternal mortality ratio (MMR) declining from 539 deaths per 100,000 live births in 1996 to 239 in 2016, and in recent 2017 estimates to 186 deaths per 100,000 live births (World Bank, 2016). Nepal reduced the under five-year-old mortality rate by 67 percent and the infant mortality rate (IMR) by 66 percent between 1996 and 2016 (MoHP, 2019). The neonatal mortality rate was 50 deaths per 1,000 live births in 1996 and was reduced to 21 in 2016, i.e. a 58 percent decrease (MoHP, 2019). Life expectancy for males is 69 years and for females is 72 years[1]. With the decline of communicable diseases, NCDs such as diabetes, cancer, and cardiovascular diseases are on the rise, particularly in urban areas. NCDs account for more than 71 percent of deaths globally; 77 percent of all NCD deaths are in low and middle-income countries (WHO, 2021). However, inequities exist between rural and urban areas on important parameters such as IMR which is higher in rural areas with 55 deaths per 1,000 live births, compared to urban areas with 38 deaths per 1,000 live births. Likewise, the under 5-year-old mortality rate in rural areas is 64 and that in urban areas is 45 deaths per 1,000 live births (Pathak & Gaire, 2020).

Nepal has moved to a three-tiered federal system of government representing the federal, provincial, and local levels. The turn towards federalism has created several potential opportunities for the national healthcare system and allowed them to make decisions that are more representative of their localized health needs (Thapa et al., 2019). As federalism speeds up, the national health system can also get a move on its decentralization process, reduce disparities in access, and improve health outcomes.

The National Health Policy (NHP) of 1991 was the first sectoral policy in the health sector of Nepal which primarily focused on the expansion of public health facilities in a rural setting. Since then, several sub-sectoral policies have been developed that focus on specific program areas. Furthermore, in 2014, a new NHP was developed which replaced the NHP of 1991. The Nepal Health Sector Strategy 2016-21 (NHSS), as a continuation of the 2003 'Nepal Health Sector Strategy: An Agenda for Reform', has adopted quality, equity, system reform, and multi-sectoral collaboration as the guiding principles to move towards universal health coverage. The government of Nepal further revised the National Health Policy in 2019. This policy was formulated based on the lists of exclusive and concurrent powers and functions of federal, state, and local levels as per the constitution; the policies and programs of the Government of Nepal; the international commitments made by Nepal at different times; and the problems, challenges, available resources, and evidence in the health sector.

1 WHO. https://who.int/countries/npl/en/. Nepal

To address climate change issues, the health sector of Nepal is primarily following the Health National Adaptation Plan (H-NAP) with the priority of developing a climate-resilient health system to protect human health from climate change (MoHP, 2015a). Additionally, National Adaptation Programmes of Actions to Climate Change (MoE, 2011), National Health Policy (GoN, 2019), National Population Policy (MoHP, 2015b), Nepal Health Sector Programme - Implementation Plan (NHSP IP-II, 2011-15), and Nepal Health Sector Strategy 2015-2020 (MoHP, 2015c) have also been the basis of identifying strategic direction and policy priorities to address the effect of climate change on the human population, health, and well-being.

However, there are additional challenges in the health sector. The Novel Coronavirus (2019-nCoV) has become a health pandemic in 2020 and 2021 globally, including Nepal (Paudel et al., 2020). Pandemics like COVID-19 are a serious threat in the public health sector, and preparedness and coordination between three tiers of governments are essential for effective and timely control of such diseases. The COVID-19 pandemic has the potential of not only delaying but effectively reversing the positive trends in most Sustainable Development Goals (SDGs), such as ending poverty, healthy lives, decent work, economic growth, quality education, reducing inequalities, and partnership for sustainable development (EDCD, 2019; NPC, 2020).

1.2 Key Challenges in the Health Sector

The health sector is currently facing several problems, some of which are listed below:

Promoting and availing quality health services at all levels: Despite the regulatory policy and guidelines, quality health services such as free medicine and giving basic priority to the vulnerable population are not accessible to all citizens. More work is required on establishing the operating health institutions as per the new federal structure governance, effectively implementing the health insurance policy, making the health sector responsible towards human health, and managing skilled human resources (Thapa et al., 2019). However, the health service delivery structure in Nepal was developed at a time when the country's population was only 10 million (Schwefel, 2011). The present health structures and human resource base of 35,000 people are not sufficient to provide adequate health service delivery in the context of changing burden of diseases, growing advancement in healthcare technologies, and increasing population (Thapa et al., 2019).

Capacity and data gaps: There is a lack of strategy to manage highly infectious diseases and emerging diseases. This is due to a lack of capacity to carry out surveillance, monitoring, response, and risk communication. There is also a lack of emergency preparedness for minimizing human casualties from disasters and retrofitting hospitals and other health institutions (EDCD, 2019). Another pressing challenge is the data gap. Currently, there is a lack of adequate data on monitoring, evaluation, review, policy-making, and decision-making processes.

Managing additional risks: Coinciding with the COVID-19 pandemic, Nepal's health system also has to cope with the influenza season, which can result in significant outbreaks. Furthermore, the impending humanitarian impact due to monsoon season and related flooding could further strain the system. Nepal: Preparedness and Response Plan (NPRP) by the United Nations highlights that pre-existing societal structures, social norms, discriminatory practices, and gender roles could contribute to heightened risks for vulnerable groups due to the pandemic. These include children, persons with disabilities, mixed migrants, refugees, sexual and gender minorities, people living with HIV/AIDS, adolescent girls, single women, pregnant women and lactating mothers, senior citizens, women from religious and ethnic minorities, and indigenous women (Naja & Hamadeh, 2020).

In addition to the existing challenges, climate change has become one of the major public health threats of Nepal. The vulnerability and the risks to this sector in the future will be very high (Regmi et al., 2016). The government report highlights that if climate change continues as projected across the Representative Concentration Pathways scenarios, increases in health risk are expected (MoHP, 2015b). The major identified risks and impacts are: i) greater risk of injury, disease, and death due to more intense heatwaves, cold waves, and fires; ii) increased risk of undernutrition resulting from diminished food production in resource-poor regions; iii) consequences on health leading to lost work capacity and reduced labour productivity in vulnerable populations; iv) increased risk of food-, water-, and vector-borne diseases, especially in previously considered non-endemic mountain areas; v) modest reductions in cold-related mortality and morbidity in the highlands due to fewer cold extremes; vi) increased morbidity and mortality related to cold waves in southern plains such as the Terai; and vii) reduced capacity of disease-carrying vectors due to exceeding thermal thresholds especially in the lowland Terai regions (MoHP, 2015a).

Several studies carried out in Nepal also revealed that climate change is triggering the occurrence and greater impact of both vector-borne and waterborne diseases. The VBDs, diarrhoeal diseases including cholera, malnutrition, cardiorespiratory diseases, psychological stress, and health effects and injuries related to extreme weather are major climate-sensitive diseases in Nepal (Dhimal & Bhusal, 2009). Although case fatality rates of diarrhoeal diseases are declining in Nepal overall, there has been a rise in the incidence among children under 5 years of age in the last decade. An analysis of data collected on temperature and diarrhoea from July 2002 to June 2014 estimated that, for a 1°C increase in ambient temperature, the incidence of diarrhoeal diseases in Nepal rose by 4.39 percent (Dhimal et al., 2017).

Climate change affects the population of those who are most vulnerable. Several factors like geography, health system emergency preparedness, health status, age, social class, and support systems determine the health status of the country (MoHP, 2015a). Climate change brings health inequalities and puts additional stress on most vulnerable populations including women, children, and the marginal and poor communities. They are more exposed to natural hazards, directly dependent on climate-sensitive resources but have limited capacity to adapt and cope with climate change impacts (WFP & CBS, 2013).

Chapter 2

Objectives and Scope of the Study

2.1 Objectives and Rationale of the Study

The overall objective of this assignment was to assess the climate change vulnerabilities and risks and identify adaptation options in the health sector for the ongoing National Adaptation Plans (NAP) formulation process. Specifically, the study's objectives were as follows:

- Assess vulnerability to climate change of public health through applicable frameworks and ranking/categorizing associated climate risks and vulnerabilities.
- Identify and categorize adaptation options to these risks to address priority climate risks and vulnerabilities of the health sector.

The outcome of Vulnerability and Risk Assessment (VRA) in the health sector was to enhance the adaptive capacity and build public health resilience of climate-vulnerable people and communities, geographical areas, physical infrastructure, and ecosystems. Through this process, medium and long-term adaptation options were identified to be integrated into the development planning process at the national and provincial levels. The VRA and identification of adaptation options are expected to guide the health sector and strategically promote the climate change adaptation agenda across Nepal.

There are four main reasons for addressing the health sector in National Adaptation Plans (NAPs). First, the health sector in Nepal is one of the most vulnerable sectors to the negative impacts of climate change. Also, the health sector is highly exposed to the impacts of climate change due to changing climate conditions. Second, the health impacts of climate change such as diseases borne from water, food, air, VBDs, cardiorespiratory diseases, and malnutrition are well established in Nepal. Besides, the shifting of VBDs and their vectors in the uplands of Nepal is an indication of early climate change effects (Dhakal et al., 2011; Dhimal et al., 2014; WHO & DFID, 2018). Third, the impacts of climate change have brought health inequalities and put additional stress on the most vulnerable populations including women, children, and marginalized and poor communities (MoHP, 2015b). And fourth, the damage of healthcare and drinking water infrastructures is the result of climate hazards and several climate-induced disasters (WHO & DFID, 2018). The VRA process is expected to bring systematic evidence on impact, vulnerability, and risk to formulate appropriate adaptation options which will be crucial to provide strategic direction to develop health strategy in Nepal.

2.2 Scope of the Study

The focus of VRA in the health sector was to cover 77 districts, seven provinces, and five physiographic regions. Municipality wise assessment was not possible due to a lack of health-related data. The district was the primary unit of analysis. District-level results were later clustered into the province-level analysis. Likewise, the physiographic region is another scale of analysis, whereby the risk and vulnerabilities of the five physiographic were categorized, analyzed, and presented. Based on the results and findings, districts, provinces, and physiographic regions were ranked and prioritized. The assessment was carried out based on a desk review of grey literature and the scientific publication, review of relevant national policies, and plans related to the health sector. Besides, it involved provincial and local level consultations, involving selected experts and stakeholders.

Chapter 3

Methodology

3.1 Framework

The VRA framework in the health sector is based on the existing government document prepared in the preparatory stage of the National Adaptation Plan (NAP) process in 2016-2017 (MoPE, 2017). 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, 2007a).

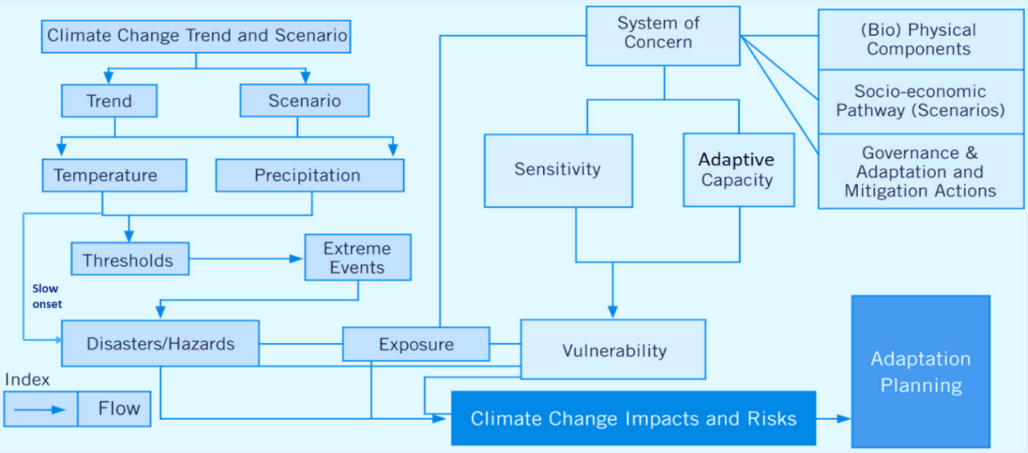


Figure 1: Climate change vulnerability and risk assessment framework

(Source: MoPE, 2017)

3.2 Approach

The assessment approach includes an analysis of trends and impacts that have already occurred and the risk of future impacts. For both past impact and future risk, a core focus of the assessment depends on characterizing hazards, exposure, and vulnerability. For both past trends and future scenarios, a core focus of the assessment depends on the detection and attribution of changes in climatic hazards. The understanding of the impacts of climate change requires a very broad perspective as risk is not only determined by climate and weather events (hazards) but also by the exposure and vulnerability of the human and natural systems to these events. The observed climate trend analysis of Nepal (1971-2014) conducted by the Department of Hydrology and Meteorology (DHM, 2017) and Climate Change Scenarios for Nepal (MoFE, 2019) was used to characterize broad future scenarios of climatic hazards. The bottom-up approach was adopted to look into people affected by climate-sensitive diseases and identify vulnerability along with the social drivers.

3.3 Methodological Steps

The methodology of climatic hazard assessment consisted of the following steps:

Identifying key indicators for hazard, exposure, and vulnerability: The most relevant indicators for assessing risks and vulnerabilities in the health sector were identified. Indicators developed by the government in 2016 were the basis for identifying hazards, exposure, sensitivity, and adaptive capacity indicators in the health sector. The indicators were used for both quantifying and qualifying the impacts, trends, and future scenarios of the assessment units. The exposure, sensitivity, and adaptive capacity indicators are given in annex 2.

Exploring data sources, nature, and character: The data was obtained mostly from government agencies, regional and global centres, international and national organizations, and other stakeholders. Trends of climate variables and extreme indices were taken from the 'Observed Climate Trend Analysis of Nepal' (1971-2014) conducted by the Department of Hydrology and Meteorology (DHM, 2017). Similarly, scenarios were taken from 'Climate Change Scenarios for Nepal' (MoFE, 2019). The data on climate-induced disasters was collected from Nepal Disaster Risk Reduction Portal[2], DesInventar[3], and the International Centre for Integrated Mountain Development (ICIMOD). The disaster data in the form of several events and losses and damages was aggregated as annual time series from 1971 to 2019. The secondary data sets were validated through consultations in all seven provinces and at the national level.

Data collection and normalization: The collected data were tabulated, filtered, and normalized. The indicator data which was directly correlated was normalized to a scale of 0 to 1 using the min-max normalization method as follows.

$$x_{norm\_i} = \frac{x_i - x_{min}}{x_{max} - x_{min}} \qquad \text{.. i}$$

2 http://drrportal.gov.np/

3 https://desinventar.net/DesInventar/statistics.jsp.

The normalized data was further analyzed and composite values were computed, assigning weightage to each normalized data for different indicators of climate change VRA in health.

Microsoft Excel software was used to tabulate and process the data.

d) **Weightage and composite value:** The weights adopted in deriving indicators' composite values were guided by available references, stakeholder consultation, and expert judgements.

$$AC = \frac{\sum_{i=1}^{n} w_i\, x_i}{\sum_{i=1}^{n} w_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ii}$$

Where AC is an aggregated indicator, e.g. aggregated adaptive capacity, xi is an individual indicatory of the adaptive capacity of a vulnerability component, and wi is the weight assigned to the corresponding indicator xi.

V= S – AC……………………………………………………………………….. iii

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

R = H × V ×E

Where *R* is the risk index, *H* is the hazard intensity, *V* is the vulnerability, and *E* is an exposure. Risks were graded into five categories.

Each of the indicators under the elements (hazard, exposure, sensitivity, and adaptive capacity) was also scored from 0 to 1. A score of 1 indicated the highest range and 0, the lowest. The outcomes of subset indicators when combined with appropriate weightage were normalized for further use.

Indicator-wise weightage for exposure, sensitivity, and adaptive capacity in population and infrastructure sub-sectors is given in tables 1 and 2.

Table 1: Indicators (exposure and sensitivity) related to the health sector and their weight

Exposures	Weight	Sensitivity	Weight
Total population	1.000	Population < 5 years	0.039
Government hospitals	0.056	Population above 60 years	0.039
Primary health care centres (PHCCs)	0.057	Heart diseases	0.048
Health posts	0.056	VBDs	0.067
SHP health posts	0.051	WBDs including acute gastroenteritis	0.018
Private/non-public health institutions	0.053	Respiratory diseases including viral influenza	0.014
Registered medical stores	0.112	Malnutrition (undernutrition)	0.016
Laboratories	0.118	House made off from mud bounded bricks/stones, the wooden pillar (outer wall), bamboo (outer wall), roof (thatch/straw)	0.536
Water supply infrastructures and services: drinking water supply schemes	0.249	Types of houses built up without any facility	0.332
Water and sludge treatment plants	0.248	Types of houses without at least one facility (radio, TV, motorcycle, refrigerator, etc.)	0.132
Total male population	0.016	Human Poverty Index (HPI)	0.390
Total female population	0.008	Human Development Index (HDI)	0.343

Table 2: Indicators related to the health sector and their weight

Adaptive Capacity	Weight	Adaptive Capacity	Weight
Medical practitioners, public health, nursing, paramedic, and administrative staff	0.028	Safe disposed excreta treatment facility (on-site)	0.136
Average FCHV (2005-2018)	0.027	Well functional drinking water supply facility (schemes)	0.039
Immunization in EPI/PHC/outreach clinics	0.058	Sanitation coverage	0.073
JE immunization % coverage	0.089	Female literacy rate	0.004
Nutrition program for mother and children	0.057	Male literacy rate	0.003
Food productivity (paddy, wheat, maize, millet, barley)	0.079	Female with health insurance	0.000
Average (Vitamin A given to severe malnourished <5 yrs)	0.091	Male with health insurance	0.020
Average (Antihelminthes given to children <5 yrs)	0.093	OCMC service	0.080
Drinking water access	0.116	Access to early warning and disease surveillance systems (sentinel site)	0.057
Water supply coverage	0.108	% area coverage by the early warning system	0.095
Water treatment facility (functioning)	0.639	Emergency healthcare services	0.017

Analysis of data: a descriptive analysis on the distribution of climate-sensitive health outcomes, socioeconomic variables, hazards, and climate factors was performed. The changes of climate-related health hazards and health risks were calculated for the period 2021-2050 based on RCP 4.5 and RCP 8.5 climate change scenarios. Trends of climate-sensitive health outcomes were analyzed. Correlations and regression analyses were also performed.

Identifying climate change vulnerability and risk: The main climate-vulnerable hotspots and risks maps were prepared for five ecological zones, seven provinces, and 77 districts.

Mapping and visualisation: The indices for the historical scenario of each hazard were imported into Geographic Information System (GIS) environment for visualization and mapping. The hazard indices were classified into five classes: very low, low, moderate, high, and very high; the districts were ranked accordingly in exposure, sensitivity, adaptive capacity, vulnerability, and risk. Districts with very high and high hazard indices were identified as hotspots.

Identifying and appraising adaptation options: The identified impacts, vulnerabilities, and risks helped in designing various health sector strategies and adaptation measures for NAP**.** 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. The following processes were adopted in this assessment:

- Potential adaptation options were identified based on the impacts, vulnerability, and risk maps and tables generated by the analysis of secondary data.
- The potential list of adaptation options was mapped based on a literature review, particularly focused on successful adaptation practices, effective local knowledge and practices, and efficient technologies.
- Consultation with relevant experts was carried out to map effective adaptation strategies in the sector and sub-sector.
- Consultation at the province level was carried out to identify adaptation options in the context of the existing risk and vulnerability.
- The list of adaptation options was presented to the Technical Committee, shared with TWG members, and finalized.

Climate Change Impacts on Health

Human health is intimately related to climate as weather and climate have a wide range of health impacts and play a role in the ecology of many infectious diseases (Patz et al., 2000). Health is sensitive to shifts in weather patterns and other climate-related impacts so climate change is likely to exacerbate already existing health problems and bring additional impacts on health and mortality (Regmi et al, 2016). According to IPCC AR5, the health of the human population is responsive towards the various aspects of climate change causing the global burden of diseases and premature death. Climate change is likely to exacerbate already existing health problems and bring additional impacts on health and mortality. The negative impacts of climate change are augmented by factors such as widespread poverty, diseases, and high population density, which are estimated to double the demand for food and water in the next 30 years (IPCC, 2014).

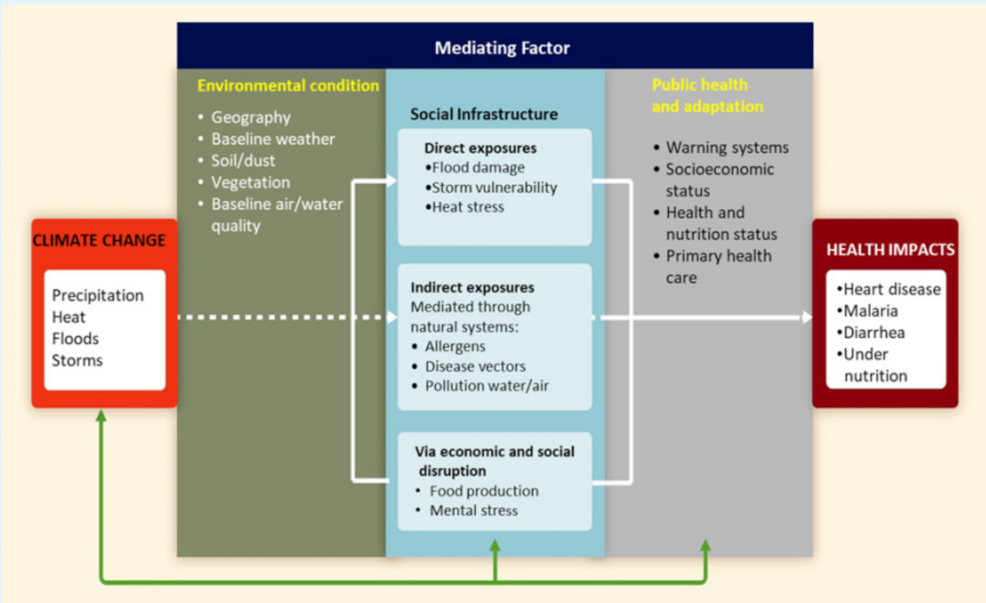


Figure 2: Climate change and health impacts

(Source: Pachauri & Meyer, 2014)

Climate change has a significant impact on human health, particularly in the occurrence and spread of diseases such as infectious diseases, cardiorespiratory disorders, malnutrition, mental illness, and allergies (Watts et al., 2015). Climate change also threatens drinking water, sanitation, and hygiene, and affects the transmission of water-borne diseases (WHO & DFID, 2018). Climate change may lead to multiple health impacts acting through a variety of different pathways, as shown conceptually in Figure 2.

4.1 Impacts of Climate Change on the Outbreak of Diseases

Over the years, Nepal has been observing increasing temperature, variations in precipitation, and extreme weather events that have profound impacts on the seasonal and temporal trend fluctuation of VBDs, WBDs, respiratory diseases, foodborne diseases, nutrition-related diseases, injuries, and mental illnesses (NPC, 2020). As a result, there is an increase in reporting of disease outbreaks, which resulted in creating health implications within the smallest clusters, physiographic regions, and administrative levels (UNISDR, 2015).

The Health-NAP shows that out of the total population, 52 percent is found to be most sensitive to malaria, 87 percent to lymphatic filariasis (LF), 54 percent to Japanese encephalitis (JE), and 30 percent to Kala-azar. However, all the population is found to be sensitive to water- and foodborne diseases as well as noncommunicable diseases. Additionally, other studies found that the reported health risks from climate change are heart diseases, respiratory diseases, VBDs, WBDs, malnutrition, psychological stress, and injuries (Dhimal & Bhusal, 2009; EDCD, 2019; Kovats & Hajat, 2008). These are systematically analyzed and explained in the section below.

A. Vector-borne Diseases

The VBDs contribute significantly to the global burden of diseases and are consequently the most well studied of the diseases associated with climate change because of their large disease burden, widespread occurrence, and high sensitivity to climatic factors (Smith et al., 2014). The climate variables that directly influence VBDs are mainly temperature and rainfall. The vectors bionomics, host behaviour, and amplification of pathogens are strongly dependent upon these variables (Fouque & Reeder, 2019). Vectors, pathogens, and hosts survive and reproduce within a range of optimal climatic conditions. Hence, temperature, precipitation, wind, and daylight intensity, and duration play important roles in the development of vectors and survival of pathogens (Gubler, 2001).

The VBDs pose a serious threat to the Nepalese population and their epidemics have been reported in different time intervals and locations (Joshi et al., 2020). VBDs including JE, malaria, kala-azar, and dengue have occurred in the warmer districts especially the Terai region of Nepal. For example, dengue was first reported in Chitawan and Parsa districts in 2004 (Pandey et al., 2004). Now, it has become one of the most serious public health challenges. In FY 2015/16, 3,424 dengue cases were reported in 44 districts. The majority of cases were reported from Sunsari (88 percent), Morang (2.4 percent), and Rupandehi (1.6 percent) (DoHS, 2018-19). Similarly, chikungunya was reported in 2013 in a patient from Dhading who was admitted at Sukraraj Tropical and Infectious Disease Hospital, Teku, Kathmandu (Pun et al., 2014). Both dengue and chikungunya are transmitted by the vector mosquito Aedes aegypti. In recent years, Ae. aegypti and Ae. albopictus have been reported in Nepal at a lower elevation of 80m to 1,350m. The climatic variables: rainfall, temperature, and relative humidity are significant predictors of chikungunya and dengue virus vector abundance.

However, despite a two-decadal decrease in malaria cases, over the last 7 years, malarial incidences are spreading to newer locations at higher altitudes (Badu, 2013). In Jhapa District (South-eastern Nepal), the trends of malaria cases and maximum temperature showed that even with a minimum increase in temperature, the number of cases increased, despite a considerable decrease in total rainfall and linear trend in relative humidity in the morning (Bhandari et al., 2012). Other studies also detail malarial cases with altitudinal shifts; the malaria vector was found at 1820 AMSL, with higher densities in the post-monsoon season. A study conducted in two districts that are highly endemic for malaria showed that a 1°C increase in minimum and mean temperatures increased the incidence of malaria by 27 percent and 25 percent respectively. Climate change is expected to trigger an increase in dengue fever.

Besides, the spatiotemporal distribution of dengue and lymphatic filariasis vectors along an altitudinal transect in central Nepal shows that dengue virus vectors have already established a stable population up to the middle mountains of Nepal (Acharya et al., 2018; Dhimal et al., 2014). The rapid expansion of the distribution of these important disease vectors in the High Mountain region, previously considered to be non-endemic for dengue and chikungunya fever, calls for urgent actions to protect the health of local people and travelers (Dhimal et al., 2014).
The findings from this VRA study show that of 70,957 VBD cases from 2005 to 2018, the highest were found in Kailali (10.6 percent) followed by Jhapa (8.3 percent) and Morang (6.3 percent). The VBD cases with malaria, LF, acute encephalitis syndrome, and Kala-azar were 48.4 percent, 18.7 percent, 16 percent, 11.3 percent, and 5.6 percent, respectively (Figure 3).

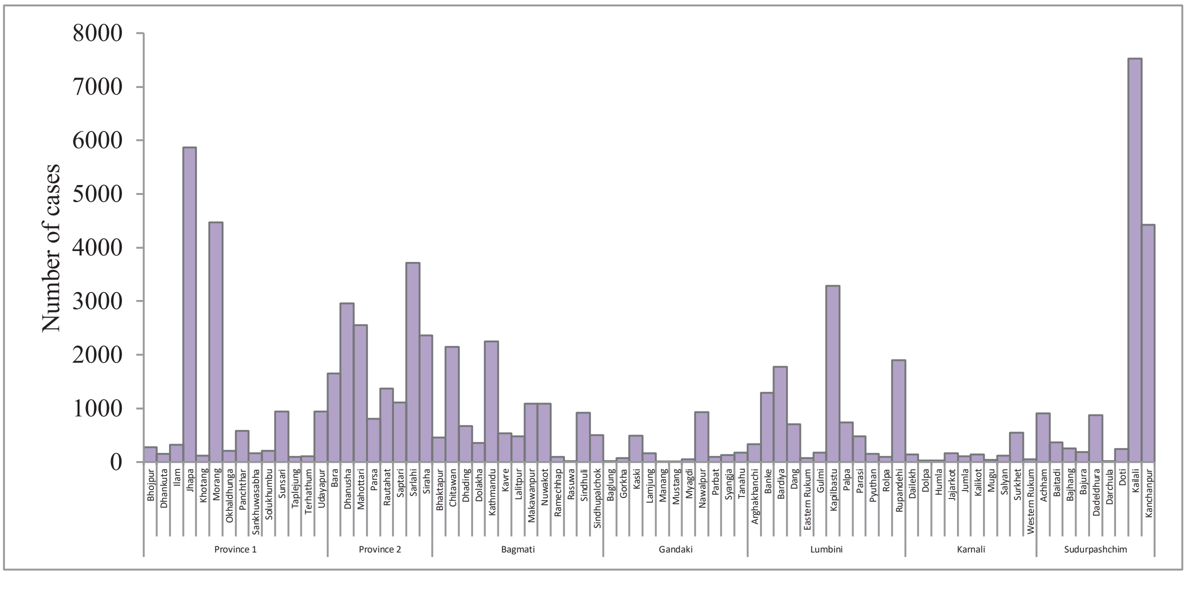


Figure 3. Distribution of vector-borne diseases in districts (2005-2018)

In the Terai region of Province 1 and Lumbini Province and Mountain, Hill, and Terai regions of Sudurpaschim Province, there is evidence of the emergence of new VBDs and WBDs, and an increase in the disease pandemic. The past study also shows that the distributions of common endemic VBDs in Nepal such as malaria, dengue, Kala-azar, JE, and LF are not uniform throughout the country. Initially, they were confined in the Terai districts but now especially malaria, JE, and filaria are spreading over the hills and mountains (Joshi et al., 2020).

The analysis in this study shows that annual variations of VBD cases with maximum temperature were positively associated in Kailali (r^2=0.14) and Kanchanpur (r^2=0.04). A previous study also found that an increasing number of VBD cases in different periods and locations are concerned with a rising average temperature in Nepal (Dhimal et al., 2014). The climate change effects on VBDs are marked in the shifting of diseases and their vectors in highlands areas of Nepal (Dhakal et al., 2011). The diverse topographical and climatic variations have supported the abundance of insect vectors and disease outbreaks. In recent years, chikungunya and scrub typhus have also produced a threat to the Nepalese population (Joshi et al., 2020).

B. Water and Food-borne Diseases

Water-related infectious diseases, such as diarrhoea, cholera, etc., are a major threat to mortality and morbidity worldwide and outbreak frequently occurs after a severe precipitation event. In developing countries, climate change increases extreme weather events, temperatures, and rainfall that elevate the burden of WBDs (Asadgol et al., 2019). Rainfall promotes the development of waterborne disease pathogens. The rainy season is interrelated to the increase of faecal pathogens as heavy rain may stir up sediments in water, leading to the accumulation of microorganisms (Levy et al., 2018). Unusual precipitation after a long drought can also increase pathogens, causing a disease outbreak (Wilby et al., 2005). Droughts lead to low river flows and favour the waterborne pathogens in effluent water (Hofstra, 2011).

As of the year 2000, South Asian countries (including Bangladesh, Bhutan, India, Maldives, and Nepal) bear the largest impact of the global burden of diarrhoea, which is expected to exacerbate in future climate scenarios (The World Bank, 2008). In Nepal, WBDs are the major public health challenge because of inadequate safe water supply as well as poor sanitation and living conditions. Other factors such as literacy rate, socioeconomic status, and social, religious, or personal perception may influence morbidity and mortality of diarrhoeal diseases (Pokhrel & Viraraghavan, 2004).

In Nepal, 15 percent of postnatal deaths (first 59 months) are due to diarrhoeal diseases (WHO and UNFCC, 2015). The diarrhoeal diseases show a definite monthly pattern or seasonal pattern in a year in different physiographic regions of Nepal (Dhimal et al., 2016). The United Nations Children's Fund Nepal Multiple Indicator Cluster Survey for 2014 found that 82.2 percent of samples of household drinking water and 71.1 percent of samples of source water were contaminated with Escherichia coli bacteria (risk level ≥1 colony-forming unit [cfu]/100 mL) (CBS, 2020). The diarrhoeal incidences are predicted to rise in the future, owing to the development of more suitable conditions for the spread of the disease. An analysis of data on temperature and diarrhoea from July 2002 to June 2014 estimated that, for a 1°C increase in ambient temperature, the incidence of diarrhoeal diseases in Nepal rose by 4.39 percent (Dhimal et al., 2016). Some studies reported the increase in temperature correlates with the outbreak of typhoid cases during the winter (Regmi et al., 2016).

The spatial analysis of WBDs carried out in this study, including acute gastroenteritis from 2005 to 2018, revealed that the highest 820,188 (3 percent) and lowest 78,825 (0.05 percent) cases were found in Siraha and Manang, respectively. Besides, looking at the provinces, Province 2 had the highest 5,281,792 (20.1 percent) and Karnali Province had the lowest 2,471,120

(9.4 percent) number of WBD cases. The distribution of diarrhoeal diseases, typhoid, acute gastroenteritis, and cholera was 63.6 percent, 22.5 percent, 13.4 percent, and 0.5 percent, respectively (Figure 4).

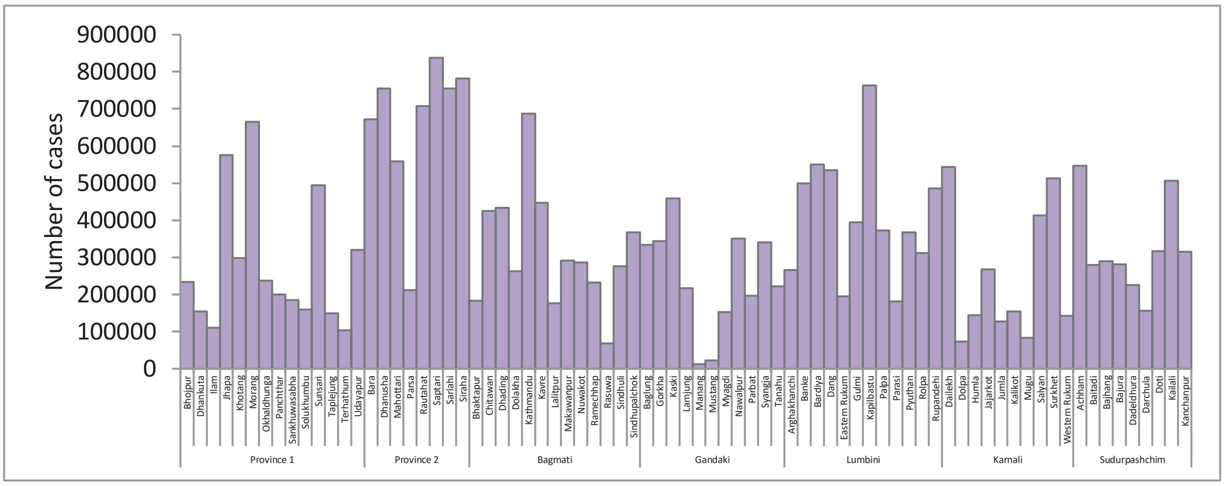


Figure 4: Distribution of waterborne disease cases, period 2005-2018

The analysis further shows that the distribution of WBD cases in Nepal varies with physiographic regions and local weather variations. The spatial-temporal distribution of WBD cases over the 14 years shows the huge fluctuation in three geographical regions (Figure 5).

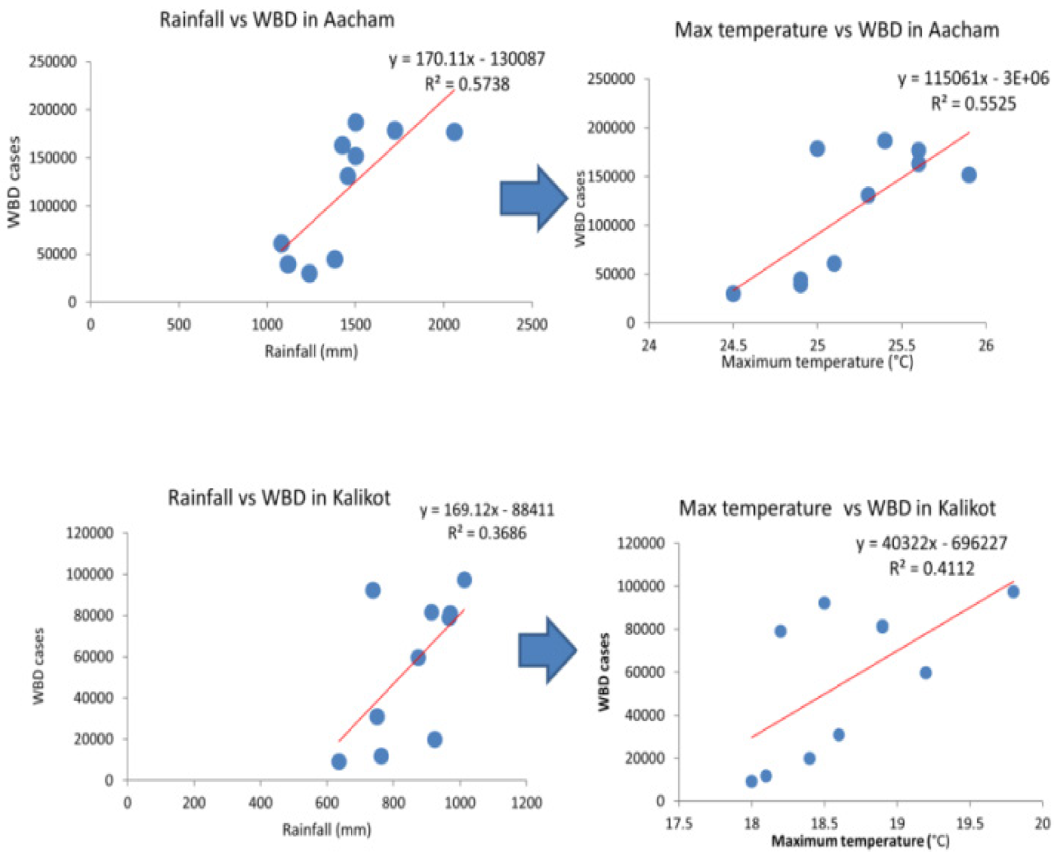


Figure 5: Trends of waterborne disease cases (2005-2018)

It also shows that the outbreaks of WBDs were found in the mountain region of Province 1 and Gandaki Province. The field observation in the villages of Janakpur and Biratnagar showed that the people living in poor settlements are often denied access to drinking water, basic health and hygiene, access to education, and other services. People in these areas lack access to the development stream because of their poverty and marginalization. Among them, the women, the elderly, and children suffer the most. Children have an issue with poor sanitation.

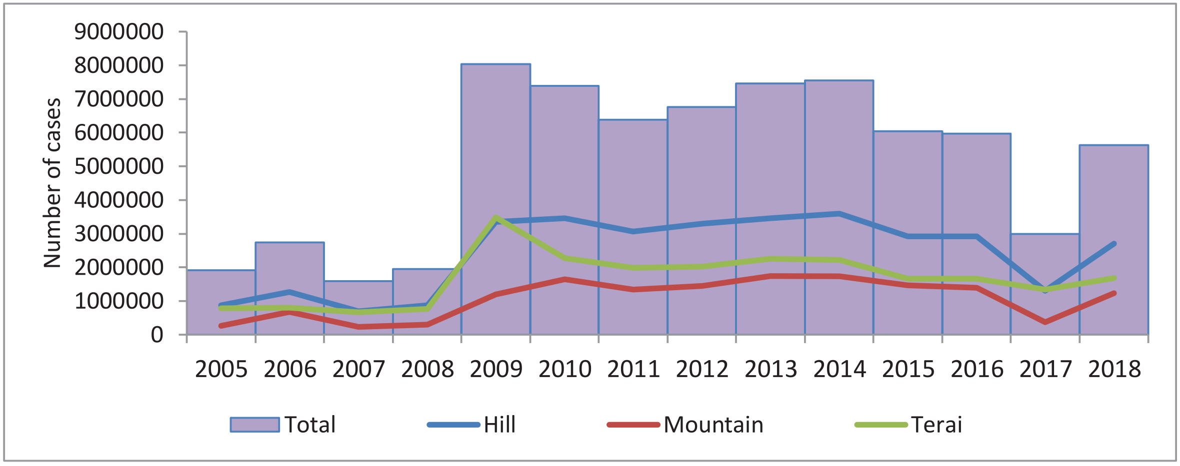


Figure 6: Association of rainfall and maximum temperature with diarrhoeal diseases in Aacham and Kalikot

The analysis in this study shows that variation in local weather patterns in temperature and precipitation influences the distribution of WBDs. Based on the data record from 2005 to 2014, a close relationship between annual rainfall and maximum temperature was found with the WBDs in Achham and Kalikot districts (Figure 6).

C. Heart Diseases

The impacts of climate change increase the risks of cardiovascular diseases. An increase in environmental temperatures and humidity increases cardiovascular disease mortality (Kovats & Hajat, 2008; Parsons, 2014). The effects of climate change together with air pollution vary with individual age, socioeconomic conditions, and health status (Peters and Schneider, 2020).

Heat stress in the Terai region results in hyperthermia, heatstroke, heat exhaustion, heat syncope, heat cramps, and heat rash. From 1974 to 2012, there were nine annual deaths from the heatwave in the Terai region (UNISDR, 2015). Besides, from 2001 to 2010, it is believed that the impact of cold waves affected 1,793 people and was associated with 376 deaths and 80 injuries. On average, approximately 37 people died due to cold waves per year with the highest impact in 2004[4]. During cold waves, people in Terai burn hay to warm themselves which increases the incidence of respiratory problems such as cough, throat infection, chronic obstructive pulmonary disease (COPD), bronchitis, asthma, pneumonia, rotavirus diarrhoea, and skin diseases.

The analysis carried out in this study shows that between 2005 and 2018, heart disease patients were found to be the highest in Kathmandu (n=346,385), followed by Kaski (n=215,609), Morang (n=143,292), and Chitawan (n=133,313). Similarly, Bagmati and Karnali provinces recorded the

4 EARTH JOURNALISH NETWORK: https://earthjournalism.net/stories/cold-waves-add-to-health-woes-in-nepals-lowlands

highest (n=836,143) and the lowest (n=56,609) number of heart disease cases, respectively. Over 14 years of observation among the 2,690,251 heart disease cases, 97 percent hypertension and 3 percent ischemic heart diseases were reported (Figure 7).

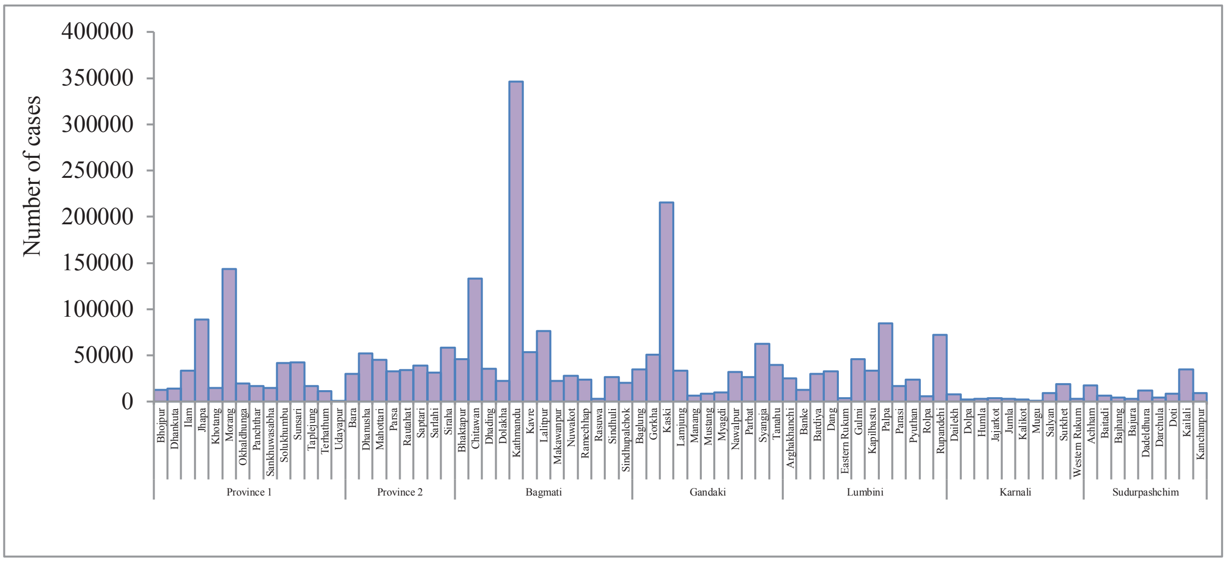


Figure 7: Distribution of heart disease cases in seven provinces and districts of Nepal, period 2005-2018

The distribution of heart disease cases over 14 years in some districts show an increase in linear trend, i.e. coefficient of determination (r^2) ≥ 0.90. Refer to Figure 8.

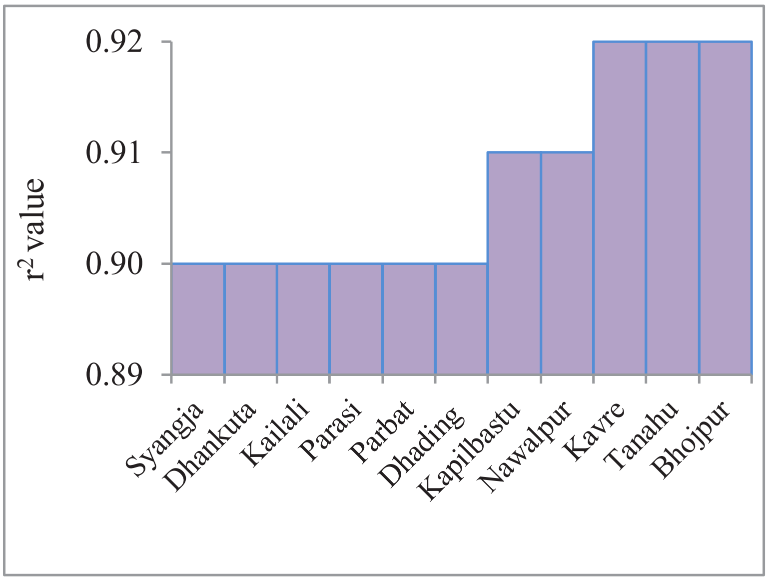


Figure 8: Coefficient of determination of heart diseases in districts, period 2005-2018

A rise in hotness and coldness of average minimum and maximum daily temperatures is positively correlated with deaths and heart disease morbidity (Shrestha et al., 2016). The assessment shows that the annual variations of the number of heart disease cases with maximum temperature show a positive association in Dhankuta (r^2=0.07), Kailali (r^2=0.06), Dhading (r^2=0.06), and Kathmandu (r^2=0.03).

The differential impacts of cold and hot periods on heart diseases depend on age, sex, and other factors such as monthly income, demographic condition, smoking behaviour, and deprivation levels (Bayentin et al., 2010; Mehata, 2018). In the urban population, insufficient physical activity, obesity, hypertension, and tobacco use are major risk factors for cardiovascular diseases (Bogati et al., 2017). The consultations at the provincial level also showed that heart diseases are very common in urban areas and are now a growing health concern for the municipal governments.

D. Respiratory Diseases

The incidence and severity of diseases from climate-sensitive respiratory pathogens have become a challenge in recent years. There will also likely be an increase in respiratory diseases in the future and its burden will be massive. Extreme weather events, such as heatwaves, floods, storms, droughts, and wildfires, change the incidence of respiratory infections (Mirsaeidi et al., 2016).

The analysis carried out in this study shows that in the spatial distribution of respiratory disease cases from 2005 to 2018, the highest numbers were found in Jhapa (n=951,748) and lowest in Eastern Rukum (n=69,322). In 28,997,422 cases over a 14-year period, highest numbers were found in Province 1 (n=5,362,570; 18.5 percent) while the lowest were from Gandaki Province (n=3,362,151; 12 percent). Over the same period, the ARI, pneumonia, bronchitis, asthma, COPD, and viral influenza cases were 45.3 percent, 13.3 percent, 11.5 percent, 11.4 percent, 11.2 percent, and 7.3 percent, respectively (Figure 9).

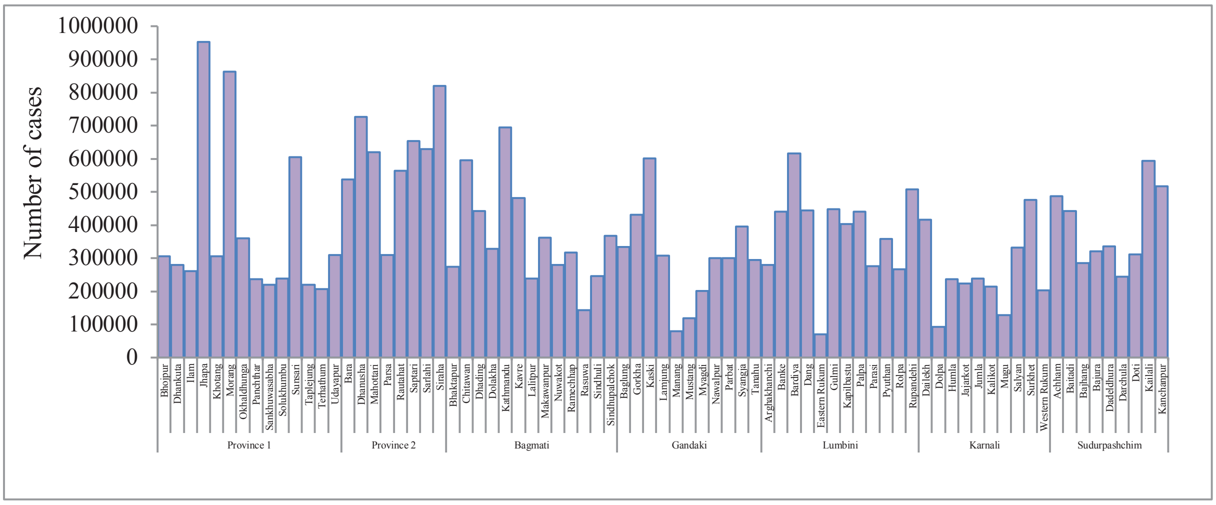


Figure 9: Distribution of respiratory disease cases, period 2005-2018

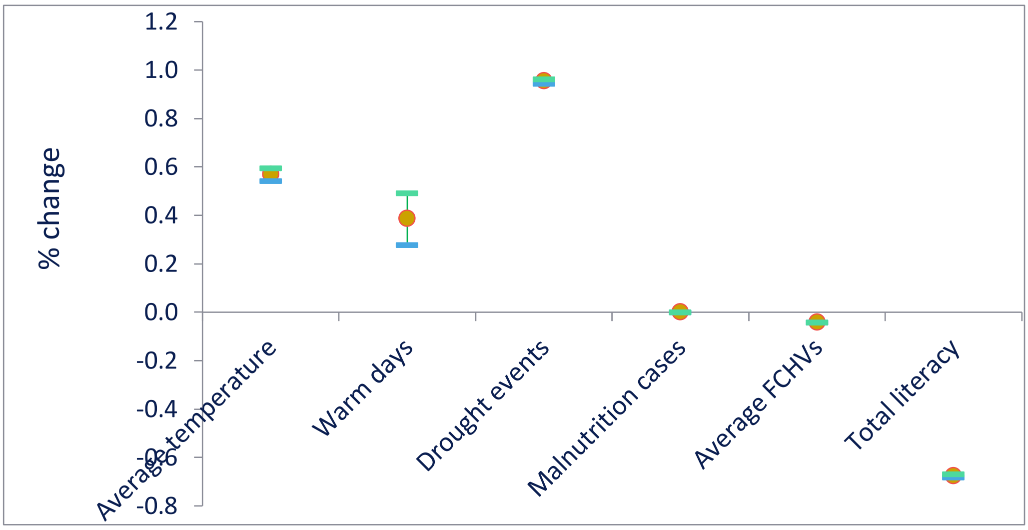


Figure 10: Poison regression model showing an association between climate indices, malnutrition, FCHVs and literacy, and the number of respiratory disease cases from 2005–2015 in the Terai region of Nepal

Studies show that climate change and changing weather patterns may directly or indirectly affect the incidence and severity of respiratory infections by affecting the host immune responses (Dobson, 2009). Young children and older adults appear to be most vulnerable to rapid fluctuations in ambient temperature. An increasing temperature develops asthma and allergic rhinitis in children (Cicco et al., 2020). The cold wave in the Terai region of Nepal causes the deaths of children and the elderly (Pradhan et al., 2019). Studies show that risk factors associated with social, behavioural, and nutritional status as well as the environment take part in the burden of respiratory diseases in Nepal such as ARI, pneumonia, cough, and COPD (Adhikari et al., 2018; Koirala, 2019).

The poison regression analysis carried out, in this study for respiratory diseases, shows that cases of one year were associated with extreme weather events, nutrition status, FCHVs, and a literacy rate of the same year in the Terai and Hill regions. In the Terai region, a 1°C increase in mean temperature was associated with a 0.57 percent (95 percent confidence interval (CI), 0.54 percent - 0.60 percent)) increase of respiratory disease cases. An additional increase of warm days was associated with a 0.39 percent (95 percent CI, 0.39percent - 0.28 percent) increase in respiratory disease cases. A unit increase of drought events was associated with a 0.95 percent (95 percent CI, 0.94 percent - 0.96 percent) maximum increase of respiratory disease cases. A one-unit increase in literacy rate was associated with a maximum -0.68 (95 percent CI, -0.68 percent - -0.67 percent) decrease in respiratory disease cases (Figure 10).

Similarly, in the Hill region, a one-unit increase of cold wave was associated with a 4.11 percent (95 percent CI, 4.07 percent - 4.14 percent) maximum increase of respiratory disease cases. On the other hand, a one-unit increase of warm days was linked to a -15.1 percent (95 percent CI -15.2 percent - -14.9 percent) decrease in cases. The number of cold wave events in the Hill region were positively associated with the increase of respiratory disease cases (r^2=0.18). The co-morbidity of cardiovascular and respiratory diseases ranges from 17 percent to 35 percent. The correlation between the annual sum of heart diseases and respiratory diseases is higher in the Mountain region (r^2=0.38) than Terai and Hill (r^2=0.30).

E. Malnutrition

Climate change and malnutrition in all its forms, including obesity and undernutrition, constitute the greatest threats to the global population and human health. Climate change has led to major weather events, crop failures, food insecurity, and other adverse health consequences. The effects of climate change are more pronounced for poorer people living in low- and middle-income countries, and further escalate existing social inequities (Swinburn et al., 2019).

Despite several efforts, the situation of malnutrition in Nepal is alarming. It has become a serious health problem in Nepal and is a major threat to the health of infants, adolescent girls, and pregnant and lactating mothers (Devine and Lawlis, 2019). In the spatial distribution of undernutrition cases (n=454,658) from 2006 to 2018, the highest were found in Saptari and Kapilvastu and the lowest in Manang. In provinces, the highest were found in Province 2 (22.6 percent), followed by Lumbini Province (21.2 percent), and the lowest (6.5 percent) in Gandaki Province (Figure 11).

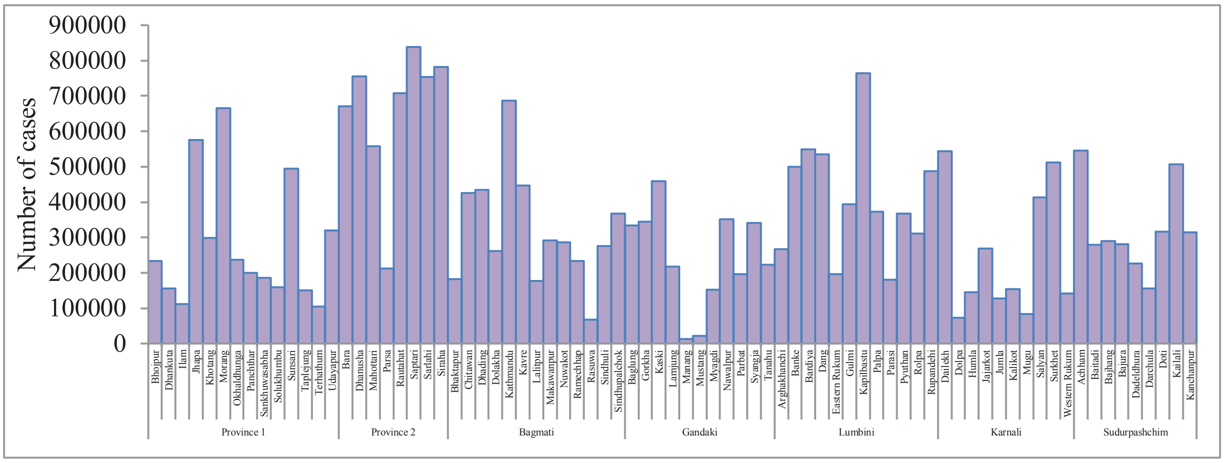


Figure 11: Distribution of malnutrition cases in provinces, period 2006–2018

The results in this study show that the annual sum of malnutrition cases was positively associated with the annual precipitation in Kapilvastu (r^2=0.27), and the annual mean temperature in Dolakha (r^2=0.58), Kanchanpur (r^2=0.36), Rolpa (0.23), and Sarlahi (r^2=0.20). The number of drought events over the 13 years showed a positive association with the number of undernutrition cases per 100,000 population (r^2=0.08). Malnutrition incidence per 100,000 population is positively correlated with the Human Poverty Index (HPI) (r^2=0.34). The distribution trend of undernutrition cases found over 13 years in Kathmandu, Kanchanpur, Lalitpur, and Mugu shows a positive trend with the r^2 values 0.54, 0.43, 0.40, and 0.31, respectively.

4.2 Socioeconomic Loss and Damage (L&D) in the Health Sector

Climate hazards such as floods and landslides cause the biggest human casualties, with an economic loss of USD 5.34 billion and the death of more than 4,000 people in the last ten years (MoHA & DPNet, 2009). Besides the economic loss, survivors experience a high level of physical and mental stress because of the loss of family members (Regmi et al., 2016). Also, there is an increasing trend in health-related hazards in Nepal as a result of the impacts of climate-induced disasters that have caused thousands of deaths in the past two decades (MoHA & DPNet, 2009).

Climate change impacts are also affecting water quality and quantity across Nepal. The heavy rain and flooding adversely affect source water quality and damages water supply infrastructures. The cascade of impacts from climate change on infrastructures is found in healthcare, water supply, electricity, roads, etc., which disrupts the delivery of health services and patient care (Guenther & Balbus, 2014; Warren et al., 2005). In the provincial consultations it was found that in most of the districts of the Terai region, the increasing temperature has lowered the water table. Flooding has impacted water sources such as tube well, ponds, and latrine damage. Heatwaves and cold waves have adversely impacted health and hygiene. The forest fires and floods resulted in a massive loss of life, properties, settlements, and infrastructure services. Floods have also damaged infrastructures in the Mountain and Hill region of Gandaki Province.

Flash floods are generally triggered by extreme rainfall or sometimes glacial lake outbursts, which would cause severe physical injuries and deaths of vulnerable groups, which are often hit the hardest (Shrestha & Bajracharya, 2013). The under-five years' population is more vulnerable to climate change and mortality remains high (i.e., 32 deaths per 1000 live births in 2018) (WHO, 2020). People living in slums or near the river banks are affected by seasonal and occasional flash floods. Similarly, the poor and disadvantaged populations are often forced to live in areas where safe and sufficient water is unavailable. The consequence of climate change may well be that their problems worsen, leading to deteriorations in health and economic aspects (WHO, 2007).

Climate change affects everybody- even though not everybody is equally vulnerable because of the differential sensitivity and adaptive capacity of individuals and groups- which together constitute their vulnerability (Adger, 2006). Several factors like geography, health-system preparedness, health status, age, social class, and support systems determine to what extent people's health will be at risk (MoHP, 2015b). For example, consultations in this study show that people living in the Terai region, flood-prone and humid areas are vulnerable to VBDs and WBDs. Once temperatures increase beyond the comfort range of human tolerance, thermal stress occurs, and that results in discomfort, physiological stress, ill health, or even death (Costello et al., 2009). The experts consulted in this study argued that the poor people, farmers, and labourers working in the sun are greatly affected by heatwaves. People living in slums or near the river banks are affected by seasonal and occasional flash floods. Similarly, during the field assessment as part of this study, it was noticed that the poor and disadvantaged are often forced to live in areas that are not safe and do not have sufficient resources. For example, the majority of the landless Mushar communities reside near the river banks and along the sides of huge dikes which are often prone to flooding during the monsoon season.

4.3 Loss and Damage (L&D) on Health Infrastructure and Services

Given Nepal's topography and climate, there is a widespread distribution of hazards across all the provinces, with the highest combined incidence in Jhapa, Morang, Rautahat, Saptari, Dhading, Makanpur, Sindhupalchowk, Kaski, Syangja, Dang, Nawalpur, Parasi, Dailekh, and Kailali. Climate change hazards such as floods and landslides pose a major risk to the health infrastructures. There is a total of 704 health facilities in Province 1, with flood risk in the Terai, as well as high hazard incidence in the North. Figure 12 shows that in Province 1 combined hazard incidences are threatening the health facilities (NHHSP, 2017).

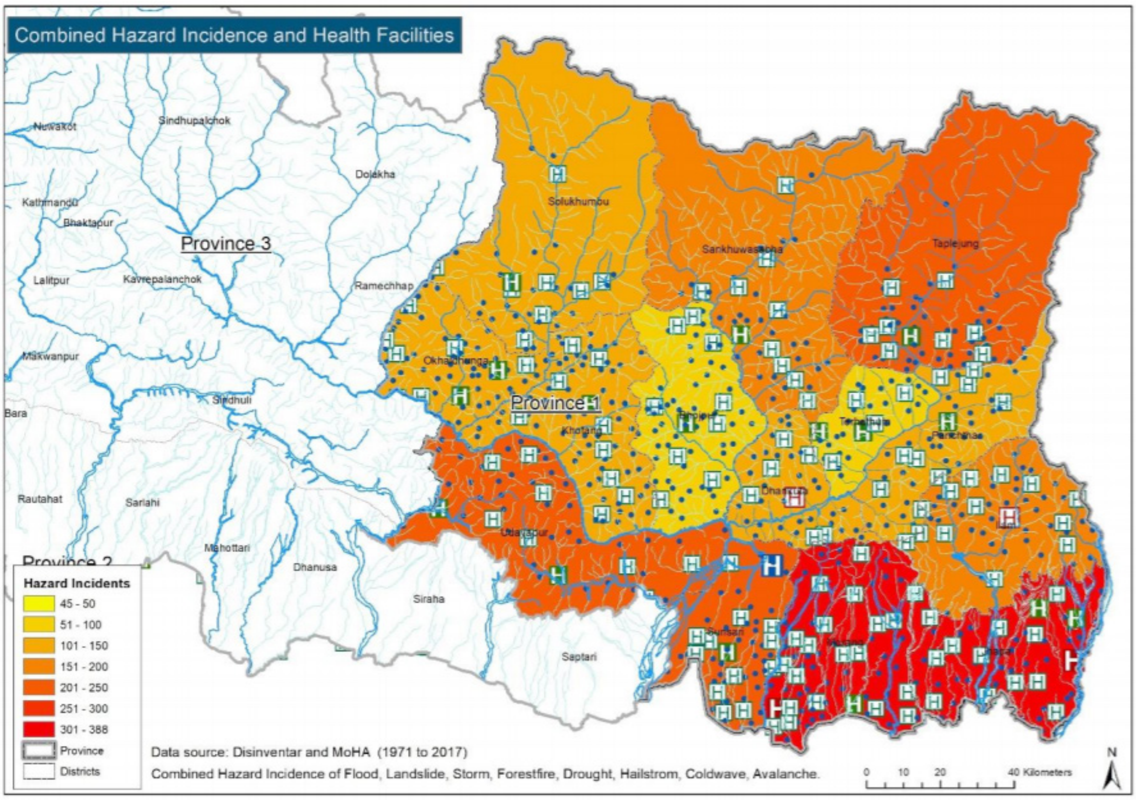


Figure 12: Combined hazard incidence and health facility overlay in Province 1

(Source: NHSSP, 2017)

This analysis by Nepal Health Sector Support Programme (NHSSP) identifies 69 health facilities within 25 m (horizontal distance without considering elevation differences) of a river, comprising 54 health posts and 15 hospitals; seven districts have three health facilities within the study zone: Udayapur and Okhaldhunga (Province 1) Sindhupalchowk (Bagmati Province), Nawalpur and Baglung (Gandaki Province), Eastern Rukum and Western Rukum (across Lumbini and Karnali Province), and Bajhang (Sudurpaschim Province). Distance from the health facility to the river in Khadak Nagarpalika in the Saptari district is outlined in Table 3 below.

Table 3: Distance from health facility to river in Khadak Nagarpalika in Saptari district

Health facility name	Distance to river	River name
Pansera HP	15 m	Amaha Khola
Banarjhula HP	1216 m	Neraha Khola
Siswa HP	641 m	Chapin Dhar
Kalyanpur PHC	411 m	Kharak Nadi
Khojpur HP	464 m	Chapin Khola
Mainal Sahashrabasu HP	2004 m	Kharak Nadi
Inaruwa Phulbadiya HP	1822 m	Kharak Nadi
Banauli HP	1331 m	Kharak Nadi

Source: NHSSP (2017)

The landslide has been one of the major causes of loss and damage in the health sector. There are districts in high incident landslide areas that have large numbers/proportions of their health facilities located on steep slopes. For example: in Ramechhap, 30 out of a total 51 facilities (59 percent); in Baglung, 28 out of a total 70 facilities (40 percent); in Kavrepalanchok, 25 out of a total 68 facilities (37 percent); and in Dolakha, 21 out of a total 38 facilities (55 percent). The NHSSP (NHHSP, 2017) study found the impact of the flood on health institutions as below:

- Health institutions in Salyan are exposed to flooding from the Babai River. The percentage of health posts exposed to flooding is approximately 4 percent of the total number of health posts in this river basin.
- Health institutions in Lalitpur, Kathmandu, Bhaktapur, and Rautahat are exposed to flooding from the Bagmati River. The percentage of health posts and hospitals affected by flooding varies from 9 to 100 percent.
- Health institutions in Siraha are exposed to flooding from the Kamala River. The percentage of health posts and hospitals affected by flooding varies from approximately 5 to 50 percent.
- Health institutions in the Jhapa district are exposed to flooding from the Kankai River. The percentage of health posts and hospitals exposed to flooding varies from approximately 3 to 4 percent.
- Health institutions in Nawalpur and Parasi are exposed to flooding from the Narayani River. Approximately 17 percent of the health posts in this district are affected by flooding. Hospitals, however, are not affected in this district.
- Health institutions in Banke and Dang are exposed to flooding from the Rapti River. Approximately 5 percent of the total number of health posts for this river basin would be affected. There are no hospitals affected in this river basin.
- Health institutions in Rupandehi are exposed to flooding from the Tinau River. 20 percent of the health posts in this district are affected by flooding. Hospitals are not affected by flooding in this district.

4.4 Perceived Impacts of Climate Change in the Health Sector

A climate perception survey (2017) carried out by the government of Nepal indicates the percentage distribution of households observing an increase in the incidence of disease in humans in the last 25 years. The survey reveals that 40.12 percent of respondents are observing an increase in the incidence of disease in humans in the last 25 years while 59.88 percent are not. The highest percentage of households in the far-western mountain eco-development region (81.72 percent) is observing such an increase while only 10.37 percent of the respondents reported so in the eastern hill. Similarly, 39.93 percent of the respondents in Kathmandu Valley reported of increment in disease in the last 25 years (CBS, 2017).

The consultations conducted in the provinces and local level as part of this study also revealed that stakeholders perceived the increase in epidemics due to climate extreme events and increasing temperature and precipitation changes. The majority of the stakeholders in Karnali, Gandaki, and Lumbini Provinces cited examples of an increase in diseases, mostly vector-borne and waterborne diseases. See Annex for more details.

Observed and Projected Climate Change Hazards and Exposure in Health

5.1 Climate Change Trends and Scenarios

The DHM study (2017) shows that significant positive trends are observed in annual and seasonal national maximum temperature. All of Nepal's minimum temperature shows a significantly positive trend only in the monsoon season. No significant trend is observed in precipitation in any season. All of Nepal's annual maximum temperature trend is significantly positive (0.056°C/yr). All of Nepal's annual minimum temperature trend is also positive (0.002°C/yr) but it is insignificant. The number of rainy days is increasing significantly mainly in the north-western districts. Very wet and extremely wet days are decreasing significantly, mainly 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.

The findings show that maximum temperature trends are higher than minimum temperature trends in all seasons and that maximum temperature trends are more robust than minimum temperature and precipitation trends. The observed climate trends in districts and physiographic regions along with the information on significance level analyzed are presented in this report. While a higher significance level provides a clear signal in the trend, no clear conclusion can be drawn from insignificant trends.

The government of Nepal has published future climate change scenarios for the medium-term (2016–2045) and the long-term(2036-2065) periods corresponding with the 2030s and 2050s respectively for the reference period 1981–2010, as laid out by the National Adaptation Plan process (DHM, 2017). The scenarios have predicted the following.

- The scenario shows about 77 percent of the precipitation falls during the monsoon season. The average mean temperature is 12°C, the average mean winter temperature is 4.6°C, and the average summer mean temperature is 17.7°C. The lower elevation areas are warmer than the mountains.

- The average annual mean temperature change is projected to increase by 0.92°C, whereas, in the long-term period, it is likely to increase by 1.72°C on average. However, there is a spatial variation of projected changes in which the western region is likely to increase more than the eastern region. There is a slightly higher temperature trend in the high mountains than in other regions in both the medium-term and long-term scenarios. In the medium-term period, the average temperature change is projected to be 1.07°C warmer whereas, in the long-term period, it is likely to be 1.82°C warmer on average. In general, RCP 8.5 will be warmer than RCP 4.5 for both periods.
- In RCP 4.5, the average annual precipitation change for the medium-term period is projected to increase by 2.1 percent, whereas, in the long-term period, it is likely to increase by 7.9 percent. The RCP 8.5 will be wetter by 6.4 percent in the medium-term period and 12.1 percent in the long-term period. Precipitation is likely to increase in the central and western parts in both the short-term and the long-term periods. In both scenarios, the eastern part is subject to a lower increase, which is mainly because the precipitation volume is the highest there.
- In the whole of Nepal, the average change in precipitation is likely to increase in the range of 2.1 to 7.9 percent for RCP 4.5 and 6.4 to 12.1 percent for RCP 8.5 concerning the reference period. Similarly, the temperature may increase in the range of 0.92ºC to 1.3ºC for RCP 4.5 and 1.07ºC to 1.82ºC for RCP 8.5 concerning the reference period by the middle of the century.

5.2 Climate Change Stressors/Hazard in Health

Climate change, together with other natural and human-made health stressors, influences human health and diseases in many ways. Climate hazards such as severe floods, landslides, and droughts have claimed millions of lives in the past 20 years (Noji, 2000). The floods (in the plains) and landslides (in the hills) associated with the monsoon rains caused the biggest human casualties and WBD and VBD outbreaks as well as infrastructure damage (Regmi et al., 2016). Both hazards also have major impacts on livelihoods, affecting tens to hundreds of thousands of people every year (MoSTE, 2014).

The health effects of climate change are temperature-related illnesses and deaths, extreme weather-related health effects, air pollution-related health effects, waterborne diseases, and vector-borne diseases (WHO, 2015). Climatic conditions affect epidemic diseases. Vectors, pathogens, and hosts each survive and reproduce within a range of optimal climatic conditions. The temperature and precipitation are the most important climate variables to influence vector survival, reproduction, and transmission. Rainfall can influence the transport and dissemination of infectious agents, while temperature affects their growth and survival.

The human and economic impacts of climate-induced disasters were analyzed from 1971 to 2019. On average, 647 people die from climate-induced disasters in Nepal each year which is about 65 percent of the total deaths from all disaster events except road (and other) accidents (MoHA, 2018). The maximum number of climate-induced disaster deaths occurred in 2001. In 2001 alone, 1866 people lost their lives due to epidemics, landslides, thunderbolts, fires, floods, heavy rainfall, and windstorms.

IPCC (2012) has concluded, with high confidence, that climate change would cause increased heat-related mortality and morbidity, decreased cold-related mortality in temperate countries, greater frequency of infectious disease epidemics following floods and storms, and substantial health effects following population displacement from sea level rise and increased storm activity.

Relationships between year-to-year variations in climate variables and infectious diseases occurrence need to be explored for understanding the attribution and future health impacts of climate change. An analysis of 49 years (1971-2019) of epidemics data revealed that Morang, Dang, Jajarkot, and Banke are the most epidemics-affected districts in Nepal. The trend of the epidemic events in the Dang district was compared with the trend of the annual rainfall and annual maximum temperature. Figure 13 shows the trend of the epidemic events and annual rainfall and their relationship.

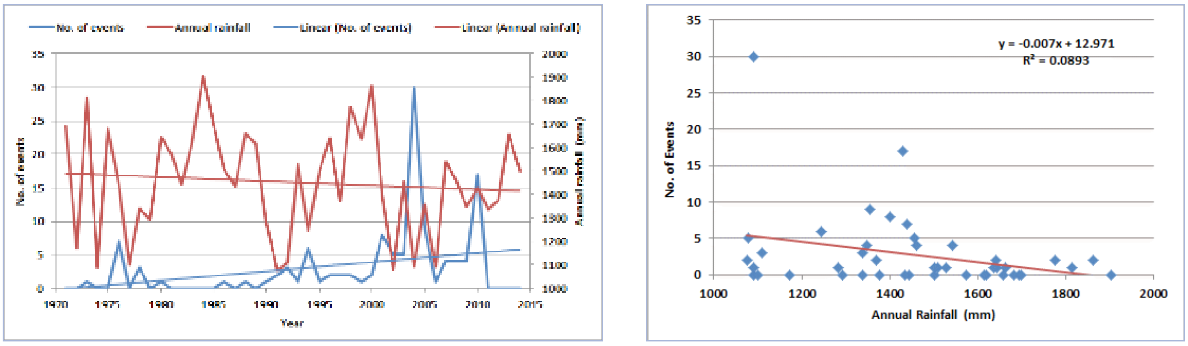


Figure 13: Trend of epidemic events and annual rainfall in Dang district

Similarly, Figure 14 shows the trend of epidemic events and annual maximum temperature and their relationship. The epidemic events and maximum temperatures are in increasing trend whereas the annual rainfalls are in slightly decreasing trend. Observed climate trend analysis by DHM (2017) showed that annual rainfall in Dang district is in decreasing trend and consecutive dry days are in increasing trend. Similarly, annual temperature, warm days, and warm spell duration are in increasing trend. A warm and dry climate provides a favourable condition for the growth and spread of vector-borne and waterborne diseases.

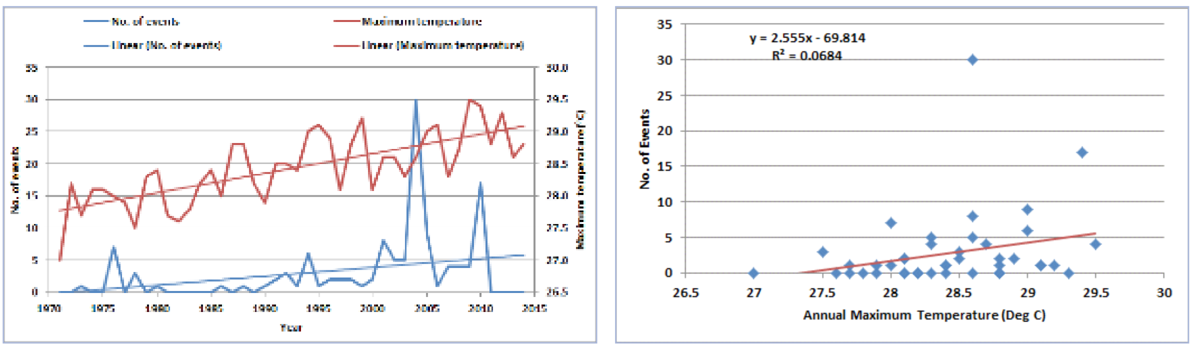


Figure 14: The trend of epidemic events and annual maximum temperature in the Dang district

The significant increasing trends in the frequency of several climatic hazards show a strong linkage between climate change and an increase in climatic hazards. The observed increase in climatic hazards may be attributed to a "complex set of interactions between the physical Earth system, human interference with the natural world, and increasing vulnerability of human communities"[5]. The IPCC (2014) also suggests that there is very high confidence that "in urban areas, climate change is projected to increase risks for people, assets, economies, and ecosystems, including risks from heat stress, storms, and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, and storm surge". The district-wise analysis of epidemics from this study is given in Figure 15.

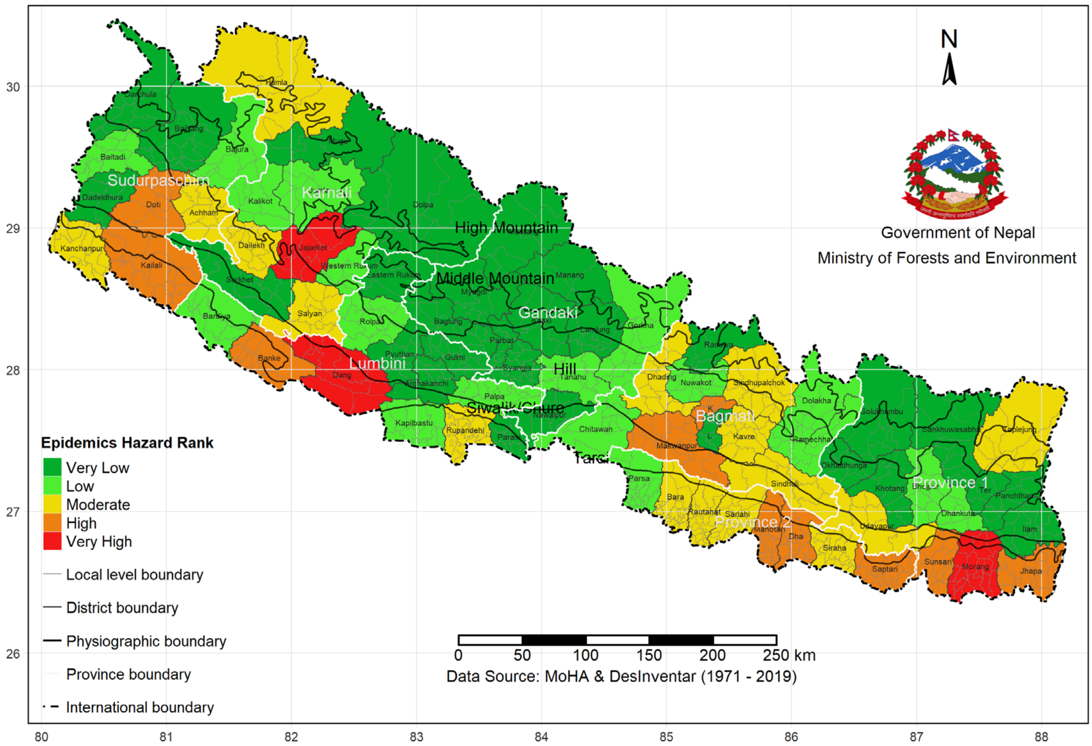


Figure 15: Map of Nepal districts showing overall disease epidemics

The high epidemic risk districts are Morang, Dang, and Jajarkot. Each epidemic event has a range of adverse effects on human health, especially that of rural, vulnerable, and marginalized populations (Shrestha & Aryal, 2011). Annex 4 shows key results of district-level epidemic hazard rank assessment in Nepal. This annex draws information from the MoFE/NAP (2020) study "climate change VRA and identifying adaptation options". Tables show the baseline climate hazard related to heart diseases, respiratory diseases, VBDs, and WBDs.

A very high risk of flood is found in some Terai districts (Jhapa, Morang, Sunsari, and Kailali). In contrast, a very high landslide risk is found in the districts (Taplejung, Sankhuwasabha, Sindhupalchowk, Dhading, Baglung, Kaski, and Dolpa) of Hill and Mountain regions (Figure 16).

5 The Conversation (Available at: https://theconversation.com/explainer-are-natural-disasters-on-the-rise-39232).

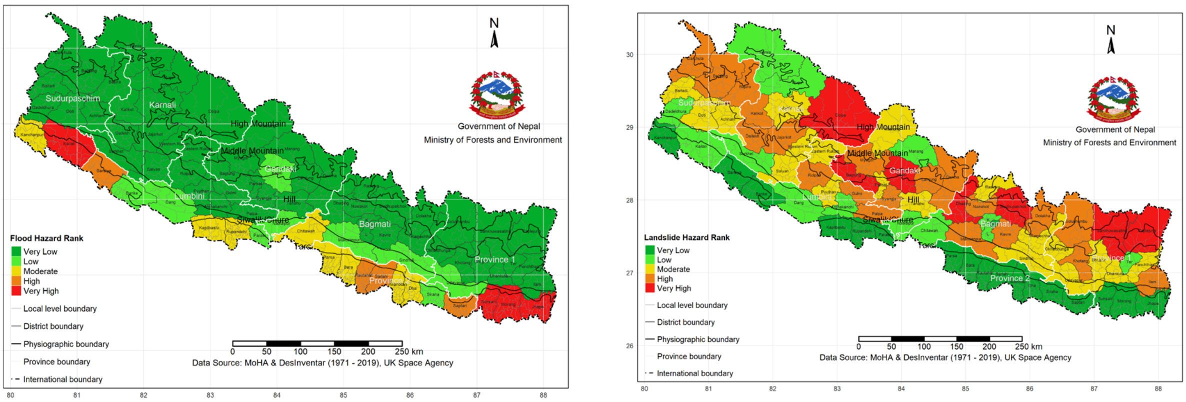


Figure 16: Maps of Nepal districts showing overall flood (left) and landslide (right) events

Climate hazards such as cold waves and heatwaves increase the VBDs, WBDs, and heat/cold-related mortality (Pachauri et al., 2014). A Ministry of Health Vulnerability and Adaptation Assessment Report (2015) found that 262 cold waves were recorded in Nepal between 2001 and 2010, and except for spikes in 2003 and 2004, an upward trend has been observed. In 2010 alone, cold waves were recorded in 58 different locations. It should be noted that although global climate models indicate that days of extreme cold (cold spell duration index) are expected to decline globally as a result of climate change, in this context, cold waves are thought to be formed by more localized influences such as smog formation which are not currently included in the global models. It is believed that in recent years, cold waves have become a major health threat to the people living in the 23 Terai districts of Nepal.

Cold-related diseases like viral flu, coughs, cold diarrhoea, fever, asthma, common cold, and pneumonia are common. Cold waves may also exacerbate the cases of arthritis among the elderly. The poor and marginalized, especially the elderly, children, the ill, pregnant women, and the disabled, are most vulnerable to the health impacts of a cold wave. Families which live in substandard housing also suffer, as do those who lack adequate clothing, food, and fuelwood (WHO, 2015). Cold wave mortality is higher in respiratory diseases and cardiovascular diseases than heatwaves (Yang et al., 2015). A very high heatwave risk is found in Bara and Bardiya. Similarly, a high cold wave risk is found in Saptari, Mahottari, and Rautahat (Figure 17).

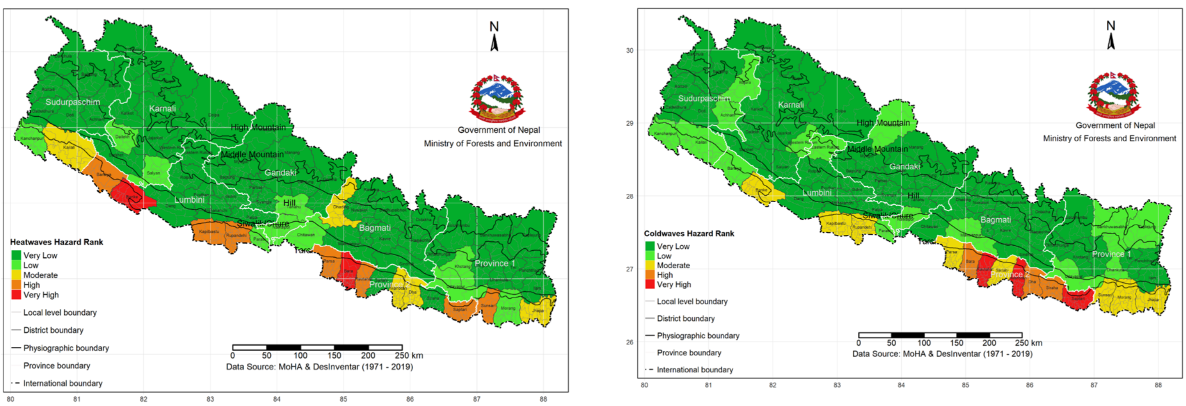


Figure 17: Maps of Nepal districts showing overall heatwave (left) and cold wave (right) events

In Nepal, both heatwaves and cold waves due to climate change have affected mainly people of the Terai districts, and the deaths belonged particularly to the poor and homeless people (Pradhan et al., 2019).

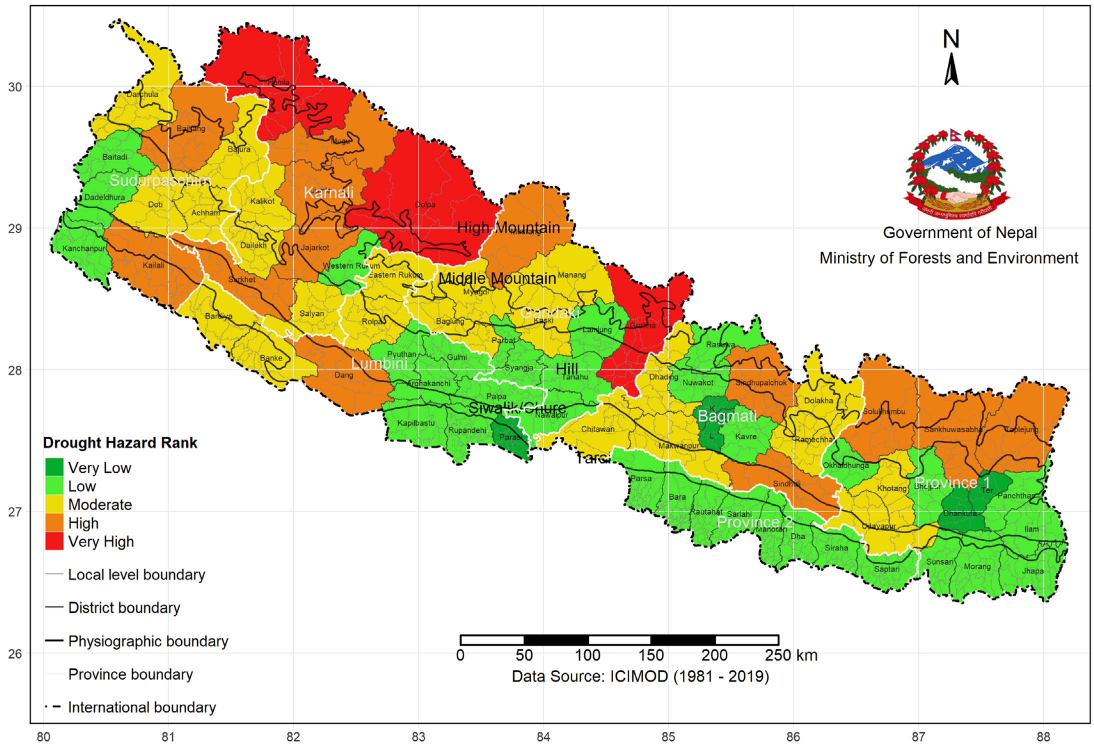


Figure 18: Maps of Nepal districts showing overall drought

The districts at a very high-risk from drought are Gorkha, Dolpa, and Humla. The high drought risk is found in most of the Mountain districts and few Hilly districts. The impact of the drought is especially found in poor people in urban and rural areas. Droughts bring food insecurity to the farmers of low-income countries where agriculture is the main source of the economy (Figure 18).

Climate extremes of temperature and precipitation create a significant impact on the disruption of food production and water supply, damage infrastructure and settlements, lead to morbidity, mortality, and consequences for mental health and human well-being. Local changes in temperature and rainfall have altered the distribution of some water-borne illnesses and disease vectors (Figure 19).

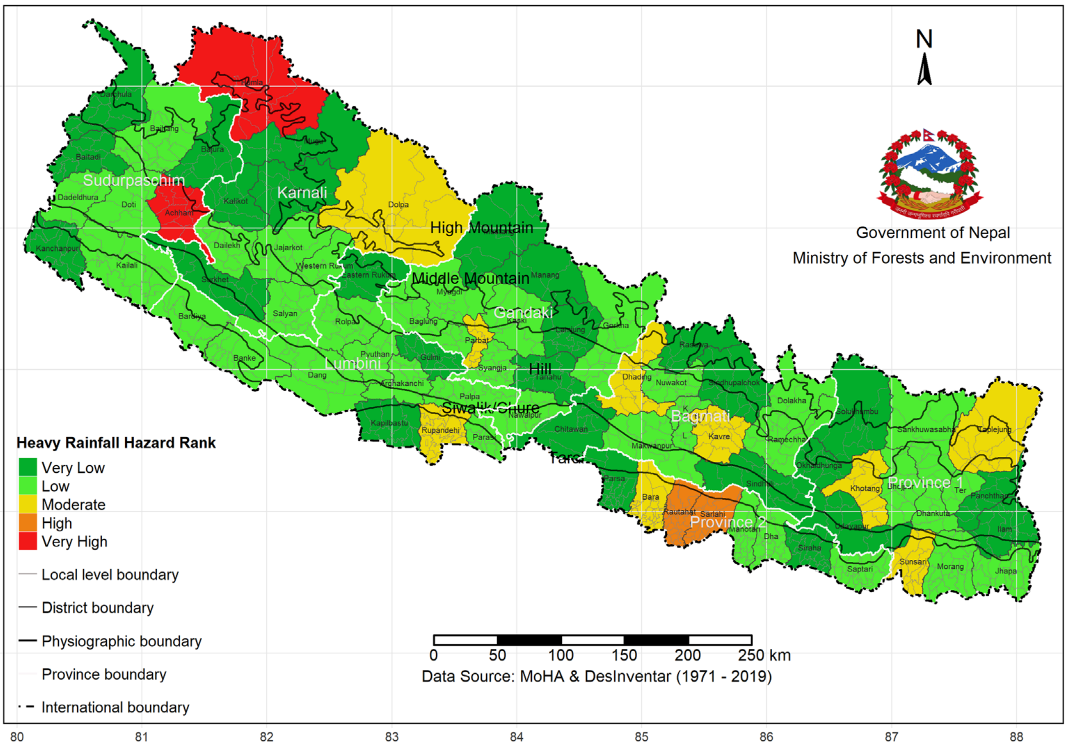


Figure 19: Map of Nepal districts showing heavy rainfall hazard

Flash floods are generally triggered by extreme rainfall or sometimes glacial lake outbursts (Shrestha & Bajracharya, 2013). The extreme precipitation has impacted the rainfall in Achham and Humla. The higher temperature increases the likelihood of precipitation falling as rain rather than snow which can result in increased likelihoods of floods during the rainy season and decreased river flows during the dry season. This ultimately affects river regimes, frequency of natural hazards, water supplies, health, infrastructures, and people's livelihoods (Jianchu et al., 2007).

Population under five is more sensitive to climate change and mortality remains high (i.e., 32 deaths per 1000 live births in 2018) (WHO, 2020). Likewise, the people living in the slum areas are vulnerable to VBDs and WBDs. Once temperatures increase beyond to which humans generally feel comfortable, thermal stress results in discomfort, physiological stress, ill health, or even death. The poor people, farmers, and labourers exposed to the sun are greatly influenced by heatwaves (Dhimal et al., 2018). People living in slums or near the river banks may be affected by seasonal and occasional flash floods (WHO, 2020).

5.2.1 Climatic Hazard Baseline and Scenarios

Hazards in this assessment have been selected based on historical events, literature studies, and consultations. Priority is given to stressors or extreme events with a certain magnitude, frequency, and potential to have immediate consequences. Weightage to the sectoral hazards indicators was given as per the experts' judgment. The experts were selected based on their competencies in the sector. The database of all the climatic parameters and extreme events in their respective trend and scenario context is available at the district level which is later factored in at province and physiographic regions. The major climate change hazards and stressors in the sector are illustrated in Table 4.

Table 4: Weightage in climate change stressors/hazards in the health

Hazard indicators	Weightage	Hazard indicators	Weightage
Change in consecutive dry days (%)	0.09	Change in consecutive wet days (%)	0.04
Change in warm days (%)	0.07	Change in number of rainy days (%)	0.28
Change in temperature (^{0}C)	0.22	Change in precipitation (%)	0.15
Change in warm spell duration (%)	0.03	Change in extreme wet days (%)	0.11
Change in cold spell duration (%)	0.04		

The provincial and local consultations carried out in this study found that community and stakeholders at the local level perceived any increasing climate extreme events and their negative impact on the socio-economy and health system. During interaction with the communities and stakeholders, they revealed the following.

- Floods, heatwaves, and cold waves were identified as the main extreme weather events in the south plains of the Terai region. The changes in the trend are mainly due to an increase in VBDs. These changes resulted in impacts on marginalized and landless households, poor labour women and elderly, children and pregnant women, and infants. The outbreak of WBDs and VBDs was mainly an increase with temperature changes and rainfall variability in Province 2 and Lumbini Province. The respiratory diseases' burden was increased from biomass burning. The temperature and rainfall variability resulted in the WBD epidemics in Lumbini Province. Poor people and landless people reside in slums, riverbanks (such as along Seti River, Kamala River, Mohana River), and other risky areas which are highly prone to disasters such as flooding and landslides.
- In the Mountain region, melting of snow and glaciers, drying of water springs, and epidemics events were identified as the main extreme weather events. The change in trends was identified as the increase in temperature, change in rainfall, and variability and occurrence of hazards. Most impacted were the ethnic minorities, Dalits, women, girls, children, and elderly belonging to marginalized and poor households. In Lumbini Province, the increasing events of floods, heatwaves, and cold waves impacted the women, elderly, and children of squatter and landless settlements and people living in flood-prone areas.
- In the Hill region, floods, landslides, droughts, and forest fires were identified as the main extreme weather events. The change in trends was identified in rainfall variability, increase in the frequency of flood and landslide events, increase in droughts and forest fires events, and increase in the epidemics with the emergence of new diseases. The changes resulted in the impacts on women, children, the elderly, ethnic groups, Dalits, ultra-poor households, and school children due to additional stress and burden for fetching water and work drudgery, and health issues for children during winter and monsoon. The loss of lives due to the spread of diseases resulted in Lumbini Province.
- In the Mountain and Hill region of Gandaki Province, floods, droughts, and temperature rise were identified as the main extreme weather events. The events resulted in the impacts on the emergence of VBDs and the dispersal of vector mosquitoes in uphills.

A. Trends of consecutive dry days and extreme wet days

Climate change-related shifts in weather patterns affect disease patterns. Prolonged dry periods and droughts impact both surface and groundwater water availability. Increased temperatures increase the rapid growth and survival of microorganisms in drinking-water storage and distribution systems (WHO & DFID, 2019).

The trend analysis here shows positive and negative trends of consecutive dry days and extreme wet days (Figure 20). In consecutive dry days, most of the districts have values between -0.35 to 0.3. This means in each consecutive 10 years, there is likely to be a decrease in consecutive dry days. On extreme wet days, most of the districts have values from 0 to 0.1. Syangja is showing a positive trend. This indicates, it is likely to increase one more extreme day in Syangja in each consecutive 10 years.

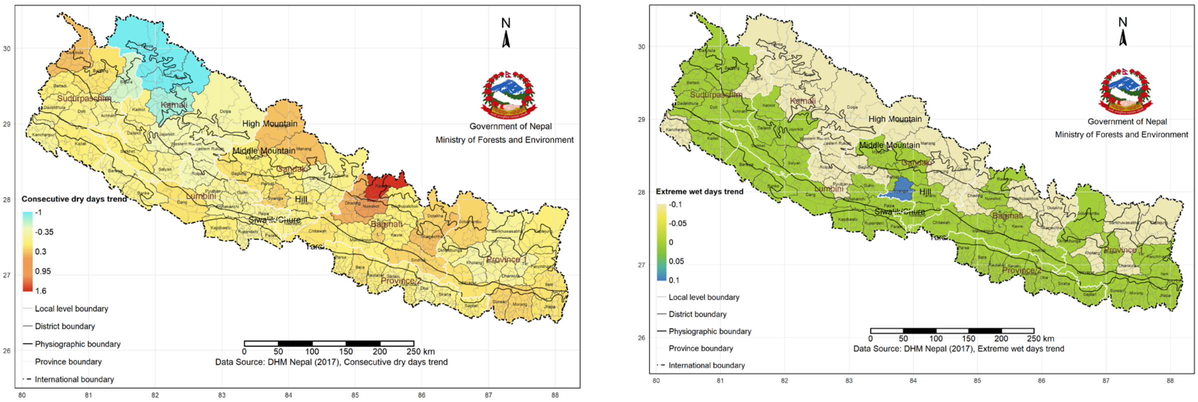


Figure 20: Trends of consecutive dry days (left) and extreme wet days (right)

B. Trends of rainy days and annual precipitation

The changes in precipitation and rainfall impact disease development by alteration of disease pattern, development of vector, and its distribution. For example, an increase in precipitation increases the intensity of a flood. The increased risks of flood on WBDs and VBDs are previously considered in the non-endemic mountain area of Nepal (Shrestha & Aryal, 2011).

The trend analysis in this study shows positive and negative trends in the changes of rainy days and precipitation (Figure 21). Most of the districts have positive values in rainy days and annual precipitation. The Humla shows the highest positive trend of rainy days. Similarly, Bardiya and Syangja show a maximum positive trend of precipitation.

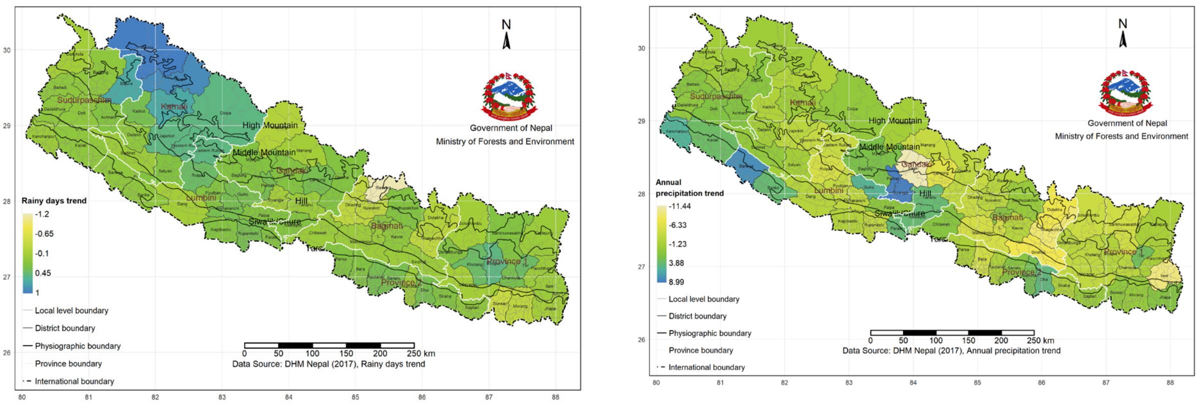


Figure 21: Trends of rainy days (left) and annual precipitation (right)

C. Trends of annual maximum temperature and warm days

The maximum temperature trend is significantly positive and is increased by 0.056^{0}C/yr in Nepal (DHM, 2017). The trend shows that Manang and Taplejung have a higher increasing trend in annual maximum temperature. Bara and Rautahat districts are observed with the least increasing trend. Similarly, the warm days' trend shows that Taplejung and Panchthar have a higher increase in annual trends.

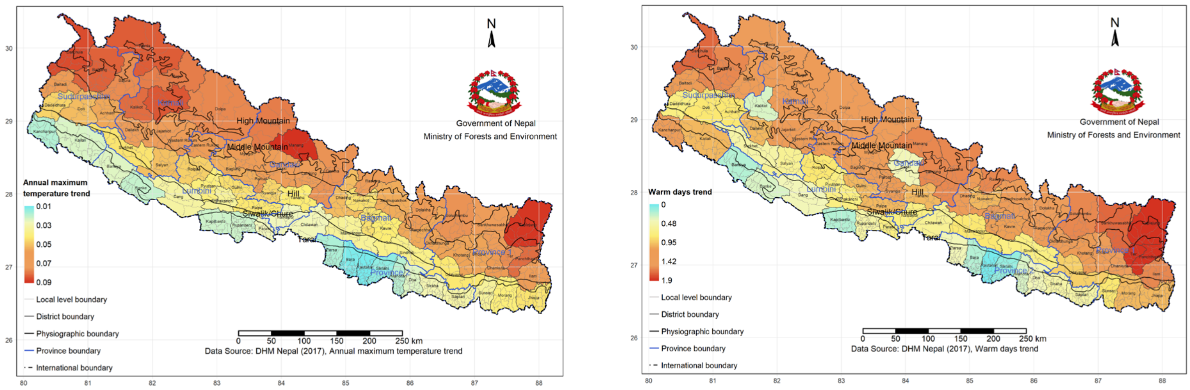


Figure 22: Trends of annual maximum temperature (left) and warm days (right)

The increasing and decreasing of long-term temperature and warm days trends have both direct and indirect impacts on disease development, transmission, and vector dispersal. The modest reductions in cold-related mortality and morbidity in the highlands, due to fewer cold extremes, increased morbidity and mortality related to cold waves in southern Terai; and the reduced capacity of disease-carrying vectors because of exceeding thermal thresholds, especially in the lowland Terai regions (Aryal et al., 2014; Baidya et al., 2008). Besides, the poor people, farmers, and labourers working in the sun are greatly affected by heatwaves (Dhimal et al., 2018).

5.2.2 Baseline and Projection of Extreme Events

The health sector and associated infrastructures are vulnerable to extreme climate conditions. Changes in consecutive wet days, consecutive dry days, warm days, number of rainy days, temperature, warm spell duration, precipitation, extreme wet days, and cold spell duration are the key climate hazards identified in this assessment. The baseline shows Taplejung, Sankhuwasabha, Ilam, and Jhapa have a very high health-related extreme event index. The Terhathum, Panchthar, Syangja, and Tanahu districts have high health-related extreme weather events. The very high and high category of baseline index in extreme weather events in Figure 23 is because of high weightage to the precipitation-related climate stressors on health.

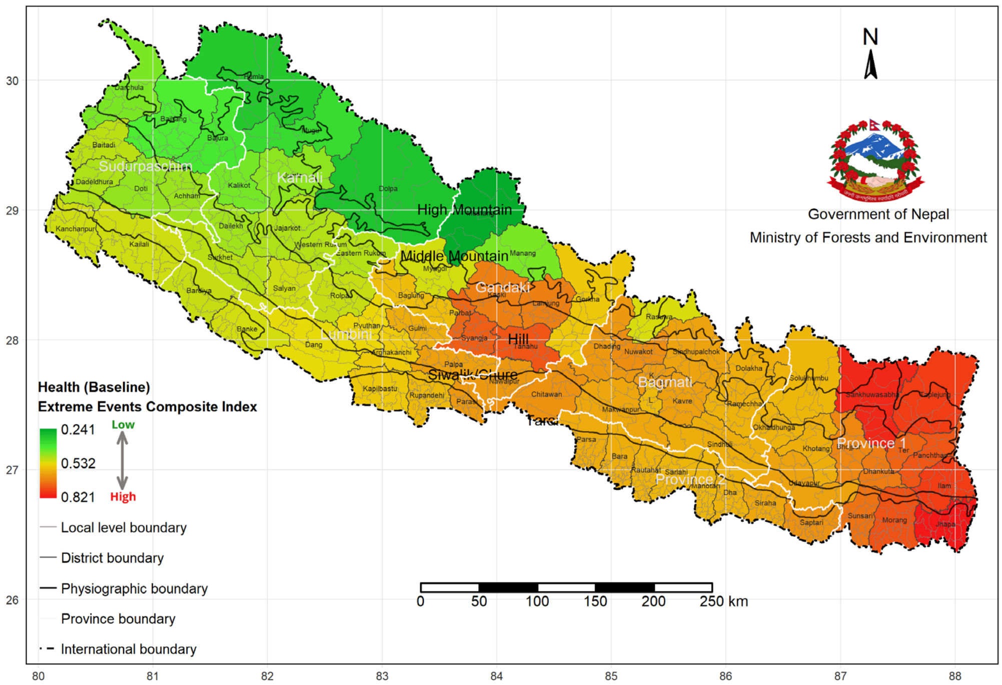


Figure 23: Baseline climate extreme events in health

In RCP 4.5 and RCP 8.5 climate change scenarios for 2030, Sankhuwasabha, Taplejung, Panchthar, Ilam, Jhapa, and Morang of Province 1 and Tanahu and Syangja of Gandaki Province will experience higher incidences of climate extreme events related to the health sector (Figure 24).

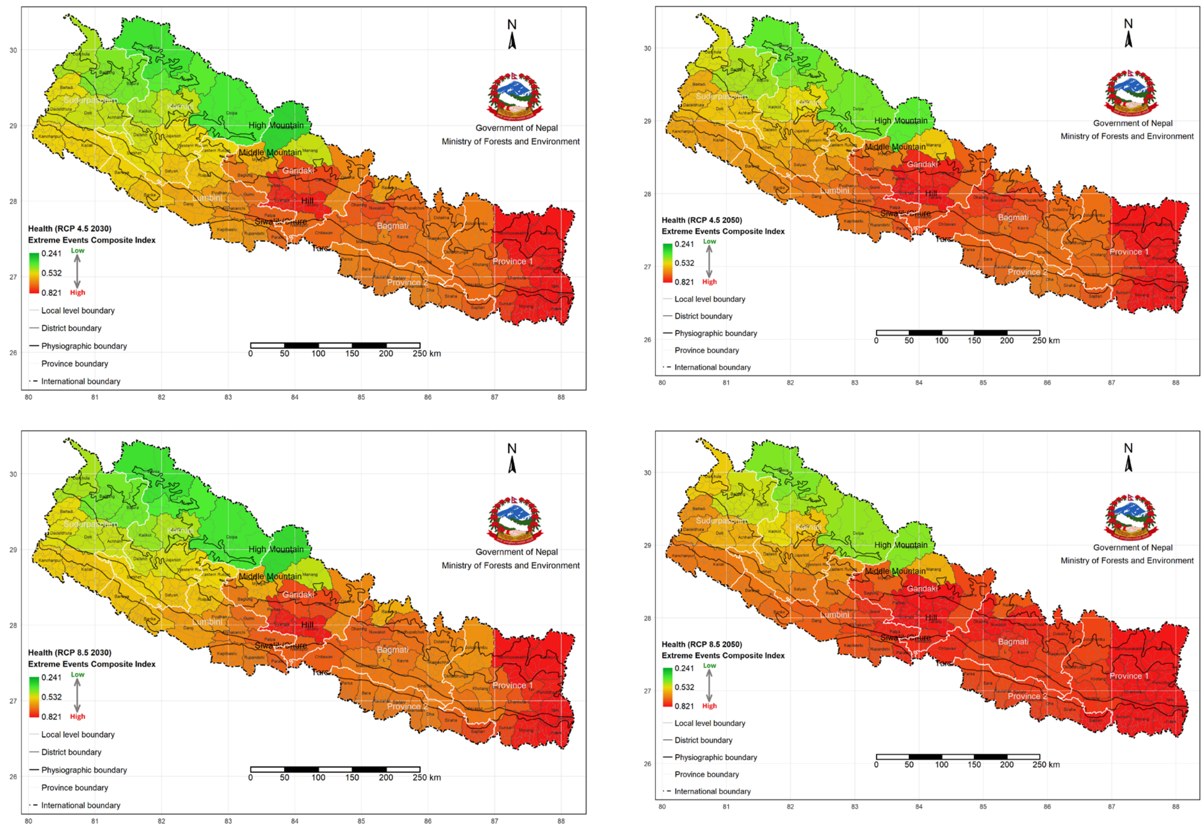


Figure 24: Projected extreme events hazard in health (RCP 4.5 and RCP 8.5)

Studies also show that climate change is expected to increase mean annual temperature and the intensity and frequency of heatwaves resulting in a greater number of people at risk of heat-related medical conditions. The elderly, children, the chronically ill, the socially isolated, and at-risk occupational groups are particularly vulnerable to heat-related conditions. Under a high emissions scenario, heat-related deaths in the elderly (65+ years) are projected to increase to about 53 deaths per 100,000 by 2080 compared to the estimated baseline of approximately 4 deaths per 100,000 annually between 1961 and 1990. A rapid reduction in global emissions could limit heat-related deaths in the elderly to about 12 deaths per 100,000 in 2080 (Honda et al., 2014). Refer to Figure 25.

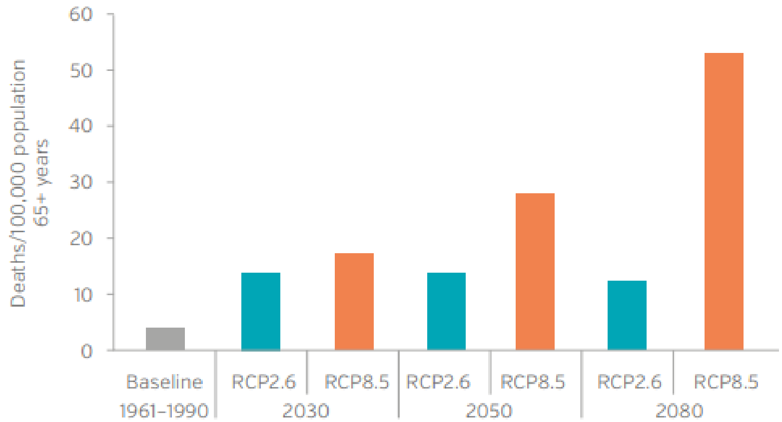


Figure 25: Heat-related mortality in population 65 years or over, Nepal (deaths/100,000 population 65+years)

(Source: WHO & UNFCCC, 2015)

5.3 Climate Change Exposure in Health

The exposure indicators considered for the analysis include total number of hospitals, health posts, sub-health posts, private/nonpublic health institutions, medical stores, laboratories, water supply infrastructures and services, drinking water supply schemes, and water treatment facilities.

The analysis shows that Kathmandu and Manang were among the district having the highest and the lowest exposure index, respectively. The exposure rank analysis revealed that Kathmandu of Bagmati Province and Morang of Province 1 has very high exposure. Similarly, Jhapa and Sunsari of Province 1, all districts of Province 2, Lalitpur, Kavrepalanchok, and Chitawan of Bagmati Province, Kaski of Gandaki Province, Rupandehi of Lumbini Province, and Kailali of Sudurpaschim Province have high exposure. Moderate exposure was found in most of the western districts of the Terai region including Panchthar, Makwanpur, Dhading, Nuwakot, Sindhupalchowk, Nawalpur, Palpa, Gulmi, Syangja, Tanahu, and Surkhet of other provinces.

The very high exposure in the districts is primarily influenced by the higher population and higher number of existing healthcare and water-supply infrastructures. Kathmandu, including the districts of the Terai region such as Jhapa, Kailali, Dhanusha, and Bara had the highest population in 2011 (CBS and NPC, 2011). In these districts, urbanization has been increasing rapidly. The increasing population pressure has created additional stress and pressure on the urban environment. This is evidenced by the occurrence of more intense climate-related hazards in the urban environment of Nepal.

The exposure is low in the districts of Karnali and Sudurpaschim provinces. Comparatively, the total population and health infrastructures are low in these districts. Besides, all the hilly and mountain districts of Province 1 have low to very low exposure. It is also similar to Gandaki and Lumbini provinces where the majority of the hilly and mountain districts have low to very low exposure except the Kaski district of the Gandaki Province. This result shows that the population and concentration of health-related infrastructure impacted by climate-induced disasters are relatively less. Kaski district has a relatively higher population compared to other districts in the region which played a role in its moderate exposure value (Figure 26).

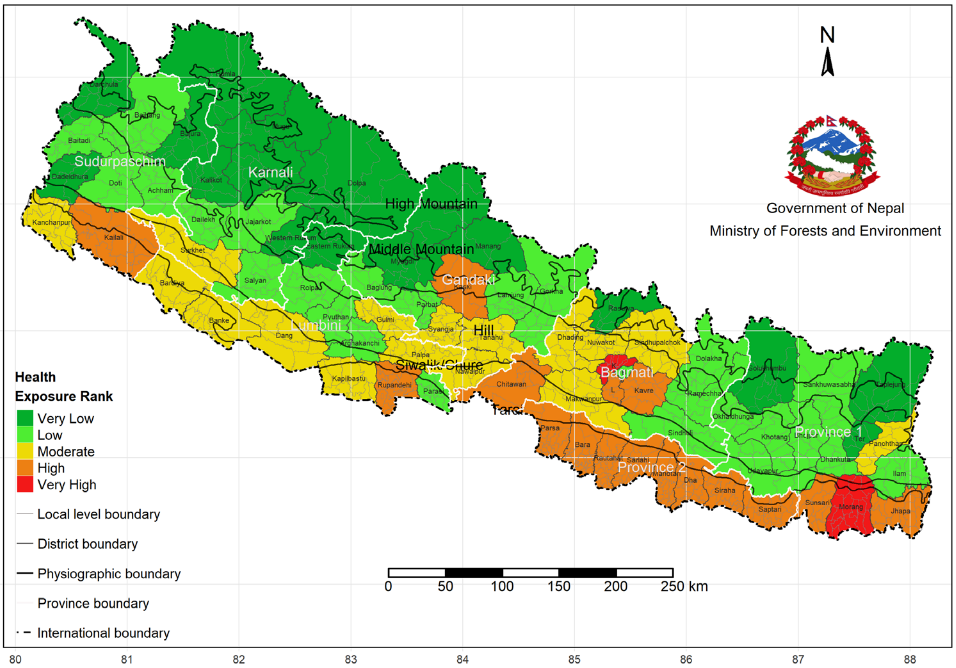


Figure 26: Distribution of exposure rank by district

The healthcare infrastructures such as hospitals, health posts, sub-health posts, and other governmental and non-governmental infrastructures are higher in Kathmandu, Lalitpur, and Morang while the infrastructures and schemes related to drinking water supply such as gravity flow, piped lifting water, groundwater lifting, and piped water, and water treatment plants are very high in Palpa, Tanahu, and Syangja. Similarly, the highest number of functional water and sludge treatment plants exist in Kathmandu and Kavrepalanchok. Both types of infrastructures and services are exposed to climate-induced hazards (Table 5).

Table 5: Distribution of exposure rank by district

Exposure Rank	District
Very High (0.673 - 1)	Morang, Kathmandu
High (0.403 - 0.672)	Sunsari, Rautahat, Lalitpur, Kavrepalanchok, Kailali, Siraha, Rupandehi, Bara, Chitawan, Dhanusha, Kaski, Jhapa, Sarlahi, Mahottari, Parsa, Saptari
Moderate (0.269 - 0.402)	Dhading, Makawanpur, Kapilbastu, Nuwakot, Sindhupalchok, Bardiya, Tanahu, Syangja, Banke, Surkhet, Palpa, Dang, Nawalpur, Kanchanpur, Panchthar, Gulmi
Low (0.142 - 0.268)	Rolpa, Lamjung, Dolakha, Dhankuta, Sankhuwasabha, Baglung, Gorkha, Dailekh, Udayapur, Bhaktapur, Parbat, Pyuthan, Achham, Arghakhanchi, Baitadi, Bhojpur, Sindhuli, Salyan, Doti, Khotang, Okhaldhunga, Jajarkot, Parasi, Bajhang, Ramechhap, Ilam
Very Low (0.008 - 0.141)	Humla, Mugu, Rasuwa, Myagdi, Terhathum, Western Rukum, Solukhumbu, Darchula, Dolpa, Mustang, Manang, Eastern Rukum, Bajura, Kalikot, Taplejung, Jumla, Dadeldhura

In physiography distribution of exposure, Terai and Siwalik have high exposure risk while in province-wise physiography, the Terai region of Province 1 and Siwalik region of Province 2 has very high exposure value (Figure 27).

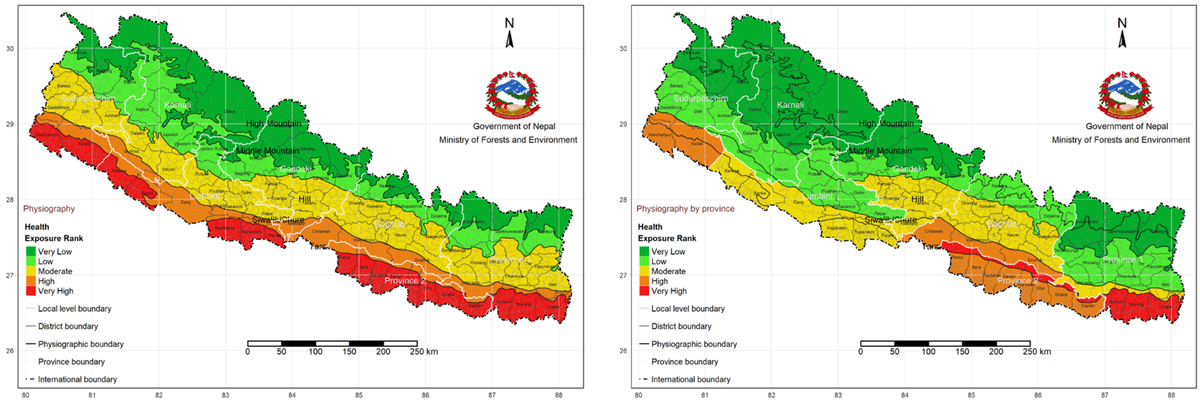


Figure 27: Distribution of exposure index by physiography (left) and physiography by province (right)

Chapter 6

Observed Climate Change Vulnerability in Health

6.1 Sensitivity in Health

The sensitivity to climate change is determined by the susceptibility to climate-induced hazards. Often the demographic, socioeconomic, physical, and other characteristics determine the degree of sensitivity of the population and resources exposed. The factors considered in this assessment were those related to climate-sensitive diseases, which are affected by changes in temperature and precipitation as well as those related to human poverty and the socioeconomic characteristics of the population. The sensitivity indicators included for the VRA assessment were the population of males and females under 5 years and above 60 years; total cases of climate-sensitive health outcomes such as heart diseases, respiratory diseases, VBDs, WBDs, malnutrition, HPI, and Human Development Index (HDI).

The analysis shows that sensitivity varied with the population characteristics, settlement types, geographical locations, and socio-political and cultural differences. The indexes depict that Mahottari and Bhaktapur were among the districts having the highest and lowest sensitivity scores, respectively. Besides, the results revealed that Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, Rautahat of Province 2, and Achham of Sudurpaschim Province are very highly sensitive. Similarly, all the Terai districts of Province 1; Bara and Parsa of Province 2; Nawalpur of Gandaki Province; Kapilvastu, Rolpa, Eastern Rukum of Lumbini Province; Jajarkot, Dailekh, Kalikot, Mugu, Humla of Karnali Province; and Kailali, Doti, Bajura, Bajhang, and Baitadi of Sudurpaschim Province have high sensitivity (Figure 28 and Table 6).

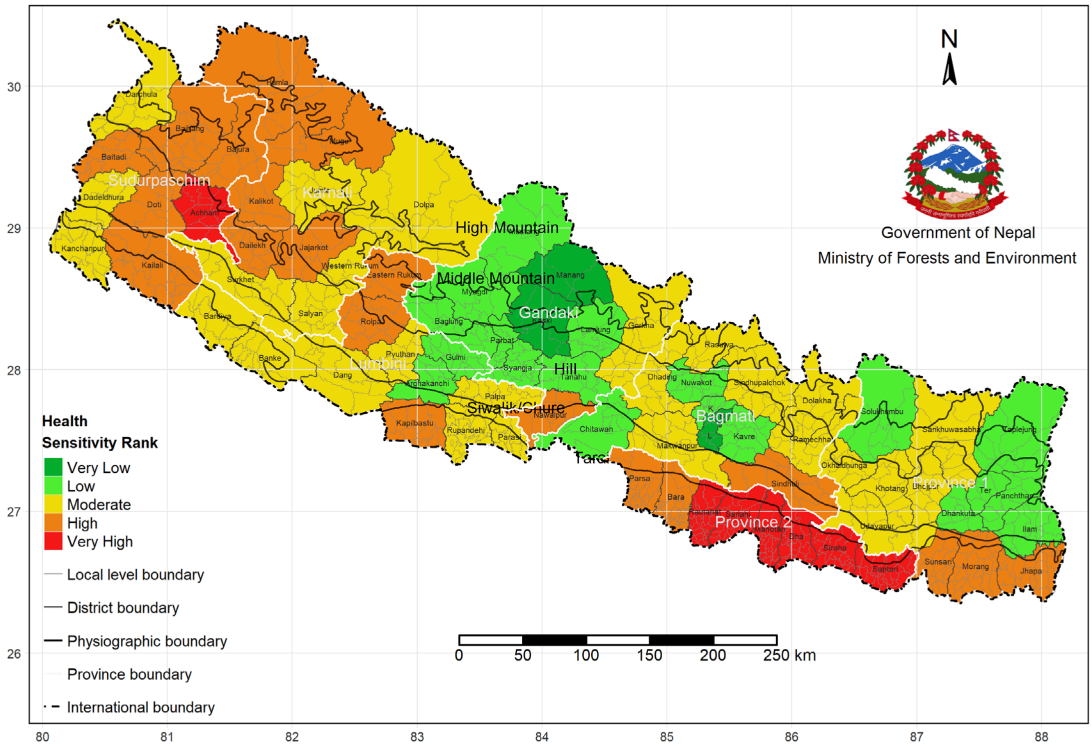


Figure 28: Distribution of sensitivity rank by district

Districts with a very high sensitivity rank index have a higher number of cases of heart disease, VBD, respiratory disease, and undernutrition, and a higher number of houses made of mud and thatched walls, houses lacking a facility of information and communication such as television, radio, etc., low number of information and communication services, and higher value of HPI. The districts with high sensitivity in the Terai region have a high number of under-five and above 60 years populations, a high number of heart and VBD cases, majority of houses made of mud-bounded bricks, most of the houses have no facility and high value of HPI. Likewise, districts of Karnali and Sudurpashchim with high sensitivity hill regions have a high number of below five-year children and high VBD, WBD, and undernutrition cases. Besides, most of the houses in the two provinces are built without any facility and districts show a high value of HPI.

Table 6: Distribution of sensitivity rank by district

Sensitivity Rank	Distribution of sensitivity rank by district
Very High (0.780 - 1)	Rautahat, Achham, Siraha, Dhanusha, Sarlahi, Mahottari, Saptari
High (0.597 - 0.779)	Rolpa, Humla, Kapilbastu, Mugu, Sunsari, Dailekh, Kailali, Baitadi, Sindhuli, Morang, Bara, Doti, Eastern Rukum, Bajura, Nawalpur, Kalikot, Jajarkot, Jhapa, Bajhang, Parsa
Moderate (0.444 - 0.596)	Dhading, Makawanpur, Rasuwa, Dolakha, Sankhuwasabha, Western Rukum, Sindhupalchok, Bardiya, Gorkha, Udayapur, Pyuthan, Darchula, Banke, Dolpa, Surkhet, Rupandehi, Palpa, Bhojpur, Salyan, Khotang, Okhaldhunga, Dang, Kanchanpur, Jumla, Parasi, Ramechhap, Dadeldhura
Low (0.297 - 0.443)	Myagdi, Lamjung, Dhankuta, Terhathum, Nuwakot, Baglung, Solukhumbu, Tanahu, Kavrepalanchok, Parbat, Syangja, Arghakhanchi, Mustang, Chitawan, Taplejung, Panchthar, Gulmi, Kathmandu, Ilam
Very Low (0.195 - 0.296)	Lalitpur, Bhaktapur, Manang, Kaski

The human settlement and types of houses also affect the human health condition of households. In this assessment, houses made of mud-bounded bricks/stones and wooden pillars, houses built without a facility[6], and types of houses with at least information and communication facility were also included. The highest number of those indicators are found in Morang, Saptari, Siraha, and Mahottari districts. This shows districts of the Eastern Terai region are highly sensitive in infrastructures.

Lalitpur, Bhaktapur, Manang, and Kaski districts have very low sensitivity. This is because the people impacted by diseases are fewer, the houses and infrastructure are well and functional, and there is a lower number of the under-five and under-60 population. The HDI, HPI in these districts also played a major role in lowering the sensitivity. Also, the demography in these districts contributed. For example, Manang has the lowest population. On the contrary, Kathmandu has the highest population but has low sensitivity which is mostly due to improved HDI, access to infrastructures, etc.

In the physiographic distribution of sensitivity, the majority of the districts that lie in the Terai region have high to very high sensitivity. The Terai districts of Province 1 and Province 2 are found highly sensitive to climate change effects on health (Figure 29).

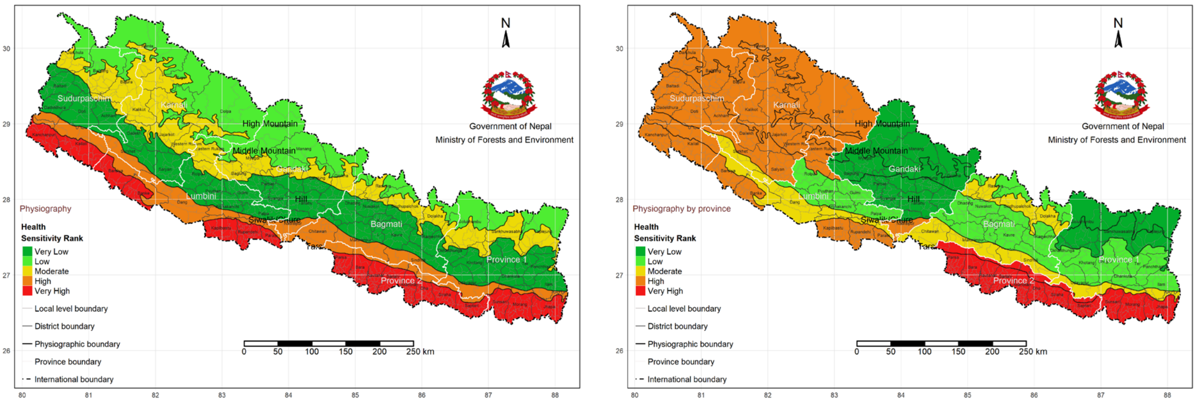


Figure 29: Distribution of sensitivity rank by physiography (left) and physiography by province (right)

6.2 The Adaptive Capacity of Health

Adaptive capacity is related to the ability of populations to adjust to possible damage and respond to the consequences of climate impacts (IPCC, 2001) which focuses on the human population and infrastructures and services related to health and drinking water. The indicator selection prioritized the gender, governance, resources, available facilities, and institutions that are considered to be reducing vulnerability and enhancing adaptation at the local level.

The indicators used for the assessment of adaptive capacity in the health sector include: medical practitioners, public health, nursing; paramedic and administrative; FCHVs, EPI/Primary Health Care (PHC)/outreach clinics; JE immunization coverage; the number of nutrition programs for mother and children; food productivity; vitamin-A gave to severe malnourished <5 years; anthelmintic given to children <5 years; drinking water access; water supply coverage; sanitation coverage; literacy rates; health insurers; and availability of One-Stop Crisis Management Centre

6 Facility = Radio, television, cable television, computer, internet, telephone, mobile phone, motor, motorcycle, cycle, other vehicle, and refrigerator.

(OCMC) service; area coverage by early warning system; available water treatment facilities; safe disposal of excreta treatment facilities; drinking water schemes; access to sentinel sites; and emergency healthcare services.

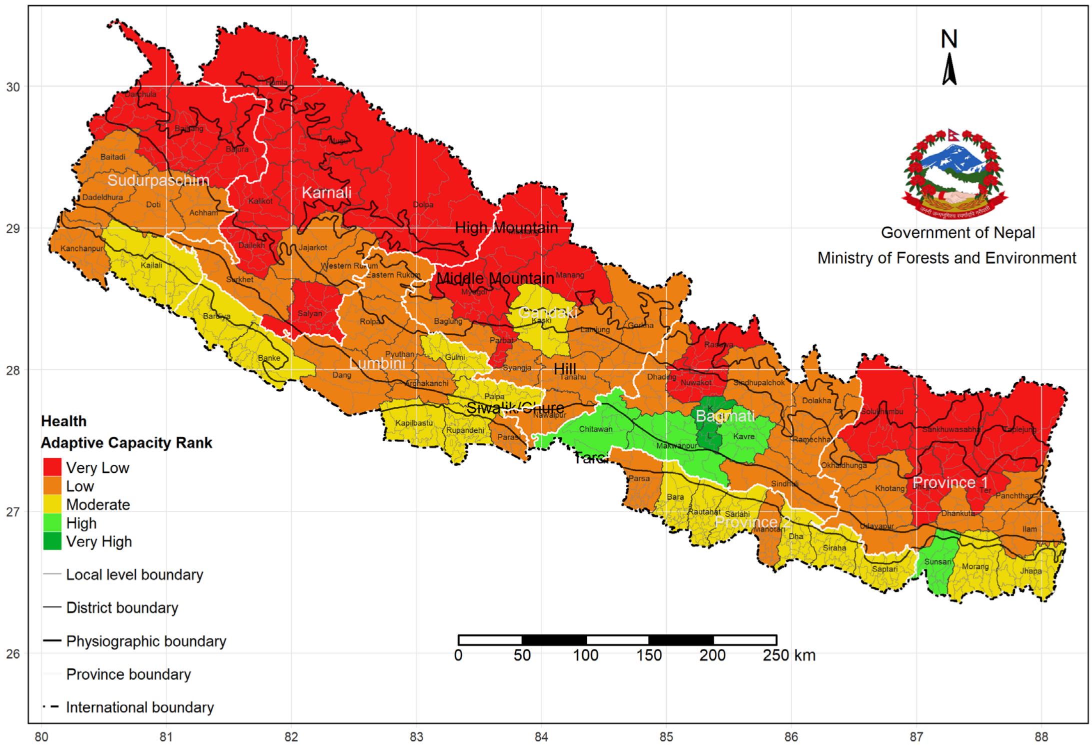


Figure 30: Distribution of adaptive capacity rank by district

The adaptive analysis revealed that Kathmandu and Lalitpur have a very high adaptive capacity. Sunsari, Chitawan, Makwanpur, and Kavrepalanchok have a high adaptive capacity. There are 17 districts that fall in the moderate adaptive capacity category. A very low and low adaptive capacity rank is scattered across the country particularly in Hill and Mountain districts. The majority of the mountain districts across provinces have a very low adaptive capacity, whereas the majority of the hill districts across the provinces have a low adaptive capacity (Figure 30 and Table 7).

Table 7: Distribution of adaptive capacity rank by district

Adaptive Capacity Rank	District
Very High (0.838 - 1)	Lalitpur, Kathmandu
High (0.570 - 0.837)	Makawanpur, Sunsari, Kavrepalanchok, Chitawan
Moderate (0.406 - 0.569)	Kapilbastu, Rautahat, Bardiya, Bhaktapur, Banke, Kailali, Siraha, Rupandehi, Palpa, Morang, Bara, Dhanusha, Kaski, Jhapa, Sarlahi, Gulmi, Saptari
Low (0.289 - 0.405)	Dhading, Rolpa, Lamjung, Dolakha, Dhankuta, Baglung, Western Rukum, Sindhupalchok, Gorkha, Tanahu, Udayapur, Pyuthan, Syangja, Surkhet, Achham, Arghakhanchi, Baitadi, Sindhuli, Doti, Eastern Rukum, Khotang, Okhaldhunga, Dang, Nawalpur, Kanchanpur, Panchthar, Jajarkot, Mahottari, Parasi, Parsa, Ramechhap, Dadeldhura, Ilam
Very Low (0.139 - 0.288)	Humla, Mugu, Rasuwa, Myagdi, Terhathum, Nuwakot, Sankhuwasabha, Solukhumbu, Dailekh, Parbat, Darchula, Dolpa, Bhojpur, Salyan, Mustang, Manang, Bajura, Kalikot, Taplejung, Jumla, Bajhang

Districts with very high adaptive capacity such as Kathmandu and Lalitpur have a higher number of medical practitioners, public health officers, nurses, paramedics, public health administrators, and

FCHVs per 100,000 population; more nutrition programs for mothers and children; higher number of malnourished <5 years received vitamin-A, functional water supply schemes, and water treatment plants; safely disposed of excreta treatment facility sites; available OCMC service, available emergency health services; and more access to early warning and disease surveillance systems.

The availability and access to technology at the individual, local, and national levels in the health sector is an important determinant of adaptive capacity. Many of the adaptive strategies that protect human health involve technology (e.g. early warning systems, pollution controls, vector control, vaccinations, water treatment, and sanitation). The population of Kathmandu and Lalitpur districts has high access to technology and health services compared to the majority of mountain districts where access and availability of health services is a major issue.

In the health sector, adaptive capacity is also determined by facilities available in healthcare infrastructures such as existing emergency services, available water, and sludge treatment plants, functional drinking water supply schemes, and access to the early warning systems. Proportionately high infrastructures are found in Kathmandu, Kavrepalanchok, Lalitpur, Chitawan, and Makwanpur. Adaptive capacity is likely to vary with the country's level of infrastructure. Adaptive responses to health impacts of climate change are enhanced by infrastructures specifically designed to reduce vulnerability to climate variability.

Demographic variables such as educational attainment and health are often cited in the literature as related to the ability to cope with risk (Scheraga & Grambsch, 1998). Socioeconomic status, the condition and accessibility of infrastructure, the accessibility of healthcare, certain demographic characteristics, human and social capital (the skills, knowledge, experience, and social cohesion of a community), and other institutional resources also contribute to the timeliness and effectiveness of adaptive capacity. In this assessment, human resources, particularly the availability of health practitioners in a particular district, played an important role. For example, Kathmandu and Lalitpur had the highest number of medical practitioners available for providing services to the population compared to mountain districts like Humla, Dolpa, Mugu.

In adaptive capacity, the Siwalik region is highly adaptive while most of the hill regions of Bagmati Province, Terai region of Province 1, Lumbini Province, and Sudurpaschim Province have very high adaptive capacity (Figure 31).

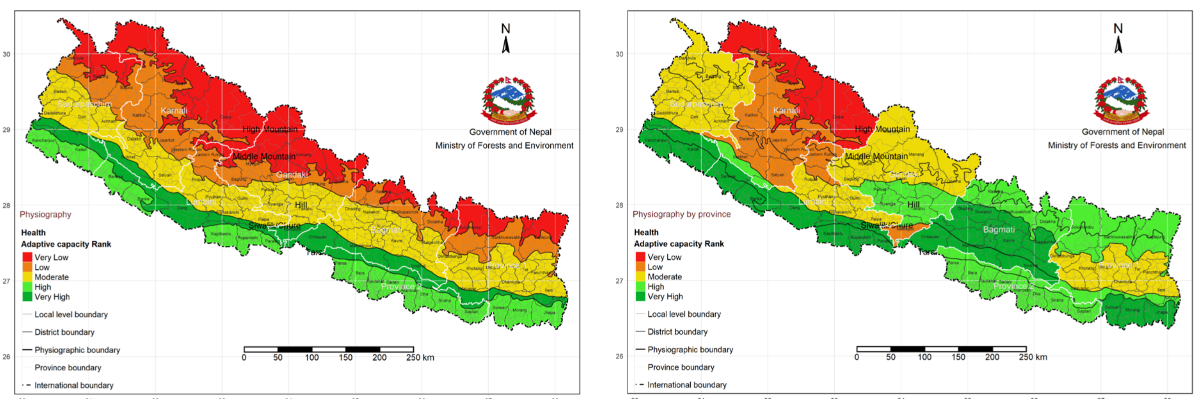


Figure 31: Distribution of adaptive capacity rank by district (left) and physiography (right)

6.3 Vulnerability in Health

According to the IPCC fifth assessment report, vulnerability is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC AR5, 2014). Both exposure and sensitivity are influenced by a wide range of social, economic, and cultural factors and processes. Individuals and communities are differentially exposed and vulnerable, and this is based on factors such as wealth, education, race/ethnicity/religion, gender, age, class/caste, disability, and health status (Cardona et al., 2012).

The result shows that Bhaktapur, Chitawan, Kaski, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, and Syangja were among the districts having the lowest vulnerability. On the contrary, most of the districts of Province 2 have the highest vulnerability (full list in Table 8). In terms of the magnitude of vulnerability, six districts of Province 2 representing the Terai region of the Eastern cluster and Humla from the Mountain region of Karnali Province, have a very high degree of vulnerability. The analysis illustrates that the high vulnerability index is found in almost all the districts of the Hill and Mountain region of Sudurpaschim and Karnali provinces, signifying greater vulnerability to climate change health impacts. Nawalpur representing the Terai region of Gandaki Province also showed high vulnerability.

The climate change vulnerability in health varies with population characteristics, geographical location settlement types, occupational groups, and social, political, and cultural aspects. In the health sector of Nepal, different intervention measures such as preventive, curative, promotive, and rehabilitative measures are being practiced to cope with the type of diseases, prevalence needs, and additional coping strategies to enhance the adaptive capacity of the people. This is the reason why those districts and provinces which are deprived of health-related services and infrastructure are most vulnerable.

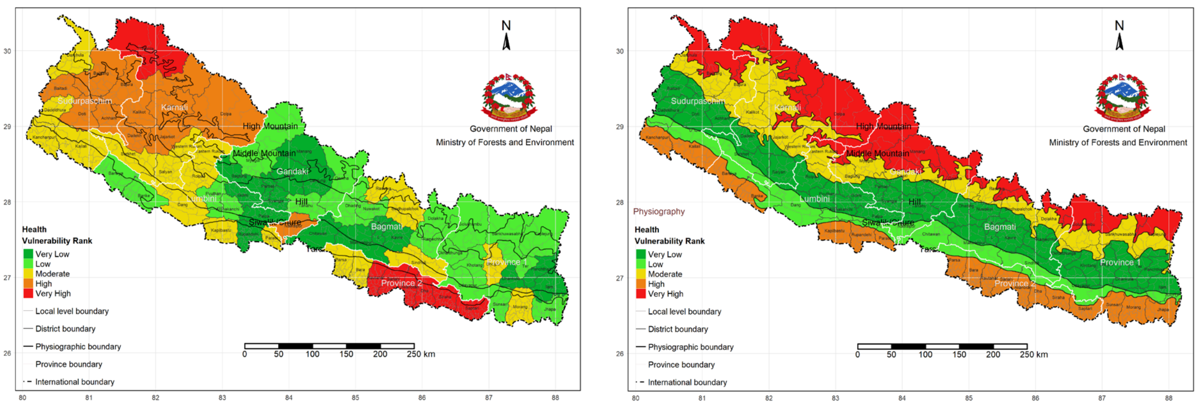


Figure 32: Distribution of vulnerability rank by district (left) and physiography (right)

The vulnerability in Nepal is linked to the availability of local resources, the effectiveness of governance and public institutions, quality of public health infrastructures, access to free medicine supply, immunization, availability of emergency health services, and access to early warning and reporting systems and local information on extreme weather threats. The spatial distribution of these factors is usually not uniform, affecting the vulnerable population at varying degrees. The differences are based on the topography, demography, and socioeconomic factors (Table 8 and Figure 32).

Table 8: Distribution of vulnerability rank by district

Vulnerability Rank	Districts
Very High (0.688 - 1)	Humla, Rautahat, Siraha, Dhanusha, Sarlahi, Mahottari, Saptari
High (0.465 - 0.687)	Mugu, Dailekh, Dolpa, Achham, Baitadi, Doti, Bajura, Nawalpur, Kalikot, Jajarkot, Jumla, Bajhang
Moderate (0.315 - 0.464)	Rolpa, Kapilbastu, Rasuwa, Western Rukum, Sindhupalchok, Darchula, Kailali, Surkhet, Bhojpur, Sindhuli, Salyan, Morang, Bara, Eastern Rukum, Dang, Kanchanpur, Parasi, Parsa, Dadeldhura
Low (0.138 - 0.314)	Dhading, Myagdi, Sunsari, Dolakha, Terhathum, Nuwakot, Sankhuwasabha, Bardiya, Gorkha, Solukhumbu, Tanahu, Udayapur, Pyuthan, Banke, Arghakhanchi, Mustang, Khotang, Okhaldhunga, Taplejung, Jhapa, Ramechhap
Very Low (0 - 0.137)	Makawanpur, Lamjung, Dhankuta, Baglung, Lalitpur, Kavrepalanchok, Bhaktapur, Parbat, Syangja, Rupandehi, Palpa, Manang, Chitawan, Kaski, Panchthar, Gulmi, Kathmandu, Ilam

Climate change vulnerability is also associated with poverty (WHO, 1997). People in poor health and those who are undernourished will be more vulnerable to the immediate and secondary impacts of extreme events, whether this takes the form of direct physical injury or a more complex impact such as food shortage or famine. Furthermore, poor adaptive capacity and poverty have the most influence on some districts of Karnali Province and Sudurpaschim Province that currently have high and very high vulnerabilities. When the current vulnerability was related to future climate change projections, the most vulnerable areas of climate extreme indices were in Province 1, Province 2, Gandaki Province, and Bagmati Province. From a socio-environmental and climatic point of view, these regions should be a priority for public policy efforts to reduce their vulnerability and prepare them to cope with the adverse aspects of climate change.

In physiographical regions, most of the areas of high mountains have very high vulnerability. Similarly, Province 2 that lies in the Terai region, and middle and high mountain regions of Karnali Province and Sudurpaschim Province, are highly vulnerable (Figure 33).

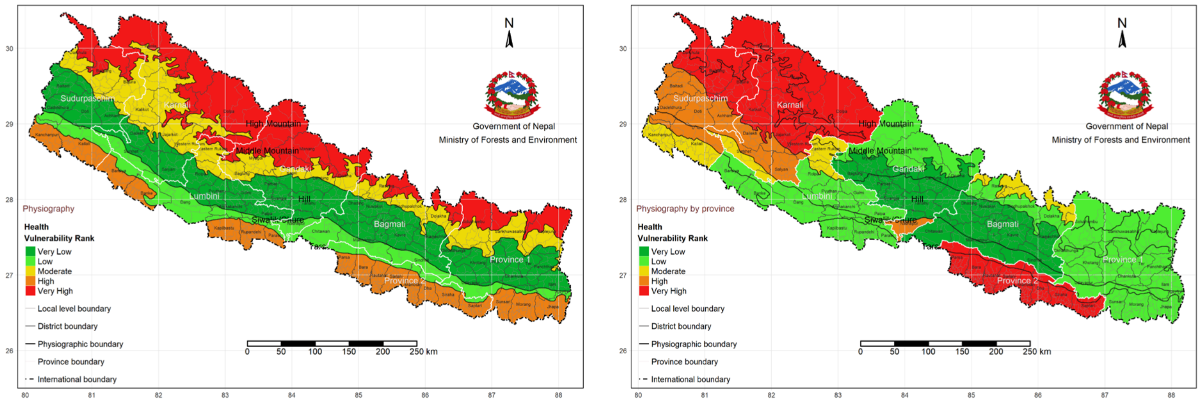


Figure 33: Distribution of vulnerability rank by physiography (left) and physiography by province (right)

Besides, Sankhuwasabha, Bhojpur, and Morang show a very high vulnerability. In Province 2, Siraha and Mahottari depict a very high vulnerability (Figure 34).

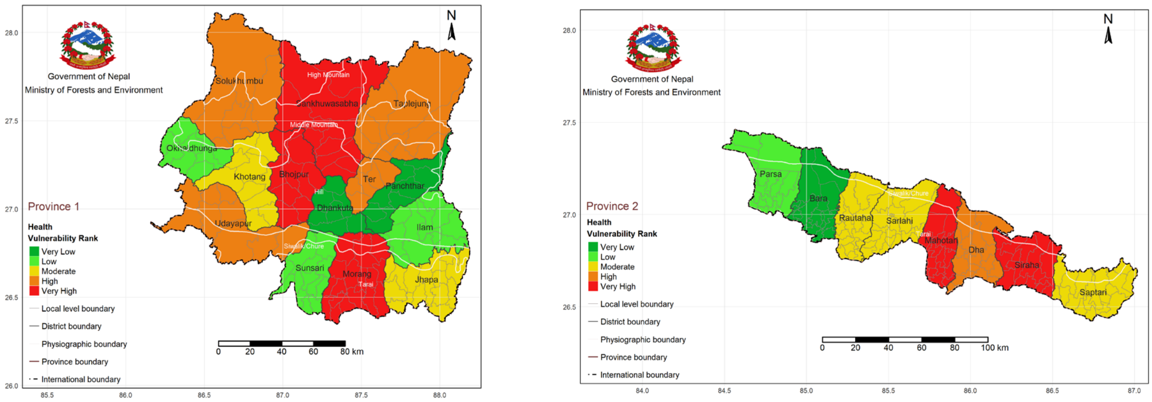


Figure 34: Health vulnerability rank in the province: Province 1 (left) and Province 2 (right)

A very high vulnerability in Bagmati Province is found in Sindhupalchok and Sindhuli districts. Similarly, in Gandaki Province, a very high vulnerability is found in Mustang and Nawalpur districts (Figure 35).

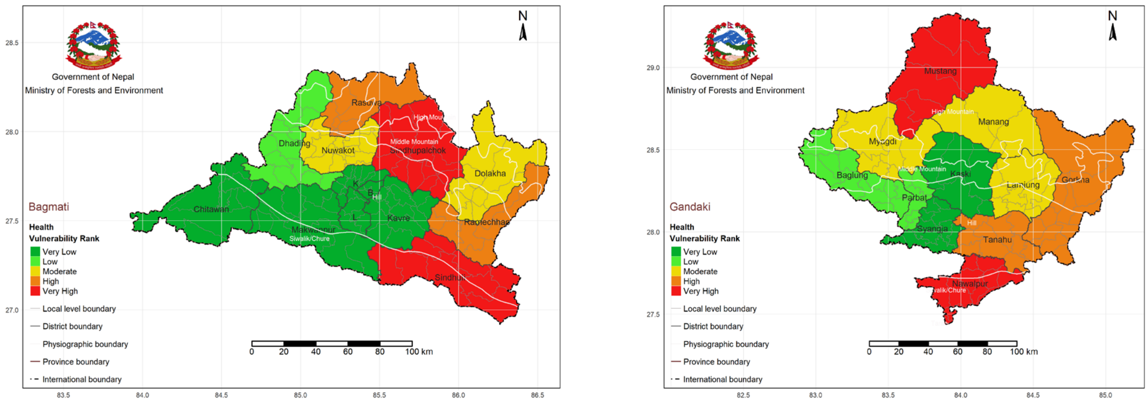


Figure 35: Health vulnerability rank in the province: Bagmati (left) and Gandaki (right)

In Lumbini Province, Eastern Rukum, Rolpa, Dang, Kapilvastu, and Parasi districts exhibit very high vulnerability. Likewise, in Karnali Province, a very high vulnerability is found in Humla and Dailekh (Figure 36).

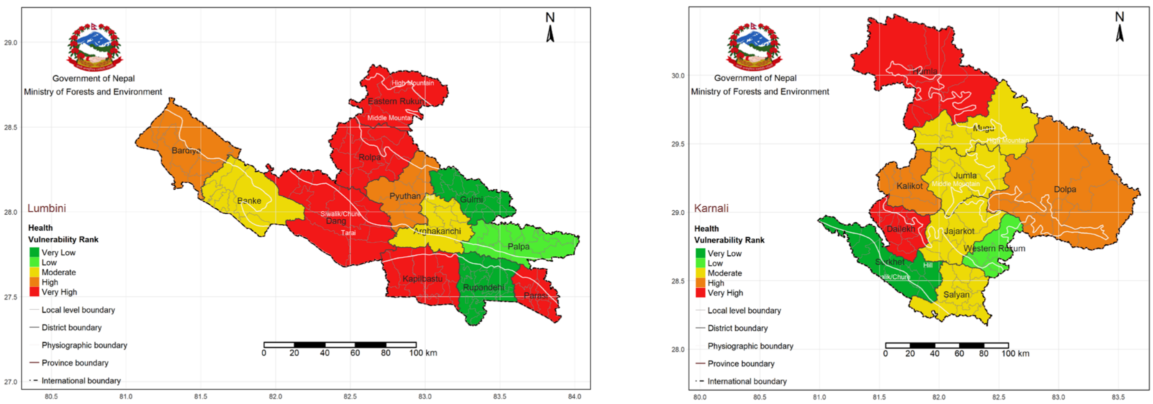


Figure 36: Health vulnerability rank in the province: Lumbini (left) and Karnali (right)

In Sudurpaschim Province, Bajhang, Bajura, and Achham districts show a high vulnerability. On the contrary, Kanchanpur district shows a very low vulnerability (Figure 37).

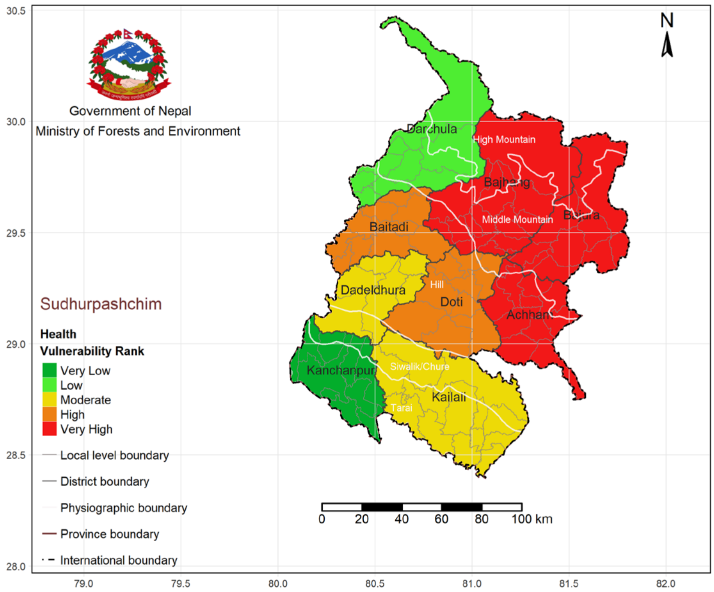


Figure 37: Health vulnerability rank in Sudurpaschim Province

Chapter 7

Projected Climate Change Risks and Adaptation Options in Health

7.1 Future Climate Change Risks in Health

The risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems, including their ability to adapt.

The results show that Rautahat, Siraha, Dhanusha, Sarlahi, Mahottari, Saptari, Morang, and Jhapa districts have a very high risk of climate change impact in health at baseline (current scenario). Besides, Sunsari, Bara, Parsa, Tanahu, and Rupandehi districts fall in the high-risk category. The impact of floods seems to be playing a major role in increasing the risk in these Terai districts. The districts of Province 2 are highly vulnerable so the risk has been very high due to high exposure and high disaster impact. In Dhankuta, Syangja, Panchthar, and Ilam, the sensitivity, adaptive capacity, and vulnerability are low. The hazard scenario reflects the positive trend of consecutive dry days and extreme wet days in Syangja. Humla shows the highest positive trend of rainy days. Similarly, Bardiya and Syangja show a maximum positive trend of precipitation. Manang and Taplejung have a higher increasing trend in annual maximum temperature. Bara and Rautahat districts are observed with the least increasing trend. Similarly, the warm days' trend shows that Taplejung and Panchthar have a higher increase in annual trends. Terhathum, Sankhuwasabha, and Taplejung districts have very low exposure and adaptive capacity, low sensitivity, and moderate vulnerability. Sunsari and Jhapa have very high exposure and sensitivity, and moderate vulnerability (Figure 38).

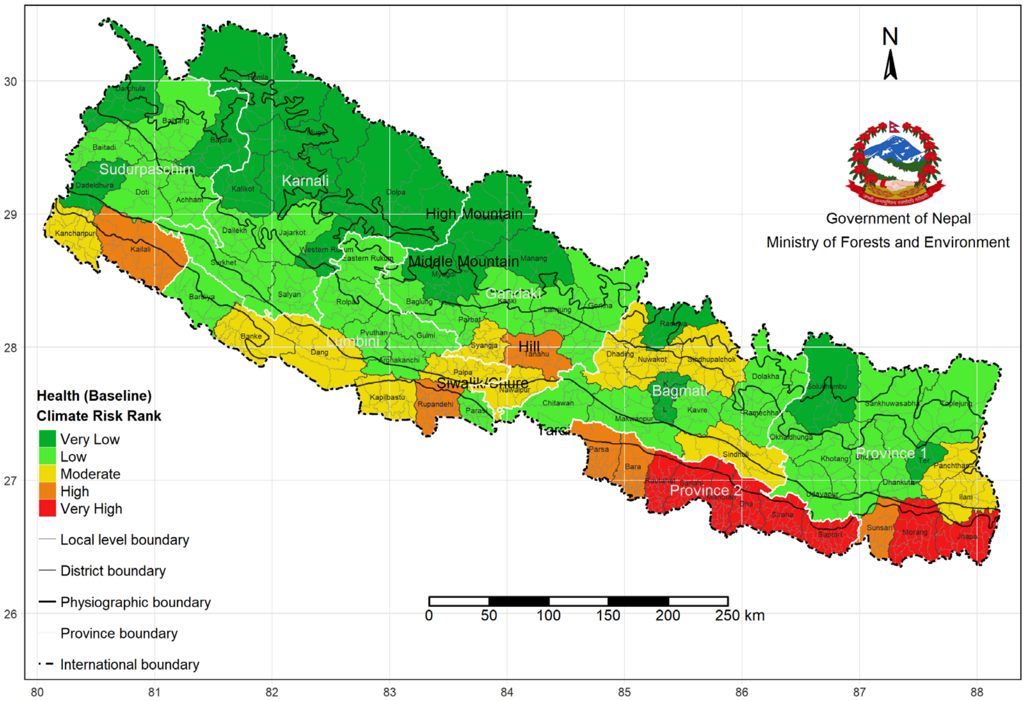


Figure 38: Baseline climate risk rank in health

Sunsari has a high adaptive capacity while Jhapa has a moderate adaptive capacity. Tanahu has low sensitivity and adaptive capacity and moderate vulnerability. Parbat has very low adaptive capacity and low exposure, sensitivity, and vulnerability. Morang has very high exposure, high sensitivity and vulnerability, and a moderate adaptive capacity. The climate risk of districts in different provinces is given in Table 9.

Table 9: Nepal districts ranked according to climate risk in health (baseline)

Risk Rank	District
Very High (0.543 - 0.809)	Siraha, Morang, Dhanusha, Jhapa, Sarlahi, Mahottari, Saptari
High (0.350 - 0.542)	Sunsari, Rautahat, Kailali, Rupandehi, Bara, Parsa
Moderate (0.239 - 0.349)	Dhading, Kapilbastu, Nuwakot, Sindhupalchok, Tanahu, Syangja, Banke, Palpa, Sindhuli, Dang, Nawalpur, Panchthar, Ilam
Low (0.115 - 0.238)	Rolpa, Makawanpur, Lamjung, Dolakha, Dhankuta, Sankhuwasabha, Baglung, Bardiya, Gorkha, Kavrepalanchok, Dailekh, Udayapur, Parbat, Pyuthan, Surkhet, Achham, Arghakhanchi, Baitadi, Bhojpur, Salyan, Doti, Khotang, Okhaldhunga, Chitawan, Kaski, Kanchanpur, Taplejung, Jajarkot, Parasi, Bajhang, Gulmi, Ramechhap
Very Low (0.004 - 0.115)	Humla, Mugu, Rasuwa, Myagdi, Terhathum, Western Rukum, Solukhumbu, Lalitpur, Bhaktapur, Darchula, Dolpa, Mustang, Manang, Eastern Rukum, Bajura, Kalikot, Jumla, Kathmandu, Dadeldhura

The analysis shows that in the projected risk based on RCP 4.5 (2030) and RCP 8.5 (2030), most of the Terai districts of Province 1 and 2 will have a high to very high risk of climate change impact. Besides, all the districts in Province 2 will be at very high to high risk due to climate change impact followed by the Jhapa, Morang, and Sunsari districts of Province 1. Likewise, Dang, Rupandehi and Kapilbastu districts of Lumbini Province and Kailali district of Sudurpaschim Province fall in the high-risk category in both the RCP scenarios. In the Gandaki Province, Myagdi, Manang, and Mustang fall in the very low-risk category.

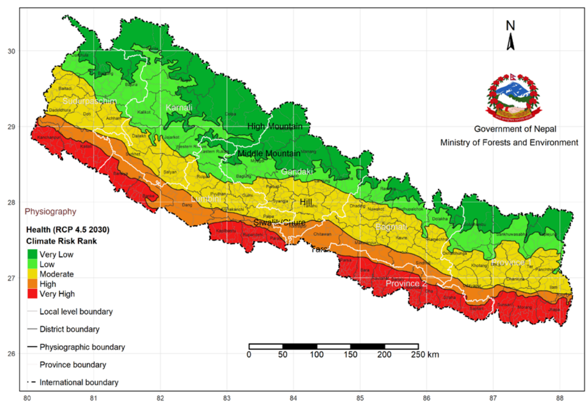
Besides, the result shows that most of the districts of the Karnali Province fall in a very low-risk category. It is also similar to the few mountain districts of Sudurpaschim Province and the Lumbini Province. In Bagmati province, Rasuwa, Lalitpur, and Bhaktapur districts fall at very low risk. There is not much variation within RCP 4.5 and RCP 8.5 results in 2030 (Table 10).

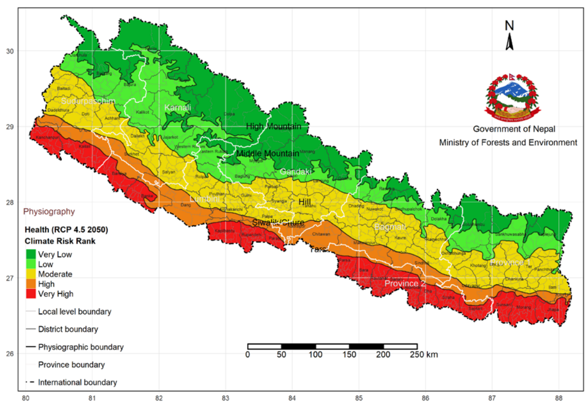
In 2050, under RCP 4.5, all the districts of Province 2 fall at very high risk due to climate change impact. Also, the three Terai districts (Jhapa, Morang, and Sunsari) fall at very high risk. The Kailali district of Sudurpaschim Province falls under a very high climate risk. Besides, Nawalpur, and Tanahu districts of Gandaki Province and Rupandehi, Kabilbastu, and Dang districts of Lumbini Province fall in the high-risk category. All the districts in the Karnali Province and Bagmati Province fall in moderate to very low climate risk. There is not much difference in the RCP 8.5 scenarios in 2050 compared to RCP 4.5 in the same period. Only one district of the Terai region (Kapilbastu) has moved from high risk to very high risk (Table 10). Under both scenarios, the mountain region of Gandaki Province, Karnali Province, and Sudurpaschim Province fall in the very low-risk category.

Table 10: Number of districts for risk rank

Risk Rank	Baseline	RCP 4.5		RCP 8.5	
		2030	2050	2030	2050
Very High (0.651 – 0.821)	7	9	12	9	13
High (0.555 – 0.650)	6	8	9	8	8
Moderate (0.482 – 0.554)	13	20	22	16	24
Low (0.360 – 0.481)	32	25	22	29	20
Very Low (0.360 - 0.481)	19	15	13	15	12

The result above indicates that heat-related hazards are playing an important role in increasing climate risk of climate change impact in the future. The Terai districts seem to be at the forefront of future climate change in the health sector which may be due to increased temperature, extreme variability in rainfall, and the disaster triggered by these which have a major impact on spreading both vector-borne, waterborne, and respiratory diseases in the Terai reason. The districts of Province 2 are also in a very high vulnerability category due to a high degree of sensitivity and low adaptive capacity. On the contrary, the Karnali and Sudurpashchim districts fall at low risk despite high vulnerability. It might be the impact of projected climate extreme events which has a low impact in the region (Figure 39).





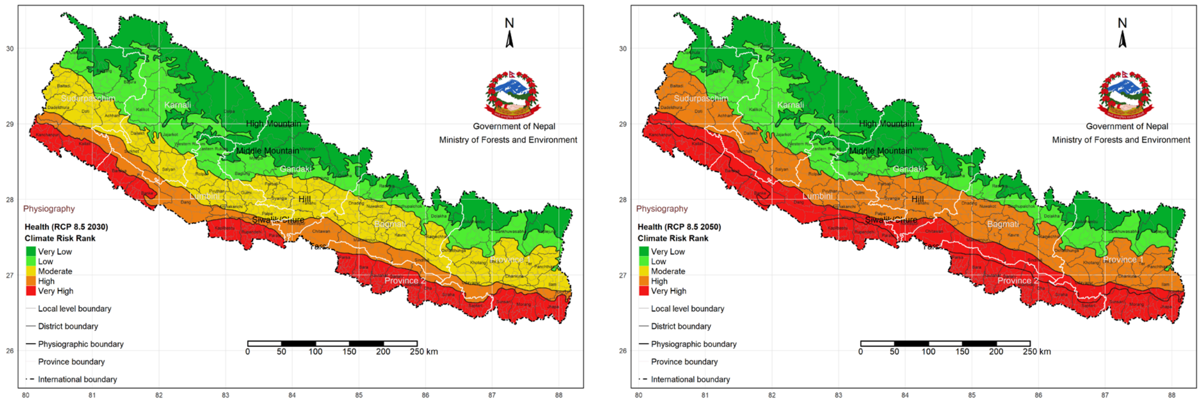


Figure 39: Project climate risk rank in (RCP 4.5 and RCP 8.5) health in physiography

Annex 5 shows detailed district-level climate change risk and their ranking in health.

In the physiographic region, the result shows that Terai has a very high risk and Chure has a high risk (Figure 36), whereas the hill and the middle mountain have moderate and low risks. The high mountain region has very low risk. In Province 2, Terai is at very high risk whereas, the Chure has moderate risk. The variation in Sudurpaschim, Lumbini, Gandaki, Bagmati, and Province 1 follows a similar pattern. Besides, Karnali Province has a high risk to very low risk where the hill districts are in a high-risk category (Figure 40).

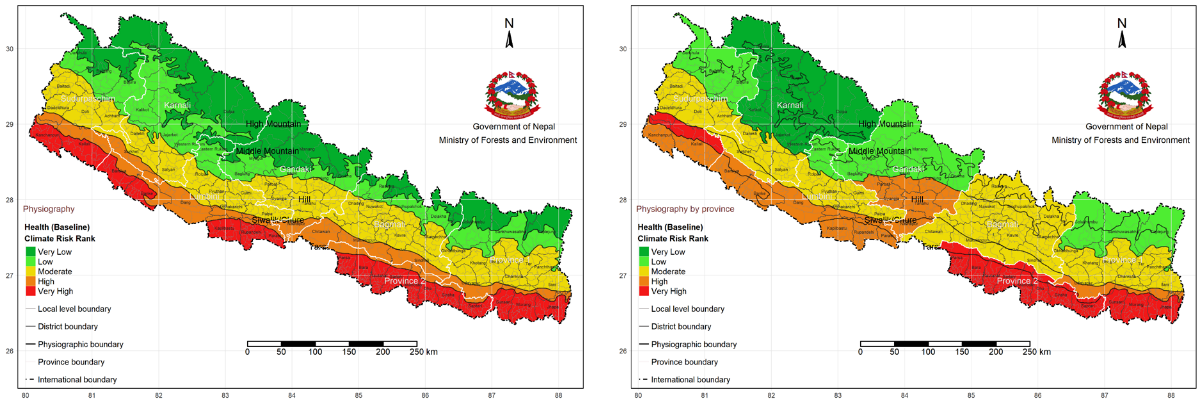
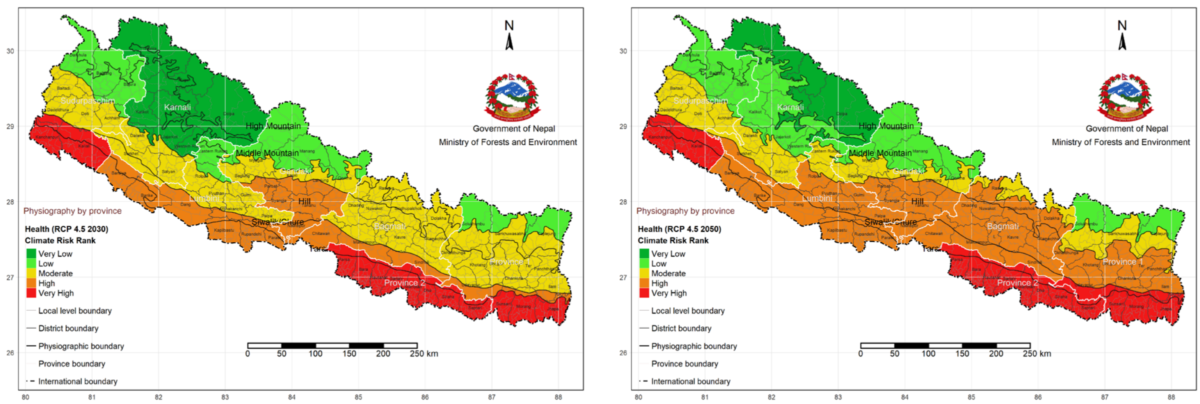


Figure 40: Risk maps: physiographic regions (left) and physiography in provinces (right)

The climate change health risks in provinces and physiographic regions following provincial consultation are given in annex 6.



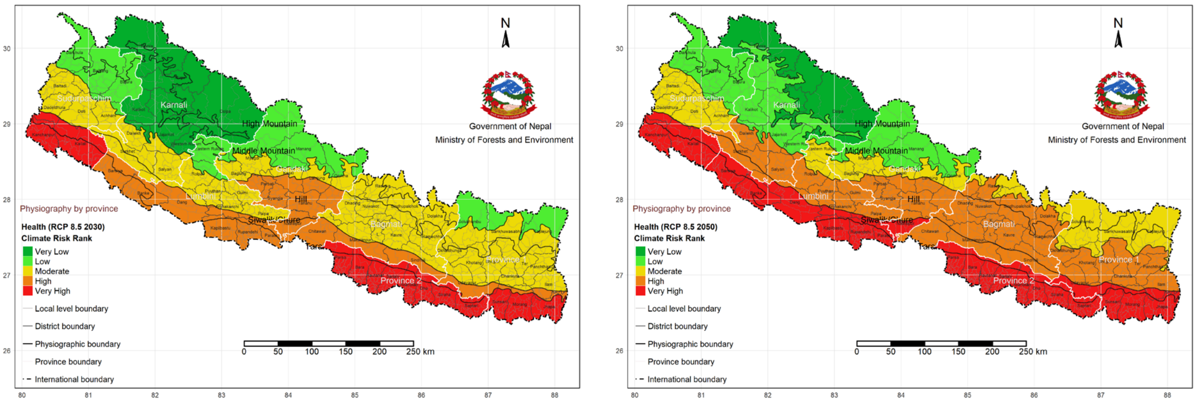


Figure 41: Projected climate risk rank in (RCP 4.5 and RCP 8.5) health in physiography by province

The assessment above shows that climate change is expected to increase mean annual temperature and the intensity and frequency of heatwaves resulting in a greater number of people at risk of heat-related medical conditions. Studies are showing that heat-related mortality will be higher in future climate scenarios. The study by Honda et al. (2015) shows that under a high emissions scenario, heat-related deaths in the elderly (65+ years) are projected to increase to about 53 deaths per 100,000 by 2080 compared to the estimated baseline of approximately 4 deaths per 100,000 annually between 1961 and 1990. A rapid reduction in global emissions could limit heat-related deaths in the elderly to about 12 deaths per 100,000 in 2080.

7.2 Opportunities of adaptation in the health

Climate change is already presenting massive risks to health, and these will be intensified in the future. However, much of the potential health burdens of climate change can be avoided by strengthening the climate resilience of both preventive and curative aspects of health systems and adapting to changing climate conditions. Besides, climate change also presents a requirement and an opportunity to work more closely (WHO, 2015).

The key vulnerabilities and risks associated with the health sector are mostly related to emergence, occurrence, and the outbreak of infectious diseases; the loss and damage to human and health-related infrastructure and services; the stress and overburden to the health system, etc. The climate change impact will be mostly felt by the people with health-related issues, children, the elderly, women, and girls. Hence, the adaptation options should look into differentiated risk and vulnerability among the population and design context-specific and tailor-made programs to target the vulnerable groups.

There are limits to adaptation due to financial and technological constraints. In addition, COVID-19 or another pandemic will have a greater influence on the timely response measures as the priority and resources will be diverted. It is suggested that the design of adaptation options considers the emerging context and thinks of more integrated, strategic, and transformative adaptation options in the future.

A great opportunity to leverage the expertise of multiple disciplines and sectors is demanding for better integration of the health adaptation up to the local level. There is a need for an interdisciplinary approach to deal with public health issues timely and effectively in the context of climate change. To achieve the demanding outputs, a collaboration between public health professionals, environmental epidemiologists, environmentalists, data scientists, social scientists, and other experts working in the health, climate change, academia, and related domains can develop to implement a health program more successfully. In addition, during adaptation planning, the effort of the health sector should focus on sharing responsibilities in health services at the federal, state, and local levels.

In this study, the potential adaptation options have also been identified based on literature review, review of sector-specific policies, plans, and guidelines, and stakeholders' consultation at the national and provincial levels. The adaptation options have been categorized into short term (up to 5 years), medium-term (up to 10 years), and long term (up to 30 years). The potential adaptation options for short-, medium-, and long-term periods are given in Table 11.

Table 11: Adaptation measures in the health sector

1A. Disease surveillance: I. VBDs			
Climate change risk and vulnerability	**Short-term (1-5 years)**	**Medium-term (1-10 years)**	**Long-term (30 years)**
Increasing temperatures and extreme variability in precipitation is very likely in future Increasing health risks due to changing spatial and temporal distribution of diseases strains public health systems, especially if this occurs in combination with an economic downturn	Launch program on the expansion of Indoor Residual Spraying (IRS) and distribution of Long-lasting Insecticidal nets (LLINs) in VBDs risk areas Commence more research and impact studies of VBDs and climate change Provide more priority for parasitologists, entomologists, and environmental health professionals	Establish regular national surveillance for disease incidence and vector populations Provide continuity in research, implement, monitor, and evaluate Integrated Vector Management (IVM) strategy	Release sterilized male insects to reduce the reproductive capacity of vector populations Promote the IVM technology and biological control of vectors
II. WBDs and Foodborne diseases (FBDs)			
Extreme precipitation, flood events, and maximum temperature and rainfall contributing to WBDs and WBDs cases outbreak The risk that the progress to date in reducing childhood deaths from diarrhoeal disease is compromised Poor, marginalized, slum dwellers, landless, and other vulnerable populations are at high risk	Carry out regular surveillance of WBDs, FBDs, and analysis of seasonal impacts on disease outbreaks Implement a climate-resilient water safety plan in water supply schemes followed by water quality surveillance Facilitate the testing of water quality in WBD and FBD epidemic areas Promote the management of waste and garbage to maintain a safe and healthy environment	Implement technological improvements such as wastewater treatment, water harvesting, and improved sanitation Maintain the Geographical Information System (GIS) based records of the drinking water distribution system and provide feedback to the concerned organization Design and implement adaptation program in the health sector targeting the most vulnerable geographic area and population groups such as women, elderly, children, and the poor	Build and maintain wastewater treatment and water harvesting techniques Provide access to a regular and safe drinking water supply to all populations, mostly the vulnerable groups Maintain a complete GIS-based record on water quality and drinking water distribution system

1A. Disease surveillance: I. VBDs			
Climate change risk and vulnerability	**Short-term (1-5 years)**	**Medium-term (1-10 years)**	**Long-term (30 years)**
III. Heart diseases			
Risk of maximum temperature and number of cold wave events increasing heart disease cases Poor people, labourers, women, the elderly, and children are vulnerable to heatwaves and cold waves Risk of increased mortality and morbidity during hot days and heatwaves. Risk of mortality, morbidity, and productivity loss, particularly among manual workers in hot climates	Promote early detection and management of chronic diseases within the community Control the adverse health effects of air pollution Promote proper solid waste management (hospital waste, etc.) Launch awareness programs to sensitize the public about precautions to be taken during extreme heat and extremely cold days	Map and project effects of climate change on the burden of heart diseases in vulnerable populations Organize mobile medical camps targeting vulnerable areas Incentivize and encourage the public and private sector to expand insurance systems covering the workers and employees	Launch programs to advance cardiovascular risk reduction through lifestyle, behaviour, and environmental modifications
IV. Respiratory diseases			
Changes in temperature, increase in the number of annual warm days and drought events in Terai, and increase in cold wave events in hill areas thus growing the respiratory disease cases	Monitor seasonal trends of respiratory diseases and the impact of climate change Encourage community-based management and treatment of ARI Promote the improved cookstoves and switch to clean energy to reduce indoor pollution and health hazard Prioritize promoting of Community Based Integrated Management of Childhood Illness (CB-IMCI) service Reinforce regulations to stop biomass burning Promote activities such as plantation, greenery park, cycling, etc.	Expand the promotion of improved cooking stoves, modern cooking devices, and cleaner means of transportation Launch advanced promotion of Community Based Integrated Management of Childhood Illness (CB-IMCI) service provided by FCHVs at the community level	Ensure better urban/ housing design to reduce air pollution Replace the use of fossil fuel with the implementation of clean cooking technology and pollution-free transportation Promote the use of improved cookstoves and modern cooking devices to reduce indoor pollution
V. Malnutrition			
Drought events, extreme precipitation such as wet and cold days contribute to increasing malnutrition Risk of a larger burden of diseases and increased food insecurity for particular population groups An increasing risk that progress made in reducing mortality and morbidity from undernutrition may slow or reverse	Promote education programs for farmers regarding the potential impacts of extreme weather events on health and agriculture Promote the practice of good dietary habits to improve the nutritional status of all people Promote home gardening, kitchen gardening, agroforestry, utilization of information on the variability of weather and climate, promote cultivation and consumption of local micronutrient-rich food, food storage, research on the nutritional crops	Promote and integrate human health benefits of climate-smart agriculture practices into farming Extend services, policies, and plans to target the vulnerable and disadvantaged groups	Develop and promote drought and flood-resistant crop varieties in vulnerable areas for required food supply Ensure food access by all people, particularly poor and vulnerable populations Ensure all provinces have Humanitarian Staging Areas equipped with supplies during emergencies

1A. Disease surveillance: I. VBDs			
Climate change risk and vulnerability	**Short-term (1-5 years)**	**Medium-term (1-10 years)**	**Long-term (30 years)**
VI. Infrastructure and health services			
Extreme events such as an increase in consecutive dry days, increase in warm days, and increase in rainy days damaging the healthcare infrastructures, such as hospitals, medical stores, and laboratories Increase in heatwave days, heavy rainfall, floods, landslides, drought events, and GLOFs damaging the drinking water infrastructures and services and water treatment plants	Map of potential health infrastructural risks from extreme events and design risk reduction measures	Assess the ability of current infrastructures/buildings to withstand extreme events and provide additional support Ensure the money is allocated for repair and maintenance	Develop and implement sustainable infrastructure and services Improve the design and plan of infrastructure and ensure climate resilience is built into it
	Retrofit the disaster affected infrastructures using available technology and local and indigenous knowledge	Rebuilt and strengthen the healthcare infrastructures according to Nepal Health Infrastructure Development Standards (2017)	Continuity to rebuilt and strengthen healthcare infrastructures according to Nepal Health Infrastructure Development Standards (2017)
	Manage and coordinate the construction and maintenance of buildings and other public health infrastructures, including the maintenance of biomedical equipment Allocate a budget for data verification and strengthening of infrastructures of sentinel sites	Promote disaster-resilient buildings construction through workshop/training Design more heat and cold resilient buildings Expand emergency system support to more frequent and more severe extreme events	Carry out immediate construction of public health infrastructure in areas where vulnerable communities are located Develop environment-friendly health institutions and education facilities
VII. Overarching adaptation options (policy and institutions, capacity, technology, communication, and finance)			
Countries like Nepal tend to be more sensitive to an elevated health risk caused by climate change due to the lack of resources and capabilities for their public health system to effectively respond to the various challenges	Enhance the integration of climate services into health planning, budgeting, and decision-making Revise and revisit current policies and strategies in the health sector to make it more environment-friendly and climate-resilient Conduct regular interaction between researchers and policymakers working in public health, environmental health, climate change, and related sectors	Develop strategies to especially tackle health-related issues prompted by climate change such as VBD, WBD, respiratory diseases, malnutrition, etc. Plan and prepare the emergency health plan to tackle issues arising from climate-induced hazards Enhance health sector emergency preparedness, disaster response, and epidemiology, and outbreak management capabilities in close coordination and collaboration with key stakeholders in the country	Strengthen information technology-based surveillance system for prediction, early detection, preparedness, and early response to VBD, WBD, and FBD outbreaks up to all community levels Manage and control climate-sensitive diseases using the Early Warning and Reporting System (EWARS)

1A. Disease surveillance: I. VBDs			
Climate change risk and vulnerability	**Short-term (1-5 years)**	**Medium-term (1-10 years)**	**Long-term (30 years)**
	Design capacity enhancement of health professionals and stakeholders on data analysis in particular to climate and health data Improve the recording and reporting of epidemic and extreme events risks Create opportunities for Environmental Epidemiologists Assess gaps in health database recording for research purpose and prepare the national health e-database for public access	Convert current paper-based data collection systems to electronic systems Ensure up to date environmental, climate-sensitive diseases and population data and forecasts Initiate to develop a national electronic database for health, vector, water, weather, and climate data that is accessible by all relevant stakeholders	Develop a national electronic daily database for health, vector, water, weather, and climate data that is accessible by all relevant stakeholders Conduct routine analyses of weather, vector, and epidemiologic data and distribute findings in a bulletin to relevant stakeholders
	Strengthen institutional capacity to integrate climate risks and adaptation into health sector planning Promote public and private sectors' participation in the research and development of the health sector in the context of climate change	Implement research findings on policies through multi-sectoral collaboration Strengthen and establish a surveillance system of climate-related/sensitive infectious diseases	Develop scientific methods to control emerging infectious diseases, such as vector control, vaccination, and pharmacological treatment Promote approaches to build a climate-resilient health system
	Improve communicating systems: internet, mobile phone, radio, etc. to provide an early and accessible early warning to the populations most likely to be affected	Improve a web-based and digital communication system in all the 753 palikas so that it is connected to people and information can flow efficiently	Increase access to digitalized communication technology such as the internet, smartphone, etc. to all the vulnerable populations
	Develop climate financing strategy for the health sector based on H-NAP and VRA in the health sector Develop project banks on looking at adaptation and risk reduction measures in the health sector	Access funding from international sources such as Green Climate Fund (GCF, Adaptation Fund) and other bilateral and multilateral funding to support the implementation of adaptation priorities in the health sector	Support in trickling down the climate finance to support the health system, services, infrastructure, and people at risk particularly at the local level

Chapter 8

Conclusion and Recommendations

8.1 Conclusion

Human health is sensitive to changes in weather patterns and climate. There are rapid changes in temperature and precipitation and the occurrence of climate extremes and hazards such as heatwaves, floods, droughts, and fires. The shifting of disease vectors, ecological disruption, and population displacement all have an impact on health. The direct health effects of extreme weather events primarily harm human health by exacerbating the burden of existing diseases and negatively impacting daily life for those with the weakest immune systems and the least ability to adapt. Climate change has become a major hazard to human health and well-being in recent decades, requiring proactive planning by health authorities. The comprehensive assessment of risks and vulnerability, for both health systems and the population, is a critical starting point for understanding the necessary measures for adaptation and building resilience.

The impacts of climate change on public health are becoming more apparent in Nepal and are likely to be multiple for any region and highly variable between different regions. The extent of impacts from adverse effects will depend on how well society can better understand and feel the impacts, the planning processes for adaptation strategies, and the successful implementation of the adaptation measures.

This vulnerability and risk assessment is part of developing the National Adaptation Plan (NAP). The vulnerability assessment along with the identification of adaptation options in the health sector will serve as baseline information that can be used towards building climate-resilient communities and protecting the health system.

A correlation study was conducted to assess the association between climate-sensitive diseases and environmental indicators. Annual maximum temperature and rainfall in Kanchanpur and Kailali showed a positive association with VBD cases. Similarly, WBDs showed a positive association with the annual rainfall and maximum temperature. Likewise, the heart disease cases showed a positive association with annual maximum temperature in Kathmandu, Dhankuta, Dhading, and Kailali. The number of malnourished cases revealed a positive correlation with precipitation in Kapilvastu and with annual maximum temperature in Dolakha, Kanchanpur, Rolpa, and Sarlahi. The HPI is found positively associated with malnutrition incidence. A time series model of respiratory disease cases in the Terai region suggested that disease risks are significantly associated with average temperature, warm days, and drought events, and in the Hill region, disease risk is significantly associated with the number of cold wave events.

The frequency of climate hazards and extreme weather events vary in different districts and have serious health implications. The RCP scenarios show health risks from climate extreme indices will be higher in the districts of Province 1, Province 2, Gandaki Province, and Bagmati Province.

The exposure analysis depicts that the highest exposure was evident in Kathmandu and Morang. The lowest score is found in Manang and very low scores are found across the country particularly in Hill and Mountain districts.

A sensitivity index score showed that Saptari, Siraha, Dhanusha, Mahottari, Sarlahi, Rautahat districts of Province 2 and Achham of Sudurpaschim Province have very high sensitivity to climate change. Besides, the adaptive capacity index shows a very low adaptive capacity scattered across the country particularly in Hill and Mountain districts. It means that Hill and mountain districts are relatively less able to cope and adapt to climate extreme events and disasters.

The analysis shows that Makawanpur, Lamjung, Dhankuta, Baglung, Lalitpur, Kavrepalanchok, Bhaktapur, Parbat, Syangja, Rupandehi, Palpa, Manang, Chitawan, Kaski, Panchthar, Gulmi, Kathmandu, and Ilam districts have the lowest vulnerability. On the contrary, Humla, Rautahat, Siraha, Dhanusha, Sarlahi, Mahottari, and Saptari districts have the highest vulnerability. In terms of the magnitude of vulnerability, six districts of Province 2 representing the Terai region of the Eastern cluster and Humla from the Mountain region of Karnali Province have a very high vulnerability. Nawalpur representing the Terai region of Gandaki Province also showed high vulnerability.

The analysis of risks of climate change impact shows that Sunsari, Dhankuta, Terhathum, Sankhuwasabha, Tanahu, Parbat, Syangja, Morang, Taplejung, Panchthar, Jhapa, and Ilam districts have the very high climate change risk in health at the baseline scenarios. Meanwhile, in RCP 4.5 for 2030 and 2050, the number of districts at very high risk to climate change impact increased to 9 and 12. Besides, in RCP 8.5 for 2030 and 2050, the high-risk district increased to 9 and 13 respectively.

This report has identified potential short-, medium-, and long-term adaptation options in the health sector that could be implemented across Nepal which can form the basis for future climate change responses by decision-makers. Building capacity is an essential step in preparing adaptation strategies which will require a forward-looking, strong, and unifying vision of healthcare as well as an understanding of the issues posed by climate change. Besides, health sector adaptation will require investment in personnel, infrastructure, and inter-agency partnerships, with such investment required in the face of uncertainty regarding the nature and severity of climate change and its impact on health.

8.2 Way Forward

- The climate-sensitive diseases follow a specific seasonality trend. The seasonal and annual variation of climate-sensitive health outcomes can be compared with the variation in the weather pattern in both spatial and temporal extensions. Therefore, VRA studies in the future on climate-sensitive health outcomes at the local level are highly recommended.
- A careful indicator selection has to be done using a review of high-quality reports and articles as well as expert consultation, making sure the indicators have a high significance in the given context. Likewise, weightage is a very sensitive issue in VRA and determines the indices calculation, results, risks, and vulnerabilities. Weightage is based on expert opinion. Selecting experts from different sub-sectors and disciplines can minimize disciplinary bias.
- The climate-related health data at different spatial and temporal scales is required for a comprehensive analysis of the vulnerability and risk. Availability of data was a major constraint limiting this study at the district level. In the future, VRA at the local level is strongly recommended. For this, climate-sensitive diseases and health sector-related infrastructure data should be collected at the municipal level. Similarly, disasters and socioeconomic data should be collected at the municipality level. The disease-specific daily or monthly data management system in one date format (A.D.) is strongly recommended.

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Annex 1: Lists of Indicators

Table 12: List of indicators used in VRA

Category/Indicator	Unit	Source
Exposure		
Total populations	nos.	CBS, 2011
Government hospitals		DoHS, Annual Reports
Primary healthcare centres		
Health posts		
Sub health posts		
Private/non-public health institutions		
Registered medical stores		DDA Annual Report (2019)
Registered laboratories		National Public Health Laboratory, Teku
Water supply infrastructures and services: Drinking-Water Supply schemes		DWSSM
Water and sludge treatment plants		
Sensitivity		
Total male population	nos.	CBS, 2011
Total female population		
Population < 5 years		
Population above 60 years		
Total Heart diseases (2005-2018)		HMIS, EDCD, VBDRTC, DoHS Annual Report, MoHP, Consultation
Vector-borne diseases (2005-2018)		
Waterborne diseases including acute gastroenteritis (2005-2018)		
Respiratory diseases (2005-2018)		
Malnutrition: undernutrition (2006-2018)		
House-made from mud bounded bricks/stones, the wooden pillar (outer wall), bamboo (outer wall), roof (thatch/straw)		CBS, 2011
Types of houses build-up without any facility		
Types of houses with at least one facility (radio, TV, motorcycle, refrigerator, etc.)		
Human Poverty Index	index	
Human Development Index	index	
Adaptive Capacity		
Total medical practitioners, public health, nursing, paramedic and administrative staff per 100,000 population	nos.	DoHS Annual Report, MoHP, Consultation
Total FCHVs per 100,000 population		
Total immunization in EPI/PHC/outreach clinics		
Average (vitamin-A that was given to severe malnourished <5 yrs)		
Average (Antihelminthes that was given to children <5 yrs)		
Japanese encephalitis immunization coverage	%	
Nutrition program for mother and children	nos.	FWD, DoHS consultation
Food productivity (paddy, wheat, maize, millet, barley)	Mt/ha	
Drinking water access	HHs	DWSSM
Water supply coverage	%	
Water treatment facility (functioning)	nos.	
Sanitation coverage	%	

Category/Indicator	Unit	Source	
Safely disposed excreta treatment facility (on-site)		%	Nepal Water Supply Corporation
Functional drinking water supply facility		nos.	
Female literacy rate		%	CBS, 2011
Male literacy rate		%	
Female with health insures		nos. Population Division, MoHP EDCD, DoHS	http://nib.gov.np/
Male with health insures			
OCMC services			
Access to early warning and disease surveillance systems (sentinel sites)			
Emergency healthcare services			
Area coverage by an early warning system		%	DHM

Annex 2: District Ranking of Climate Hazard

Table 13: Nepal districts ranked according to flood hazard index

Flood hazard rank	District
Very High (0.731 - 1)	Sunsari, Kailali, Morang, Jhapa
High (0.595 - 0.730)	Rautahat, Bardiya, Sarlahi, Saptari
Moderate (0.412 - 0.594)	Kapilbastu, Rupandehi, Bara, Chitawan, Dhanusha, Kanchanpur, Mahottari, Parsa
Low (0.170 - 0.411)	Makawanpur, Udayapur, Banke, Siraha, Sindhuli, Dang, Nawalpur, Kaski, Parasi
Very Low (0 - 0.169)	Dhading, Rolpa, Humla, Mugu, Rasuwa, Myagdi, Lamjung, Dolakha, Dhankuta, Terhathum, Nuwakot, Sankhuwasabha, Baglung, Western Rukum, Sindhupalchok, Gorkha, Solukhumbu, Lalitpur, Tanahu, Kavrepalanchok, Dailekh, Bhaktapur, Parbat, Pyuthan, Darchula, Syangja, Dolpa, Surkhet, Achham, Arghakhanchi, Baitadi, Palpa, Bhojpur, Salyan, Mustang, Doti, Manang, Eastern Rukum, Khotang, Okhaldhunga, Bajura, Kalikot, Taplejung, Panchthar, Jajarkot, Jumla, Bajhang, Gulmi, Ramechhap, Kathmandu, Dadeldhura, Ilam

Table 14: Nepal districts ranked according to landslide hazard index

Landslide hazard rank	District
Very High (0.757 - 1)	Dhading, Sankhuwasabha, Baglung, Sindhupalchok, Dolpa, Kaski, Taplejung
High (0.539 - 0.756)	Rolpa, Makawanpur, Myagdi, Lamjung, Dolakha, Nuwakot, Gorkha, Solukhumbu, Kavrepalanchok, Dailekh, Darchula, Syangja, Palpa, Khotang, Bajura, Kalikot, Jajarkot, Bajhang, Gulmi, Ilam
Moderate (0.366 - 0.538)	Rasuwa, Dhankuta, Western Rukum, Tanahu, Udayapur, Parbat, Pyuthan, Achham, Baitadi, Bhojpur, Sindhuli, Salyan, Mustang, Doti, Eastern Rukum, Okhaldhunga, Panchthar, Jumla, Ramechhap
Low (0.143 - 0.365)	Humla, Mugu, Terhathum, Lalitpur, Kailali, Surkhet, Arghakhanchi, Manang, Chitawan, Dang, Nawalpur, Kathmandu, Dadeldhura
Very Low (0 - 0.142)	Kapilbastu, Sunsari, Rautahat, Bardiya, Bhaktapur, Banke, Siraha, Rupandehi, Morang, Bara, Dhanusha, Kanchanpur, Jhapa, Sarlahi, Mahottari, Parasi, Parsa, Saptari

Table 15: Nepal districts ranked according to drought hazard index

Drought hazard rank	District
Very High (0.599 - 1)	Humla, Gorkha, Dolpa
High (0.443 - 0.598)	Mugu, Sankhuwasabha, Sindhupalchok, Solukhumbu, Kailali, Surkhet, Sindhuli, Mustang, Dang, Taplejung, Jajarkot, Jumla, Bajhang
Moderate (0.330 - 0.442)	Dhading, Rolpa, Makawanpur, Myagdi, Dolakha, Baglung, Bardiya, Dailekh, Udayapur, Darchula, Banke, Achham, Salyan, Doti, Manang, Eastern Rukum, Khotang, Chitawan, Bajura, Kalikot, Kaski, Ramechhap
Low (0.172 - 0.329)	Kapilbastu, Rasuwa, Lamjung, Sunsari, Nuwakot, Rautahat, Western Rukum, Tanahu, Kavrepalanchok, Parbat, Pyuthan, Syangja, Siraha, Arghakhanchi, Baitadi, Rupandehi, Palpa, Bhojpur, Morang, Bara, Okhaldhunga, Dhanusha, Nawalpur, Kanchanpur, Panchthar, Jhapa, Sarlahi, Mahottari, Parsa, Gulmi, Saptari, Dadeldhura, Ilam
Very Low (0 - 0.171)	Dhankuta, Terhathum, Lalitpur, Bhaktapur, Parasi, Kathmandu

Table 16: Nepal districts ranked according to epidemics hazard index

Epidemics hazard rank	District
Very High (0.673 - 1)	Morang, Dang, Jajarkot
High (0.427 - 0.672)	Makawanpur, Sunsari, Banke, Kailali, Doti, Dhanusha, Jhapa, Mahottari, Kathmandu, Saptari
Moderate (0.287 - 0.426)	Dhading, Humla, Rautahat, Sindhupalchok, Kavrepalanchok, Dailekh, Udayapur, Achham, Siraha, Rupandehi, Sindhuli, Salyan, Bara, Kanchanpur, Taplejung, Sarlahi
Low (0.180 - 0.286)	Rolpa, Kapilbastu, Dolakha, Dhankuta, Nuwakot, Western Rukum, Bardiya, Gorkha, Tanahu, Baitadi, Palpa, Bhojpur, Chitawan, Bajura, Kalikot, Jumla, Parsa, Ramechhap

Epidemics hazard rank	District
Very Low (0 - 0.179)	Mugu, Rasuwa, Myagdi, Lamjung, Terhathum, Sankhuwasabha, Baglung, Solukhumbu, Lalitpur, Bhaktapur, Parbat, Pyuthan, Darchula, Syangja, Dolpa, Surkhet, Arghakhanchi, Mustang, Manang, Eastern Rukum, Khotang, Okhaldhunga, Nawalpur, Kaski, Panchthar, Parasi, Bajhang, Gulmi, Dadeldhura, Ilam

Table 17: Nepal districts ranked according to heavy rainfall hazard index

Heavy rainfall hazard rank	District
Very High (0.493 - 1)	Humla, Achham
High (0.280 - 0.492)	Rautahat, Sarlahi
Moderate (0.173 - 0.279)	Dhading, Sunsari, Kavrepalanchok, Bhaktapur, Parbat, Dolpa, Rupandehi, Bara, Khotang, Taplejung
Low (0.080 - 0.172)	Rolpa, Makawanpur, Myagdi, Dolakha, Dhankuta, Terhathum, Nuwakot, Sankhuwasabha, Baglung, Western Rukum, Bardiya, Gorkha, Lalitpur, Dailekh, Pyuthan, Syangja, Banke, Kailali, Arghakhanchi, Palpa, Bhojpur, Salyan, Morang, Doti, Dhanusha, Dang, Nawalpur, Kaski, Jajarkot, Jhapa, Mahottari, Parasi, Bajhang, Ramechhap, Kathmandu, Saptari, Dadeldhura
Very Low (0 - 0.079)	Kapilbastu, Mugu, Rasuwa, Lamjung, Sindhupalchok, Solukhumbu, Tanahu, Udayapur, Darchula, Surkhet, Siraha, Baitadi, Sindhuli, Mustang, Manang, Eastern Rukum, Okhaldhunga, Chitawan, Bajura, Kalikot, Kanchanpur, Panchthar, Jumla, Parsa, Gulmi, Ilam

Table 18: Nepal districts ranked according to coldwave hazard index

Cold waves hazard rank	District
Very High (0.662 - 1)	Rautahat, Mahottari, Saptari
High (0.277 - 0.661)	Siraha, Bara, Dhanusha
Moderate (0.154 - 0.276)	Kapilbastu, Sunsari, Banke, Rupandehi, Morang, Jhapa, Sarlahi, Parsa
Low (0.001 - 0.153)	Makawanpur, Humla, Mugu, Rasuwa, Dhankuta, Terhathum, Sankhuwasabha, Western Rukum, Sindhupalchok, Bardiya, Solukhumbu, Tanahu, Kavrepalanchok, Udayapur, Bhaktapur, Parbat, Darchula, Kailali, Surkhet, Achham, Baitadi, Palpa, Bhojpur, Sindhuli, Salyan, Mustang, Manang, Eastern Rukum, Khotang, Chitawan, Bajura, Nawalpur, Kalikot, Kanchanpur, Taplejung, Panchthar, Jajarkot, Jumla, Parasi, Gulmi, Ramechhap, Kathmandu, Dadeldhura, Ilam
Very Low (0)	Dhading, Rolpa, Myagdi, Lamjung, Dolakha, Nuwakot, Baglung, Gorkha, Lalitpur, Dailekh, Pyuthan, Syangja, Dolpa, Arghakhanchi, Doti, Okhaldhunga, Dang, Kaski, Bajhang

Table 19: Nepal districts ranked according to heatwave hazard index

Heatwaves hazard rank	District
Very High (0.875 - 1)	Banke, Bara
High (0.625 - 0.874)	Kapilbastu, Sunsari, Rautahat, Bardiya, Rupandehi, Parsa, Saptari
Moderate (0.375 - 0.624)	Dhading, Kailali, Dhanusha, Jhapa, Mahottari
Low (0.001 - 0.374)	Tanahu, Dailekh, Udayapur, Salyan, Morang, Khotang, Chitawan, Nawalpur, Kanchanpur, Parasi
Very Low (0	Rolpa, Makawanpur, Humla, Mugu, Rasuwa, Myagdi, Lamjung, Dolakha, Dhankuta, Terhathum, Nuwakot, Sankhuwasabha, Baglung, Western Rukum, Sindhupalchok, Gorkha, Solukhumbu, Lalitpur, Kavrepalanchok, Bhaktapur, Parbat, Pyuthan, Darchula, Syangja, Dolpa, Surkhet, Achham, Siraha, Arghakhanchi, Baitadi, Palpa, Bhojpur, Sindhuli, Mustang, Doti, Manang, Eastern Rukum, Okhaldhunga, Bajura, Dang, Kalikot, Kaski, Taplejung, Panchthar, Jajarkot, Jumla, Sarlahi, Bajhang, Gulmi, Ramechhap, Kathmandu, Dadeldhura, Ilam

Annex 3: District Ranking of Epidemic/Disease Hazard Index

Table 20: Nepal districts ranked according to overall heart diseases hazard index

Heart disease hazard rank	District
Very High (0.622 - 1)	Kaski, Kathmandu
High (0.255 - 0.621)	Morang, Chitawan, Jhapa
Moderate (0.132 - 0.254)	Gorkha, Lalitpur, Kavrepalanchok, Bhaktapur, Syangja, Siraha, Rupandehi, Palpa, Dhanusha, Gulmi
Low (0.058 - 0.131)	Dhading, Makawanpur, Kapilbastu, Lamjung, Sunsari, Dolakha, Nuwakot, Rautahat, Baglung, Sindhupalchok, Bardiya, Solukhumbu, Tanahu, Parbat, Pyuthan, Kailali, Arghakhanchi, Sindhuli, Bara, Dang, Nawalpur, Sarlahi, Mahottari, Parasi, Parsa, Ramechhap, Saptari, Ilam
Very Low (0 - 0.057)	Rolpa, Humla, Mugu, Rasuwa, Myagdi, Dhankuta, Terhathum, Sankhuwasabha, Western Rukum, Dailekh, Udayapur, Darchula, Banke, Dolpa, Surkhet, Achham, Baitadi, Bhojpur, Salyan, Mustang, Doti, Manang, Eastern Rukum, Khotang, Okhaldhunga, Bajura, Kalikot, Kanchanpur, Taplejung, Panchthar, Jajarkot, Jumla, Bajhang, Dadeldhura

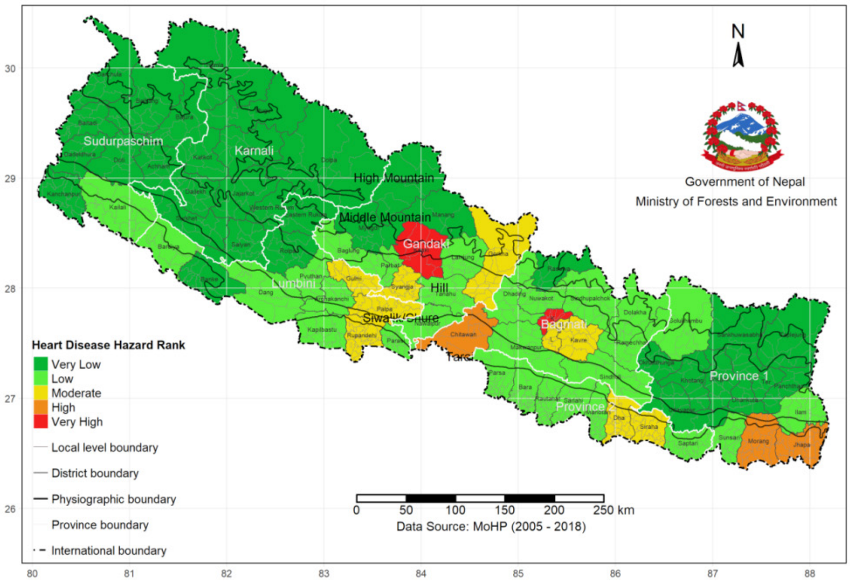

Figure 42: Map of Nepal districts showing overall heart disease hazard index

Table 21: Nepal districts ranked according to overall respiratory diseases hazard index

Respiratory disease hazard rank	Districts
Very High (0.744 - 1)	Siraha, Morang, Dhanusha, Jhapa
High (0.506 - 0.743)	Sunsari, Rautahat, Bardiya, Kailali, Bara, Chitawan, Kaski, Kanchanpur, Sarlahi, Mahottari, Kathmandu, Saptari
Moderate (0.302 - 0.505)	Dhading, Makawanpur, Kapilbastu, Sindhupalchok, Gorkha, Kavrepalanchok, Dailekh, Pyuthan, Syangja, Banke, Surkhet, Achham, Baitadi, Rupandehi, Palpa, Okhaldhunga, Dang, Gulmi, Dadeldhura
Low (0.084 - 0.301)	Rolpa, Humla, Rasuwa, Myagdi, Lamjung, Dolakha, Dhankuta, Terhathum, Nuwakot, Sankhuwasabha, Baglung, Western Rukum, Solukhumbu, Lalitpur, Tanahu, Udayapur, Bhaktapur, Parbat, Darchula, Arghakhanchi, Bhojpur, Sindhuli, Salyan, Doti, Khotang, Bajura, Nawalpur, Kalikot, Taplejung, Panchthar, Jajarkot, Jumla, Parasi, Bajhang, Parsa, Ramechhap, Ilam
Very Low (0 - 0.083)	Mugu, Dolpa, Mustang, Manang, Eastern Rukum

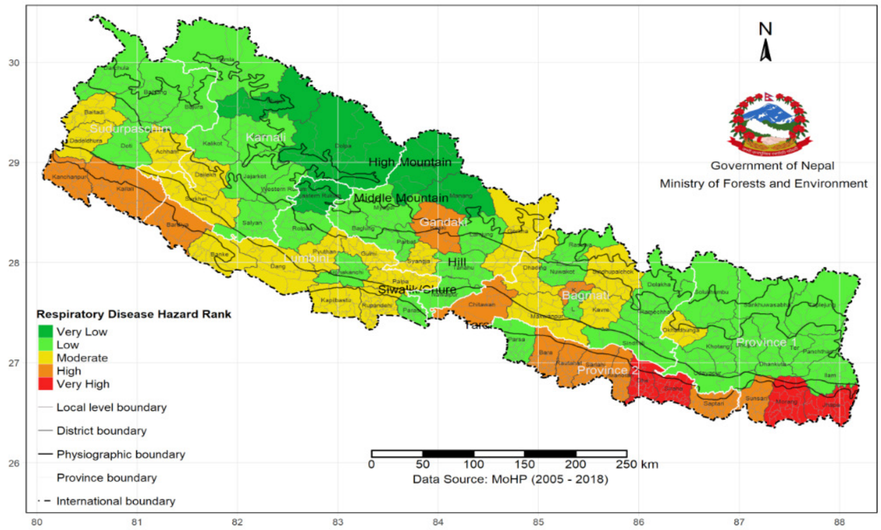

Figure 43: Map of Nepal districts showing overall respiratory hazard index

Table 22: Nepal districts ranked according to overall VBD hazard index

VBD hazard rank	Districts
Very High (0.587 - 1)	Kailali, Kanchanpur, Jhapa
High (0.304 - 0.586)	Kapilbastu, Siraha, Morang, Dhanusha, Sarlahi, Mahottari
Moderate (0.131 - 0.303)	Makawanpur, Rautahat, Bardiya, Banke, Rupandehi, Bara, Chitawan, Kathmandu, Saptari
Low (0.047 - 0.130)	Dhading, Sunsari, Nuwakot, Lalitpur, Kavrepalanchok, Udayapur, Surkhet, Achham, Baitadi, Palpa, Sindhuli, Dang, Nawalpur, Kaski, Panchthar, Parasi, Parsa, Dadeldhura
Very Low (0 - 0.046)	Rolpa, Humla, Mugu, Rasuwa, Myagdi, Lamjung, Dolakha, Dhankuta, Terhathum, Sankhuwasabha, Baglung, Western Rukum, Sindhupalchok, Gorkha, Solukhumbu, Tanahu, Dailekh, Bhaktapur, Parbat, Pyuthan, Darchula, Syangja, Dolpa, Arghakhanchi, Bhojpur, Salyan, Mustang, Doti, Manang, Eastern Rukum, Khotang, Okhaldhunga, Bajura, Kalikot, Taplejung, Jajarkot, Jumla, Bajhang, Gulmi, Ramechhap, Ilam

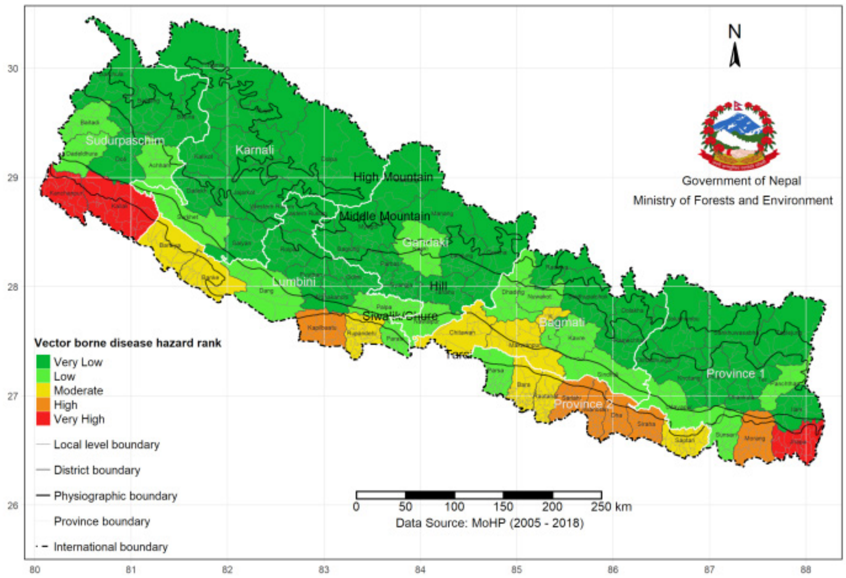

Figure 44: Map of Nepal districts showing overall disease VBDs hazard index

Table 23: Nepal districts ranked according to the overall WBD hazard index

WBD hazard rank	Districts
Very High (0.771 - 1)	Dailekh, Surkhet, Achham, Siraha, Saptari
High (0.592 - 0.770)	Humla, Kapilbastu, Sunsari, Rautahat, Bardiya, Banke, Kailali, Baitadi, Morang, Bara, Doti, Dhanusha, Bajura, Jhapa, Sarlahi, Mahottari
Moderate (0.450 - 0.591)	Dhading, Rolpa, Rasuwa, Dolakha, Kavrepalanchok, Pyuthan, Rupandehi, Salyan, Okhaldhunga, Dang, Kanchanpur, Jajarkot, Jumla, Bajhang, Kathmandu, Dadeldhura
Low (0.292 - 0.449)	Makawanpur, Myagdi, Lamjung, Nuwakot, Baglung, Sindhupalchok, Gorkha, Solukhumbu, Udayapur, Darchula, Syangja, Palpa, Bhojpur, Sindhuli, Khotang, Chitawan, Kalikot, Kaski, Taplejung, Panchthar, Parsa, Gulmi, Ramechhap
Very Low (0 - 0.291)	Mugu, Dhankuta, Terhathum, Sankhuwasabha, Western Rukum, Lalitpur, Tanahu, Bhaktapur, Parbat, Dolpa, Arghakhanchi, Mustang, Manang, Eastern Rukum, Nawalpur, Parasi, Ilam

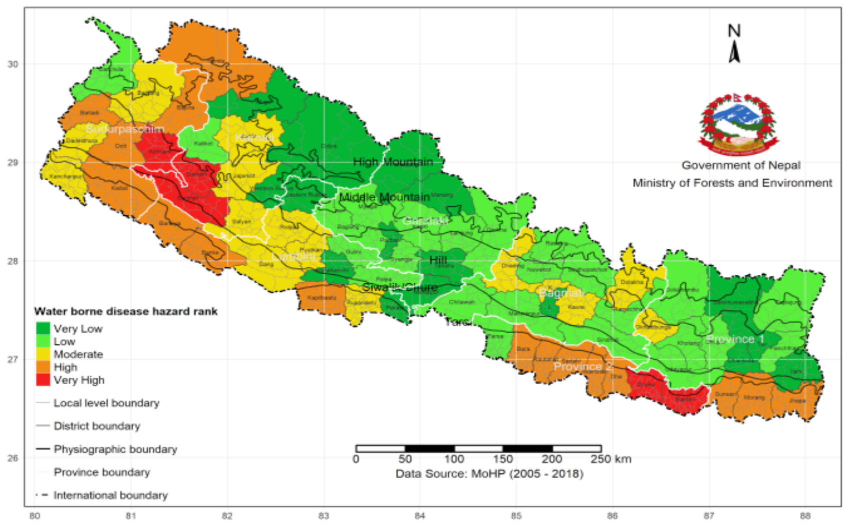

Figure 45: Map of Nepal districts showing overall disease WBDs

Annex 4: Climate Risk Rank in Health

Table 24: Nepal districts ranked according to climate risk in health (RCP 4.5 2030)

Risk Rank	District
Very High (More than 0.542)	Sunsari, Rautahat, Siraha, Morang, Dhanusha, Jhapa, Sarlahi, Mahottari, Saptari
High (0.350 - 0.542)	Kapilbastu, Tanahu, Kailali, Rupandehi, Bara, Dang, Panchthar, Parsa
Moderate (0.239 - 0.349)	Dhading, Dolakha, Nuwakot, Sankhuwasabha, Sindhupalchok, Gorkha, Udayapur, Syangja, Banke, Surkhet, Baitadi, Palpa, Bhojpur, Sindhuli, Chitawan, Nawalpur, Kaski, Kanchanpur, Gulmi, Ilam
Low (0.115 - 0.238)	Rolpa, Makawanpur, Lamjung, Dhankuta, Terhathum, Baglung, Bardiya, Kavrepalanchok, Dailekh, Parbat, Pyuthan, Achham, Arghakhanchi, Salyan, Doti, Eastern Rukum, Khotang, Okhaldhunga, Taplejung, Jajarkot, Parasi, Bajhang, Ramechhap, Kathmandu, Dadeldhura
Very Low (Less than 0.115)	Humla, Mugu, Rasuwa, Myagdi, Western Rukum, Solukhumbu, Lalitpur, Bhaktapur, Darchula, Dolpa, Mustang, Manang, Bajura, Kalikot, Jumla

Table 25: Nepal districts ranked according to climate risk in health (RCP 8.5 2030)

Risk Rank	District
Very High (More than 0.542)	Sunsari, Rautahat, Siraha, Morang, Dhanusha, Jhapa, Sarlahi, Mahottari, Saptari
High (0.350 - 0.542)	Kapilbastu, Tanahu, Kailali, Rupandehi, Bara, Dang, Nawalpur, Parsa
Moderate (0.239 - 0.349)	Dhading, Nuwakot, Sindhupalchok, Gorkha, Syangja, Banke, Surkhet, Baitadi, Palpa, Sindhuli, Chitawan, Kaski, Kanchanpur, Panchthar, Gulmi, Ilam
Low (0.115 - 0.238)	Rolpa, Makawanpur, Lamjung, Dolakha, Dhankuta, Terhathum, Sankhuwasabha, Baglung, Bardiya, Kavrepalanchok, Dailekh, Udayapur, Parbat, Pyuthan, Achham, Arghakhanchi, Bhojpur, Salyan, Doti, Eastern Rukum, Khotang, Okhaldhunga, Taplejung, Jajarkot, Parasi, Bajhang, Ramechhap, Kathmandu, Dadeldhura
Very Low (Less than 0.115)	Humla, Mugu, Rasuwa, Myagdi, Western Rukum, Solukhumbu, Lalitpur, Bhaktapur, Darchula, Dolpa, Mustang, Manang, Bajura, Kalikot, Jumla

Table 26: Nepal districts ranked according to climate risk in health (RCP 4.5 2050)

Risk Rank	**District**
Very High (More than 0.542)	Sunsari, Rautahat, Kailali, Siraha, Morang, Dhanusha, Jhapa, Sarlahi, Mahottari, Bara, Parsa, Saptari
High (0.350 - 0.542)	Dhading, Kapilbastu, Sindhupalchok, Tanahu, Rupandehi, Dang, Nawalpur, Panchthar
Moderate (0.239 - 0.349)	Dolakha, Nuwakot, Sankhuwasabha, Baglung, Bardiya, Gorkha, Dailekh, Udayapur, Syangja, Banke, Surkhet, Achham, Baitadi, Palpa, Bhojpur, Sindhuli, Salyan, Chitawan, Kaski, Kanchanpur, Gulmi, Ilam
Low (0.115 - 0.238)	Rolpa, Makawanpur, Lamjung, Dhankuta, Terhathum, Solukhumbu, Kavrepalanchok, Parbat, Pyuthan, Arghakhanchi, Doti, Eastern Rukum, Khotang, Okhaldhunga, Bajura, Taplejung, Jajarkot, Parasi, Bajhang, Ramechhap, Kathmandu, Dadeldhura

Table 27: Nepal districts ranked according to climate risk in health (RCP 8.5 2050)

Risk Rank	**District**
Very High (More than 0.542)	Sunsari, Rautahat, Kailali, Siraha, Rupandehi, Morang, Bara, Dhanusha, Jhapa, Sarlahi, Mahottari, Parsa, Saptari
High (0.350 - 0.542)	Dhading, Kapilbastu, Nuwakot, Sindhupalchok, Tanahu, Dang, Nawalpur, Panchthar
Moderate (0.239 - 0.349)	Dolakha, Sankhuwasabha, Baglung, Bardiya, Gorkha, Dailekh, Udayapur, Pyuthan, Syangja, Banke, Surkhet, Achham, Baitadi, Palpa, Bhojpur, Sindhuli, Salyan, Khotang, Chitawan, Kaski, Kanchanpur, Gulmi, Ramechhap, Ilam
Low (0.115 - 0.238)	Rolpa, Makawanpur, Myagdi, Lamjung, Dhankuta, Terhathum, Solukhumbu, Kavrepalanchok, Parbat, Arghakhanchi, Doti, Eastern Rukum, Okhaldhunga, Bajura, Taplejung, Jajarkot, Parasi, Bajhang, Kathmandu, Dadeldhura
Very Low (Less than 0.115)	Humla, Mugu, Rasuwa, Western Rukum, Lalitpur, Bhaktapur, Darchula, Dolpa, Mustang, Manang, Kalikot, Jumla

Annex 5: The Outcome of Provincial Consultations

Province 1

Challenges posed by climate change and extreme events	Trends of the changes	Impacts and vulnerabilities	Who is or what is most impacted?	Medium-term adaptation options	Long-term adaptation options
Mountains					
Snowfall Irregular rainfall and flood Melting of snow and glaciers Drying of water springs Lack of clean and safe drinking water Sanitation and hygiene issues Outbreak of diseases	The massive increase in the trends of temperature change, rainfall variability, and occurrence of hazards Impacts being observed frequently Loss and damage in increasing trend	Impact on livelihood resources: agriculture production decline, declining livestock production, poor quality of products Impacts on water resources: drying leading to unavailability of water resources which led to the migration of communities Impacts on resources: vegetation shifting, the emergence of new species, new crops-positive but many species are declining Impact on infrastructure in the mountain areas	Ethnic minorities, Dalits, women, girls, children, and elderly belonging to marginalized and poor households Communities leaving in rain shadow districts	Improve the capacity of service providers and equip them with new knowledge and skills on climate resilient health and sanitation system Prioritize research and development on issues related to climate change and health and sanitation Protection of water resources Conserve and manage local seeds, crops, and varieties that are stress-tolerant Conduct health campaign targeting the impacted and vulnerable population	Develop necessary policy and regulations to respond effectively to climate change in a mountainous region Promote water conservation technologies for the mountains Prevent people from migrating by providing alternative drinking water facilities and alternative livelihood options

Challenges posed by climate change and extreme events	Trends of the changes	Impacts and vulnerabilities	Who is or what is most impacted?	Medium-term adaptation options	Long-term adaptation options
			Hills		
Rainfall variability Increase in floods and landslides Temperature rise leading to increase in droughts, forest fires and the emergence of new diseases, and spread of alien species	Temperature rise in increasing trend. Both summer and winter are warmer Intense rainfall in a short duration of time Increased frequency of floods and the impacts of floods and landslides are massive Increased incidence of fires, windstorms, and diseases outbreak	Impact on water resources: drying of springs leading to lack of water and increased burden on women and girls Impact on food production: changes in rainfall pattern is creating uncertainties in rain-fed farming Habitat loss due to degradation of land, loss of soil, and landslides and flood trigger damages Health and sanitation crisis: lack of water and spread of diseases during monsoon and winter Damage to roads, infrastructure such as drainage, canals An increase in water demand is contrary to the declining water yield and availability	Women, children, the elderly, ethnic groups are impacted due to additional stress and burden for fetching water and work drudgery Health issues for children, the elderly, and infant during the winter and monsoon	Protect spring sheds and water bodies for drinking water Promote soil and water management schemes Promote water conservation and storage system (conservation ponds, water collection ponds, water recharge system, water reservoirs)	Develop longer-term sustainable water management plan in the context of climate change Invest in big water storage and water recharge system in the hills to rejuvenate and recharge the springs Carry out plantation activities Implement adaptation plans targeting the health and wash sector
			Terai		
Temperature rise Rainfall variability Disasters: floods, inundation, fires, diseases outbreaks	Increasing trend	Impact on water table: lower in many districts The problem of flooding, and impact on water sources, such as tube wells, wells, ponds, and latrines Impacts on health and hygiene during the heatwave, cold wave, and flood Water scarcity also leading to health and hygiene issues	Mostly the marginalized communities who are landless and homeless are impacted Children, the elderly, and health patients areamong those who are impacted	Protect groundwater and surface water from pollution and depletion Promote water conservation technologies at the community level Conserve the churiya region for water recharge Protect wetlands and watersheds, ponds, and conservation areas	Formulate water regulatory policy and provisions Promote water-efficient technologies and water-saving schemes Promote climate-friendly design of WASH infrastructures

Province 2

Challenges posed by climate change and extreme events	Trends of the changes	Impacts and vulnerabilities	Who is or what is most impacted?	Medium-term adaptation options	Long-term adaptation options
The water table is low due to the degradation of churiya Drying of water sprigs and other water sources, e.g. streams, ponds, well, etc. A new type of disease due to loss of trees and vegetation Health and hygiene issues due to lack of water Impacts due to fires, windstorms, and floods	Massive changes in weather and climate The temperature in summer is very high Experience of heat and cold wave Flooding is a record high in recent years	The outbreak of disease due to lack of clean drinking water Respiratory diseases due to burning of biomass Waterborne and vector-borne diseases due to temperature increase and changes in rainfall pattern leading to flooding Massive loss of life and properties due to flooding and its damage on human life, settlements, infrastructure, and services	Poor, marginalized, slum dwellers, landless are impacted. Among them are children, elderly,women, and the disabled population	Promote water source protection and water management technology and practices Promote integrated soil and water conservation in churiya region Ensure safety while constructing drinking water and latrines Implement riverbank protection schemes and bioengineering in churiya region	Promote sustainable water management programme targeting to conserve and manage water Develop a master plan for churiya conservation Implement disaster risk reduction and climate change adaptation programme in managing water resources and hygiene

Bagmati Province

Geographic areas	Challenges and Risks	Impact	Adaptation options
Mountain	• Extinction of indigenous and local systems • Increase in the evidence of natural calamities (sudden floods and landslides) • Food insecurity • Poverty • Increased temperature and extreme variability in rainfall • Less snowfall • Issues of access to drinking water	• Shifting of snowline • Increase in disaster events (avalanches, snowstorms, and landslides) • Decrease in the flow of water in the winter season • Glacier Lake Outburst Flood (GLOF) • Shifting of agro-ecological zone • The decrease in the availability of water • Impact on the drinking water • Increase in health and hygiene issues	• Rainwater harvesting and plastic ponds • Cultivation inside the protected structure, e.g. naturally ventilated green-house • Promotion of integrated watershed management • Awareness and capacity building of communities • Repair and maintenance of drinking water • Disease surveillance • Improvement of drinking water facilities
Hills and Terai	• Landslides and flash flooding are common issues • Increase in incidence of diseases - mostly vector-borne diseases • Extreme temperature and precipitation events • Malnutrition and food security issues • Water and sanitation challenges in Terai	• Loss and damage from climate-induced disasters • Damage to drinking water and sanitation facilities • An outbreak of diseases (vector-borne and waterborne) • The decrease in the water table • Drying of water springs and depletion of water sources	• Promoting water-efficient technologies and practices (multi-use water system, rainwater harvesting) • Rehabilitation of ponds and natural springs • Protection of springs by plantation nearby • Promotion of integrated water management schemes • Protection of tubewells • Promotion of water conservation techniques • Promotion of bio-engineering practices

Gandaki Province

Geographic location	Main challenges and disaster event	Impact	Midterm Adaptation	Long Term Adaptation
Mountain/hills	• Air pollution and excessive carbon • Flood • Drought • Temperature rise	• A decline in quality of health • Water infrastructure damage • Water source contamination • Waterborne diseases • Water Scarcity • Wetland shrinkage and biodiversity loss • Mosquito and pest migration to the upper region and increase in vector-borne diseases	• Waste segregation • Penalty for open dumping of waste • Management of waste generated from households and SMEs. • Community awareness • Advocacy for budget allocation to counteract the disaster-induced problem • Empowering community-based organization – CFUGs, women group and youth club	• Integrated urban planning for water sources, forests, and other public lands • Health infrastructure development • Policy for wetland conservation • Ensure accountability and transparency in waste management at all levels

Lumbini Province

Challenges posed by climate change and extreme events	Trends of the changes	Impacts and vulnerabilities	Who is or what is most impacted?	Medium-term adaptation options	Long-term adaptation options
Hills					
Landslide and floods	Increasing trends Landslide: Siddha baba, Transen road Flood: Badganga Fires	Infrastructure damage Road blockage Damages to irrigation facilities Damage to hydropower infrastructures Damage to water sources Damages to settlements Impact on socio-demography Glumi resettlement (20-25 households) Impact on livelihood assets loss of life and properties such as agricultural land Impact on human lives Loss of life due to damages Loss of life due to spread of diseases	Squatters, female, pregnant women, elderly people, people with disability, socially excluded communities such as Dalits, ultra-poor households, and children and infants	Improve data and evidence (MIS) Invest in capacity building Promote bio-engineering (plantation of Amrisso and Bamboo) Implementation of WSP and contingency plan Protect water sources and arrange alternative drinking water Invest in research and development particularly understanding water demand and other issues impacted by climate change Implement a health surveillance system Implement fire control measures particularly protecting water pipes	Develop reallocation and resettlement plans Implement river protection works Promote rainwater harvesting and other water conservation technologies Implement water-efficient technologies and irrigation systems Conserve and manage water resources and other critical infrastructures Implement guidelines for making water resources and energy production infrastructure more climate-resilient Implement early warning systems

Challenges posed by climate change and extreme events	Trends of the changes	Impacts and vulnerabilities	Who is or what is most impacted?	Medium-term adaptation options	Long-term adaptation options
Terai					
Increase in temperature Rainfall variability Other extreme events – heatwaves and cold waves	The frequency, intensity, and magnitude of floods, inundation, heatwaves and cold waves is increasing	Flood: Marchwar flooding Embankment of Tinau: damage to the suspension bridge Impact to the population by the heatwaves, cold waves and flooding (squatter population around Tinau) Health hazards due to extreme temperature and rainfall-poor health and sanitation conditions of poor households Damage to infrastructure such as drinking water, latrines are causing water pollution and increasing the incidence of diseases Damage to other infrastructures such as transmission lines, irrigation canals, roads, suspension bridge, water catchment areas, ponds	The poor households belonging to ethnic groups, Dalits are impacted Women, the elderly, disease-prone people, and children are impacted People living in flood-prone areas- squatter, landless are impacted	Promote early warning systems including disease surveillance Build capacity of local governments Help local and provincial government develop standard codes for building climate-resilient infrastructure	Implement resettlement plans Develop DRM and CCA guidelines Invest in water conservation and management technologies Implement sustainable and climate-resilient WASH programmes Implement guidelines to control health hazards particularly heat wave and cold waves Promote insurance for people and their resources

Karnali Province

Physiography	Climate-related major events	Sectoral impact from climate-related events	Adaptation option	
			Medium-term	Long-term
Mountain/hill	Increase in: Avalanche GLOF Flood-landslides Epidemics Cold waves Thunderbolt Animal-infestation	Relocation and immigration Increase unhygienic environment Increase epidemics River encroachment Spring drying up Spring relocation Food insufficiency Increased temperature Water pollution Depletion of groundwater level	Bio-engineering Tree-plantation and increase greenery and park area nearby settlement Spring protection (Taar-Baar and tree plantation) Rainwater harvesting (common – pond and private in HH) Mainstreaming the climate change in every development Green roads Access to the health, (vaccines, health centres, moveable health centres, blood banks)	Squatter settlement management Integrated settlement plan Based on physiography – develop the building codes to ensure climate-sensitive building construction. Increase the health centres based on the physical distance and population proportion. Policy to use the underground water resources. Develop the high dam and reservoirs at the basin level Consider the increased climate change especially precipitation intensity while constructing the culverts and drainage.

Sudurpaschim Province

<table>
<tr><th>Physiography</th><th>Climate-related major events</th><th>Sectoral impact from climate-related events</th><th>Medium term adaptation option</th><th>Long term adaptation option</th></tr>
<tr><td>Mountain</td><td>Increase in river flow due to melting of snow
GLOF
Increase in temperature
Landslides
Fires</td><td rowspan="3">Life and economic loss; migration, cultural transformation
A decrease in tourism activities
Haphazard urbanization
Increase in land/air/water/ noise pollution
Challenge in solid waste management
Loss and damage in physical infrastructure
Increase in the rate of child mortality
Increase in gender inequality and negative impact on female health
A decrease in entrepreneurship and income generation
The negative impact in school and education sector
Overloading in urban infrastructure
Depletion of agricultural land
Change in a traditional river system
Encroachment of sewerage and drain system
Depletion of the groundwater table
Increase in vector-borne and waterborne diseases
Increase in social conflict
Impact on good governance</td><td rowspan="3">Preparation and implementation of land use plan
Proper implementation of environmental impact assessment (EIA) during the construction of development and physical infrastructure
Awareness campaign in society and school about health and sanitation
Implementation of the integrated solid waste management system and site
Coordination between government, private sector, non-government organization, and relevant stakeholders
Afforestation in risk-prone areas
Relocation of the settlement located in risk-prone areas
Increase the accessibility of health services in remote areas
Proper management of faecal sludge
Identification and conservation of tourism spots
Conservation of water resources (lake, ponds, wetland, watersheds)</td><td rowspan="3">Revision of national building code with the integration of climatic factor
Construction of environment-friendly infrastructure
Implementation of an integrated managed settlement plan
Balanced development of infrastructure as per prior need
Afforestation
Minimization of increased exploitation of natural resources
Implement the concept of groundwater recharge via recharge pit and recharge pond
Preparation of integrated masterplan and policy for infrastructure development</td></tr>
<tr><td>Hill</td><td>Landslides
Increase in diseases (Pandemic)
Soil erosion
Fires
Floods and inundation
Droughts</td></tr>
<tr><td>Terai</td><td>Cold waves
Heatwaves
Windstorms
Floods
Fires
Increase in diseases (Pandemic)
Riverbank cutting</td></tr>
</table>

Annex 6: Overall Indices

District	Exposure	Sensitivity	Adaptive capacity	Vulnerability
Achham	0.225	0.78	0.389	0.633
Arghakhanchi	0.223	0.375	0.302	0.138
Baglung	0.257	0.394	0.36	0.083
Baitadi	0.255	0.597	0.312	0.465
Bajhang	0.175	0.698	0.269	0.684
Bajura	0.128	0.681	0.269	0.657
Banke	0.338	0.53	0.437	0.179
Bara	0.475	0.735	0.55	0.33
Bardiya	0.28	0.565	0.449	0.215
Bhaktapur	0.237	0.196	0.559	0
Bhojpur	0.201	0.474	0.249	0.367
Chitawan	0.469	0.431	0.669	0
Dadeldhura	0.139	0.516	0.289	0.373
Dailekh	0.224	0.656	0.234	0.669
Dang	0.377	0.574	0.354	0.368
Darchula	0.119	0.462	0.237	0.367
Dhading	0.314	0.505	0.387	0.213
Dhankuta	0.179	0.352	0.302	0.102
Dhanusha	0.498	0.93	0.454	0.769
Dolakha	0.233	0.48	0.317	0.277
Dolpa	0.029	0.586	0.209	0.596
Doti	0.179	0.683	0.306	0.605
Eastern Rukum	0.139	0.609	0.366	0.404
Gorkha	0.262	0.468	0.331	0.238
Gulmi	0.293	0.419	0.406	0.053
Humla	0.04	0.676	0.184	0.773
Ilam	0.267	0.367	0.304	0.122
Jajarkot	0.142	0.668	0.316	0.568
Jhapa	0.54	0.655	0.556	0.198
Jumla	0.084	0.592	0.253	0.543
Kailali	0.527	0.714	0.455	0.436
Kalikot	0.099	0.681	0.288	0.629
Kanchanpur	0.294	0.532	0.346	0.315
Kapilbastu	0.373	0.683	0.489	0.339
Kaski	0.432	0.262	0.505	0
Kathmandu	1	0.432	1	0
Kavrepalanchok	0.445	0.393	0.769	0
Khotang	0.229	0.444	0.311	0.23
Lalitpur	0.484	0.205	0.838	0
Lamjung	0.205	0.347	0.298	0.1
Mahottari	0.403	1	0.37	1
Makawanpur	0.379	0.475	0.711	0
Manang	0.009	0.22	0.14	0.135
Morang	0.673	0.763	0.568	0.348
Mugu	0.056	0.611	0.242	0.587
Mustang	0.016	0.341	0.183	0.258
Myagdi	0.122	0.354	0.28	0.138
Nawalpur	0.269	0.625	0.307	0.514

District	Exposure	Sensitivity	Adaptive capacity	Vulnerability
Nuwakot	0.287	0.431	0.28	0.255
Okhaldhunga	0.162	0.483	0.383	0.184
Palpa	0.328	0.463	0.445	0.064
Panchthar	0.313	0.383	0.323	0.119
Parasi	0.172	0.559	0.305	0.417
Parbat	0.163	0.297	0.259	0.079
Parsa	0.448	0.665	0.401	0.438
Pyuthan	0.22	0.546	0.365	0.308
Ramechhap	0.219	0.491	0.328	0.278
Rasuwa	0.052	0.491	0.276	0.353
Rautahat	0.442	0.929	0.509	0.688
Rolpa	0.198	0.628	0.385	0.405
Rupandehi	0.621	0.505	0.511	0.033
Salyan	0.22	0.566	0.284	0.457
Sankhuwasabha	0.172	0.444	0.259	0.306
Saptari	0.425	0.915	0.457	0.743
Sarlahi	0.491	0.946	0.484	0.75
Sindhuli	0.247	0.642	0.375	0.442
Sindhupalchok	0.294	0.559	0.346	0.356
Siraha	0.425	0.979	0.45	0.852
Solukhumbu	0.109	0.396	0.225	0.281
Sunsari	0.515	0.657	0.57	0.181
Surkhet	0.282	0.572	0.368	0.344
Syangja	0.32	0.336	0.355	0
Tanahu	0.337	0.405	0.3	0.185
Taplejung	0.13	0.359	0.207	0.251
Terhathum	0.103	0.362	0.188	0.283
Udayapur	0.226	0.562	0.405	0.274
Western Rukum	0.065	0.587	0.322	0.435

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	0.443	0.49	0.554	0.492	0.587	0.21	0.232	0.262	0.233	0.278
Arghakhanchi	0.547	0.628	0.687	0.654	0.743	0.17	0.196	0.214	0.204	0.231
Baglung	0.568	0.656	0.712	0.653	0.755	0.193	0.223	0.242	0.222	0.257
Baitadi	0.477	0.528	0.59	0.527	0.627	0.222	0.246	0.275	0.245	0.292
Bajhang	0.36	0.417	0.469	0.405	0.499	0.133	0.154	0.173	0.15	0.184
Bajura	0.355	0.406	0.454	0.401	0.492	0.094	0.108	0.121	0.107	0.131
Banke	0.507	0.568	0.64	0.579	0.68	0.249	0.278	0.314	0.284	0.333
Bara	0.589	0.66	0.693	0.66	0.744	0.461	0.517	0.543	0.517	0.583
Bardiya	0.497	0.542	0.615	0.564	0.658	0.208	0.227	0.258	0.236	0.276
Bhaktapur	0.616	0.704	0.729	0.679	0.783	0.079	0.09	0.094	0.087	0.101
Bhojpur	0.637	0.722	0.73	0.693	0.81	0.217	0.246	0.249	0.236	0.276
Chitawan	0.624	0.689	0.734	0.699	0.783	0.236	0.261	0.278	0.265	0.296
Dadeldhura	0.466	0.512	0.575	0.521	0.623	0.11	0.121	0.136	0.123	0.148
Dailekh	0.45	0.5	0.565	0.501	0.593	0.211	0.234	0.265	0.235	0.278
Dang	0.529	0.597	0.66	0.611	0.703	0.339	0.382	0.423	0.391	0.45
Darchula	0.409	0.46	0.518	0.459	0.55	0.083	0.093	0.105	0.093	0.111
Dhading	0.615	0.707	0.758	0.698	0.801	0.289	0.332	0.356	0.328	0.376
Dhankuta	0.651	0.739	0.754	0.714	0.827	0.157	0.178	0.182	0.172	0.2
Dhanusha	0.582	0.655	0.659	0.653	0.758	0.645	0.726	0.73	0.723	0.84
Dolakha	0.588	0.659	0.684	0.643	0.763	0.216	0.242	0.252	0.237	0.281
Dolpa	0.286	0.352	0.407	0.349	0.442	0.017	0.02	0.024	0.02	0.026
Doti	0.441	0.493	0.557	0.49	0.588	0.159	0.177	0.2	0.176	0.211
Eastern Rukum	0.472	0.536	0.589	0.532	0.627	0.115	0.13	0.143	0.129	0.152
Gorkha	0.555	0.64	0.698	0.632	0.736	0.222	0.256	0.279	0.253	0.295
Gulmi	0.585	0.675	0.733	0.683	0.776	0.22	0.254	0.276	0.257	0.292
Humla	0.298	0.341	0.386	0.337	0.421	0.027	0.03	0.034	0.03	0.038
Ilam	0.759	0.858	0.869	0.858	0.936	0.279	0.315	0.319	0.315	0.344
Jajarkot	0.468	0.526	0.582	0.514	0.607	0.13	0.146	0.162	0.143	0.169
Jhapa	0.821	0.918	0.928	0.932	1	0.654	0.731	0.739	0.742	0.796
Jumla	0.435	0.485	0.529	0.47	0.561	0.07	0.079	0.086	0.076	0.091
Kailali	0.502	0.544	0.612	0.56	0.655	0.473	0.512	0.576	0.527	0.617
Kalikot	0.402	0.451	0.503	0.441	0.529	0.081	0.091	0.102	0.089	0.107
Kanchanpur	0.5	0.541	0.6	0.55	0.659	0.239	0.259	0.287	0.263	0.315
Kapilbastu	0.554	0.611	0.666	0.649	0.723	0.343	0.378	0.412	0.402	0.448
Kaski	0.647	0.733	0.792	0.734	0.84	0.218	0.247	0.266	0.247	0.283
Kathmandu	0.611	0.707	0.735	0.68	0.781	0.107	0.124	0.129	0.12	0.137
Kavrepalanchok	0.605	0.684	0.707	0.67	0.777	0.145	0.164	0.169	0.161	0.186
Khotang	0.587	0.667	0.674	0.644	0.758	0.204	0.232	0.234	0.224	0.263
Lalitpur	0.572	0.645	0.673	0.633	0.734	0.007	0.008	0.008	0.008	0.009
Lamjung	0.649	0.737	0.798	0.734	0.84	0.179	0.203	0.22	0.203	0.232
Mahottari	0.576	0.649	0.66	0.661	0.755	0.587	0.661	0.672	0.673	0.769

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
Makawanpur	0.597	0.666	0.705	0.66	0.752	0.184	0.206	0.218	0.204	0.232
Manang	0.414	0.493	0.552	0.487	0.589	0.005	0.006	0.007	0.006	0.007
Morang	0.72	0.808	0.819	0.807	0.889	0.81	0.909	0.921	0.908	1
Mugu	0.331	0.378	0.423	0.364	0.45	0.037	0.042	0.047	0.04	0.05
Mustang	0.241	0.313	0.38	0.326	0.424	0.006	0.008	0.009	0.008	0.011
Myagdi	0.51	0.589	0.645	0.593	0.698	0.087	0.1	0.11	0.101	0.119
Nawalpur	0.616	0.681	0.724	0.7	0.782	0.313	0.346	0.368	0.356	0.398
Nuwakot	0.629	0.735	0.78	0.712	0.82	0.28	0.327	0.347	0.317	0.365
Okhaldhunga	0.58	0.658	0.665	0.636	0.747	0.137	0.155	0.157	0.15	0.176
Palpa	0.608	0.697	0.745	0.703	0.791	0.259	0.297	0.318	0.3	0.337
Panchthar	0.714	0.818	0.829	0.805	0.894	0.306	0.351	0.356	0.346	0.384
Parasi	0.616	0.681	0.724	0.7	0.782	0.187	0.206	0.219	0.212	0.237
Parbat	0.688	0.782	0.839	0.783	0.879	0.148	0.168	0.18	0.168	0.189
Parsa	0.591	0.648	0.69	0.666	0.742	0.474	0.52	0.554	0.534	0.595
Pyuthan	0.532	0.615	0.672	0.624	0.716	0.19	0.219	0.239	0.222	0.255
Ramechhap	0.582	0.657	0.669	0.636	0.751	0.201	0.227	0.232	0.22	0.26
Rasuwa	0.518	0.609	0.668	0.591	0.709	0.045	0.053	0.058	0.052	0.062
Rautahat	0.58	0.66	0.688	0.652	0.739	0.543	0.618	0.644	0.611	0.692
Rolpa	0.492	0.565	0.625	0.561	0.659	0.17	0.195	0.216	0.194	0.228
Rupandehi	0.574	0.625	0.665	0.654	0.728	0.449	0.489	0.52	0.511	0.569
Salyan	0.5	0.563	0.63	0.561	0.656	0.2	0.225	0.252	0.224	0.262
Sankhuwasabha	0.788	0.88	0.903	0.852	0.973	0.219	0.245	0.251	0.237	0.271
Saptari	0.627	0.703	0.706	0.744	0.808	0.584	0.654	0.657	0.692	0.752
Sarlahi	0.579	0.656	0.677	0.66	0.753	0.625	0.708	0.731	0.713	0.813
Sindhuli	0.585	0.665	0.676	0.655	0.759	0.259	0.295	0.3	0.29	0.336
Sindhupalchok	0.599	0.684	0.731	0.673	0.793	0.296	0.338	0.362	0.333	0.392
Siraha	0.598	0.672	0.672	0.698	0.761	0.593	0.666	0.666	0.692	0.755
Solukhumbu	0.575	0.651	0.675	0.627	0.742	0.099	0.112	0.117	0.108	0.128
Sunsari	0.669	0.753	0.761	0.746	0.837	0.5	0.563	0.569	0.558	0.626
Surkhet	0.482	0.53	0.597	0.54	0.634	0.226	0.249	0.281	0.254	0.298
Syangja	0.705	0.8	0.857	0.803	0.893	0.274	0.311	0.333	0.312	0.347
Tanahu	0.713	0.806	0.863	0.811	0.896	0.35	0.396	0.424	0.399	0.44
Taplejung	0.759	0.86	0.884	0.839	0.945	0.152	0.173	0.178	0.168	0.19
Terhathum	0.697	0.8	0.812	0.775	0.884	0.114	0.131	0.133	0.127	0.144
Udayapur	0.602	0.683	0.688	0.668	0.771	0.214	0.243	0.245	0.238	0.274
Western Rukum	0.472	0.536	0.589	0.532	0.627	0.055	0.062	0.068	0.062	0.073

Annex 7: TWG Members and Stakeholders Consulted

S.N.		Name	Gender	Designation/affiliation
1	TWG members	Prof. Dr Jageshwor Gautam	Male	Coordinator TWG, MoHP
2		Dr Samir Kumar Adhikari	Male	Co-Coordinator, TWG, MoHP
3		Mr. Rajit Ojha	Male	Co-Coordinator, TWG, MoWSS
4		Dr Meghnath Dhimal	Male	Member, TWG, NHRC, MoHP
5		Er. Rajaram Pote Shrestha	Male	Member, TWG, WHO Nepal country office
6		Ms. Ranjana Prajapati	Female	Member, TWG, MoHP
7		Prof. Bandana Pradhan	Female	Member, TWG, IoM
8		Mr. Prabhat Shrestha	Male	Member, TWG, MoWSS
9		Ms. Sheela Shrestha	Female	Member, TWG, NHTC, MoHP
10		Mr. Mahendra Dhoj Adhikari	Male	Member, TWG, EDCD, DoHS, MoHP
11		Dr Surendra Chaurasiya	Male	Member, Management Division, DoHS, MoHP
12		Dr Guna Nidhi Sharma	Male	Member, MoHP
13		Mr. Upendra K. C.	Male	Support Staff, MoHP, WHO Nepal country office
14	Stakeholders	Prof. Sujan Babu Marhatta	Male	Expert, Nepal Open University
15		Mr. Dinesh Bhandari	Male	Expert, University of Adelaide
16		Dr Prakash Gyawali	Male	DoAAM, DoHS, MoHP
17		Mr. Ganesh Srivastav	Male	MoHP
18		Dr Basu Dev Pandey	Male	EDCD, DoHS, MoHP
19		Dr Yuva Raj Pokherel	Male	VBDRTC, MoHP
20		Mr. Krishna Raj Pandey	Male	EDCD, DoHS, MoHP
21		Mr. Bir Bahadur Rawal	Male	HMIS, DoHS, MoHP
22		Mr. Laxmi Prasad Upadhaya	Male	DWSSSM, Ministry of Water Supply
23		Ms. Anju Adhikari	Female	FWD, DoHS/UNICEF Nepal country office
24		Mr. Prakash Pokhrel	Male	Curative Service Division, DoHS, MoHP