

# Climate and Health Vulnerability Assessment

NEPAL



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*Cover image: A Nepali woman makes her daily walk to the nearest river with her daughter to obtain clean water. Shutterstock/Javing Herrera.*

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June 2024



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# ACKNOWLEDGMENTS

The authors are thankful to the Climate Investment Funds (CIF) and the Climate Support Facility (CSF) for funding this work.

This Climate and Health Vulnerability Assessment (CHVA) for Nepal was produced by the Health-Climate, Environment and Disasters (HCED) program in the Health, Nutrition and Population (HNP) Global Practice of the World Bank, which is led by Tamer Rabie. The assessment is authored by Mikhael Iglesias, Jessica Huang, Stephen Dorey, and Tamer Rabie.

The authors sincerely appreciate the valuable contributions provided by Jhabindra Bhandari, Ana Lucrecia Rivera-Rivera, Muloongo Simuzingili, April Frake and Loreta Rufo.

This work benefited from the administrative support of Fatima-Ezzahra Mansouri and Julie Luvisa Bazolana, the editorial work of Kah Ying Choo, and the production of Sarah Jene Hollis.

The authors are also highly grateful to the HNP management for their strong support of the HCED program and this product and would like to extend their thanks to Juan Pablo Uribe and Monique Vledder.

# LIST OF ABBREVIATIONS

|                 |                                                        |
|-----------------|--------------------------------------------------------|
| <b>AAP</b>      | Ambient Air Pollution                                  |
| <b>ACRORAB</b>  | Association of Community Radio Broadcasters Nepal      |
| <b>AGDP</b>     | Agricultural Gross Domestic Product                    |
| <b>AHW</b>      | Auxiliary Health Worker                                |
| <b>AR6</b>      | Assessment Report 6 [of the IPCC]                      |
| <b>AQI</b>      | Air Quality Index                                      |
| <b>BC</b>       | Black Carbon                                           |
| <b>CCDR</b>     | Country Climate Development Report                     |
| <b>CCKP</b>     | Climate Change Knowledge Portal [World Bank]           |
| <b>CD</b>       | Communicable Disease                                   |
| <b>CDC</b>      | Center for Diseases Control and Prevention             |
| <b>CHVA</b>     | Climate and Health Vulnerability Assessment            |
| <b>CHWs</b>     | Community Health Workers                               |
| <b>CMIP6</b>    | Coupled Model Inter-Comparison Project Phase 6         |
| <b>COP</b>      | Conference of the Parties                              |
| <b>COPD</b>     | Chronic Obstructive Pulmonary Disease                  |
| <b>COVID-19</b> | Coronavirus Disease 2019                               |
| <b>CRU</b>      | Climatic Research Unit [University of East Anglia, UK] |
| <b>CVD</b>      | Cardiovascular Disease                                 |
| <b>DA</b>       | Department of Ayurveda                                 |
| <b>DALYs</b>    | Disability Adjusted Life Years                         |
| <b>DDA</b>      | Department of Drug Administration                      |
| <b>DHM</b>      | Department of Hydrology and Meteorology                |
| <b>DHS</b>      | Demographic and Health Survey                          |
| <b>DoHS</b>     | Department of Health Services                          |
| <b>DRM</b>      | Disaster Risk Management                               |
| <b>EWS</b>      | Early Warning System(s)                                |
| <b>ENSO</b>     | El Niño Southern Oscillation                           |
| <b>FbA</b>      | Forecast-based Action                                  |
| <b>FCHVs</b>    | Female Community Health Volunteers                     |
| <b>FEWS</b>     | Famine Early Warning System                            |
| <b>GCM</b>      | General Circulation Model                              |
| <b>GDP</b>      | Gross Domestic Product                                 |
| <b>GFDRR</b>    | Global Facility for Disaster Reduction and Recovery    |
| <b>GIS</b>      | Geographic Information System                          |
| <b>GHG</b>      | Greenhouse Gas [emissions]                             |

|                         |                                                                   |
|-------------------------|-------------------------------------------------------------------|
| <b>GLOFs</b>            | Glacial Lake Outburst Floods                                      |
| <b>HA</b>               | Health Assistant                                                  |
| <b>HAP</b>              | Household Air Pollution                                           |
| <b>HDI</b>              | Human Development Index                                           |
| <b>HIS</b>              | Health Information System(s)                                      |
| <b>HRH</b>              | Human Resources for Health                                        |
| <b>HNP</b>              | Health, Nutrition and Population [World Bank]                     |
| <b>HNAP</b>             | Health National Adaptation Plan                                   |
| <b>HSSP</b>             | Health Sector Strategic Strategy                                  |
| <b>HSS</b>              | Health System Strengthening                                       |
| <b>HTA</b>              | Health Technology Assessment                                      |
| <b>ICIMOD</b>           | The International Centre for Integrated Mountain Development      |
| <b>IHIMS</b>            | Integrated Health Information Management Systems                  |
| <b>IPCC</b>             | Intergovernmental Panel on Climate Change                         |
| <b>LAPA</b>             | Local Adaptation Plans for Action                                 |
| <b>LI-BIRD</b>          | Local Initiatives for Biodiversity, Research and Development      |
| <b>MAGICC</b>           | Model for the Assessment of Greenhouse Gas Induced Climate Change |
| <b>MoHP</b>             | Ministry of Health and Population                                 |
| <b>MoFE</b>             | Ministry of Forest and Environment                                |
| <b>MoPI</b>             | Ministry of Physical Infrastructure                               |
| <b>MoHA</b>             | Ministry of Home Affairs                                          |
| <b>MO</b>               | Medical Officer                                                   |
| <b>MOU</b>              | Memorandum of Understanding                                       |
| <b>MPI</b>              | Multidimensional Poverty Index                                    |
| <b>NAP</b>              | National Adaptation Plan                                          |
| <b>NAPA</b>             | National Adaptation Programme of Action                           |
| <b>NBoD</b>             | Nepal Burden of Disease                                           |
| <b>NCD</b>              | Non-Communicable Disease                                          |
| <b>NDC</b>              | Nationally Determined Contribution                                |
| <b>NGO</b>              | Non-Governmental Organization                                     |
| <b>NHRC</b>             | Nepal Health Research Council                                     |
| <b>NHMS</b>             | Nepal National Mental Health Survey                               |
| <b>NHSS</b>             | Nepal Health Sector Strategy                                      |
| <b>NHTC</b>             | National Health Training Center                                   |
| <b>OOP</b>              | Out-of-Pocket (spending on health)                                |
| <b>PET</b>              | Potential Evapotranspiration                                      |
| <b>PHC</b>              | Primary Health Care                                               |
| <b>PM<sub>2.5</sub></b> | Fine Particulate Matter                                           |
| <b>RCP</b>              | Representative Concentration Pathway                              |
| <b>SAHW</b>             | Senior Auxiliary Health Worker                                    |
| <b>SLCP</b>             | Short-Lived Climate Pollutant                                     |

|               |                                                       |
|---------------|-------------------------------------------------------|
| <b>SMS</b>    | Short Messaging Service                               |
| <b>SPEI</b>   | Standardized Precipitation Evapotranspiration Index   |
| <b>SOPs</b>   | Standard Operating Procedures                         |
| <b>SRI</b>    | System of Rice Intensification                        |
| <b>SRSP</b>   | Shock-Responsive Social Protection                    |
| <b>SSP</b>    | Shared Socioeconomic Pathway                          |
| <b>UHC</b>    | Universal Health Coverage                             |
| <b>UNDP</b>   | United Nations Development Programme                  |
| <b>UNEP</b>   | United Nations Environment Program                    |
| <b>UNFCCC</b> | United Nations Framework Convention on Climate Change |
| <b>USAID</b>  | United States Agency for International Development    |
| <b>VBD</b>    | Vector-Borne Disease                                  |
| <b>VIIRS</b>  | Visible Infrared Imaging Radiometer Suite             |
| <b>WASH</b>   | Water Sanitation and Hygiene                          |
| <b>WBD</b>    | Waterborne Disease                                    |
| <b>WFP</b>    | Water Food Programme                                  |
| <b>WHO</b>    | World Health Organization                             |



# EXECUTIVE SUMMARY

**Nepal's diverse geoclimatic system makes it vulnerable to a myriad of climatic-related events.** The combination of variable torrential rainfall patterns and heavy monsoons, both extreme heat and cold, along with steep terrain, increase the risks of floods including Glacial Lake Outburst Floods (GLOFS), landslides, droughts, and waterborne diseases (WBDs). Nepal's communities are particularly vulnerable to climate change, as they are already hampered by poverty, being located in remote areas and operating on subsistence agriculture.

**Given Nepal's high exposure and vulnerability to climate change, the World Bank, through the Health Climate and Environment Program (HCEP), is conducting a Climate and Health Vulnerability Assessment (CHVA) in Nepal.** The objective of this CHVA is to assist decision-makers with planning effective adaptation measures to deal with climate-related health risks. Where available, these measures are provided at a subnational level to assist regional health planners. The recommendations of this CHVA are primarily targeted at the health sector and related sectors that influence health risks from climate changes, such as disaster risk management (DRM).

This CHVA begins with an analysis of observed and projected climatology data from the Climate Change Knowledge Portal (CCKP) and climate hazards to provide information on climate-related health risks:

- Nepal's changes in temperature and precipitation are **not homogenous** across the country's surface area, nor are they defined consistently by altitude. There is great seasonal variability.
- **Temperatures** have increased by 0.62°C between the period 1961-1990 and 1991-2020. Extreme temperatures, both cold and hot, occur in Nepal, with the Central Region experiencing the highest temperatures and the Mid-Western Region the coldest temperatures. By the 2050s, extreme heat temperatures will become more common, especially during warmer months (April to June), with Nepalis in the Central Region at the greatest risk. In contrast, the Terai Lowlands have been experiencing cold waves.
- **Precipitation** changes varying widely will increase floods and landslides risks, with the Far Western Region expected to experience some of the highest increases at 12.45 percent in 2020–2039 and 16.92 percent in 2040–2059, respectively, during the months of June to August.
- The risk of **floods** is greatest in the lower elevation and more populated provinces of the country, with the estimated population exposed to extreme floods expected to increase to nearly 370,000 by 2035–2044. Rising temperatures can impact **GLOFs** and snow stability, thereby contributing to avalanches and landslides.
- The combination of earthquakes and extreme rainfall can lead to a six-fold increase in rainfall-triggered **landslides** during the monsoon months from June to August.

- **Droughts** are becoming more frequent during the winter months, while **wildfires** are increasing in the dry months preceding the monsoon season.

Despite making significant advances in reducing its burden of disease over the last three decades, Nepal is still facing an increasing burden of non-communicable diseases (NCDs) that may be exacerbated by climate change. Furthermore, risks to health outcomes from climate are not evenly distributed in the population, with some groups at greater risk than others.



**Nutrition risks:** Climate change is likely to substantially aggravate food security and nutrition outcomes in Nepal. Global estimations project that populations at risk of climate-related nutritional risks will increase by up to 30 percent between 2010 and 2050. Nepal already ranks amongst the highest in the South Asia Region for stunting, which affects nearly a third of the population. Adverse climate impacts on agriculture and crop yields, particularly rice, are projected to increase, thus putting further strain on food security and nutritional outcomes.



**Vector-Borne Diseases (VBDs):** Vector suitability ranges — in particular for mosquitoes — are highly sensitive to climate. Analyses indicate that climate will put an additional 600,000 people at risk of malaria and an additional 400,000 at risk of dengue. This is on top of an already very high burden of VBDs across the country, thereby imposing additional strain onto already stretched surveillance, control, and treatment services.



**Water-borne diseases (WBDs):** Nepal's extreme topography and limited access to safely managed drinking services results in a large proportion of the population being highly vulnerable to WBDs. Climate-related changes to precipitation patterns, floods, and landslide events will further exacerbate this vulnerability.



**Extreme temperature risks:** Increases in the annual mean temperature, coupled with an increase in the intensity and frequency of heatwaves, will result in a greater number of people at risk of heat-related NCDs. Projections indicate that under a high emissions scenario (Representative Concentration Pathway [RCP]8.5), heat-related mortality would increase to around 53 deaths per 100,000 annually by the 2080s, compared with 4 deaths per 100,000 between 1961 and 1990. There have also been morbidity and mortality increases due to cold waves.



Other climate-related health risks to be prioritized include **air pollution** and **mental health**.

**The extent to which the health system in Nepal is prepared with the capacity to manage changes in hazards, exposure, and susceptibility will determine their resilience in coming decades.** In this CHVA, Nepal's adaptive capacity to prevent and manage climate-related health risks is examined, according to the World Health Organization's (WHO) six health system building blocks.

- **Climate change risks exacerbating existing disparities in health service delivery, particularly with regard to remote regions.** Nepal has made significant improvements in health coverage; however, gaps remain between policy and practice, especially at the subnational level. Full assessments of climate readiness of the health care infrastructure and workforce are needed, along with adequate contingency planning for anticipated climate-related hazards, such as heat, floods, and landslides. Minimum standards for climate-sensitive health care infrastructure are required to avoid impeding the refurbishment efforts of existing healthcare facilities.
- **Nepal has a Health-National Adaptation Plan (H-NAP) that is incorporated within the health financing strategy of the National Health Sector Strategy (NHSS); however, a lack of resource allocations and integration with health budgets in response to climate-related health risks remains a challenge.** In addition, current mechanisms for risk pooling in Nepal do not account for climate-related health risks, thus putting climate-vulnerable groups, such as women, children, and older people, at physical and financial risk.
- **Despite significant improvements to the Early Warning and Reporting System (EWS) since its establishment in 1997, there is insufficient integration with health information systems and limited inclusion of climate-related information.** Although EWS mechanisms do exist for several climate-related disasters, such as community-based early warning systems for floods, a more comprehensive approach is still needed for a fully climate-informed health EWS. Health information systems are not fully integrated with hydrological and meteorological (hydromet) services, and there is limited collaboration between entities across the health and environmental sectors.

**Recommendations include establishing a climate-smart health system to reduce climate-related health risks and improve overall health service delivery.** This would prioritize (a) improving governance coordination mechanisms mainly between the Ministry of Health and Population (MoHP) and the Ministry of Forest and Environment (MoFE), and also serving as a bridge between the federal and provincial and local governments; (b) harnessing public private partnerships in order to mobilize resources and strengthen health service delivery; (c) expanding health information systems to include climate-related health risks and climate-related hazards; (d) developing capacity-building programs for both policymakers and practitioners, among others; along with (e) adopting a climate-smart approach in order to retrofit and strengthen the current health care infrastructure.



# INTRODUCTION

## COUNTRY CONTEXT

**1. Nepal's economic and social development has continued to increase, despite challenges including major natural disasters.** With a Gross Domestic Product (GDP) per capita of USD1,336.5 and a Human Development Index (HDI) ranking of 142 out of 189 countries in 2020, Nepal is a medium-development nation in the South Asia region that has experienced an HDI value increase of 55.6 percent from 0.387 to 0.602 between 1990 and 2019.<sup>1</sup>

**2. The Nepali economy has been battered by multiple shocks, including the 2015 earthquake.** Before COVID-19 hit, the economy was affected by a magnitude-7.8 earthquake in 2015 that had an immediate economic impact estimated at as much as USD10 billion (half of Nepal's USD20-billion GDP at the time).<sup>2</sup> The agricultural sector alone suffered an estimated USD283.7 million worth of damage.<sup>3</sup> The Nepali government estimated that in 2019, 17.4 percent of Nepalis were considered poor under the multidimensional poverty index (MPI) — an improvement from 30.1 percent in 2014.<sup>4</sup> However, starting in 2020, the COVID-19 pandemic exacerbated economic challenges that led to the contraction of the economy,<sup>5</sup> with past marginal gains in poverty reduction partially undone by the recent shocks.

**3. The population of Nepal has increased since the mid-century, with a plateau in population growth in the 2010s.** By 2020, the population of Nepal was over 29.1 million,<sup>6</sup> with an annual growth rate of approximately 1.8 percent.<sup>7</sup> The population is projected to reach over 35

million people by 2050.<sup>8</sup> Nepal's population is relatively young: people under 15 represent 28 percent of the total population<sup>9</sup> and only 6 percent of the population is over the age of 65.<sup>10</sup> As of 2021, women accounted for more than 54 percent of the total population.<sup>11</sup> Persons of working age (15–64 years old) represent 66 percent of the total population.<sup>12</sup>

**While Nepal is one of the 10 least urbanized countries in the world (21 percent in 2021),<sup>13</sup> it also has one of the 10 fastest urbanization rates globally (3.9 percent in 2021, and up to 7 percent in the fastest-growing settlements).<sup>14,15</sup>** According to the World Population Prospects report, Nepal's net outflow was 1.8 million migrants between 2010 and 2020, making it one of the top 10 countries experiencing outflow.<sup>16</sup>

**4. Nepal's diverse geoclimatic system makes it vulnerable to a myriad of climatic-related events.** Climate variability combines heavy monsoons, steep terrain, and both extreme heat and cold to place Nepal at high risk of floods, including Glacial Lake Outburst Floods (GLOFS), landslides, droughts, and

waterborne diseases (WBDs). Nepal's vulnerability to climate hazards is characterized by: (a) flood events that are triggered by rapid snow and ice melts in the mountains; (b) extreme torrential rainfall episodes in the foothills during the monsoon season (June–September); (c) GLOFs; (d) landslides that are also triggered by rapid snow and ice melts, along with and extreme rainfall patterns; and (e) droughts that are becoming more frequent during the winter months. Nepal's communities are particularly vulnerable to climate change, due to their poverty, location in remote areas, and dependence on subsistence agriculture.<sup>17</sup>

5. **Nepal is committed to tackling climate change within its own borders, with strategies in place to mitigate net greenhouse gas (GHG) emissions and plans developed to reduce the country's vulnerability to climate change.** Nepal signed the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) on April 22, 2016;<sup>18</sup> it aims to limit the global mean temperature increase to well below 2°C compared with pre-industrial levels. Nepal also submitted the nationally determined contributions (NDCs) on May 10th, 2016<sup>19</sup> and the second set of NDCs on December 8th, 2020.

The NDCs outline Nepal's commitment to addressing climate change within their own borders, in addition to planned mitigation and adaptation strategies to reduce the country's vulnerability to the adverse impacts of climate change. Adaptation measures are developed in their National Adaptation Plan (NAP), which includes an area on Health, Drinking Water, and Sanitation. Adaptation efforts focus on (a) capacity building on climate resilience for health and water sanitation and hygiene (WASH) services; (b) climate-related disease

surveillance and emergency response; (c) environmental health measures for urban development; (d) promotion and conservation of water sources; (e) policy reform and strategic planning for climate-resilient health systems; along with (f) research, innovation, and development for climate-resilient measures and technologies.<sup>20</sup>

## AIMS OF ASSESSMENT AND CONCEPTUAL FRAMEWORK

6. **The objective of this Climate and Health Vulnerability Assessment (CHVA) is to assist decision-makers with planning effective adaptation measures to deal with climate-related health risks.** Where available, these measures are provided at a subnational level to assist regional health planners. The recommendations of this CHVA are primarily targeted at the health sector and related sectors that influence health risks from climate changes, such as disaster risk management (DRM).
7. **Adaptation priorities need to run alongside fundamental and urgent action to mitigate climate change.** It is important to stress how complex the climate challenge is and how hard it is to predict exactly how severe climate exposures facing populations will become. There are many factors that could slightly slow or significantly speed up rates of change, including positive feedback effects, and most worrying of all, cascading climatological tipping points. For this reason, mitigating existing greenhouse gas emissions (GHGs), along with developing and implementing measures to protect human development from the changing climate, is of paramount importance.
8. **Investing in adaptation strategies to proactively address the effects of climate change on health outcomes is critical.** This

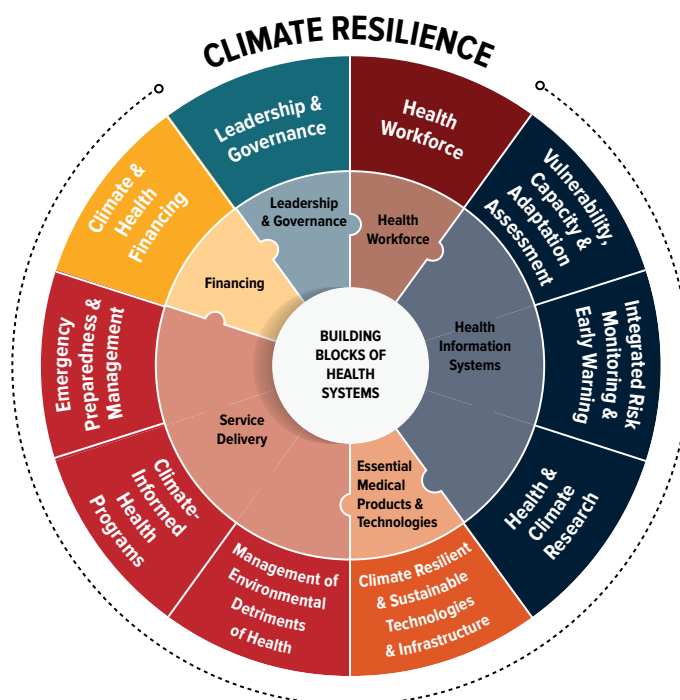
assessment is focused on climate risks to health and health systems, the adaptive capacities that are in place to deal with these risks, and recommendations to meet identified gaps. The primary focus of this assessment is, therefore, on climate adaptation and resilience measures. However, as the Intergovernmental Panel on Climate Change's (IPCC) Assessment Report Six (AR6)<sup>21</sup> makes clear, "Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered." Mitigation is no longer a sufficient strategy, regardless of the pace with which governments and communities around the world act. Adaptation is now as critical a part of climate action as mitigation. Therefore, although this report is focused on adaptation measures, it also includes

recommendations on reducing the carbon footprint from the healthcare sector.

**9. The World Health Organization's (WHO) operational framework for building climate-resilient health systems has been adopted to analyse Nepal's adaptive capacity to adequately deal with current and future identified risks.** Following this framework (Figure 1), the assessment is, therefore, structured around the six health system strengthening (HSS) building blocks. These six categories structure the assessment of capacities and gaps — currently and into the future. The framework then moves on to consider the 10 components of health system climate resilience for the "Recommendations" section.

**FIGURE 1.**

WHO's Operational framework for building climate-resilient healthcare systems, comprising 10 components and their connections to the building blocks of health systems.



Source: World Health Organization, 2015, Operational Framework for Building Climate Resilient Health Systems.

**10. This assessment follows a stepwise linear approach.** The first step characterizes the **climatology** in Nepal, highlighting observed and future climate exposures relevant to health. The second step examines **climate-related health risks**, including identifying vulnerable populations most at risk. The final step assesses the **adaptive capacity of the health system** by identifying gaps to manage current and future climate-related health risks. Together, these steps inform a series of **recommendations** to reduce climate-related health vulnerability in Nepal.

The assessment was based on a review of the published literature; national statistics; and consultations with key counterparts in government. They include the Focal Point of Climate Change in the Ministry of Health and Population (MoHP); the Ministry of Forestry and Environment (MoFE); the Department of Hydrology and Meteorology; The Kathmandu

University; Tribhuvan University; Local Initiatives for Biodiversity, Research and Development (LI-BIRD); The International Centre for Integrated Mountain Development (ICIMOD); the Nepal Health Research Council (NHRC); WHO; and the United Nations Environment Program (UNEP).

**11. The assessment also incorporates subnational considerations for health-related climate action.** For the purpose of this assessment, the administrative departments of Nepal were considered as follows. There are 7 provinces: Koshi, Madhesh, Bagmati, Gandaki, Lumbini, Karnali, and Sudurpashchim. (Figure 2). However, given that the administrative departments in Nepal changed in 2015, the analysis of this assessment will focus mostly on the different agroecological zones in the country.

**FIGURE 2.**

Administrative boundaries of Nepal's provinces.



Source: Hermes Database

# CLIMATOLOGY

## 12. This section describes observed climatic changes and projected climate trends, highlighting the priority climate-related hazards in relation to human health risks in Nepal.

Climate information has been taken from the World Bank Group's Climate Change Knowledge Portal (CCKP) where historical, observed data is derived from the University of East Anglia's Climatic Research Unit (CRU). Observed changes in the mean annual temperature, the mean maximum temperature, the mean minimum temperature, and the precipitation presented on CCKP are derived from the CRU's Time-Series (TS) version 4.05 gridded dataset for the 1901–2020 period. Model-based, climate projection data is derived from the Coupled Model Inter-Comparison Project Phase 6 (CMIP6). CMIP6 is a standard framework used for the analysis of coupled atmosphere-ocean general circulation models (GCMs). It provides estimates of future temperature and precipitation scenarios and serves as foundational data that is used in IPCC's assessment reports. CMIP6 projections are shown through five shared socioeconomic pathway (SSP) scenarios that present different societal development pathways. The total radiative forcing level by 2100 (the cumulative measure of GHGs from all sources) is presented at the end of each pathway. This assessment explores projected climate changes under SSP3-7.0 for the short term (2030s; 2020-2039) and the medium term (2050s; 2040–2059). This pathway represents a scenario in which countries are increasingly competitive and emissions continue to climb, doubling from current levels by 2100.

## 13. Climate data in this section are presented according to Nepal's Administrative Provinces, while considering the different agro-ecological zones: Terai, Hills, and Mountains (Figure 3).

## NEPAL'S GEOGRAPHY

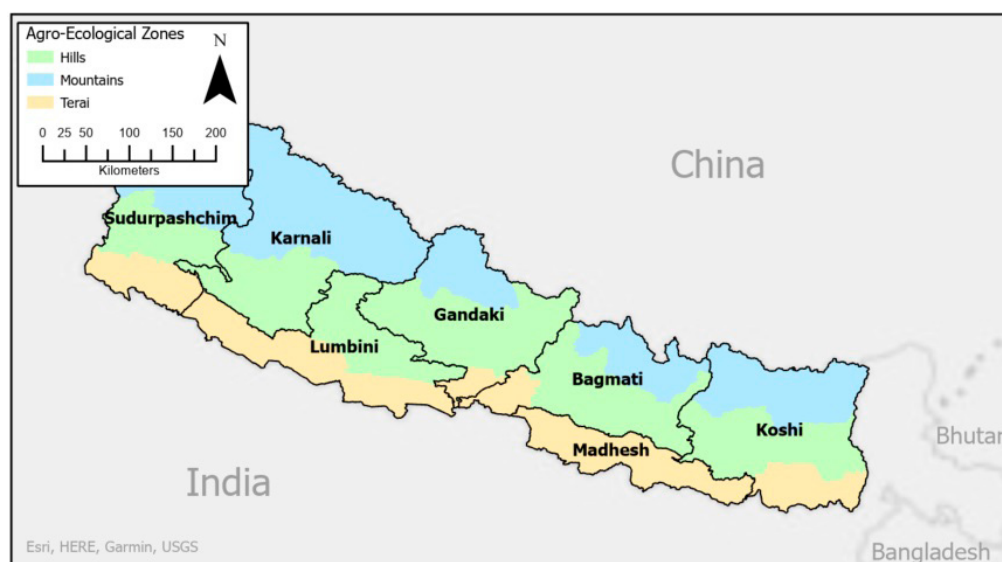
14. Nepal is a landlocked country of South Asia, located in the Himalayas between India and China. The terrain is mountainous and contains many of the world's highest peaks, including Mount Everest (8,848 meters [m]). The country also has low-lying areas in the south, with elevations less than 100 m. At the subnational level, most of the different provinces cover different agroecological zones, characterized by higher elevations in the north and progressively lower elevations

as one moves southward until the Terai region with its low-lying areas. Water and forests are Nepal's most abundant natural resources, with freshwater (derived from glaciers, snow

melts, and rainfall) accounting for an estimated 2.27 percent of the total world supply. This water feeds the country's major rivers — Koshi, Gandaki, and Karnali<sup>22</sup> (Figure 4).

**FIGURE 3.**

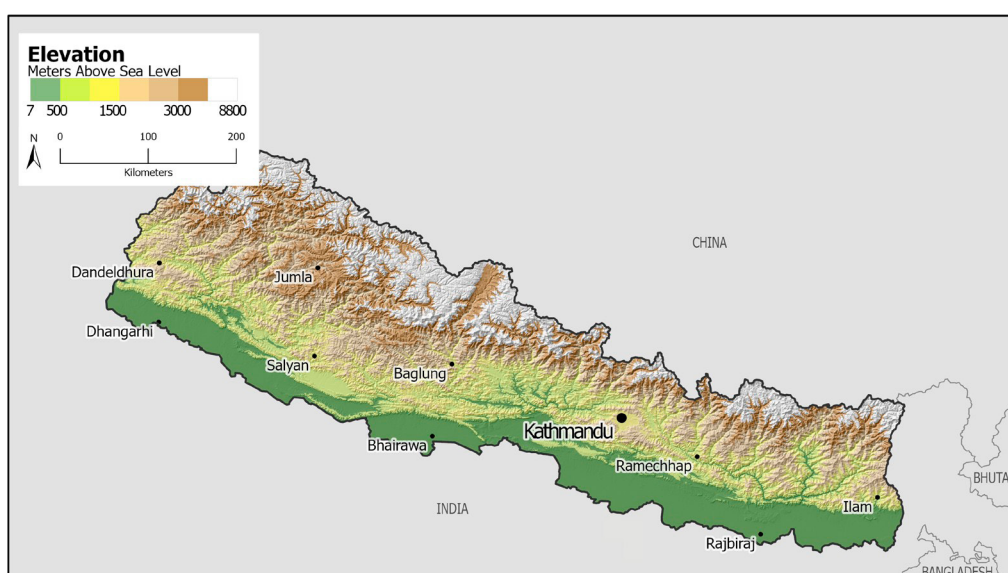
Nepal's agroecological zones by Province.



Source: Adapted from: Yergeau, Marie-Eve & Boccanfuso, Dorothee & Goyette, Jonathan. (2017). Reprint of: Linking conservation and welfare: A theoretical model with application to Nepal. Journal of Environmental Economics and Management. 86. 10.1016/j.jeem.2017.09.006.

**FIGURE 4.**

Elevation map of Nepal.



Source: Natural Earth, ASTER GDEM Version 3

## OBSERVED AND PROJECTED CLIMATOLOGY

### 15. Nepal's climate varies considerably, both seasonally and according to its geography.

Nepal can be divided into different climate zones by elevation — ranging from the Terai region in the south at less than 500 m above sea level, with a humid subtropical climate, to the High Himalayan region in the north at over 5,000 m, with a continental subarctic climate. Average temperatures decline from a peak of over 24°C in the south down to sub-zero temperatures in Nepal's highest

mountains. Annual precipitation variability is heavily influenced by the El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole. Precipitation is variable, with some central and northerly pockets of the country getting more than 3,000 millimeters (mm), while the central and southern plains and some high-altitude areas in the north typically receive 1,500–2,000 mm and less than 1,000 mm, respectively.<sup>23</sup> Climate also varies drastically on a monthly basis: while intense precipitation takes place in June and July, there is almost no rain from November to February (Table 1).

**TABLE 1.**

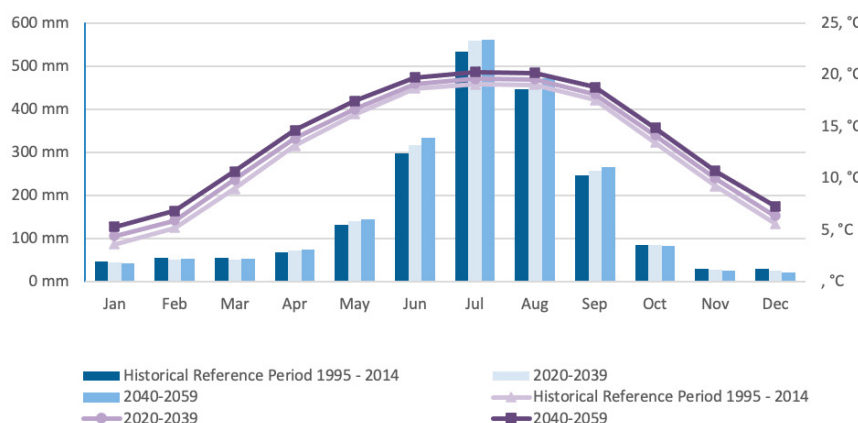
Temperature and precipitation — Monthly patterns.

|                     | JAN              | FEB | MAR              | APR | MAY                    | JUN                   | JUL                     | AUG | SEP                   | OCT | NOV                   | DEC |
|---------------------|------------------|-----|------------------|-----|------------------------|-----------------------|-------------------------|-----|-----------------------|-----|-----------------------|-----|
| Temperature         | Cooler Months    |     |                  |     |                        | Hot                   |                         |     |                       |     | Cooler Months         |     |
| Precipitation       | Dry Season       |     |                  |     |                        | Long and Intense Rain |                         |     |                       |     | Dry Season            |     |
| Nepal Season (Ritu) | Winter (Shishir) |     | Spring (Basanta) |     | Early Summer (Grishma) |                       | Summer Monsoon (Barkha) |     | Early Autumn (Sharad) |     | Late Autumn (Hemanta) |     |

Note: The Table above was developed by the authors using data from various sources.

**FIGURE 5.**

Projected average monthly temperature and precipitation patterns in Nepal under SSP3-7.0.



Source: World Bank Climate Change Knowledge Portal

## TEMPERATURE

**16. Nepal has experienced a general warming trend since the 1960s.** The observed average annual mean temperature has increased from 13.55°C to 14.17°C between the time periods of 1960–1991 and 1991–2020, respectively. Overall, the highest monthly increases were observed between November and December as well as between February and March, with a maximum increase of 0.87°C in March and November. These increases have occurred simultaneously with annual maximum and minimum temperature increases. At a subnational level, the Lumbini province experiences the highest temperatures, with an average annual mean temperature of 20.66°C (11.45°C–26.64°C), while Karnali has the coldest temperatures, with an annual mean of 7.24°C and a mean minimum temperature going as low as -2.77°C in January.

**17. The mean annual temperature in Nepal is projected to increase by 0.73°C in the 2030s and by 1.48°C by the 2050s.** Most of this increase will be experienced in the month of December, with an increase of 0.9°C and 1.95°C by the 2030s and 2050s, respectively, meaning that the cooler months will get warmer. On the other hand, the warmer months will be experiencing temperatures above 19°C by the 2030s and above 20°C by the 2050s. At the subnational level, warmer temperatures will be in the Madhesh, with an annual mean temperature of 25.05°C by the 2030s and 25.72°C by the 2050s, along with mean temperatures of above 30°C in May and June. Other provinces, such as Lumbini, will experience mean temperatures above 25°C from May to August, thereby increasing the exposure of populations to heat. See the section on climate hazards for a further discussion on population vulnerability to extreme temperatures.

## PRECIPITATION

**18. Average annual precipitation across Nepal has decreased by 64.81 mm over the last half century, with the most substantial change occurring in the Sudurpaschim.** By the 1961–1990 period, the average annual precipitation in Nepal was 1,331.17 mm, with most of the rainfall occurring between June and September. November has historically been the driest month. At the subnational level, Bagmati experiences the largest amount of annual precipitation (1,691.79 mm), followed by Koshi with 1,606.08 mm.

**19. Precipitation is expected to increase by around 124.67 mm in the 2050s.** While there will be a higher increase in precipitation (13 and 15 percent) between May and June, there will be a steep decrease of 25 percent of rainfall in December, by the 2050s. At the subnational level, Madhesh will experience the overall highest increase in rainfall, mostly between May and June (11 and 12 percent, respectively), but it will also experience a 41-percent decrease during December by the 2050s. Nationally, while the rainy season will have more intense rainfall, the dry season is expected to get drier by the 2050s. A more intense rainy season (June–September) would also increase the risk of floods and direct injuries from floods or landslides, while a drier season (November–February) would affect crop yields, and therefore, food security (see the next section for more information).

**TABLE 2.**

CMIP6 projections under SSP3-7.0.

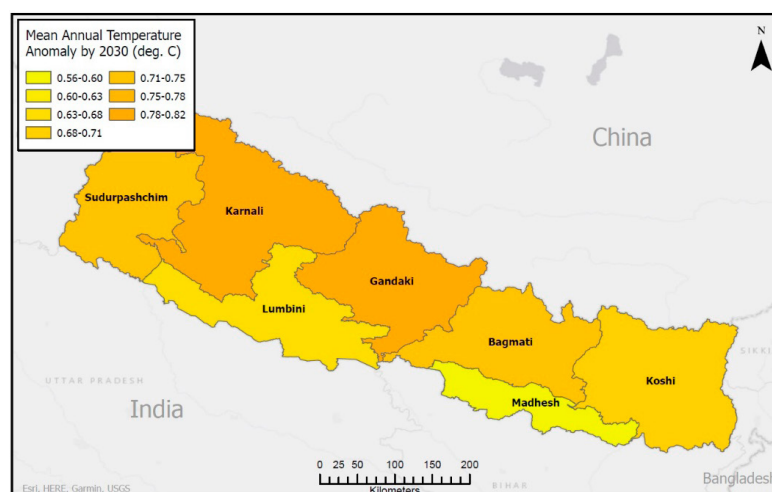
| CMIP6 ENSEMBLE PROJECTION    | 2020–2039                   | 2040–2059                    |
|------------------------------|-----------------------------|------------------------------|
| Annual Mean Temperature (°C) | <b>13.17</b> (+0.73°C)      | <b>13.92</b> (+1.48°C)       |
| Annual Precipitation (mm)    | <b>2,087.08</b> (+72.99 mm) | <b>2,137.74</b> (+124.67 mm) |

Note: Bold value is the median (or 50th percentile); values in parenthesis indicate the increase in Celsius degrees.

Source: World Bank Climate Change Knowledge Portal

**FIGURE 6.**

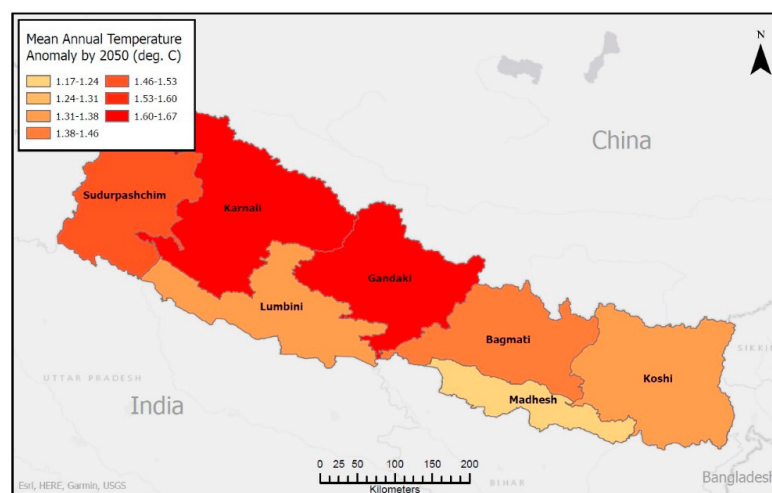
Mean temperature — Anomaly projections for the 2030s.



Source: World Bank Climate Change Knowledge Portal

**FIGURE 7.**

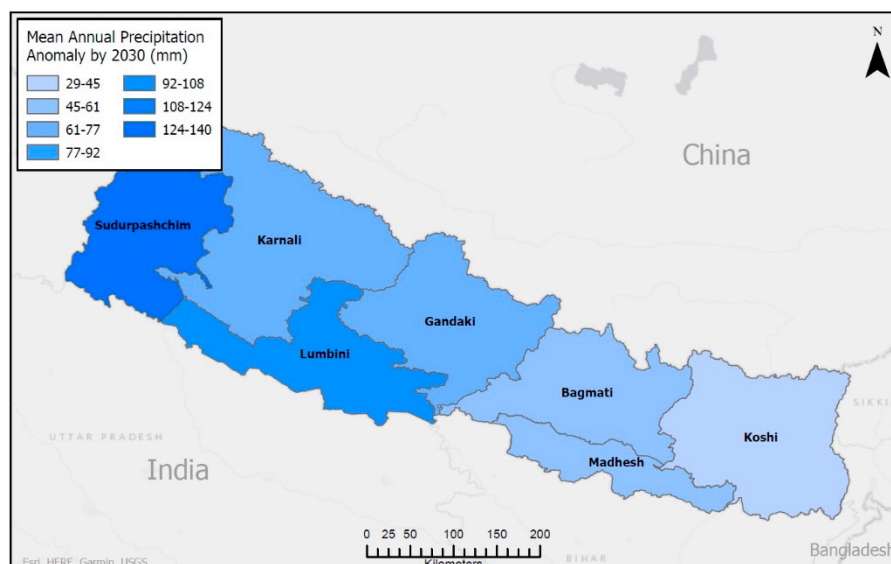
Mean temperature — Anomaly projections for the 2050s.



Source: World Bank Climate Change Knowledge Portal

**FIGURE 8.**

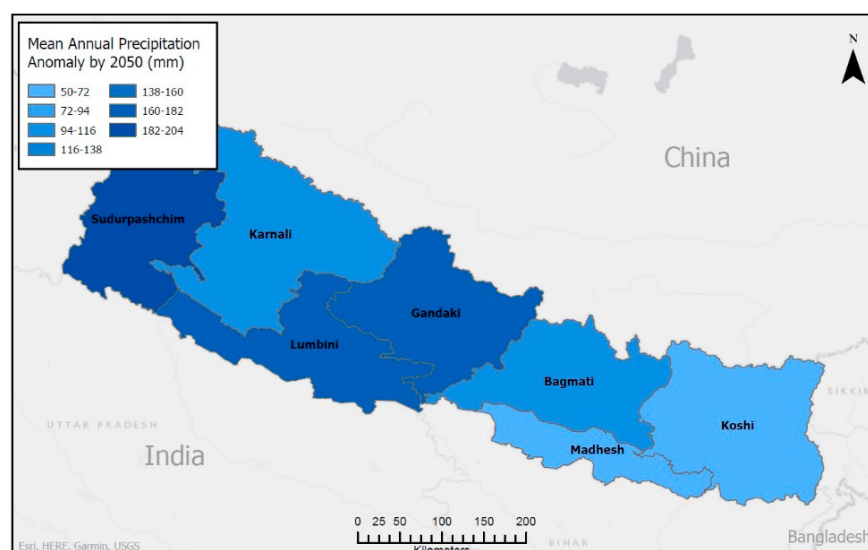
Mean precipitation — Anomaly projections for the 2030s.



Source: World Bank Climate Change Knowledge Portal

**FIGURE 9.**

Mean precipitation — Anomaly projections for the 2050s.



Source: World Bank Climate Change Knowledge Portal

## CLIMATE HAZARDS

**20. There are several climate-related hazards affecting population health in Nepal, which are linked to changes in baseline temperatures and precipitation.** The most common climate-related hazards affecting Nepal are floods, landslides, avalanches, wildfires, droughts, and extreme temperatures (including heat and cold waves). Other climate hazards, such as extreme weather events, pose additional risks. Although cyclones are not as frequent as other climate-related hazards, with a 1-percent chance of potentially damaging wind speeds over the next 10 years, according to the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR), infrastructure damage and health risk are prominent due to cyclone-induced heavy rains and subsequent floods. Major cyclones in recent years have included Cyclone Yaas (2021), Cyclone Hudhud (2014), and Cyclone Pailin (2013). The overall impacts of such events in Nepal are not merely attributable to changing environmental conditions, for they are compounded by anthropogenic causes, including rapid deforestation, mining, urbanization, and inadequate housing.

## FLOODS

**21. Climate-related increases in total and extreme precipitation are exacerbating flood risks in Nepal.** Floods in Nepal frequently occur during the monsoon seasons in the valleys and the Terai lowlands, with the rainiest months being June to September, as summarized in Table 1. Flash floods are often triggered by heavy or sustained rainfall, which increases river volumes, and insufficient or blocked drainage infrastructure.<sup>24</sup> Between 1900 and 2005, it is estimated that 3.2 million people died due to floods in Nepal, of whom 2.8 million were from the Terai lowlands.<sup>25</sup> One

of the worst floods took place during the monsoon season in July 1993, when over 700 people were killed in Central Nepal.<sup>26</sup> More recently, heavy rain during monsoons led to river floods along the Melamchi River, killing over half a dozen people and leading to the evacuation of more than 260 households in June 2021.<sup>27,28</sup>

Another concern is unseasonal heavy rain, which can trigger floods and landslides, when people are not prepared for such hazards. This was the case in October 2021, when the rain killed over 100 people along the Karnali River and Mahakali River following typical summer monsoon months.<sup>29,30</sup> Floods in densely populated urban areas (such as Kathmandu Valley) are of particular concern, leading to costly infrastructure damage, as well as losses of lives and livelihoods. Beyond precipitation, policies also contribute to flood risks due to a lack of zoning, of development planning, and of building regulations. Urban flooding risk is categorized as “high” by the GFDRR, meaning that potentially damaging and life-threatening urban floods are expected to occur at least once in the next 10 years.<sup>31</sup> The construction of homes on hill tops and deforestation, mining on hills, the destruction of vegetation leading to erosion, along with the buildup of waste in drains and culverts, further compounding flood risks.<sup>32</sup>

**22. Accelerated glacial melting and glacial lake outburst floods (GLOFs) are a growing risk in Nepal.** GLOFs are sudden releases of water from a lake fed by glacier melts.<sup>33</sup> Nepal possesses over 2,000 glacial lakes.<sup>34</sup> While not all glacial lakes are near populated areas, some lakes can cause damage to downstream communities through floods, as well as significant movement of sediment and debris, so the country currently has efforts underway to mitigate GLOFs.

**23. Nepal's precipitation levels may increase further and become more variable, which can exacerbate flood risk.**

The projected precipitation percent change varies widely across the country, Sudurpaschim is expected to experience some of the highest increases during the months of May and June by 17.89 percent in 2020–2039 and 19.4 and 24.26 percent in 2040–2059, during the same months. The average largest one-day precipitation is projected to reach more than 60 mm by 2040–2059, which is an indicator of both flood and landslide risks (see the next section on “landslides”). Beyond the largest one-day precipitation, another measure to consider is the five-day cumulative rainfall because this represents a different risk where areas become saturated over a number of days, thereby increasing the risks of floods as well as landslides through the sustained loss of slope stability. The average largest five-day cumulative rainfall is projected to reach 300 mm in the month of in the period 2020–2039 and reach more than 320 mm in the same month by 2040–2059, which is an increase of more than 50 mm from the historical reference period (1995–2014).

## **LANDSLIDES AND AVALANCHES**

**24. Landslides are responsible for the loss of life, as well as damage to homes and other infrastructure (for example, transport, energy, and health) in Nepal.** Ongoing climate change will aggravate both landslide risk in the hillsides and avalanche risk in the mountains. Between 1972 and 2016, it is estimated that over 5,100 people have lost their lives in over 3,400 recorded landslide events.<sup>35</sup> One of the deadliest landslides in Nepal was the 2014 Jure landslide: it killed 156 people and caused over NPR5 million in damage.<sup>36</sup> There have been deadly and destructive landslides

almost every year since then, mostly linked to heavy rainfall and floods.

The relationship between climate change and landslide and mudslide risks is complex due to several factors. While changes in rainfall and temperature may lead to more landslide events, with rainfall being a primary trigger, increasing droughts and vegetation can decrease the likelihood of these events. In addition, the impacts of climate on landslides can also be difficult to separate from the impacts of earthquakes. Landslide hazards in the worst-affected districts in Central and Western Nepal have increased after the 2015 earthquake, with a significant number of landslides also occurring in new locations.<sup>37</sup> New research suggests that the combination of earthquakes and extreme rainfall can lead to a six-fold increase in rainfall-triggered landslides during the monsoon months of June to August, when Nepal typically experiences severe landslides.<sup>38</sup> Human activity is yet another contributing factor. Development and land use policies impact landslide risk as well, with deforestation and the unmanaged planning of the built environment exacerbating landslides by weakening slope stability, with socioeconomic factors further increasing a community's vulnerability to landslides.<sup>39,40</sup>

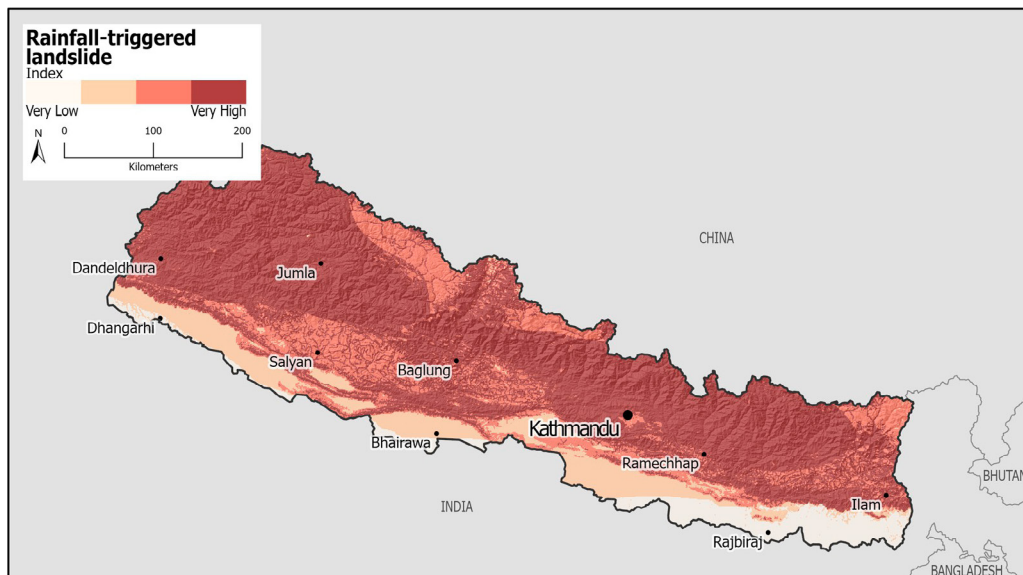
While landslides have historically impacted a larger number of homes and people in Nepal, avalanches have had serious impacts on tourism and the communities residing in the mountains, including the Sherpas who often rely on mountain tourism for their livelihoods. Recent deadly avalanches in Nepal occurred in 2014, 2015, and 2021, with at least one avalanche in 2014 documented to have been triggered by a snowstorm. From a climate change standpoint, rising temperatures, apart from precipitation changes, can impact snow

stability, which may trigger avalanches, making the projected mean monthly temperature increases of over 1°C in Nepal by the 2050s a considerable concern.

Finally, the elevation differences in Nepal among the mountainous highlands, the

midland hills, and the Terai lowlands, combined with erosion from tropical weathering and heavy precipitation during the rainy season, also influence their vulnerability to landslide and avalanche events (Figure 10).

**FIGURE 10.**  
Current risk for rainfall-triggered landslide.



Source: Natural Earth, ASTER GDEM Version 3, and GFDRR 2020.

## DROUGHT

**25. While the risk of drought is currently relatively low, this may increase in parts of Nepal, due to erratic rainfall, coupled with increasing temperatures; as such, the risk of water scarcity remains high.** The annual Standardized Precipitation Evapotranspiration Index (SPEI) drought index measures drought severity according to its intensity and duration, taking into account both precipitation and potential evapotranspiration (PET), where negative SPEI values indicate a negative water balance and values below -2 equate to a severe drought (Figures 11 and 12). CMIP6 data does not project Nepal to have negative SPEI values

in 2020–2039 or 2040–2059; however, various models have been inconsistent in estimating the change of drought hazards.<sup>41</sup>

The projected maximum number of consecutive dry days (CMIP5) is another indicator that varies across Nepal. The drier months of November to January are projected to have slight increases (<5 days) in consecutive dry days; these months already have a relatively high number of consecutive dry days, so even a slight increase can be impactful. Historically, Nepal has experienced drought events that impacted agricultural production, which took place in 1982, 1985,

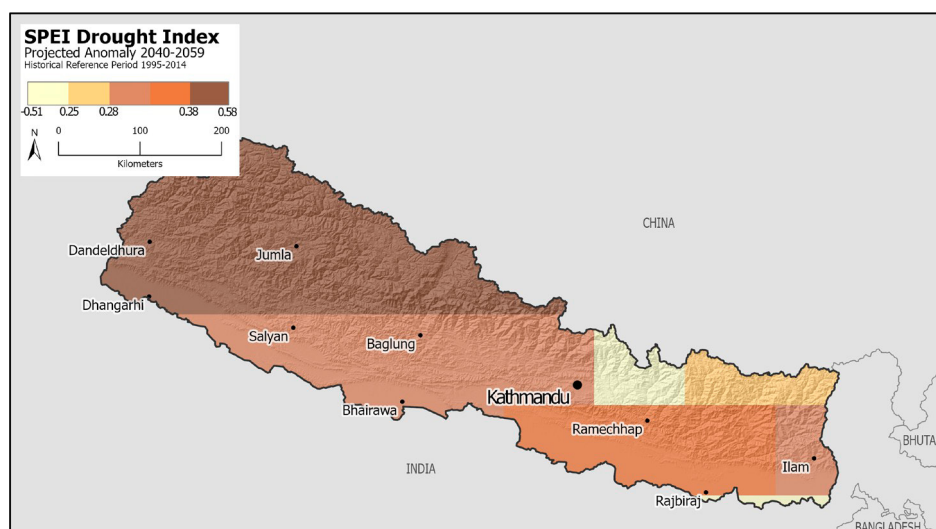
1991–1992, 1994, 2005–2006, 2008–2009, 2012, 2013, and 2015.

While the drought season are expected to increase, adequate management of sources of water becomes essential during the dry months. Water scarcity risk in Nepal is

categorized as “high” by the GFDRL, indicating that droughts are expected to occur once every 5 years on average, and highlighting the need to consider the possibility of droughts during project planning, project design, and construction.<sup>42</sup>

**FIGURE 11.**

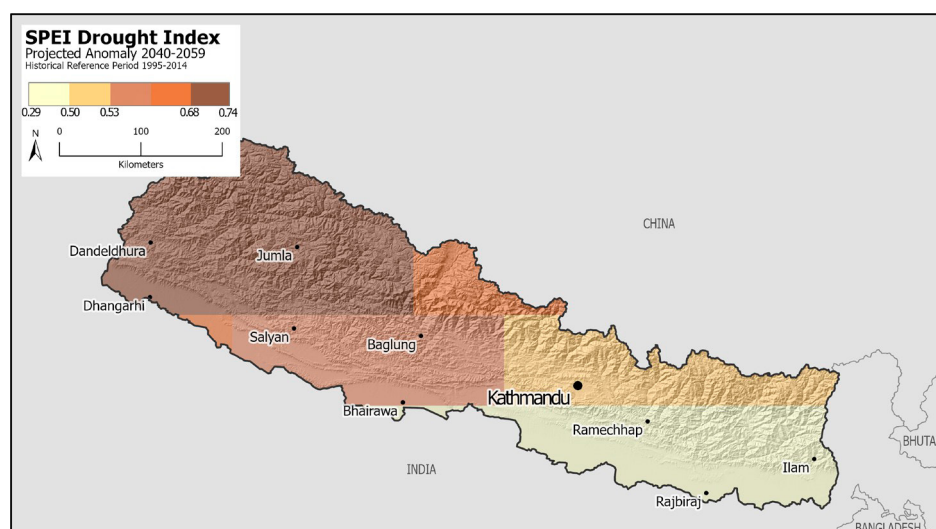
SPEI Drought Index’s projections for the 2030s (CMIP5).



Source: Natural Earth, ASTER GDEM Version 3, and GFDRL 2020.

**FIGURE 12.**

SPEI Drought Index’s Projections for the 2050s (CMIP5).



Source: Natural Earth, ASTER GDEM Version 3, and GFDRL 2020.

## WILDFIRES

**26. Wildfire events are a concern in Nepal, especially for air quality, and fire risks may be impacted by the projected increase in the maximum number of consecutive dry days and the projected decrease in seasonal precipitation during the drier months from November to February.** Historically, the wildfire season in Nepal has coincided with the drier months of March and April preceding the monsoons. In 2021, Nepal experienced some of the country's worst wildfires in recent decades, with 22 out of 77 districts impacted.<sup>43</sup> The visible infrared imaging radiometer suite (VIIRS) satellite detected around 41,000 thermal anomalies or hotspots in Nepal from January 1 to April 7, 2021 — which is among the highest number observed for that time period, second only to January 1 to April 7, 2016.<sup>44</sup> The wildfire risk in Nepal is categorized as “high” by the GFDRR, meaning that there is a 50 percent chance of encountering weather that could support a wildfire that is significant enough to result in both life and property loss in any given year.<sup>45</sup>

Wildfires can be exacerbated by climate change through increases in temperature and rainfall variability, and the literature suggests that wildfire seasons may lengthen from climate change. However, it is challenging to determine what proportion of the increases in the wildfire frequency and / or severity in Nepal can be attributable to climate change. A contributing reason is that information on wildfire events in Nepal is scarce, including whether individual incidents are natural or human-induced. For example, fire is often used as a tool for land-clearing practices for agriculture in Nepal, but wildfires can also be started by lightning from convective storms. Studies have not yet been published on

predicting the impact of wildfires in Nepal, as climate continues to change.

Despite the limited data, it is reasonable to assume that the increasing temperatures in Nepal, coupled with the higher likelihood of drought conditions, could exacerbate wildfire risks. Wildfires have also been linked to severe declines in air quality in Nepal, with the Air Quality Index (AQI) in Kathmandu reaching over 400 during the 2021 wildfires and leading to school shutdowns.<sup>46</sup> To put this figure into context, AQI levels above 300 are categorized as “hazardous” — a warning of emergency conditions where all members of the general population are likely to experience health effects and members of sensitive groups may experience more serious health effects.

## EXTREME TEMPERATURES

**27. Nepal faces risks of both extreme heat and extreme cold.** The climate of Nepal ranges from subtropical to arctic, depending on the elevation. Nepal experiences both extreme hot temperatures, with days above 35°C during the warmer months (April–June), and extreme cold temperatures, with days where the minimum temperatures are below 0°C during the colder months (November–February). Moreover, temperatures vary widely subnationally, with Madhesh being the warmest and Karnali the coldest.

**28. Extreme heat exposure will become more common through the 2050s, especially during warmer months (April–June), with Nepalis in Madhesh at the greatest risk.** Extreme heat is defined by the Centers for Disease Control and Prevention (CDCs) as temperatures and humidity that are much higher than average for a particular location.<sup>47</sup> On the average, annual mean temperature will increase by

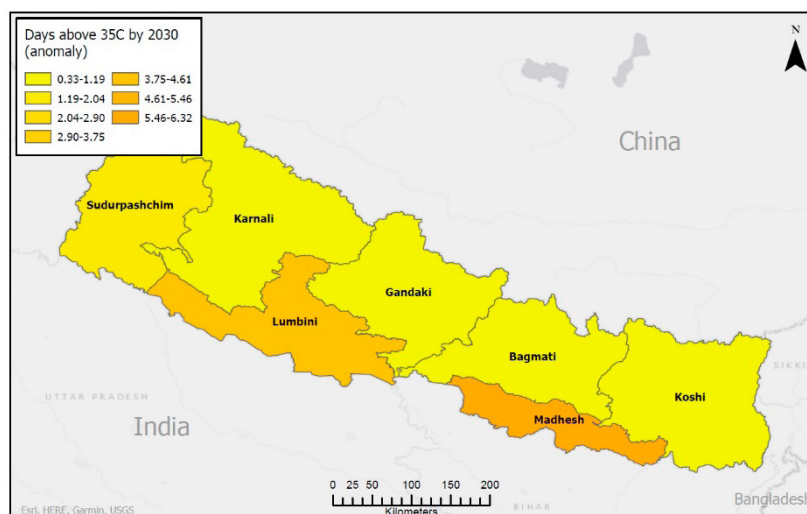
0.73 and 1.48 degrees during the 2030s and 2050s, respectively (Table 2). Nepalis in Madhesh will be the most vulnerable to extreme heat conditions, with an increase of 14 days to an estimated 61 days of temperatures above 35°C annually by the 2050s. Hot days in Nepal will primarily occur from April to June, when more than half of each month will have temperatures above 35°C.

The impacts on heat-related morbidity and mortality are only, in part, a function of daytime temperatures, with high nighttime temperatures and humidity also playing a significant role. High humidity, prevents sweat from readily evaporating because of the high

moisture content in the air. As the body's natural cooling mechanism is compromised, temperatures feel warmer and require considerably more blood circulation and respiration to lower core temperature.

Daytime temperature increases will be coupled with a large number of annual of tropical nights. In Madhesh, the number of tropical nights will increase to 212.6 in the 2050s. Other provinces such as Lumbini, will have a projected increase in tropical nights to 136.13 by the 2050s (Table 3). Seasonally, these tropical nights are projected to be concentrated from May to September, with almost every nighttime temperature above 20°C in July, across the country.

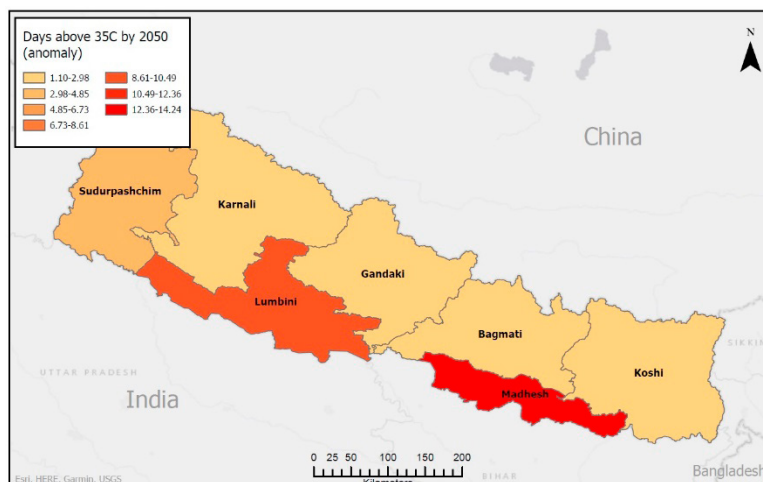
**FIGURE 13.**  
Days above 35 C — anomaly projections for the 2030s.



Source: World Bank Climate Change Knowledge Portal

**FIGURE 14.**

Days above 35 C — Anomaly projections for the 2050s.



Source: World Bank Climate Change Knowledge Portal

**TABLE 3.**

CMIP 6 Ensemble Projections SSP3-7.0 by province, for the 2030s and 2050s.

| CMIP 6 ENSEMBLE PROJECTIONS SSP3-7.0 |                 | 2020–2039      | 2040–2059       |
|--------------------------------------|-----------------|----------------|-----------------|
| <b>Lumbini</b>                       | Hot Days        | 28.21 (+3.8)   | 34.34 (+4.01)   |
|                                      | Tropical Nights | 125.75 (+8.69) | 136.13 (+19.72) |
|                                      | Ice Days        | 2.02 (-0.43)   | 1.54 (-0.93)    |
| <b>Gandaki</b>                       | Hot Days        | 1.41 (+0.33)   | 34.34 (+1.15)   |
|                                      | Tropical Nights | 34.02 (+4.23)  | 39.58 (+10.01)  |
|                                      | Ice Days        | 52.28 (-7.23)  | 46.26 (-13.63)  |
| <b>Koshi</b>                         | Hot Days        | 4.81 (+0.85)   | 6.28 (+2.26)    |
|                                      | Tropical Nights | 74.18 (+7.52)  | 83.19 (+16.3)   |
|                                      | Ice Days        | 20.94 (-3.29)  | 17.93 (-6.31)   |
| <b>Sudurpaschim</b>                  | Hot Days        | 11.71 (-1.82)  | 14.57 (+4.68)   |
|                                      | Tropical Nights | 59.74 (+6.38)  | 69.19 (+15.47)  |
|                                      | Ice Days        | 17.11 (-2.7)   | 14.81 (-4.96)   |
| <b>Karnali</b>                       | Hot Days        | 1.54 (+0.36)   | 2.29 (+1.1)     |
|                                      | Tropical Nights | 18.48 (+2.8)   | 21.97 (+6.52)   |
|                                      | Ice Days        | 74.13 (-7.92)  | 67.7 (-14.36)   |

| CMIP 6 ENSEMBLE PROJECTIONS SSP3-7.0 |                 | 2020–2039      | 2040–2059      |
|--------------------------------------|-----------------|----------------|----------------|
| Bagmati                              | Hot Days        | 4.98 (+0.99)   | 6.94 (+2.8)    |
|                                      | Tropical Nights | 76.18 (+9.58)  | 87.44 (+21.04) |
|                                      | Ice Days        | 9.09 (-1.62)   | 7.73 (-3)      |
| Madhesh                              | Hot Days        | 50.44 (+6.32)  | 60.58 (+14.24) |
|                                      | Tropical Nights | 203.72 (+7.65) | 212.6 (+16.17) |
|                                      | Ice Days        | 0              | 0              |

**29. Exposure to extreme cold temperatures is expected to continue being a risk in Nepal, with the most profound threat experienced by populations residing in Karnali.** Average annual mean minimum temperatures are projected to increase by 0.74°C in the 2030s and 1.51°C in the 2050s. These increases in temperatures will subsequently be coupled with declines in the number of Ice days, as defined by days with Maximum Temperatures falling below a threshold of 0°C.

However, despite rising temperatures, the risk of extreme cold exposure will not be eliminated altogether. Populations residing in the Karnali are likely to be the most vulnerable to extreme cold conditions, where the annual number of ice days is projected to be 74.13 and 67.7 days in the 2030s and 2050s, respectively, being the highest in the country. Nationally, It is projected that ice days will be similar in the 2030s, while decreasing slightly for the 2050s with 27.37 days per year.<sup>48</sup>

# KEY MESSAGES:



Nepal's changes in temperature are not homogenous across the country's surface area, nor is it defined consistently by altitude. The country shows great seasonal variability, having cold temperatures from October to February and hot temperatures from March to September.



Temperatures have increased by 0.62°C between the period 1961-1990 and 1991-2020. Extreme temperatures, both cold and hot, occur in Nepal, with Madhesh experiencing the highest temperatures and Karnali the coldest temperatures.



By the 2050s, extreme heat temperatures will become more common, especially during the warmer months (April–June), with Nepalis in the Madhesh at the greatest risk. In contrast, Karnali will continue to experience ice days.



Precipitation changes varying widely will increase floods and landslides risks, with Sudurpaschim expected to experience some of the highest increases at 3.25 percent in 2020–2039 and 3.03 percent in 2040–2059 during the months of June to August.



The risk of floods is greatest in the lower-elevation areas and the more populated provinces of the country, with the estimated population exposed to extreme flood increasing to nearly 370,000 by 2035–2044. Furthermore, rising temperatures can impact GLOFs and snow stability, leading to avalanches and landslides.



The combination of earthquakes and extreme rainfall can lead to a sixfold increase in rainfall-triggered landslides during the monsoon months of June to August.



Droughts are becoming more frequent during the winter months, while wildfires are increasing in the dry months preceding the monsoon season.



# CLIMATE-RELATED HEALTH RISKS

## 30. Nepal has made significant advances in reducing its burden of disease over the last three decades, but now faces an increasing burden of non-communicable diseases (NCDs) that may be exacerbated by climate change.

Life expectancy has increased from 58.4 to 71.1 years between 1990 and 2019.<sup>49</sup> NCDs are now the leading cause of mortality, responsible for 71.1 percent of all deaths, while communicable, maternal, and neonatal disease, as well as nutritional outcomes, still account for 21.1 percent.<sup>50</sup> This means that Nepal can be considered to be undergoing an epidemiological transition, necessitating a response to a double burden of disease.<sup>51</sup> It is evident from the 2019 Nepal Burden of Disease (NBoD) report that NCDs are a major public health concern that could be worsened by climate change.<sup>52</sup>

## 31. Risks to health outcomes from climate are not evenly distributed in the population, with some groups at greater risk than others.

The factors that affect a population's vulnerability to climate are often similar to those that affect health more broadly.<sup>53</sup> However, climate may exacerbate health inequalities, especially among certain vulnerable population groups, including the poor, rural populations, those living in informal urban settlements, women and young children, the elderly, those living with pre-existing conditions and disabilities, and displaced populations. Notably, remote communities in Nepal are already at high risk. Therefore, investments in adaptation and mitigation measures must carefully consider groups who would directly benefit from, or may be disadvantaged by, adopted measures.

## 32. Nepal's CHVA assesses five climate-related health risk categories.

These include risks to (a) nutrition, (b) vector-borne disease (VBD) risks, (c) waterborne disease (WBD) risk, (d) air quality health risks, (e) mental health

and well-being, and (f) extreme temperature risks. Each category is assessed, in terms of current and future risks, with considerations for both national and subnational peculiarities, wherever possible. It is important to note that these risk categories represent only the most pressing health risks to the population in Nepal. Other climate-related health risks have not been included in this assessment and these may incorporate, but are not limited to, direct injuries and mortality associated with natural hazard events.

## NUTRITION RISKS

## 33. Despite Nepal achieving the world's fastest recorded reduction in stunting prevalence between 2001 and 2011,<sup>54</sup> progress has stagnated in recent years, with the country still ranked amongst the highest in the South Asia region for stunting, wasting, and the percentage of those severely underweight,<sup>55,56</sup> each of which are climate-sensitive.<sup>57</sup> Over

one-third (36.4 percent) of Nepal's population suffers from moderate or severe food insecurity, representing a nearly 7-percent increase over the last 4 years (previously 29.5 percent).<sup>58</sup> While the prevalence of undernourishment has declined significantly over the past two decades (from 23.5 percent in 2001 to 4.8 percent in 2019), recent nutrition statistics for children under 5 years of age (2022) showed that Nepal still experiences around 24.8 percent of stunting, 7.7 percent of wasting, and overall 18.7 of underweight.<sup>59</sup>

**34. Weather and climate are the foundational drivers of healthy and sustainable diets.** The mechanisms by which climate change affects nutrition via the food system are profound. Climate variability is already contributing to increases in global hunger and malnutrition. While a comprehensive analysis of climate change's impact on the food system is beyond the scope of this assessment, this CHVA examines climate and nutrition linkages through a food security lens in Nepal, as it relates to weather and climate impacts on agricultural productivity.

Agricultural productivity is a key determinant of food availability and is affected by weather and climate in a multitude of ways, from short-term shocks (for example, natural disasters) to longer-term changes in agroecological conditions that can drastically reduce yields or redefine spatiotemporal patterns of crop suitability. Furthermore, apart from agricultural production, climate variability can also impose acute and chronic effects on agricultural storage, processing, distribution, and consumption.<sup>60</sup>

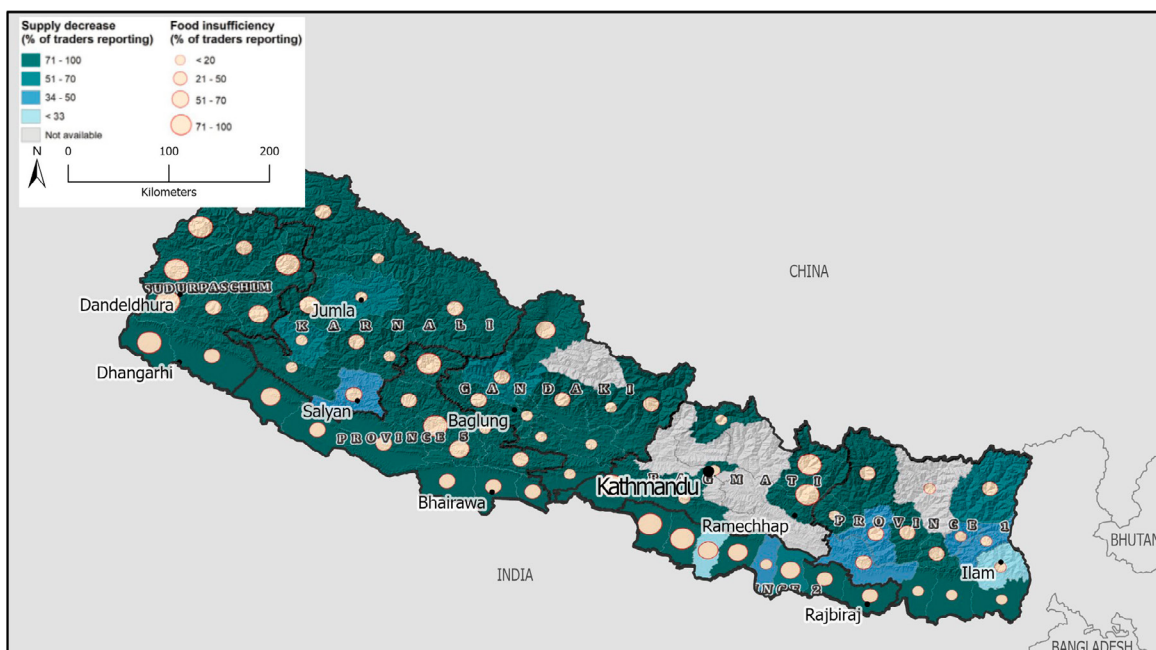
**35. Food security and poor nutritional outcomes in Nepal are compounded by shifting climate baselines and shocks, including climate-related hazards.** Projected warmer temperatures, water deficits, and the increasing frequency and intensity of climate-related hazards are very likely to aggravate food insecurity and nutritional deficiencies, with important geographical variations. Erratic rainfall can drastically reduce agricultural production. To that end, irrigation, fertilizer application to reduce plant susceptibility, and the adoption of drought-resistant varieties are common adaptation measures under consideration in response to climate change, including in Nepal.

**36. Impacts to cereal crop production, particularly rice, will be an especially critical climate risk factor for nutrition.** Agriculture in Nepal is largely dependent on cereal crops: it is made up mostly of rice, wheat, and maize, with each contributing to 20.8, 7.14, and 2.64 percent of the agricultural gross domestic product (AGDP), respectively.<sup>61,62,63</sup> Changing temperature and precipitation baselines, coupled with climate shocks (for example, droughts and floods), will not only impact agricultural production and yield, and in turn, price and profit, but also personal consumption at a household level.

Approximately 84 percent of Nepal's population are subsistence farmers who depend on producing crops for their own consumption and income.<sup>64</sup> Studies on the impact of climate change on rice production in Nepal show a largely negative impact.<sup>65,66</sup> Production shortfalls are very likely to aggravate food insecurity at the household level. Quantity, both in terms of food availability and calories consumed, and quality of food products play a considerable role in the nutrition outcomes for most Nepalis. Additional

**FIGURE 15.**

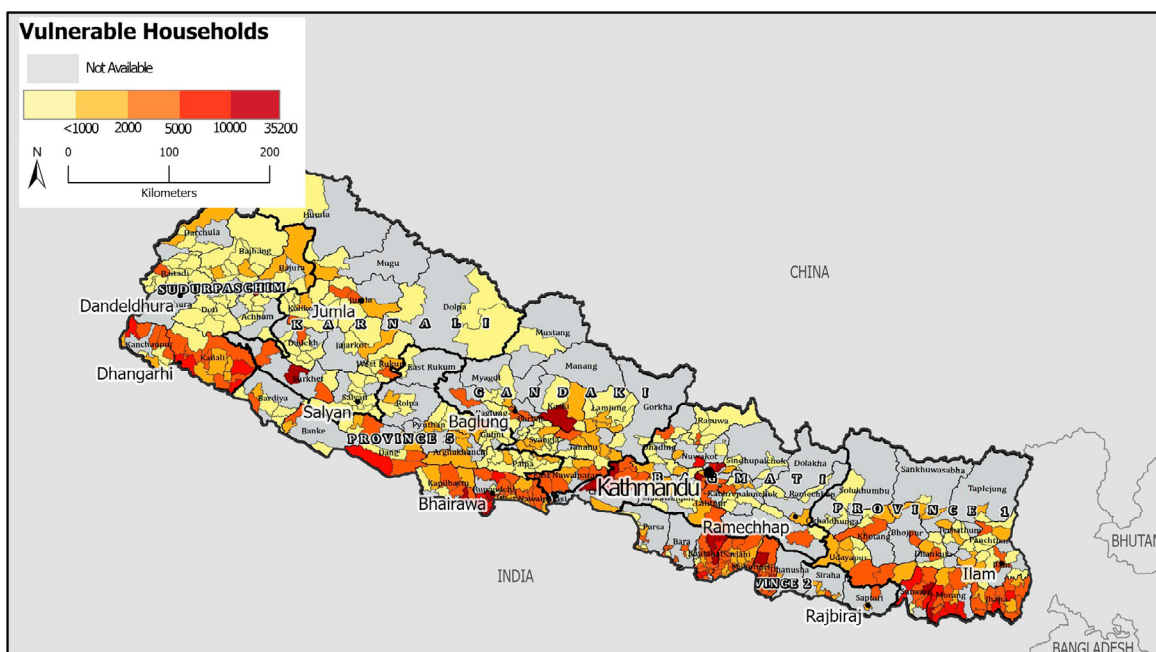
Trader-reported food insufficiency and supply decreases in 2020.



Source: World Food Programme

**FIGURE 16.**

Households vulnerable to food insecurity in 2020.



Source: World Food Programme

drivers include poor feeding practices and infectious diseases, such as diarrhea.<sup>67</sup>

At a household level, crop productivity and affordability are critical determinants of proper nutrition across Nepal. Despite agriculture contributing significantly to annual GDP (23.13 percent) as of 2020, Nepal does not currently produce enough food to adequately supply its population and thus relies on imports.<sup>68</sup> The average household spends over half (54 percent) of its total income on food, with grain and cereals providing the foundation for the majority of the Nepalese population's diets, especially rice.<sup>69,70</sup> The consequences of malnutrition, especially in children, are far-reaching with profound implications on human and physical capital which can constrain a country's overall economic growth and development.

**37. In the absence of adaptation, climate change is likely to substantially aggravate food security and nutrition outcomes in Nepal.**<sup>71</sup> While there is uncertainty on the precise number of individuals in Nepal who will be at risk of food insecurity because of climate variability, recent findings suggest that globally, between 2010 and 2050, the population at risk could increase by up to 30 percent, as a result of climate change.<sup>72</sup> The rise in food insecurity spurred by climate change will have profound effects on nutrition outcomes, particularly in the lower elevations to the south that are already facing food insecurity.

As of April 2020, the most vulnerable provinces were Koshi, Madhesh, Bagmati, and Lumbini, with all reporting over 150,000 households susceptible to food insecurity; affected districts are primarily concentrated in the south.<sup>73</sup> The figure below shows food insufficiencies and supply decreases reported

by traders in April 2020, as well as where there are high numbers of households vulnerable to food insecurity. According to a United States Agency for International Development (USAID) survey from 2019, households in the rural areas of the country, where food prices tend to be higher, are more likely to be food-insecure than people living in urban areas.<sup>74</sup>

## VECTOR-BORNE DISEASE RISKS

### **38. Weather and climate are critical drivers of spatiotemporal vector-borne disease (VBD) distribution and transmission dynamics.**

Climate variability causes vector and host ranges to expand or contract, shifting disease distribution, changing seasonality, and / or facilitating the emergence or reemergence of VBDs.<sup>75</sup> Investigating species distribution and the seasonality of vectors is valuable for understanding plausible VBD distributions and planning efficient, spatially targeted methods of control, both for the current situation and as the climate continues to change. The epidemiology of the majority of VBDs is climate-sensitive; however, this initial assessment is focused on dengue and malaria, given their significance to the overall burden of disease in Nepal and the potential for causing large-scale outbreaks among the population.

This assessment has modeled epidemiological data and geographic information system (GIS) information to estimate plausible spatial distributions of the vectors of dengue and malaria to assess the risk propensity of these diseases for different populations. The climate data used are sourced from the World Bank's CCKP and modeled under RCP 8.5, using the historical reference period (1986–2005) in comparison with the 2030s (2020–2039) and the 2050s

(2040–2059). Further details of this analysis are available in Annex A to this document.

## DENGUE

**39. It is estimated that an additional 400,000 people by 2030 and 550,000 people by 2050 will be living in dengue-vulnerable areas**

## in Nepal due to climate change (Table 4).

Dengue is transmitted by the bite of infected *Aedes aegypti*, and to a lesser extent, *Aedes albopictus* mosquitoes. Madhesh has the highest absolute risk, independent of climate change, and it is possible that climate change will further increase risk.

**TABLE 4.**

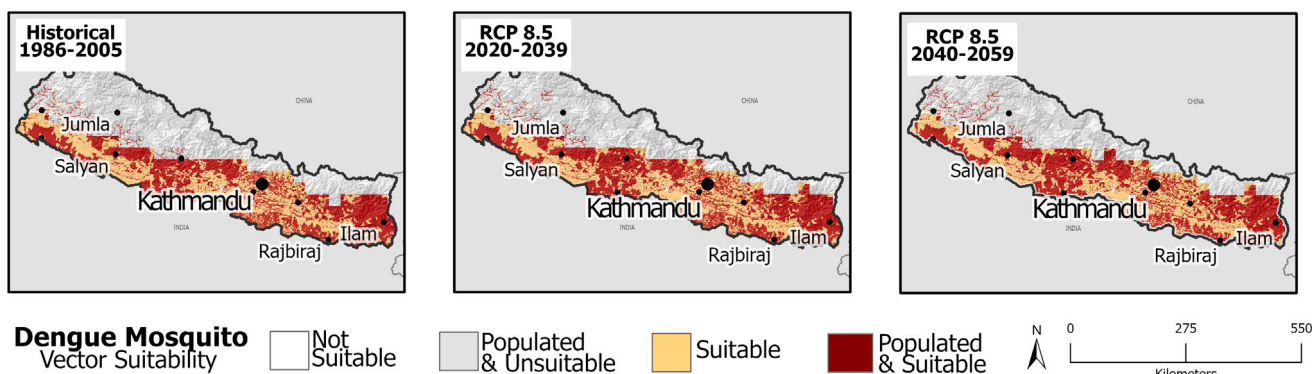
Proportions of regions of Nepal suitable for dengue vector species habitat and corresponding populations.

| Province     | PROPORTION OF REGION BY AREA SUITABLE FOR DENGUE VECTORS |       |       |                     |       |       | VULNERABLE POPULATION |            |            |         |         |
|--------------|----------------------------------------------------------|-------|-------|---------------------|-------|-------|-----------------------|------------|------------|---------|---------|
|              | OVERALL SUITABILITY                                      |       |       | POPULATED, SUITABLE |       |       | ABSOLUTE VALUES       |            |            | DELTA   |         |
|              | Ref. period                                              | 2030s | 2050s | Ref. period         | 2030s | 2050s | Ref. period           | 2030s      | 2050s      | 2030s   | 2050s   |
| Koshi        | 67.45                                                    | 73.60 | 73.60 | 46.20               | 51.15 | 51.15 | 3,315,841             | 3,382,784  | 3,382,784  | 66,943  | 66,943  |
| Madhesh      | 99.38                                                    | 99.38 | 99.38 | 51.28               | 51.28 | 51.28 | 4,034,414             | 4,034,414  | 4,034,414  | -       | -       |
| Bagmati      | 74.81                                                    | 80.76 | 83.49 | 28.20               | 30.07 | 30.72 | 3,167,238             | 3,222,651  | 3,246,108  | 55,413  | 78,870  |
| Gandaki      | 35.28                                                    | 45.71 | 48.78 | 22.13               | 29.13 | 31.85 | 1,380,503             | 1,650,342  | 1,674,295  | 269,839 | 293,792 |
| Lumbini      | 90.82                                                    | 91.19 | 91.34 | 52.92               | 53.39 | 53.42 | 3,871,841             | 3,881,698  | 3,886,066  | 9,857   | 14,225  |
| Karnali      | 18.69                                                    | 19.04 | 21.10 | 9.68                | 10.02 | 11.84 | 646,340               | 653,056    | 762,910    | 6,716   | 116,570 |
| Sudurpaschim | 40.13                                                    | 40.23 | 40.58 | 20.64               | 20.71 | 20.99 | 1,740,974             | 1,741,311  | 1,747,581  | 337     | 6,607   |
| Total        |                                                          |       |       |                     |       |       | 18,157,151            | 18,566,256 | 18,734,158 | 409,105 | 577,007 |

Note: The Table above was developed by the authors using data from various sources. See Annex A.

**FIGURE 17.**

Dengue mosquito vector suitability across Nepal, under RCP8.5, from across three model time periods.



Note: The maps above were developed by the authors using data from various sources. See Annex A.

However, the analysis conducted for this assessment looks at the change of vector range, and using this approach, a different picture can be discerned. The greatest climate-related increases are expected in Madhesh, where over a quarter of a million more people will be at risk by 2030, rising to almost 300,000 by 2050, accounting for over two-thirds of the national increase in risk due to climate change. These findings complement the Nepal Annual Department of Health Services (DoHS) Health Report for 2018/2019, which identified Koshi, Madhesh and Lumbini as being the national focus for dengue. This is, indeed, still the case for absolute figures, but it is important to factor in the future predicted impact of climate in using this kind of analysis.

Further analysis will attempt to explore subprovincial disaggregation in order to better identify the regions of focus. The map in Figure 17 illustrates the subprovincial heterogeneity seen in the distribution of dengue vector habitat suitability and the way in which this is

focused on the southern low-altitude regions. It is expected that the distribution will creep northwards into progressively higher-altitude regions, as the climate changes.

## MALARIA

### 40. More than 25 million people in southern Nepal are already vulnerable to malaria each year (Table 5).

Malaria in Nepal is transmitted by the *Anopheles fluviatilis*, *Anopheles maculatus*, and *Anopheles annularis* mosquitoes. Malaria is endemic in southern Nepal,<sup>76</sup> with modeled results demonstrating the provinces of Koshi, Madhesh, Bagmati, and Lumbini having the highest overall suitability for malaria vectors. Madhesh will not see an increase due to its already overwhelming suitability to malaria vectors. Koshi is not expected to see any increase in malaria vector ranges in the near term (2030s), but by the 2050s, it is projected to account for the second-highest increase in populations at risk. Karnali shows the greatest overall increase, with at-risk population numbers increasing progressively through

**TABLE 5.**

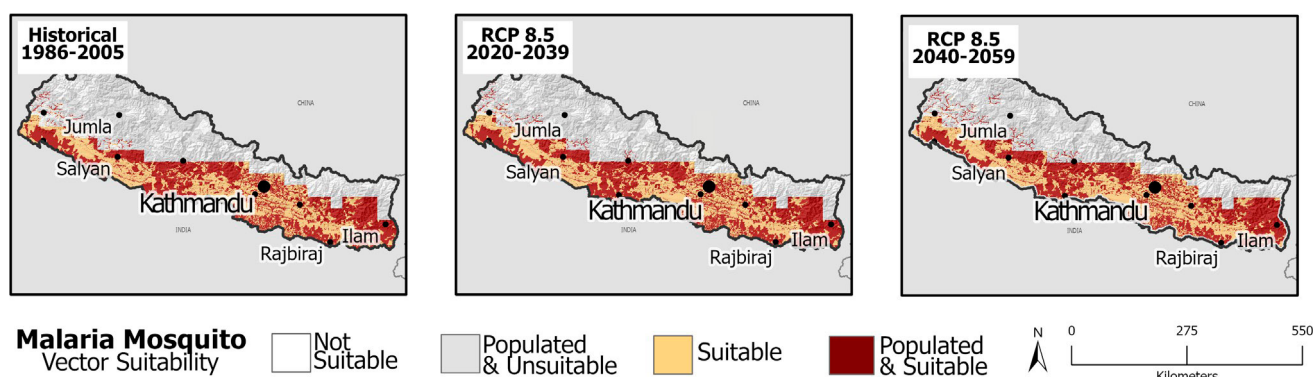
Percent area of suitable malaria vector species habitat, by province, in Nepal.

| Province     | PROPORTION OF REGION BY AREA SUITABLE FOR DENGUE VECTORS |        |        |                     |       |       | VULNERABLE POPULATION |            |            |         |         |
|--------------|----------------------------------------------------------|--------|--------|---------------------|-------|-------|-----------------------|------------|------------|---------|---------|
|              | OVERALL SUITABILITY                                      |        |        | POPULATED, SUITABLE |       |       | ABSOLUTE VALUES       |            |            | DELTA   |         |
|              | Ref. period                                              | 2030s  | 2050s  | Ref. period         | 2030s | 2050s | Ref. period           | 2030s      | 2050s      | 2030s   | 2050s   |
| Koshi        | 62.67                                                    | 62.67  | 67.95  | 41.65               | 41.65 | 46.58 | 4,842,718             | 4,842,718  | 4,990,009  | 0       | 147,291 |
| Madhesh      | 100.00                                                   | 100.00 | 100.00 | 51.88               | 51.88 | 51.88 | 5,949,982             | 5,949,982  | 5,949,982  | 0       | 0       |
| Bagmati      | 72.88                                                    | 76.12  | 76.12  | 28.36               | 29.18 | 29.18 | 6,334,604             | 6,418,822  | 6,418,822  | 84,218  | 84,218  |
| Gandaki      | 33.51                                                    | 34.10  | 35.60  | 21.08               | 21.64 | 22.41 | 1,738,546             | 1,767,915  | 1,789,053  | 29,369  | 50,507  |
| Lumbini      | 87.66                                                    | 88.17  | 91.09  | 50.21               | 50.72 | 53.14 | 4,416,395             | 4,425,919  | 4,474,078  | 9,524   | 57,683  |
| Karnali      | 12.41                                                    | 18.01  | 19.05  | 5.88                | 9.05  | 9.05  | 488,893               | 634,326    | 651,354    | 145,433 | 162,461 |
| Sudurpaschim | 34.43                                                    | 38.66  | 40.28  | 18.04               | 19.56 | 19.56 | 1,903,494             | 1,962,494  | 1,998,183  | 59,000  | 94,689  |
| Total        |                                                          |        |        |                     |       |       | 25,674,632            | 26,002,176 | 26,271,481 | 327,544 | 596,849 |

Note: The Table above was developed by the authors using data from various sources. See Annex A.

**FIGURE 18.**

Comparison of Malaria mosquito vector suitability across Nepal, under RCP8.5, across three epochs: 1986–2005 (historical baseline), 2020–2039, and 2040–2059.



Note: The maps above were developed by the authors using data from various sources. See Annex A.

the 2030s and 2050s. The maps in Figure 18 illustrate the southern concentration of malaria vector suitability. Similar to dengue vectors, it is expected that this concentration will creep northwards into progressively higher-altitude regions, as the climate progressively changes.

**41. In the absence of coordinated control measures, ongoing climate change is likely to increase malaria vector ranges across Nepal, thereby placing nearly 600,000 additional people at risk (Table 5).** Overall suitability at the national scale will increase from 51 percent during the historical reference period to 53 percent in the 2030s and 55 percent in the 2050s. Besides Madhesh, all other provinces will also experience an increase in overall vector suitability in the 2030s, 2050s, or during both periods. While Madhesh, Lumbini, Bagmati, and Koshi will remain the most vulnerable to malaria, it is important to note the increases in the provinces with less historic exposure to malaria infection. In Karnali, nearly a doubling of populated area is projected through the 2050s, thus placing an additional 162,000 people at risk.

## WATERBORNE DISEASE RISKS

**42. Water quality, which is in part affected by climate related hazards such as floods or landslides, has been associated with an increased incidence of waterborne diseases (WBDs).** Nepal faces an important burden of WBDs, particularly due to their impact on children under 5 years of age. Current drivers of WBDs throughout the country are attributable to many factors, including the sources, quality, and quantity of drinking water, sanitation facilities, and hygiene practices,<sup>77</sup> each of which can be negatively affected by climate-related factors, in particular, floods and landslides.

Diarrhea is a key WBD affecting Nepali children. Nepal has been registering a downward trend in cases of diarrhea in children under 5 years of age, from 12 percent in 2006 to 10.4 percent in 2022.<sup>78</sup> Rates were slightly higher in urban areas with 11.1 percent, and rural areas with 9.1 percent. The highest rates were found in the Bagmati Province in 2022<sup>79</sup>. Additionally, most of diarrheal cases were reported between May and October.<sup>80</sup> On the other hand, enteric infections have also seen a decreasing trend

in the burden of disease, going from 4,610.11 DALYs in 1999 to 1,075.82 DALYs in 2019. While the burden of disease from enteric infections have decreased, it still results in 22.6 deaths per 100,000 population (by 2019).

- 43. Water sources, waste, and sanitation services are at risk of climate hazards, thereby increasing waterborne and water-related diseases in the country.** The majority of households had access to improved sources of drinking water (98 percent, without major differences between rural and urban areas -96.4 and 98.8 respectively) by 2022. Likewise, around 92 percent of households were reported to have access to improved sanitation,<sup>81</sup> increasing from 83.8 percent in 2016.<sup>82</sup> Subnational vulnerability differences between regions and districts depend mostly on remoteness and agro-ecological zones (see Fig 3).

Subnational impact differences would determine level of risk and vulnerability, for example, the Terai region, which is projected to be affected mostly by droughts and high temperatures, would also impact access to safe water sources, increasing the risk of WBDs.<sup>83</sup>

- 44. Areas experiencing increased precipitation, floods, and landslide events, with limited access to safely managed drinking services, will likely experience greater vulnerability to WBDs in Nepal.** The Red Cross has reported that all provinces are at risk of landslides, floods, or both. The risk of floods is greatest in the lower-elevation areas and the more populated provinces of the country, with the estimated population exposed to extreme flood increasing to nearly 370,000 by 2035–2044.<sup>84</sup> At the median level of elevation, there is a risk of both floods and landslides, due to the greater concentration of hills and valleys,

with landslide hazards in the worst-affected districts increasing after the 2015 earthquake.<sup>85</sup> Due to the varying elevations of the country and the high disparity of safe water coverage, it is estimated that a large percentage of the population is vulnerable and could be at greater risk in the future to WBD risk, as a result of changing climate patterns.<sup>86</sup>

- 45. Climate change projections will have a different impact on Nepali communities, depending on their current vulnerability due to remoteness, poverty, and access to WASH services, with wide differences between and within provinces.** In this sense, diarrheal disease incidence is higher in the mountainous region when compared to lowland areas. Research suggests that the risk of diarrhea increases by approximately 5.05 percent per 1°C-rise in the average temperature in mountainous regions compared with non-mountainous areas in Nepal.<sup>87</sup> Overall, 60 percent of diarrheal cases in Nepal, occur from May to October, which correspond to the rainy season. Considering that the rainy season is projected to increase its rainfall patterns, while temperatures will continue to increase throughout the country, waterborne and water-related diseases could increase concomitantly, as WASH services would be affected by climate-related hazards.

## AIR QUALITY HEALTH RISKS

- 46. Ambient air pollution (AAP) and household air pollution (HAP) pose a risk to the health of people in Nepal.** Exposure to urban air pollution, as well as smoke from indoor cooking, wildfires, and dust storms, can adversely affect health. The inhalation of fine particulate matter 2.5 micrometers or smaller (PM<sub>2.5</sub>) and other toxins, which can enter the deeper sections of the lungs and bloodstream,

has contributed to the development of severe chronic health conditions. People who are particularly vulnerable to particulate air pollutants include those with asthma, chronic obstructive pulmonary diseases (COPDs), children, and those with close exposure to the sources of air pollution, such as women when cooking with biomass and firefighters addressing wildfires. According to the World Bank Development Indicators, the age-standardized mortality rate attributed to ambient and household air pollution was 193.80 deaths per 100,000 in 2016,<sup>88</sup> and nearly 100 percent of the population was estimated to be exposed to levels exceeding WHO guideline values for PM<sub>2.5</sub> air pollution in 2017, with little decline since 2010.<sup>89</sup>

**47. Climate change exacerbates AAP and HAP risks to human health.** The State of Global Air 2020 report shows that Nepal is among the top 10 countries with the highest outdoor PM<sub>2.5</sub> levels and an annual average of 83.1 micrograms per cubic meter of PM<sub>2.5</sub>.<sup>90</sup> In urban areas, increased temperatures can result in “heat island” effects — characterized by an increased risk of smog formation, where polluted air (mainly with high levels of ozone and particulate matter) stagnates, thereby impacting health acutely and chronically through damage to the cardiovascular and respiratory systems.

Ambient air quality is also impacted by smoke from wildfires, which typically occur during the drier months of March and April before the monsoons in Nepal. The country saw one of the worst wildfire seasons in 2021, and projected increases in temperatures and risks of wildfires could lead to the deterioration of air quality, especially when combined with high wind speeds and prolonged droughts. Droughts can increase the frequency,

intensity, geographic proximity, and length of the wildfire season in Nepal, worsening wildfire-induced air pollution. Additionally, increasing temperatures and atmospheric carbon dioxide can extend the allergy season due to their impact on plant phenologies, and while this is not well documented in Nepal, recent research elsewhere has shown that poor air quality is significantly associated with the risk of autoimmune diseases.<sup>91,92</sup> Predicted air quality deterioration is linked to the risk of autoimmune diseases, such as connective tissue disorder, inflammatory bowel diseases, and rheumatoid arthritis.

**48. The Indo-Gangetic Plain (IGP) areas of the Terai region are a global hotspot for AAP, including from black carbon (BC) — a short-lived climate pollutant (SLCP).**<sup>93</sup> Studies in other countries in the region, such as India, have shown a strong association of black carbon aerosol and cardiovascular disease mortality (CVD). The IGP, which includes the Terai region in Nepal, has been found to be a global hot spot of atmospheric pollutants, showing large concentrations of BC aerosols during winter. Research has found that around 60 million people live over BC hotspots along the IGP, with approximately 400,000 annual deaths estimated to be attributable to BC exposure.<sup>94</sup>

**49. Indoor air pollution is another concern in Nepal, with the World Bank estimating that only 35 percent of the population had access to clean fuels and technologies for cooking in 2020.**<sup>95</sup> The 2017 Biomass Energy Strategy found that nearly 77 percent of Nepal’s energy is supplied by traditional biomass energy and recommended switching households to clean cooking technologies by 2022.<sup>96</sup> Precipitation pattern changes in Nepal can indirectly influence air quality health

outcomes via exposure to indoor biomass air pollution. Exposure to biomass air pollution can change during the monsoon months in Nepal, when cooking must be done indoors in rooms that may have poor or no ventilation. Further, during heavy rain, there is limited access to dry wood for fuel, and wet firewood is not only harder to burn but also produces more smoke, thereby increasing air pollution. However, some households in Nepal are able to switch from using wood to another fuel source, such as gas, during the monsoon; though more costly, gas is a cleaner burning fuel with reduced indoor air pollution risk. The projected changes in precipitation frequency, as well as the timing of rainfall events, are relevant to cooking and subsequent exposure to indoor biomass air pollution.

## MENTAL HEALTH

### **50. The association between climate change-related events and mental health can be direct or indirect, short-term, and long-term.**

Acute events (such as a flood or cyclones) in the short term can precipitate a psychopathological pattern similar to experiencing traumatic stress, whereas exposure to extreme or prolonged weather-related impacts may result in delayed mental impacts, such as symptoms of post-traumatic stress in the future or psychological impacts on younger generations. The 2019/2020 Nepal National Mental Health Survey (NMHS) highlighted that 10 percent of Nepali adults reported any mental disorder along their lifespan, with 4.3 percent experiencing a current mental illness. In particular, major depressive disorder showed a prevalence of 3.6 percent, being higher than the prevalence in the South Asia region (2.6 percent).<sup>97</sup>

### **51. To assess mental health in the context of climate change, the full spectrum from mental “illnesses to psychological and social well-being,” or “psychosocial health,” is considered, thereby allowing for the incorporation of considerations of well-being and resilience.**<sup>98</sup>

This is particularly relevant in Nepal, where there is background strain on the resilience of the population, coupled with limited opportunities for psychological or psychiatric assessment and diagnoses.

The concept of mental health and well-being can thus be framed as a spectrum of “psychosocial health.” It embodies the diverse psychological and social strains of climate change impacts, such as housing, water and income insecurities, as well as living in physically uncomfortable drought or humid conditions. In this sense, the mental health and overall well-being of Nepalis are affected by contextual factors that can culminate in curtailing the cognitive energy for developing the coping mechanisms to deal with contextual stressors, namely, climate-related hazards.

### **52. The impact of climate change and climate extreme events on mental health and well-being is mediated by individual and community resilience.**

Although there has been increasing public awareness on the relevance of mental health among Nepali communities, there is still a long history of using traditional healing methods to treat mental health and well-being issues, which are typically performed by community or religious leaders. In this sense, they would be the key community members to contribute to the development of individual and collective coping mechanisms for addressing climate-related mental health and well-being disorders.<sup>99</sup>

**53. The climate change's impact on rural communities, and their access to water, can increase anxiety and stress levels among women involved in subsistence farming.<sup>100</sup>**

In this sense, climate change impacts on mental health and well-being are mediated by social and contextual factors, namely, poverty conditions, water insecurity, sudden loss of property, personal or family diseases, or illness, among others. Households who experience these cumulative shocks are less able to develop coping mechanisms that can build on structural and social support, therefore worsening their well-being and possibilities of improving their livelihoods.<sup>101,102</sup>

**54. It is challenging to project mental health outcomes related to climate change.** In Nepal, there is a need for improved surveillance and diagnostics, as well as specialist training and services, to meet the mental health and well-being needs of the population. Projections for the impact of climate change on mental health would need to encompass the overall vulnerability of livelihoods, communities' resiliency, and individual coping mechanisms. Research in other countries<sup>103</sup> have projected levels of heat-related excess mortality for mental disorders. These estimates may not transfer directly to the context of Nepal; however, the trends between increasing temperatures and associated mental disorders have been found with regard to self-harm and suicide rates. Moreover, other findings suggest that suicide rates increased between 0.7 percent and 3.1 percent, for a 1°C-increase in the monthly average temperature.<sup>104</sup>

## EXTREME TEMPERATURE RISKS

**55. The health risks of extreme heat are wide-ranging, including effects on mortality, heat-related injuries, mental health, and**

**well-being.** Health effects caused by heat, include the direct effect of heat stress, heat rash, cramps, exhaustion, dehydration, and the acute exacerbation of pre-existing conditions including respiratory and cardiovascular diseases. Longer-term mental health risks are also an important effect to consider. In addition to the impacts on individuals, the whole-of-population exposure, which occurs with an extreme heat event, can lead to significant increases in hospitalizations imposing a strain on health systems.<sup>105</sup>

**56. Projections of increasing mean and extreme temperatures, especially in the Terai region, would increase the mortality rate in the population segment of those aged 65 years old and above.** Considering the temperature projections under the high-emissions scenario (developed in the previous section), it is estimated that around 53 out of 100,000 deaths would be attributable to heat by 2080.<sup>106</sup> Moreover, the overall rise of mean temperatures, and the increase in the number of days with extreme temperatures, would also lead to an increase in heat-related morbidities.

**57. A perverse effect of the changing climate has been the precipitation of cold waves as a phenomenon, resulting in adverse respiratory health effects.** Cold waves are characterized by a rapid drop in temperature (10°–15°C) during the winter season. The cold increases health risks, such as viral flu, coughs, “cold diarrhea,” fever, and respiratory diseases common during the cold season in general. It is estimated that during the period from 2001 to 2010, around 1,793 people have been affected by cold waves, leading to a possible 376 deaths.<sup>107,108</sup>

# KEY MESSAGES

## NUTRITION RISKS



- Nepal ranks amongst the highest in the South Asia Region for stunting (24.8 percent), wasting (7.7 percent), and underweight (18.7 percent), among children under 5 years of age, with each of these conditions being climate-sensitive.
- Over one-third (36.4 percent) of Nepal's population suffers from moderate or severe food insecurity, which has been increasing in recent years, and is expected to worsen with climate impacts on agriculture.
- The provinces that are the most vulnerable to food insecurity include Koshi, Madhesh, Bagmati, and Lumbini, with each reporting over 150,000 vulnerable households; affected households are concentrated in districts in the south.

## WATERBORNE DISEASES



- Water sources, as well as waste and sanitation services, are at risk of climate hazards, thereby the risks of increasing waterborne and water-related diseases in the country. Around 98 percent of the population is reported to have access to improved sanitation.
- Areas experiencing increased precipitation, floods, and landslide events with limited access to safely managed drinking services, will likely experience greater vulnerability to WBDs in Nepal.
- Diarrhea increases by approximately 5.05 percent per 1°C-rise in the average temperature in mountainous regions compared with non-mountainous areas. Overall, 60 percent of diarrheal cases in Nepal, occur from May to October, which correspond to the rainy season.

## VECTOR-BORNE DISEASE



- It is estimated that an additional 400,000 people by 2030 and 550,000 people by 2050 will be living in dengue-vulnerable areas in Nepal, due to climate change.
- Around 25 million people in Nepal are already at risk of malaria. In the absence of coordinated control measures, ongoing climate change is likely to increase malaria vector ranges across Nepal, placing nearly 600,000 additional people at risk.

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## AIR QUALITY HEALTH RISKS



- The State of Global Air 2020 report shows that Nepal is among the top 10 countries with the highest outdoor PM<sub>2.5</sub> levels — at an annual average of 83.1 micrograms per cubic meter of PM<sub>2.5</sub>.
- Indoor air pollution is another concern in Nepal, with the World Bank estimating that only 31 percent of the population had access to clean fuels and technologies for cooking in 2019.

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## MENTAL HEALTH



- Acute events (such as a flood or cyclones) in the short term can precipitate a psychopathological pattern similar to experiencing traumatic stress. Exposure to extreme or prolonged weather-related impacts may result in delayed mental impacts, such as symptoms of posttraumatic stress in the future or psychological impacts on younger generations.
- Climate change's impact on rural communities, and their access to water, can increase anxiety and stress levels among women involved in subsistence farming. Projections for the impact of climate change on mental health would need to encompass the overall vulnerability of livelihoods, the communities' resiliency, and individual coping mechanisms.

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## EXTREME TEMPERATURE RISKS



- Nepal experiences both extreme heat and cold, thereby increasing risks for human health.
- Extreme heat is projected to increase in both the 2030s and 2050s, especially in the Terai region. It is expected that heat-related mortality will increase to 53 out of 100,000 by 2080.
- Cold waves increase health risks, predominantly as a result of respiratory diseases.



# ADAPTIVE CAPACITY OF THE HEALTH SYSTEM

## HEALTH SYSTEM OVERVIEW

**58. Nepal has made significant improvements in health coverage, but there remain gaps between policy and practice, especially at the subnational level.** The public

health system in Nepal is decentralized, backed by a mix of public, private, and non-governmental organizations (NGOs). Moving from a centralized structure has allowed Nepal to employ greater management at more levels, leading to a greater availability of services and coverage at the community level.

**59. The country has made efforts in decentralizing health care delivery by strengthening the service response at the district level.**

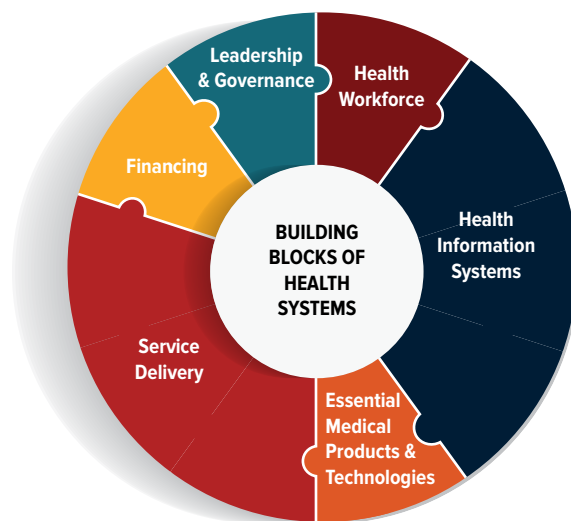
Moreover, policies and strategy planning documents highlight the pivotal role that communities can play as key stakeholders and actors so as to increase the access and quality of health service delivery. The governance structure has also integrated local and Indigenous knowledge, particularly from Ayurveda, thereby furthering projects and programs that improve service delivery. Finally, efforts in building cross-sectoral partnerships have been key in main policies and guidelines in the health sector; however, it is not clear how these efforts are being implemented and how the Ministry of Health and Population (MoHP) has been furthering cross-sectoral projects, such as climate-related health ones. Nonetheless, despite the expansion of health services around the country and the adoption of bottom-up programs, improvements in the quality of health have lagged.

**60. The emergence of the COVID-19 pandemic has brought with it a focus on health and health systems, specifically the capacity to manage emerging public health risks.** Climate change, as the COVID-19 pandemic has done, has the potential to disrupt and overwhelm health systems, including healthcare facilities and healthcare staff. This is especially important in settings that may already have weak health systems, including leadership challenges, a lack of resources, and / or limited capacity.

**61. The extent to which the health system in Nepal has the capacity to be prepared for managing changes in hazards, exposure, and susceptibility will determine their resilience in the coming decades.** In this assessment, Nepal's adaptive capacity<sup>109</sup> to prevent and manage climate-related health risks is examined according to WHO's six health system building blocks, as shown in Figure 19 (see also Annex B for the "Adaptive Capacity Rapid Assessment" and the summarized "Adaptive Capacity and Climate Change-Related Health Risks Gap Analysis" that informs this section).

**FIGURE 19.**

WHO's climate-resilient health system building blocks.



Source: World Health Organization, 2015, Operational Framework for Building Climate Resilient Health Systems.

It should be noted that several factors outside the scope of the health sector can also drive reductions in adaptive capacity to manage the health risks of climate change in Nepal's institutions and people. These include the country's economic challenges, the changing demographic patterns, and slowly improving social conditions. The promotion of equity, as a cross-cutting theme for enhancing the adaptive capacity and resilience to the health risks of climate change, is also critical. Adaptive capacity is likely to be robust, when access to resources within a community, nation, or the world is equitably distributed.

## LEADERSHIP AND GOVERNANCE

**62. The Government of Nepal is aware of the current and potential negative impacts of climate change on health and its health system.** As a result, the government has been actively developing policies and plans to support mitigation and adaptation actions. Among the sector policies and plans relevant

to climate change and health, there is a special emphasis on community engagement and capacity building at local levels (including the use of community-based volunteers), which is important for addressing subnational needs. For example, MoHP works closely with district-level stakeholders to develop operational plans that ensure bottom-up approaches for key health programs.

**The evolution of the climate change and health policy landscape in Nepal can be summarized as follows:**

- **2010 — National Adaptation Programme of Action (NAPA).** This document is the product of the commitment of the country after the seventh session of the Conference of the Parties (COP). It highlights the relevance of climate change's impact on public health, focusing mostly on VBDs and WBDs. It also integrates the impacts on other areas that concomitantly affect the health system, such as water and agriculture.

Regarding adaptation strategies and efforts, the document underlines (a) the relevance of research to improve evidence-based decision-making processes; (b) the pivotal role of communities as key actors in a climate-related emergency response; (c) the focus of research on disease outbreaks and emergency responses; (d) programs on VBDs, WBDs, and food-borne diseases; and (e) the strengthening of the early warning and surveillance systems in order to integrate climate change and health data.<sup>110</sup>

- **2011 — Local Adaptation Plans for Action (LAPA).** This framework highlights the importance of engaging with communities for integrating climate adaptation and resilience into local and national planning and adopting a bottom-up approach. This approach is aimed at ensuring a more inclusive, responsive, and flexible organization in order to further adaptation and resilience efforts.

The LAPA highlights different strategies and activities for ensuring the implementation of the bottom-up approach: (a) identify vulnerable communities, villages, and municipalities, along with their adaptation opportunities; (b) prioritize adaptation actions for communities; (c) prepare adaptation plans for action that integrate it into local and national plans; (d) mobilize resources and services delivery agents for the implementation of adaptation efforts; (e) conduct monitoring and evaluation studies in order to ensure effective implementation; and (g) identify cost-effective interventions that can be scaled up for incorporation into local and national planning.<sup>111</sup>

- **2015 — Nepal Health Sector Strategy, 2015–2020.** The NHSS highlights the

current burden of disease and goals for the next five years. It acknowledges the impact of climate change on shifting trends on the burden of disease and the direct impact of climate-related disasters on injuries and death rate. However, it also underscores the lack of knowledge and research for determining the health vulnerabilities to climate-related phenomena and related risks.<sup>112</sup>

- **2016 — Nepal's first National Determined Contribution (NDC).** Although the first NDC submission mentions adaptation efforts and initiatives, it does not provide details regarding the adaptation of the health care sector. The document focuses on building resilience and knowledge management, signposting to the NAPAs for further details.<sup>113</sup>
- **2017 — Health National Adaptation Plan (HNAP) 2017–2021.** It provides details on risks and vulnerabilities from different districts and regions, highlighting the main climate-related health risks in the country, namely, extreme weather-related health impacts such as heat waves and cold waves; VBDs including malaria and dengue; and diarrheal diseases. The document also underlines the differences between agroecological zones, identifying the risk of floods in the Terai region and the risk of GLOFs and landslides in the mountains, for example.

Based on the risks and vulnerabilities of climate change for health, the HNAP prioritizes (a) raising public awareness about climate change's impact on health; (b) generating evidence through research and studies efforts; (c) reducing morbidity and mortality related to communicable diseases

(CDs) (for example, VBDs, WBDs, along with airborne and foodborne diseases); (d) managing the direct impact of extreme weather events; and (e) incorporating health in all policies and adopting a multi-sectoral cooperation.<sup>114</sup> The document also provides specific targets for each objective and corresponding implementation arrangements.

- **2019 — Climate Change Policy (updated policy from 2011).** The country is committed to integrating climate change into its main goals and strategies. Regarding climate change and health, the policy framework focuses on building preparedness and prevention mechanisms to avoid outbreaks from vector-borne and other communicable diseases. It also highlights the key role of water management and the importance of having access to drinking water. Lastly, it underlines the importance of the management of hazardous waste in order to prevent the contamination of water sources or exposure to waste.<sup>115</sup> However, it does not provide details on the implementation and coordination mechanisms that would ensure the development of projects and programs to strengthen the health system and further adaptation efforts.
- **2020 — The 15th Plan (Fiscal Year 2019/2020– 2023/2024).** This document addresses the long-term planning for the country, covering a wide range of areas, including macroeconomics, governance, as well as specific policy frameworks and guidelines. Regarding health, the health guidelines focus mostly on health service delivery and increasing the access and quality of the health system, with the aim of transforming the profit-orientation of the health system into a service-oriented

one. This document also outlines a section on climate change, highlighting the importance of increasing adaptive capacity, implementing clean energies to further mitigation efforts, as well as accessing international finance and technologies in order to strengthen adaptation and mitigation projects.<sup>116</sup> While it acknowledges the role of climate change and its impact on health and the country's health system, the document does not provide strategies to address these impacts.

- **2020 – Second National Determined Contribution (NDC).** The second communication to the UNFCCC focuses mostly on mitigation opportunities and efforts in Nepal. Although it mentions the adaptation component within the NDCs, it only touches upon the thematic areas that are being taken into consideration for furthering programs and interventions, and for building adaptation. Within those areas, health, drinking water, and sanitation are outlined. The document also mentions cross-cutting areas for all the thematic areas, namely, (a) gender equality and social inclusion, (b) awareness and capacity building, (c) research and technology development, and (d) climate finance. The thematic areas, including health, are signposted for the NAPs, which are scheduled to be updated every 10 years.<sup>117</sup>
- **2021 — Third National Determined Contribution (NDC).** The last communication to the UNFCCC is a thorough document that deep-dives into different sectors for mitigation and adaptation strategies. Regarding health, it provides extensive information on how climate change is impacting health, with a focus on VBDs and diarrheal diseases. Adaptation measures to

reduce vulnerabilities highlight the need to do the following: (a) raise awareness, (b) increase research to generate evidence, (c) reduce the morbidity and mortality of infectious diseases, (d) manage the risks of extreme weather events, and (e) ensure a multi-sectoral response to further health in all policies.<sup>118</sup>

- **Forthcoming — 2022 NHSS & the new HNAP**

**63. Nepal has made substantial efforts in furthering health into their policies and strategies to address climate change.**

Although health has been identified in the policy landscape as a key area for furthering adaptation to climate change measures, there are few policies in the health sector addressing climate change as a challenge or priority in strategic planning. Despite the existence of different coordination mechanisms, such as the technical working groups for health and climate change or a climate change focal point in MoHP, there appears to be limited engagement, financing, and implementation of programs from MoHP. The level of participation of these coordination mechanisms or the extent of their decision-making involvement is unclear; it is also uncertain whether they are dependent on specific budget lines for advancing climate and health actions. Policy makers have demonstrated an awareness of the health impacts of climate change; however, the engagement of MoHP with its climate change, DRM, and agriculture counterparts is still ambiguous.

**64. At the subnational level, the development of policies and plans to address climate-related health risks is lacking.** Although MoHP has developed local-level strategic plans, climate change and health in these subnational plans

are not well integrated into local-level planning initiatives. Regions that are highly vulnerable to climate-related hazards, such as the Terai region, would require tailored programs and strategic planning in order to address the compounded effect of different climate hazards and climate-related health risks (for example, floods, heat, and WBDs).

**65. The World Bank's Country Climate Development Report (CCDR)<sup>119</sup> for Nepal is a policy guideline for building efforts, both in mitigation and adaptation strategies, including climate change impacts on health.** The CCDR for Nepal adopts an all-of-government perspective of climate change, highlighting the just and green transitions, as well as providing macroeconomic and selected sectoral recommendations to support the country in responding to the climate challenge and protecting economic development. Sectoral recommendations include the following: (a) establishing an integrated and collaborative framework to different areas such as water, agriculture, and forests; (b) strengthening Nepal's hydropower capacities for an energy transition; (c) enhancing urbanization and environmental quality in order to increase resilience and improve health outcomes, and (d) strengthening Nepal's low-carbon, resilient roads to improve connectivity, economic growth, and services. Overall, having a just and green transition in the country is expected improve health co-benefits<sup>120</sup> from adjusting to climate change.

## HEALTH WORKFORCE

**66. Nepal has an emerging crisis in health human resources, as identified by the Human Resources for Health Strategic Plan, 2011–2015.<sup>121</sup>** Nepal is one of the 57 Human

Resources for Health (HRH) crisis countries identified by the WHO, where the health worker to population density is below the critical threshold of 2.3 per 1,000 people needed to provide the basic health services.<sup>122,123</sup> Nepal faces numerous health workforce challenges, which have been exacerbated during the COVID-19 pandemic. They include insufficient staffing levels, urban-rural maldistribution, the lack of proper skill mix, limited education access, poor absorption capacity, rural retention issues, international outmigration, lack of community support, and low salary payments.<sup>124</sup> The MoHP has developed a National Human Resources for Health (HRH) Strategy 2021–2030 that addresses the health workforce challenges and envisions ensuring the equitable distribution and availability of quality health workforce in order to advance universal health coverage.

To reach more people who live in rural and remote settings in Nepal, it is critically important to increase the training and support of community health workers (CHWs). In the Nepali CHW workforce, a female community health volunteers (FCHVs) program that was started in 1988 has since expanded to provide maternal and child health services on a large scale.<sup>125</sup> In 2017, it was estimated that there are 52,000 FCHVs who contribute to health education, counseling, outreach, and resource distribution as part-time unpaid workers.<sup>126</sup> Overall, there is still limited data availability on the health workforce in Nepal, particularly for unsalaried workers and private sector workers.

Climate change can impact the health workforce through mechanisms related to changes in the frequency and intensity of extreme weather events that may affect a facility or the workers' ability to reach the facility, apart from altering patterns of

climate-sensitive diseases, to which health professionals may not be able to respond, in a timely manner.<sup>127</sup>

#### **67. Nepal has a shortage of healthcare personnel.**

In 2019, Nepal had 8 physicians per 10,000 population, and 33 nurses and midwives per 10,000 population — slightly below the WHO minimum threshold of 44.5 healthcare workers per 10,000 to achieve universal health coverage.<sup>128</sup> In 2014, the specialist surgical workforce was only 3 per 100,000 population.<sup>129</sup> There is limited data on the availability of medical pathologists and laboratory scientists and environmental and occupational health and hygiene professionals, who play a vital role in reducing climate change-related health risks. Regarding the mental health workforce, a study found 200 practicing psychiatrists in Nepal in 2021 — a substantial increase from 39 in 2008, but there are still vacancies in mental health worker posts in the government healthcare system.<sup>130</sup>

As seen in Table 6, several healthcare worker posts in government health facilities have vacancies that remain unfilled, particularly in certain provinces like Sudurpaschim, often due to limited human resources and non-preferences to work in remote areas.<sup>131</sup> These shortages are worsened by the outmigration of medical doctors and nurses, due to a lack of adequate labor conditions and training opportunities. Previous research estimates that 16 percent of registered doctors may be working or studying outside of Nepal.<sup>132</sup>

#### **68. There are limitations in the professional expertise and distribution of the health workforce, and an overarching lack of information on the awareness of climate change and health risks among health personnel.** The health workforce, particularly

doctors and nurses, are more concentrated in the urban areas. There is an uneven distribution of the health workforce across provinces, with most of the highly skilled professionals found in large hospitals and administrative offices in Kathmandu Valley. In contrast, CHWs are better distributed in more rural regions, but there is currently a lack of clinical supervision for trained non-specialist providers.<sup>133</sup> The skilled health workforce distribution is important to consider because more than 90 percent of

Nepalis receive their health services at the community level.<sup>134</sup>

There is limited data on the quantity or level of expertise on climate-related health risks in the health workforce. This issue is important, as climate change can exacerbate the health impacts of having significant disparities in the roles and types of health professionals at subnational levels, including substantial urban-rural divides.

**TABLE 6.**

Percent of roles filled in government health facilities, by province.

| PROVINCE                                                                                                                                                                                                                                                    | KOSHI | MADHESH | BAGMATI | GANDAKI | LUMBINI | KARNALI | SUDURPASCHIM | NATIONAL AVG. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------|---------|---------|---------|---------|--------------|---------------|
| <b>Medical Doctor - General Practitioner (MDGP)</b>                                                                                                                                                                                                         | 64.3  | 63.6    | 61.5    | 63.6    | 50.0    | 33.3    | 40.0         | <b>56.5</b>   |
| <b>Medical Officer (MO)</b>                                                                                                                                                                                                                                 | 57.5  | 47.2    | 62.7    | 59.8    | 48.2    | 63.9    | 34.4         | <b>55.9</b>   |
| <b>Nurse</b>                                                                                                                                                                                                                                                | 75.9  | 71.1    | 70.2    | 74.1    | 70.5    | 67.7    | 75.1         | <b>72.1</b>   |
| <b>Paramedic and Other</b><br>Including Health Assistant (HA), Auxiliary Health Worker (AHW), Senior Auxiliary Health Worker (SAHW), Public Health Inspector, Laboratory Technologist / Officer / Technician / Assistant, Radiographer, Dark Room Assistant | 75.1  | 77.5    | 63.8    | 83.1    | 77.8    | 69.1    | 78.4         | <b>74.3</b>   |

Source: MoHP's data on health services availability and readiness in the seven provinces of Nepal in 2018.

**69. Labor conditions for health workers curtail health workforce capacity.** Many unsalaried workers have limited training and / or are lower-skilled, and there is a need for more regulations to include their education or role within the health workforce. Although there have been efforts to increase salaries for the formal workforce, this remains a challenge

for retaining human capital within the health system in Nepal and the broader region. Moreover, education limitations including the shortage of faculty and teaching resources further contribute to the shortage of qualified health professionals,<sup>135</sup> thereby increasing risks of health challenges, such as maternal mortality.

Within the context of climate change, an unsalaried health workforce, coupled with the lack of a unified health training curriculum on climate, can deepen the disparities and gaps in workforce distribution and roles. Moreover, the reliance on private initiatives or NGOs for health service delivery, without strengthening and articulating efforts with the public sector, could increase vulnerabilities for the health workforce in a changing climate.

**70. Nepal’s health education system lacks a national plan to prioritize climate change and health, and it is uncertain whether the health workforce is receiving education on climate change’s impact on health and health systems.** Health workforce training monitoring is centralized through the National Health Training Center (NHTC), which was developed under MOHP to oversee all health training for DoHS, the Department of Drug Administration (DDA), and the Department

**FIGURE 20.**  
Nepal’s health care system levels.

| LEVEL      | TYPE OF FACILITY                                                                                                                                                                                                                                                                      |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Federal    | General Hospital (300 plus beds)<br>Specialized Hospital (min 100 beds)<br>Teaching Hospital (Academy and others)<br>Central Ayurveda Hospital                                                                                                                                        |
| Provincial | General Hospital (25-300 beds)<br>Provincial Ayurveda Hospital<br>Provincial Ayurveda <i>Chikitsalaya</i> /<br>Ayurveda Health Centre                                                                                                                                                 |
| Local      | Basic Hospital (5, 10, 15 beds)<br>Basic Health Service Centres <ul style="list-style-type: none"> <li>• Primary Health Care Centers</li> <li>• Health Posts</li> <li>• Community Health Unit</li> <li>• Urban Health Center</li> </ul> Ayurveda Dispensaries ( <i>Aushadhalaya</i> ) |

Source: Public Health Service Regulation, 2020

of Ayurveda (DA).<sup>136</sup> However, information is limited regarding the integration of climate change impacts on health as part of the health workforce training.

**71. Nepal's workforce has limited knowledge, technical capacity, and resources to prevent and manage current and future climate-related health risks.** There is an absence of a systematic approach for developing the capacity of the health workforce in integrating climate change with emergency preparedness and response. Climate change has not been prioritized in human resource planning mechanisms. Although climate change policies in Nepal mention climate change impacts on health, there are just a few programs and policies integrating climate-related risks into the development of health workforce capacities, such as the Kathmandu University School of Medical Sciences, are starting to incorporate climate-related courses into health curricula and training programs. Additionally, there is a lack of assessments to establish a baseline understanding, knowledge, and technical needs of the health workforce in relation to climate change.

**72. Overall, the health sector faces an imbalance in the number, capacities, deployment of the health workforce, as well as inadequate resource allocations across the different levels of health care, when compared with global minimum thresholds.** Improving workforce capacity would strengthen job satisfaction, human resources retention, salaries, work environment, and resource allocations.

## HEALTH INFORMATION SYSTEMS (HIS)

**73. Surveillance, reporting, and early warning systems (EWS) in Nepal, which are robust and free to access, provide relevant information on current diseases, management, and infrastructure.** However, the current strategy planning document is from 2007, and there have been no updated guidelines or progress monitoring. The main sources of information are (a) the census, (b) vital registration, (c) the Demographic and Health Survey (DHS) and the Nepal Living Standard Survey (carried out every 5 years), (d) rapid assessments, (e) Sentinel Reporting that uses a representative sample of hospitals in order to surveil specific diseases, (f) research, (g) disease surveillance, (h) human resource management information, (i) financial management information, (j) physical assets management information, (k) logistics management information, (l) health service information, (m) drug information network, and (n) Ayurveda Reporting.<sup>137</sup>

**74. Disease surveillance systems monitor several communicable and non-communicable diseases, with an early warning and response system put in place for three vaccine-preventable diseases and three VBDs.** Among the diseases under the surveillance system are (a) acute flaccid paralysis, (b) measles, (c) neonatal tetanus, (d) malaria (falciparum), (e) Kalazar, (f) Japanese encephalitis, (g) cholera, and (h) any other unusual occurrence of a disease.<sup>138</sup> In 2020, Nepal reported having 118 health facilities with an integrated surveillance system. The information collected from the different facilities is provided weekly to a centralized platform that is integrated with the management information system.<sup>139</sup>

**75. The Department of Hydrology and Meteorological Services collects daily data on weather and climate, in order to disseminate and support water resource management, agriculture, and energy.** The department is a key stakeholder in providing information on weather and climate forecasts. It collects and publishes daily (24/7) data on temperature and precipitation, as well as information on the monsoon season onset and withdrawal, which is key for agricultural production. The department also monitors long-range forecasts, such as the El Niño/La Niña phenomenon. This data also feeds into the World Meteorological Organization and the EWS, especially for floods, which are common during the monsoon season. Nepal's wider EWS exists for climate-related disasters, such as floods. However, there isn't a comprehensive climate-informed health approach: health management, facilities, workforce, and surveillance information systems do not sufficiently include climate / weather data or other environmental factors.

**76. The early warning and reporting system has made significant improvements since its establishment in 1997, having community-based early warning systems for floods in place.** Regarding climate-related events, the first early warning and reporting system for floods was established in 2002, and improved in 2007 by adopting digital methods, such as push notifications and radio, to communicate expected flood hazards. The early warning and reporting system employs local disaster management committees, which receive training in risk reduction and emergency response in case of floods, and volunteer to work as part of the warning and emergency response system.<sup>140</sup> While aspects of Nepal's wider early warning and reporting system exist for climate-related disasters, such as floods, there isn't a comprehensive climate-informed

health early warning and reporting system. Health management, facilities, workforce, and surveillance information systems do not sufficiently include climate/weather data or other environmental factors. MoHP has recently developed a strategic roadmap (2021–2030) for strengthening National Integrated Health Information Management Systems (IHIMS) that aims to harmonize different health information systems and advance eHealth architecture for ensuring availability and use of quality health data and information for decision making.

## ESSENTIAL MEDICAL PRODUCTS & TECHNOLOGIES

**77. The strong monitoring and evaluation of expired and stock essential medicines can help improve access in Nepal.** A 2018 study found the availability of essential medicines to be 92 percent, with the percentage of expired medicines at 8.4 percent in district warehouses; however, it recommended stronger monitoring and evaluation to ensure access in peripheral and rural health facilities.<sup>141</sup> Moreover, the data is limited, making it challenging to assess and plan for adequate drug stocks and allocate resources to health facilities.

Factors influencing the availability of medical supplies in Nepal include a variety of interrelated issues,<sup>142</sup> ranging from simple to complex problems involving different levels and cadres of workers within the medical supply chain, which necessitates a coordinated approach between the government and partner stakeholders. Under-resourced hospitals and healthcare facilities (including preventive, primary health care facilities, and critical care) are ill-equipped, characterized by limited access to health technologies,<sup>143</sup> stock-outs of medicines and supplies,<sup>144</sup> and a lack of management of health system needs. The

gaps and vulnerabilities in equipment and supplies would exacerbate the impact of climate-related health risks; and therefore, reliable stockpiles of essential medicines and emergency supplies (particularly in rural areas) are needed to adequately prepare for extreme weather events.

**78. Laboratory capabilities in Nepal face several challenges in several areas, including testing services, the transport of specimens, quality management, and regulations.**<sup>145</sup> These challenges are further exacerbated by poor supply chains, thereby resulting in a lack of basic needs (for example, water and electricity) and contributing to stock-outs of laboratory reagents, consumables, and equipment.

At the same time, Nepal has demonstrated an ability to increase its laboratory capabilities under certain high-demand scenarios. For example, over 100 laboratories were established to conduct RT-PCR tests during the COVID-19 pandemic, and this investment will help to improve disease surveillance overall in the future.<sup>146</sup>

Laboratory capacities and other health technologies in Nepal need further assessment to better understand the country's ability to manage current and projected climate-sensitive diseases. This could include the fundamental strengthening of its laboratory capabilities to ensure access to essential medicines, testing, and equipment.

## SERVICE DELIVERY

**79. Nepal faces several barriers that impede access to health services, which can be exacerbated by climate change.** Achieving adequate delivery of quality of health services and care is a recurrent challenge in Nepal,

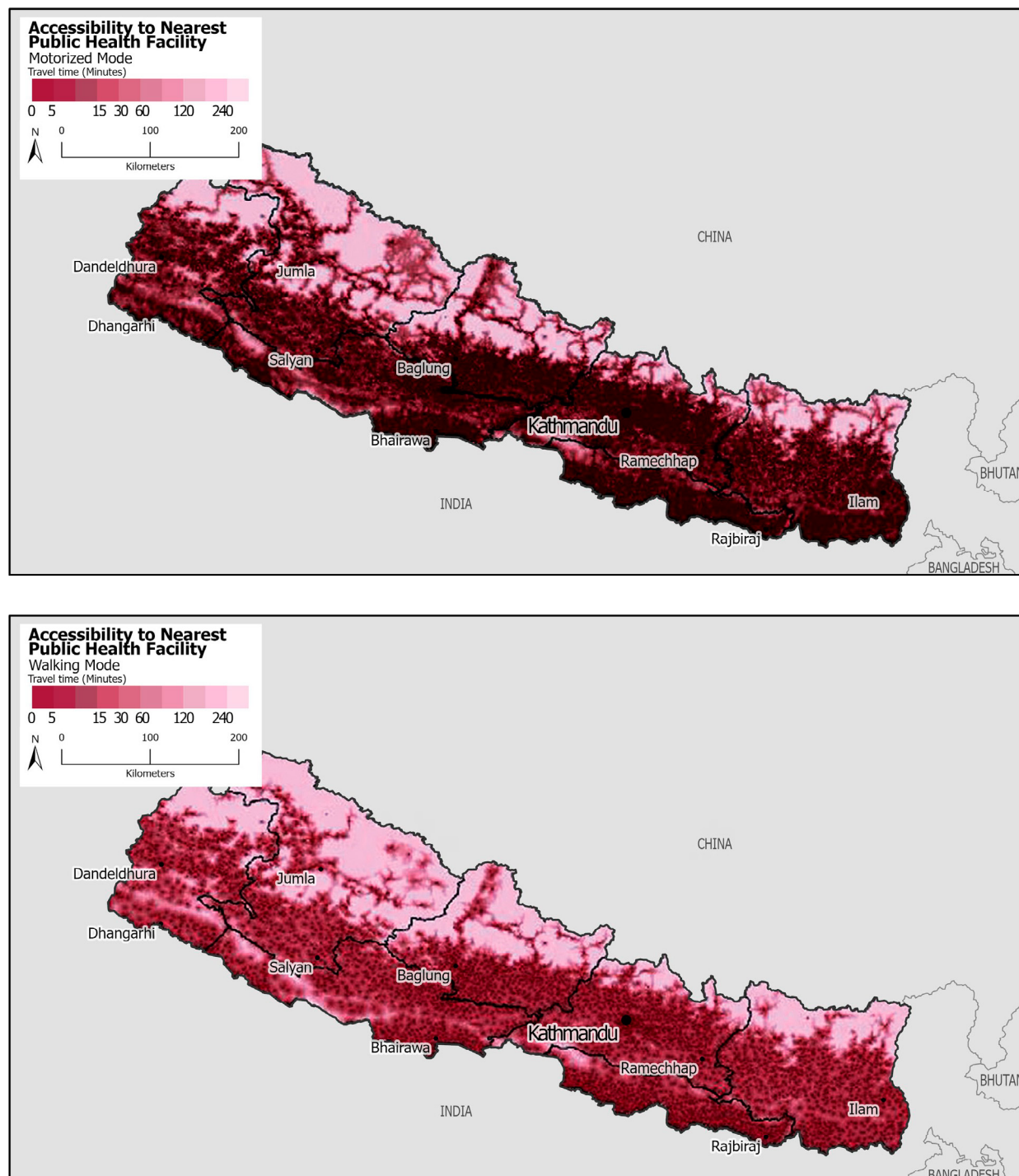
where low-quality health care can result in poor health outcomes. Despite progress from the establishment of the primary health care (PHC) service in 1978, by using a network of mostly peripheral district and distal health posts and sub-health posts to reach communities, remote rural areas in Nepal have seen little or slow change in access to key elements of health coverage.<sup>147</sup> Health care in these areas are still affected by weaknesses in the following areas: (a) health facilities (often due to geographic reasons and lack of transportation); (b) availability of basic and specialized services; (c) affordability concerns due to high out-of-pocket (OOP) expenditures; and (d) quality of care.<sup>148</sup>

Additional shocks and stressors related to climate change have the potential to exacerbate existing issues and barriers to quality health service delivery. During climate-related emergencies such as floods, access to health services and health workers can be particularly difficult due to damaged infrastructure and transport services, interrupted power and refrigeration, and other negative impacts.<sup>149</sup> The lack of access to health services and information has been shown to increase household vulnerability to health risks in flood-prone areas.

**80. There are vast disparities in the accessible resources and support at the different types of health facilities.**<sup>150</sup> For example, more centralized urban facilities have specialized staff, medicines, equipment, and services, which are not available at many rural facilities. There are also differences between public and private healthcare facilities. Some public facilities face common challenges, such as being understaffed, understocked, and lacking in adequate infrastructure. Rural access to healthcare infrastructure is also complexified

**FIGURE 21.**

Geographical accessibility of health facilities (average travel times in minutes by motorized transport and walking).



Source: BMJ Global Health 2021. Equity of geographical access to public health facilities in Nepal.

by a lack of transportation and health facilities within a 5-mile radius. Figure 21 illustrates some of the disparities in geographical accessibility to health facilities, with lower accessibility in the northern mountain areas, as compared with the central and southern Terai belt.<sup>151</sup> Another study in 2015 found significant discrepancies between urban (85.9 percent) and rural areas (59 percent) in the percentage of Nepali households with access to health facilities within 30 minutes.<sup>152</sup> As facilities are not near every community, the distance increases for the patients to get to other communities' healthcare facilities. Greater distances may result in a decreased utilization of healthcare facilities, although there are other factors that may play a larger role in detracting from healthcare usage and health outcomes (such as education, socio-economic status, and access to resources).<sup>153</sup>

**81. The health infrastructure in Nepal is impacted by several climate-related hazards, most notably floods and landslides.** Floods and landslides are unlikely to recede given current projections (according to the GFDRR), with potential damage to health infrastructure, including healthcare facilities, especially in the remote areas, likely to occur in a changing climate.

Climate-resilient health infrastructure guidelines and assessments are still in the process of being developed to build resilience and strengthen health facilities and technologies for climate-related events, as there is a need for adequate coordination across sectors to ensure that climate risks are being incorporated into health infrastructure planning. Building resilience is crucial, as the health infrastructure was overwhelmed in the wake of the 2015 earthquake, where over 90 percent of the health facilities in the affected areas

were destroyed or severely damaged.<sup>154</sup> The health sector can improve the coordination of DRM and climate change adaptation efforts in order to reduce interruptions in health service delivery caused by climate hazards and natural disasters in the future.

**82. Climate change impacts a wide range of health program areas that are important for service delivery (including CDs, maternal and child health, and nutrition), making it vital to be incorporated into all levels of health planning.** Nepal's 2019 Climate Change Policy, which was updated from 2011, does include commitments to integrate climate change into the country's main goals and strategies. However, climate change and its associated impacts have not yet been mainstreamed into the operations of health programs at all levels. A coordinated approach is lacking in addressing climate-sensitive epidemics and disease outbreaks, as well as other climate-related health risks at multiple levels and with multiple stakeholders. The COVID-19 pandemic revealed gaps in health system preparedness, including physical infrastructure limitations, lack of skilled personnel, and other resource constraints.<sup>155</sup> These gaps in health system preparedness could lead to poor health outcomes in the face of climate-related health risks. The Red Cross in Nepal has been working on anticipatory measures, including forecast-based action (FbA) and shock-responsive social protection (SRSP), for risks such as floods and extreme temperatures, in order to improve service delivery and reduce disaster burden<sup>156</sup>.

**83. Climate change impacts other determinants of health in Nepal (including water quality and quantity, air quality, nutrition and food security, waste management, and housing), which need to be monitored and addressed**

**in all health policies and regulations.** More baseline information can be collected on key environmental determinants of health where data is currently limited. Existing environmental quality standards and environmental health strategies have not been updated, with many of the emerging health issues related to climate change. Additionally, most health plans do not specifically address how to prepare for the ways in which climate change will affect implementation.

## HEALTH FINANCING

**84. Although there have been improvements in national investments on health, Nepal still has not achieved universal health coverage (UHC).** Government expenditure, as a percentage of GDP in health, has slightly decrease since 2015/2016. However, it is still above the threshold of the recommended 5-percent spending in order to progress towards UHC. Nepal went from a current health expenditure as percentage of its GDP of 6.3 in 2016 to 5.2 in 2020.

In terms of per capita health expenditure, Nepal's government has increased gradually, going from USD 11.3 in 2015/2016 to USD 20.2 in 2019/2020. The inadequate health expenditure has been coupled with an increase in the health sector budget, which has more than doubled from 2015/2016 to 2020/2021. Moreover, the share of the health sector budget against the national budget has increased by 6 percentage points between 2017/2018 and 2020/2021.

By 2020, the health care expenditure comes from different sources, with 54.2 percent coming from revenues from households, 30.1 percent from government domestic revenue, 9.3 percent from direct foreign transfers, 3.8

percent from Corporations, and 2.6 from others. Moreover, the general government current health expenditure is distributed between pharmaceuticals and medical goods with 37.4 percent, curative care with 33.4 percent, preventive care with 11 percent, other health care services with 9.2 percent, ancillary services with 4.6 percent, and administration with 4.5 percent.<sup>157</sup>

**85. Nepal's relies significantly on out-of-pocket (OOP) payments.** Out of the total expenditure in health care, more than half come from OOP expenditures (54.2 percent), while nearly 30 percent comes from government schemes.<sup>158</sup> High OOP expenditures, put pressure to household's budget, increasing risks for pushing families to poverty.<sup>159</sup> This picture may be further aggravated by climate change putting more strain on individuals and households in Nepal, especially those most vulnerable to climate impacts.<sup>160</sup>

**86. Climate change's impact on health is incorporated within the health financing strategy in the NHSS II.** While the NHSS acknowledges the impact of climate change on the burden of disease and the service delivery and health infrastructure, there are no evident allocations from the MoHP that are dedicated to addressing climate change's impact on health and the health system. Additionally, risk pooling mechanisms do not account for climate exposures or vulnerabilities.

While there is a lack of integration of climate change in health budget and resource allocation, it is important to point out that the basic services health service package does account for health risks that are influenced by climate-related hazards, such as malnutrition, enteric diseases, malaria, depression and anxiety, postnatal care and screening, and

laboratory services for VBDs such as malaria. However, it is noticeable that NCDs, such as cardiovascular and respiratory illnesses, which are climate-related, are not included in the basic services, free of cost.<sup>161</sup>

**87. Health financing progress toward UHC has been affected by the 2015 earthquake, and most recently, by COVID-19, which has required large investments for recovery.** The 2015 earthquake impacted health facilities, with a total of 446 public and 16 private health facilities destroyed and a total of 765 partially damaged. This amounted to losses totaling NPR7.54 billion, representing around 15 percent of the total health budget of 2016 (in 2016/2017, the health budget was NPR49.8 billion). On the other hand, by FY2020/2021, there was an allocation of NPR6.1 billion for COVID-19. It is unclear whether resources have been allocated to address climate shocks, such as heat and cold waves, floods, or landslides.<sup>162</sup> The National Health Financing Strategy (2021–2030) aims to expand fiscal space in the health sector, with an increase in the investment in the health sector. About 10 percent of the provincial and local governments' budgets will be allocated to the health sector to help address the health emergencies or pandemics.

**88. Building resilient health systems for climate change requires budget allocations as an integrated component in the overall planning of a national health plan.** Although there is a multi-sectoral approach and an integration of climate change in the strategic planning for the health sector, there is a lack of guidelines for integrating a climate-resilient approach for specific climate-related health risks, such as food insecurity and malnutrition, as well as heat-related morbidity and mortality, which are necessary to inform rationalized resource allocation. Moreover, while Nepal adopts

risk-pooling mechanisms, it is not clear if it is accounting for climate-related risks.

**89. Climate change mitigation and adaptation options in the health sector have not been adequately promoted as cost-effective options.** Arguments for implementing climate change mitigation policies often focus on the perceived short-term financial costs. However, these cost assessments are lacking; moreover, they rarely account for the health co-benefits of these policies, in terms of strengthening the resilience and outcomes for human health, while also reducing costs for the health sector. Therefore, additional studies are needed to quantify the longer-term cost savings through the health co-benefits of climate change adaptation and mitigation policies in Nepal.

**TABLE 7.**

Summary of the health system's adaptive capacity gaps for Nepal.

| HEALTH SYSTEM'S<br>BUILDING BLOCK                          | SUMMARY OF GAPS IN<br>ADAPTIVE CAPACITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Leadership and Governance</b>                           | <ul style="list-style-type: none"> <li>• There is a lack of policies and strategic planning at the local and community levels to address climate-related health risks. Climate change and health actions remain at the national level, with little engagement of districts and local communities and support for them.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Health Workforce</b>                                    | <ul style="list-style-type: none"> <li>• Nepal is one of the 57 HRH crisis countries identified by the WHO, with 8 physicians per 10,000 population and 33 nurses / midwives per 10,000 population. These numbers are below the recommended minimum thresholds for achieving UHC and climate resilience.</li> <li>• There is an uneven distribution of the skilled health workforce. Since more than 90 percent of Nepalis receive their health services at the community level, this leaves certain communities more vulnerable to climate-related health risks than others.</li> <li>• Nepal's workforce has limited knowledge, technical capacity, and resources to prevent and manage current and future climate-related health risks.</li> </ul> |
| <b>Health Information and Disease Surveillance Systems</b> | <ul style="list-style-type: none"> <li>• Although Nepal's wider EWS exists for climate-related disasters, such as floods, there is no comprehensive climate-informed health EWS. Health management, facilities, workforce, and surveillance information systems do not incorporate climate/weather data or other environmental factors, as key variables that could affect the prevalence of diseases.</li> </ul>                                                                                                                                                                                                                                                                                                                                     |
| <b>Essential Medical Products and Technologies</b>         | <ul style="list-style-type: none"> <li>• The gaps in equipment and supplies, along with the corresponding vulnerabilities, exacerbate the impact of climate-related health risks. Thus, reliable stockpiles of essential medicines and emergency supplies (particularly in rural areas) are needed to adequately prepare for extreme weather events.</li> <li>• Laboratory capabilities in Nepal are characterized by several challenges in the following areas, including testing services, the transport of specimens, quality management, and regulations. The national network of laboratories needs to be strengthened to respond to climate-sensitive diseases.</li> </ul>                                                                      |

| HEALTH SYSTEM'S BUILDING BLOCK | SUMMARY OF GAPS IN ADAPTIVE CAPACITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Health Service Delivery        | <ul style="list-style-type: none"> <li>• The health infrastructure in Nepal is impacted by several climate-related hazards, most notably floods and landslides. There are vast disparities in the resources and support that are accessible at the different types of health facilities, which affects the country's ability to respond to climate change impacts effectively.</li> <li>• Climate change impacts and environmental determinants of health have not yet been incorporated into all levels of health planning.</li> </ul> |
| Financing                      | <ul style="list-style-type: none"> <li>• There are no evident budget allocations from MoHP that are dedicated to addressing climate change's impact on health and the health system.</li> <li>• Risk pooling in Nepal does not account for climate vulnerability differences among different population groups.</li> <li>• Guidelines for integrating the climate-resilient approach for health care and public health systems are not available to inform rationalized resource allocation.</li> </ul>                                 |

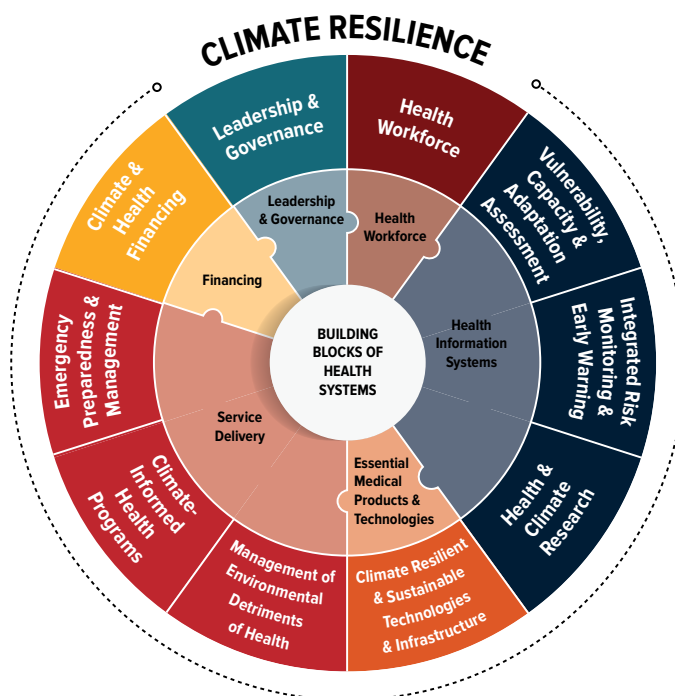


# RECOMMENDATIONS

**90. This section outlines a set of recommendations to enhance health system resilience and adaptation to climate change, including potential health interventions and strategies that can be put in place.** The recommended options are based on an assessment of both the magnitude of the current and projected climate-related health risks, the existing gaps in adaptive capacity to manage and/or prevent these risks, and the feasibility to develop them in the short and medium terms. This section is organized, using the 10 components of climate-resilient health systems (Figure 22), and drawing from the consultations and the review of all relevant governmental policies, as well as the World Bank's Health, Nutrition and Population (HNP) Climate and Health Guidance Note. See **Annex D** for a summary of recommendations for building a climate-resilient health system across the identified climate change-related health risks. Further details on the stakeholders' involvement for the recommendations are in **Annex E**.

**FIGURE 22.**

WHO's operational framework for climate-resilient health systems.



Source: World Health Organization, 2015, *Operational Framework for Building Climate Resilient Health Systems*.

**a. Increase and strengthen collaboration among the national government, the subnational regions, communities, and the civil society.**

Strengthen the current multi-sectoral platform on climate change, involving MoFE and MoHP, by positioning climate change impacts on health as a key priority in the strategic planning. The multi-sectoral platforms need to develop the terms of reference to ensure that the composition of these platforms aligns to the climate-related health needs that the platform is set up to respond to. *(This recommendation falls under Component 1 — Leadership and Governance.)*

**b. The multi-sectoral platform, which already exists at the federal and provincial levels, could be expanded to the local level.**

This could include developing an updated LAPA in order to ensure implementation mechanisms at the local level for responding to climate-related health risks. *(This recommendation falls under Component 1 — Leadership and Governance.)*

**c. A public private partnership approach could be harnessed to make available further resources for a climate-sensitive health system, with the priority given to (a) service delivery interventions directed at responding to climate-related health risks, (b) climate-smart health infrastructure, and (c) medical waste management.**

*(This recommendation falls under Component 10 — Climate and Health Financing.)*

**d. Review the current basic health service package to ensure that it covers key climate-related health risks.**

This would include the effective implementation of a national health financing strategy (2021–2030) to expand the fiscal space in the health sector at all levels. More specifically, options and provisions for increased domestic resources need to be explored to address climate

change and health-related vulnerabilities at the provincial and local levels. *(This recommendation falls under Component 10 — Climate and Health Financing.)*

**e. Develop a capacity-building program that builds on the National Human Resources for Health Strategy (2021–2030), including the development of national technical guidelines for climate-related health risks.**

The capacity-building program would benefit different levels, such as the following:

- **Cross-sectoral and national government level:** Officials from MoHP and other ministries would acquire skills on strategies, policy, and planning to account for climate-related health risks.
- **Local governments:** They would need to strengthen their knowledge on climate hazards and climate-related health risks, so they can ensure the adequate implementation of strategies and policies tailored to their climate-related vulnerabilities.
- **Academia and research departments:** They could incorporate the guidelines as priorities for their research agendas and climate-related health risks into the curricula of the universities' medical schools and nursing course.
- **Overall health workforce of CHWs, FCHVs, physicians, and nurses:** They need to integrate climate-related health risks into their work. *(This recommendation falls under Component 2 — Health Workforce, and Component 3 — Vulnerability, Capacity and Adaptation Assessment.)*

- f. Strengthen communication networks between the Department of Hydrology and Meteorology (DHM), MoHP, and communities at risk of extreme weather events.** While DHM possesses the information needed to provide at-risk communities with the advanced warning of extreme climate events, warning messages often do not reach at-risk communities with sufficient time for adequate preparation. A pilot is thus currently underway to notify communities of floods and extreme temperatures via a short messaging service (SMS).

Options for strengthening the communication may include (a) expanding push notifications to mobile users in anticipation of meteorological events that could present health risks; (b) coordinating with rural broadcasting stations through the Association of Community Radio Broadcasters Nepal (ACORAB) to relay warning messages to listeners — a system that has been used to reach rural households with information during the COVID-19 lockdowns; (c) improving the coordination and reporting mechanisms between DHM and the focal points in MoHP and the Ministry of Home Affairs (MoHA) in response to climate and other natural disasters. *(This recommendation falls under Component 4 — Integrated Risk, Monitoring, & Early Warning.)*

- g. Integrate climate-related health risks into the existent HIS in order to establish integrated climate-informed disease surveillance.** This could include the development of an implementation guideline that ensures a coordination and reporting mechanism among the Epidemiology and Disease Control Division of DoHS at the federal level and the provincial and local levels. This would build on current efforts in MoHP, which will be aligned with the Nepal Health Sector Strategy Plan (2022–2030). *(This*

*recommendation falls under Component 4 — Integrated Risk, Monitoring, & Early Warning.)*

- h. Harness the linkage between MoHP and the Ministry of Physical Infrastructure (MoPI) to ensure the adoption of a climate-smart approach to health care infrastructure.** Coordination between MoHP and MoPI could prioritize retrofitting and climate-proofing current health facilities at the federal and provincial levels, accounting for the specific climate-related hazards that could affect the infrastructure. This would also include locking in budgets to increase preparedness and responses to extreme weather events, emergency plans for hospitals, and integrated management information systems for MoHP, in order to prevent and plan strategic purchasing accordingly to specific climate-related hazards. *(This recommendation falls under Component 6 — Climate-Resilient & Sustainable Technologies and Infrastructure, and Component 9 — Emergency Preparedness and Management.)*
- i. Conduct a review of climate-readiness in the current health care system, adopting a DRM for health networks approach.** This would include conducting health technology assessments (HTAs) to understand the value of adaptation measures in the health sector, creating a national register for climate-related health risks with seasonal climate outlooks to inform health sector programming, and enhancing contingency planning for acute climate shocks at all administrative levels. This would align with the current Nepal Health Sector Strategy Plan (2022–2030). *(This recommendation falls under Component 6 — Climate-Resilient & Sustainable Technologies and Infrastructure.)*



# ANNEXES

## ANNEX A. METHODS FOR ESTIMATING MOSQUITO SUITABILITY UNDER RCP8.5 IN NEPAL

To demonstrate the plausible spatial distributions of the vectors of dengue and malaria, spatial models were constructed to assess the risk propensity of these diseases. Climate data are taken from the historical reference period (1986–2005), the 2030s, and the 2050s. The epidemiology of VBDs is directly influenced by environmental factors that facilitate vector development and survival. It is important to recognize that spatial modeling results are limited by the input data's spatial resolutions and the parameterization of predictor variables, as demonstrated from the literature review, including laboratory studies.

Here, results are largely a function of minimum and maximum temperatures (that is, the thermal tolerances of vector species), as well as land use and land cover (that is, species habitat preference characteristics) whose input data's spatial resolutions are 25 km and 100 m, respectively. These resolutions provide large, not fine-scale estimations of suitable breeding areas.

In addition, this methodology does not incorporate sociodemographic factors, which can play an appreciable role in facilitating or curtailing vector breeding risk. To opine on the population at risk of these VBDs, suitable areas were spatially overlaid with population data from the Global Human Settlement Layers (2015) to calculate the population residing in suitable areas, by region. Population data are held constant in all models, in the absence of spatial population projection information. As such, these results should be taken as a conservative estimation of the areas of Nepal presenting suitable conditions for vector breeding and suitable conditions for vector breeding where humans are present (that is, populated areas).

## ANNEX B.

### ASSUMPTIONS OF FUTURE GLOBAL CLIMATE CHANGE

Predicting the future climate of any country requires several assumptions to be made about the direction of the future global climate. Climate information was acquired from the World Bank Group's Climate Change Knowledge Portal (CCKP). Observed climate data for 1901–2020 was presented at a spatial resolution of 50 km x 50 km. The model-based climate projection data was derived from the Coupled Model Intercomparison Project Phase 6 (CMIP6), with projections shown through five shared socio-economic pathways (SSPs).

This assessment explores projected climate change under SSP3-7.0 for the short (2030s; 2020–2039) and medium (2050s; 2040–2059) terms. The SSP3-7.0 is a high-greenhouse gas (GHG) emissions scenario in which countries are increasingly competitive and emissions continue to climb, doubling from the current levels by 2100. This assessment uses future time periods that can be compared with the baseline and for which assumptions or models can be used to predict changes in future climate-related disease burdens.

The World Bank's Climate and Health Vulnerability Assessments (CHVAs) use two 20-year time periods: together, they cover the next four decades to show imminent climatic changes and medium-term climatic changes in a given country.

The baseline period covers 30 years (1990–2020): this has conventionally been the length of time over which climatic conditions are measured to reduce noise from annual or other cyclical variations.

Looking to the future, 20-year time periods are used as a consequence of the accelerating pace of change of global climate and to be able to analyze climate-related threats over a sufficiently proximate timescale.

- 2030s: This is a 20-year period from 2020 to 2039, with 2030 as the chronological mid-point. This can be seen to represent the immediate coming years to which countries and their governments need to respond with utmost urgency.
- 2050s: This is a 20-year period from 2040 to 2059, with 2050 as the chronological mid-point. This can be seen to represent a medium-term period, still well within the lifetime of current populations over which countries and governments have sufficient time to make profound changes in preparation for expected threats.

## ANNEX C.

### ADAPTIVE CAPACITY RAPID ASSESSMENT

| LEADERSHIP AND GOVERNANCE                                                                                                                                                                                  |            |    |         |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----|---------|-----|
| Questions                                                                                                                                                                                                  | Assessment |    |         |     |
|                                                                                                                                                                                                            | Yes        | No | Partial | N/A |
| 1.1: Does the country have a national climate change and health plan / strategy?                                                                                                                           |            |    |         |     |
| 1.2: Is health mentioned as a priority in the Nationally Determined Contributions (NDCs)?                                                                                                                  |            |    |         |     |
| 1.3: Is there a designated focal point responsible for health and climate change in their Ministry of Health (MoH)?                                                                                        |            |    |         |     |
| 1.4: Is there a multi-sectoral technical working group / committee focused on climate change and health?                                                                                                   |            |    |         |     |
| 1.5: Does the MoH actively participate in climate change coordination and / or working groups?                                                                                                             |            |    |         |     |
| 1.6: Is there a memorandum of understanding (MOU) between the MoH and the key climate change-related ministries / departments (for example, Environment, Meteorological Services, Agriculture, and Water)? |            |    |         |     |
| 1.7: Are decision-makers (both within the MoH and outside) aware of climate change and health risks and potential adaptation options?                                                                      |            |    |         |     |
| 1.8: Does relevant information related to climate change and health risks and adaptation reach key stakeholders across sectors?                                                                            |            |    |         |     |
| 1.9: Is climate change included in health plans at subnational levels?                                                                                                                                     |            |    |         |     |

| HEALTH WORKFORCE                                                                                                                                                                                          |            |    |         |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----|---------|-----|
| Questions                                                                                                                                                                                                 | Assessment |    |         |     |
|                                                                                                                                                                                                           | Yes        | No | Partial | N/A |
| 2.1: Are there dedicated full-time staff devoted to climate change and health?                                                                                                                            |            |    |         |     |
| 2.2: Is the number of healthcare workers above 4.5 per 1,000?                                                                                                                                             |            |    |         |     |
| 2.3: Are health workers adequately distributed between urban and rural areas?                                                                                                                             |            |    |         |     |
| 2.4: Is the health workforce aware of the health risks of climate change?                                                                                                                                 |            |    |         |     |
| 2.5: Are there capacity-building programs focused on climate change and health within the MoH?                                                                                                            |            |    |         |     |
| 2.6: Have the MoH staff received training on climate change and health over the last two years?                                                                                                           |            |    |         |     |
| 2.7: Does the health workforce have the technical capacity to interpret and utilize climate change information (for example, scenarios, projections, and forecasts) to inform planning / decision-making? |            |    |         |     |
| 2.8: Is climate change and health included in the educational curriculum (for example, schools of public health, medicine, nursing)?                                                                      |            |    |         |     |
| 2.9: Are there context- or country-specific climate change and health training / educational materials available for the health workforce?                                                                |            |    |         |     |

## HEALTH INFORMATION AND DISEASE SURVEILLANCE SYSTEM

| Questions                                                                                                                       | Assessment |    |         |     |
|---------------------------------------------------------------------------------------------------------------------------------|------------|----|---------|-----|
|                                                                                                                                 | Yes        | No | Partial | N/A |
| 3.1: Has the country completed a climate change and health vulnerability and adaptation or risk assessment?                     |            |    |         |     |
| 3.2: Do surveillance systems exist for climate-sensitive diseases (for example, heat-related illnesses, VBDs, and WBDs)?        |            |    |         |     |
| 3.3: Does the country have a centralized monitoring system for climate-related diseases?                                        |            |    |         |     |
| 3.4: Do health surveillance systems integrate meteorological and / or environmental information?                                |            |    |         |     |
| 3.5: Are there efforts from the MoH to utilize national climate / meteorological information?                                   |            |    |         |     |
| 3.6: Does the country have a climate-informed EWS for any health risks?                                                         |            |    |         |     |
| 3.7: Are there EWS in place for climate change-related extreme events / hazards? (for example, flooding, droughts, and storms)? |            |    |         |     |
| 3.8: Does the MoH coordinate with disaster / hazard-focused EWS?                                                                |            |    |         |     |

## ESSENTIAL MEDICAL PRODUCTS, TECHNOLOGIES, AND INFRASTRUCTURE

| Questions                                                                                                                                                             | Assessment |    |         |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----|---------|-----|
|                                                                                                                                                                       | Yes        | No | Partial | N/A |
| 4.1 Has the country's healthcare facilities been assessed for climate resilience?                                                                                     |            |    |         |     |
| 4.2 Are health facilities accessible for rural communities?                                                                                                           |            |    |         |     |
| 4.3: Do healthcare facilities implement measures to remove mosquito-breeding sites?                                                                                   |            |    |         |     |
| 4.4: Have healthcare facilities employed adaptive measures to protect against climate change-related hazards (for example, flood walls or drainage systems)?          |            |    |         |     |
| 4.5: Does the national laboratory have the capacity to conduct diagnostic tests for climate-sensitive diseases?                                                       |            |    |         |     |
| 4.6: Are building codes for healthcare facilities to protect against climate change-related hazards in place and enforced?                                            |            |    |         |     |
| 4.7: Have healthcare facilities implemented "greening" activities (for example, tree planting and cooling designs)?                                                   |            |    |         |     |
| 4.8: Are there efforts to incorporate long-term planning (for example, urban design) to reduce climate change and health impacts?                                     |            |    |         |     |
| 4.9: Are health facilities adequately equipped to prepare for and respond to climate change related hazards (for example, stockpile of medical / emergency supplies)? |            |    |         |     |

| HEALTH SERVICE DELIVERY                                                                                                            |            |    |         |     |
|------------------------------------------------------------------------------------------------------------------------------------|------------|----|---------|-----|
| Questions                                                                                                                          | Assessment |    |         |     |
|                                                                                                                                    | Yes        | No | Partial | N/A |
| 5.1: Has the country enacted legislation mandating universal healthcare coverage?                                                  |            |    |         |     |
| 5.2: Are there climate change-specific health programs underway in the country?                                                    |            |    |         |     |
| 5.3: Does health service delivery have contingency measures for extreme weather events (e.g., floods, storms, and heatwaves)?      |            |    |         |     |
| 5.4: Does current public health planning consider climate change information (for example, scenarios, projections, and forecasts)? |            |    |         |     |
| 5.5: Has the MoH implemented any climate-health awareness campaigns to increase public awareness?                                  |            |    |         |     |
| 5.6: Is there access to safe WASH for over 80 percent of the country?                                                              |            |    |         |     |
| 5.7: Do over 80 percent of healthcare facilities have access to safe WASH and healthcare waste removal / storage?                  |            |    |         |     |
| 5.8: Have multi-hazard risk assessments been conducted in the country?                                                             |            |    |         |     |
| 5.9: If conducted, do multi-hazard risk assessments include potential health risks?                                                |            |    |         |     |

| FINANCING                                                                                          |            |    |         |     |
|----------------------------------------------------------------------------------------------------|------------|----|---------|-----|
| Questions                                                                                          | Assessment |    |         |     |
|                                                                                                    | Yes        | No | Partial | N/A |
| 6.1: Is the MoH currently receiving international funds to support climate change and health work? |            |    |         |     |
| 6.2: Is there dedicated funding within the MoH for climate change and health activities?           |            |    |         |     |
| 6.3: Is the health expenditure percentage of GDP above WHO's recommendation?                       |            |    |         |     |
| 6.4: Is the national health budget dependent on donors or foreign aid?                             |            |    |         |     |
| 6.5: Are there climate considerations in the national health budget?                               |            |    |         |     |

## ANNEX D. HEALTH ADAPTATION RECOMMENDATIONS/MENU OF OPTIONS

|                                               | Food security and nutrition                                                                                                                                                                                                      | Vector-borne diseases                                                                                                                            | Water-related diseases                                                                                                                                                                                                                                                                                                            | Heat-Related Morbidity and Mortality                                                                            | Air quality                                                                                                                                                                                                                             | Mental health and well-being                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Component 1: Leadership and Governance</b> | <p>Incorporate climate change risks into food security and nutrition strategic plans, including sustainable agriculture efforts.</p> <p>Strengthen coordination mechanisms among MoHP, MoFE, and international stakeholders.</p> | <p>Develop plans for vector control, depending on agroecological zones, particularly malaria that affects most of the population.</p>            | <p>Develop an independent government agency to oversee water quality surveillance, monitoring, and enforcement of water quality policies and laws.</p> <p>Enhance the coordination and engagement between rural water boards and national offices.</p> <p>Promote community-based water management and governance approaches.</p> | <p>Develop and implement national heat health policy and city-level plans.</p>                                  | <p>Develop an operational framework for climate change programs that integrates climate change impacts on air quality and health.</p> <p>Formulate a national climate and air quality policy / law that integrates health issues.</p>   | <p>Advocate for and promote mental health as a key component in MoHP's strategic planning that also accounts for climate-related mental health risks.</p> <p>Establish a coordination mechanism that integrates religious and local leaders, and the Ayurveda approach, which is aimed at reducing the stigma around mental health.</p>                                                                                                    |
| <b>Component 2: Health workforce</b>          | <p>Incorporate educational materials on climate change impacts on food security and nutrition into health worker training.</p>                                                                                                   | <p>Implement training at subnational levels to of dengue prevention and control, as well as the knowledge on climate change-related factors.</p> | <p>Promote routine training and refresher opportunities for the health workforce, including CHWs, on the diagnosis and treatment of WBDs.</p>                                                                                                                                                                                     | <p>Conduct heat- health training for health workers.</p> <p>Ensure occupational heat exposures are managed.</p> | <p>Map gaps and create training opportunities in air pollution and related health outcomes.</p> <p>Provide health workers with health- specific awareness and education materials on the risks of indoor and outdoor air pollution.</p> | <p>Promote and create incentives to increase the mental health of workers, along with avenues of training, including those related to climate change risks.</p> <p>Develop mental health services that are aimed at providing services to healthcare workers.</p> <p>Develop mental health courses that are focused on emergency psychological services for healthcare workers who are deployed in response to extreme weather events.</p> |

|                                                                        | Food security and nutrition                                                                                                                                                                                                                                                                               | Vector-borne diseases                                                                                                                                       | Water-related diseases                                                                                                                                                    | Heat-Related Morbidity and Mortality                                                                                                                          | Air quality                                                                                                                                                 | Mental health and well-being                                                                                                                                                                                                                |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Component 3: Vulnerability, capacity, and adaptation assessment</b> | <p>Conduct a vulnerability assessment of the impact of climate change on nutrition.</p> <p>Assess the nutrition benefits of climate- smart agricultural interventions.</p> <p>Assess the capacities of the health system to respond to acute food insecurity and emergency-related nutritional risks.</p> | <p>Conduct district- and community- level assessments to better understand local risks related to VBDs and the capacity to manage outbreaks.</p>            | <p>Enhance and promote routine vulnerability assessment and adaptation planning.</p>                                                                                      | <p>Conduct assessments of high-risk groups at the local level, including informal settlements, and remote communities, and incorporate economic analyses.</p> | <p>Assess indoor and outdoor air pollution levels and health impacts in both urban and rural areas.</p>                                                     | <p>Develop baseline data on mental health related to climate change, and improve the surveillance of mental health outcomes.</p> <p>Assess the capacity of community- centered resilience building and targeted vulnerable populations.</p> |
| <b>Component 4: Integrated risk monitoring and early warning</b>       | <p>Develop and include long-term strategies for nutrition interventions into the famine early warning system (FEWS).</p>                                                                                                                                                                                  | <p>Build from the HIS to incorporate climate-informed seasonal and agroecological outlooks.</p>                                                             | <p>Integrate climate change projections with WBD surveillance to strengthen WBD outbreak predictions.</p>                                                                 | <p>Strengthen heat wave alert systems for urban and rural populations.</p>                                                                                    | <p>Develop air quality monitoring systems and public health risk communications campaigns.</p>                                                              | <p>Develop monitoring and surveillance systems that account for climate-related mental health risks, and well-being-related indicators that impact mental health (for example, livelihoods and stressful events).</p>                       |
| <b>Component 5: Health and climate research</b>                        | <p>Analyze the long-term effects of climate change on food systems, nutritional outcomes, and the economy.</p>                                                                                                                                                                                            | <p>Conduct climate change modeling studies to estimate risk projections for dengue and other climate-sensitive diseases to inform adaptation decisions.</p> | <p>Enhance scientific research to support a better understanding of climate change variability and health impacts, and guide climate change adaptation communication.</p> | <p>Conduct Studies to further explore the impacts of extreme heat on health systems, including urban heat island mapping.</p>                                 | <p>Invest in more research on air pollution-related health effects and further the understanding of the linkage between climate change and air quality.</p> | <p>Include climate-related mental health risks into the MoH research agenda and promote partnerships with national universities and research institutions to better understand the impact of climate change on mental health.</p>           |

|                                                                                       | Food security and nutrition                                                                                                                                                                   | Vector-borne diseases                                                                                                                                                                                                                                                                                                                            | Water-related diseases                                                                                                                                                                      | Heat-Related Morbidity and Mortality                                                                                                                                                                                      | Air quality                                                                                                                                  | Mental health and well-being                                                                                                             |
|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Component 6: Climate-resilient and sustainable technologies and infrastructure</b> | <p>Improve drainage systems in crop fields at risk of floods.</p> <p>Explore smart-agriculture and crop diversification practices.</p>                                                        | <p>Improve laboratory capabilities for testing and the diagnosis of endemic as well as novel and reemerging diseases.</p> <p>Develop a list of essential medicines needed for VBD outbreaks.</p> <p>Adopt irrigation systems that account for increased exposure to VBDs, such as alternate wet-dry or system of rice intensification (SRI).</p> | <p>Improve WASH facilities (including appropriate waste disposal systems) both in healthcare facilities and in the communities, and ensure that these facilities are climate resilient.</p> | <p>Enable space cooling in healthcare facilities to prevent overheating and protect information technology and equipment.</p> <p>Put in place energy efficient or passive measures of cooling to reduce energy costs.</p> | <p>Invest in the use of sustainable and renewable energy sources, such as the use of solar power, in healthcare facilities.</p>              | <p>Explore technologies that could improve access to mental health services (for example, telemedicine).</p>                             |
| <b>Component 7: Management of environmental determinants of health</b>                | <p>Conduct community-led efforts to map food insecurity and inform interventions to improve the food system in a changing climate.</p>                                                        | <p>Conduct community awareness campaigns to increase the awareness on the climate sensitivity of VBDs and engage vulnerable groups on outbreak prevention.</p>                                                                                                                                                                                   | <p>Strengthen the environmental health program and surveillance.</p> <p>Enhance a reliable plan for routine public water source cleaning and testing.</p>                                   | <p>Engage in Occupational health management.</p>                                                                                                                                                                          | <p>Enhance routine indoor and outdoor air pollution exposure assessments.</p>                                                                | <p>Engage in urban planning to address climate change impacts on the environmental determinants of mental health.</p>                    |
| <b>Component 8: Climate-informed health program</b>                                   | <p>Implement interventions involving the establishment of gardens or food-growing opportunities.</p> <p>Implement community-mediated delivery of nutrition services, including screening.</p> | <p>Incorporate climate change information into VBD prevention and outbreak response standard operating procedures (SOPs).</p>                                                                                                                                                                                                                    | <p>Strengthen public awareness program on proper hygiene and sanitation, and climate change impacts on health.</p>                                                                          | <p>Ensure heat risks are incorporated into maternal health guidance, guidance for diabetes management, etc.</p>                                                                                                           | <p>Raise awareness on air pollution and its impacts on health in communities and engage communities in air pollution awareness programs.</p> | <p>Integrate mental health services that account for climate-related mental health risks into primary and secondary health services.</p> |

|                                                           | Food security and nutrition                                                                                                                                                                                    | Vector-borne diseases                                                                        | Water-related diseases                                                                                                                   | Heat-Related Morbidity and Mortality                                                                                                                      | Air quality                                                                                                                                                           | Mental health and well-being                                                                                                      |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| <b>Component 9: Emergency preparedness and management</b> | Reinforce the food production and distribution chain to withstand impacts from extreme weather events.                                                                                                         | Factor VBD outbreaks into DRM plans at national, provincial, district, and community levels. | Enhance emergency response planning for safe and sustainable water supply and clean sanitation in healthcare facilities and communities. | Include heat-related responses into DRM operations.                                                                                                       | Integrate air quality emergencies into DRM plans and program.<br><br>Enhance routine air and monitoring.                                                              | Develop a program on an emergency psychology response to climate-related hazards.                                                 |
| <b>Component 10: Climate and health financing</b>         | Establish a budget line for the research and development of technologies for agricultural resiliency.<br><br>Invest in the dissemination of crop varieties and breeds adapted to changing climatic conditions. | Formulate proposals for external donors to support the improved control of VBDs.             | Prioritize investments in climate-resilient WASH infrastructure in healthcare facilities and displacement camps.                         | Finance sustainable/cool cities that address heat risks.<br><br>Implement other interventions related to heat-health responses (for example, cool roofs). | Improve multi-sectoral coordination and international collaboration opportunities for financing air pollution research, equipment, training, and prevention programs. | Establish a budget line allocated to the improvement of mental health and well-being services, as well as awareness and outreach. |

## ANNEX E. KEY RECOMMENDATIONS AND RELEVANT LINE MINISTRIES IN NEPAL

| RECOMMENDATIONS                                                                                                                                                                                                                                                                                                                            | RELEVANT LINE MINISTRIES                                                                                                                                                                                                                                                                                | WHO'S CLIMATE AND HEALTH OPERATIONAL COMPONENT |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Increase and strengthen collaboration among the national government, subnational regions, as well as the communities and the civil society.</li> <li>• The multi-sectoral platform, which already exists at the federal and provincial level, needs to be extended to the local level.</li> </ul> | MoHP; MoFE; Provincial Health Directorates; Local Government Authorities; Key development partners, such as WHO, ICIMOD, UNEP, and key civil society organizations like LI-BIRD                                                                                                                         | Leadership and Governance                      |
| <ul style="list-style-type: none"> <li>• Harness a public private partnership approach to make available further resources for a climate-sensitive health system.</li> <li>• Review the current basic health service package to ensure that it covers key climate-related health risks.</li> </ul>                                         | National Planning Commission; Ministry of Finance; MoHP; Provincial and Local government authorities                                                                                                                                                                                                    | Climate and Health Financing                   |
| <ul style="list-style-type: none"> <li>• Develop a capacity building program that builds on the National Human Resources for Health Strategy (2021– 2030), including the development of national technical guidelines for climate-related health risks.</li> </ul>                                                                         | MoHP; MoFE; Ministry of Federal Affairs and General Administration; Ministry of Education Science and Technology; Nepal Medical Association; NHRC; NHTC; Key academia institutions, such as Kathmandu and Tribhuvan University; Key development partners, such as WHO, UNEP, the World Bank, and ICIMOD | Health Workforce                               |

| RECOMMENDATIONS                                                                                                                                                                              | RELEVANT LINE MINISTRIES                                                                                                                                                  | WHO'S CLIMATE AND HEALTH OPERATIONAL COMPONENT                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Strengthen communication networks between DHM, MoHP, and communities at risk of extreme weather events.</li> </ul>                                    | National Planning Commission; MoHP; DHM; Ministry of Agriculture and Livestock Development; MoFE; MoHA; National Disaster Risk Reduction and Management Authority; ACORAB | Integrated Risk, Monitoring & Early Warning                                                             |
| <ul style="list-style-type: none"> <li>Integrate climate-related health risks into existing HIS in order to establish an integrated climate-informed disease surveillance system.</li> </ul> | MoHP; MoFE; Key development partners, such as WHO and NHRC                                                                                                                |                                                                                                         |
| <ul style="list-style-type: none"> <li>Harness the linkage between MoHP and MoPI to ensure the adoption of a climate-smart approach to the health care infrastructure.</li> </ul>            | National Planning Commission; MoHP; MoPI; National Disaster Risk Reduction and Management Authority; and MoFE                                                             | Climate-Resilient & Sustainable Technologies and Infrastructure / Emergency Preparedness and Management |
| <ul style="list-style-type: none"> <li>Conduct a review of climate readiness in the current health care system by adopting DRM into the health networks approach.</li> </ul>                 | MoHP; MoHA; Key development partners such as WHO                                                                                                                          |                                                                                                         |

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