CHANGING CLIMATE-INDUCED HAZARDS AND SOCIO-ECONOMIC VULNERABILITIES IN LOWER KARNALI WATERSHED REGION, BARDIYA

A Thesis

Submitted to

Faculty of Humanities and Social Sciences, Department of Sociology

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In Partial Fulfillment of Requirements for

Master's Degree of Arts in Sociology

Submitted By

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त्रिभुवन विश्वविद्यालय
त्रि-चन्द्र बहुमुखी क्याम्पस
(स्थापित १९७५ वि.सं.)

क्याम्पस प्रमुखको कार्यालय
सरस्वती सदन, काठमाडौं ।

मितिः.....

LETTER OF RECOMMENDATION

This is to certify that the entitled **"Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities in Lower Karnali Watershed Region, Bardiya"** is an independent study of Miss. Samikchhya Gurung, which is completed under my guidance and supervision. I recommend this thesis for final evaluation and approval.

.....

Asst. Prof. Sunita Raut

Thesis Supervisor

Tri-Chandra Multiple Campus, Ghantaghar

Kathmandu

Date: Feb 14, 2025

फोन : ४-२४४०४७

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मिति:.....

LETTER OF APPROVAL

We hereby certify that this entitled "**Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities in Lower Karnali Watershed Region, Bardiya**", Thesis submit by Miss. Samikchhya Gurung, meet the necessary scope and quality standard. The thesis has been deemed satisfactory for partial fulfillment of the requirements for the Master of Arts and humanities. Consequently, the committee approved this thesis as a part of the degree requirements.

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Date: Feb 27, 2025

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The study entitled "**Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities in Lower Karnali Watershed Region, Bardiya**" has been conducted for the partial fulfillment of the degree of Master of Arts and Humanities in Tribhuvan University.

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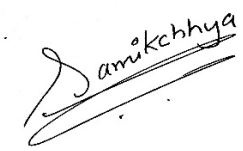
Samikchhya Gurung

DECLARATION

I, Samikchhya Gurung, hereby declare that the thesis entitled "**Changing Climate Induced Hazards and Socio- Economic Vulnerabilities in Lower Karnali Watershed Region Bardiya**" is my original work and has not been copied, published or submitted before anywhere, all sources of information used in the document are properly acknowledge and cited, also documented in the reference section.

I have followed all the guidelines and ethical standards required for conducting and reporting research. Any assistance and support from the others have been clearly mentioned and recognized. I take full responsibility for the content of this research study.



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Samikchhya Gurung

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LIST OF ABBREVIATIONS

CBC : Community-Based Conservation

CBS : Central Bureau of Statistics

CI : Confidence Interval

CSDR : Center for Social Development and Research

DFID : Department for International Development

DRRM : Disaster Risk Reduction and Management

EM-DAT : Emergency Events Database

GDP : Gross Domestic Product

GCRI : Global Climate Risk Index

IFRC : International Federation of Red Cross and Red Crescent Societies

INGO : International Non-Governmental Organization

IPCC : Intergovernmental Panel on Climate Change

IRDA : Integrated Rural Development Approach

LAPA : Local Adaptation Plans of Action

LKWR : Lower Karnali Watershed Region

LMIC : Low and Middle-Income Countries

MoFE : Ministry of Forests and Environment

NAPA : National Adaptation Program of Action

NCCP : Nepal Climate Change Policy

NGOs : Non-Governmental Organizations

OECD : Organization for Economic Co-operation and Development

OR : Odds Ratio

PHDI : Palmer Hydrological Drought Severity Index

RDI : Reconnaissance Drought Index

SC-PDSI : Self-Calibrated Palmer Drought Severity Index

SDG : Sustainable Development Goals

SFI : Standardized Streamflow Index

SLF : Sustainable Livelihoods Framework

SPEI : Standardized Precipitation Evapotranspiration Index

UNCCD : United Nations Convention to Combat Desertification

UNDP : United Nations Development Program me

UNFCCC : United Nations Framework Convention on Climate Change

USAID : United States Agency for International Development

VDC : Village Development Committee

WASH : Water, Sanitation, and Hygiene

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ABSTRACT

This thesis study entitled "*Changing Climate Induced Hazards and Socio- Economic Vulnerabilities in Lower Karnali Watershed Region Bardiya*". Climate change has emerged as a critical global challenge, disproportionately affecting vulnerable communities that rely on climate-sensitive livelihoods. The Lower Karnali Watershed Region, particularly Geruwa-3 and Madhuwan-2, has been increasingly experiencing climate-induced hazards such as floods, droughts, river erosion, and heatwaves. These environmental changes have intensified socio-economic vulnerabilities, particularly among indigenous ***Tharu*** and ***Dalit*** communities, whose livelihoods depend primarily on agriculture and natural resources. Women face compounded challenges due to their responsibility for securing water, food, and household resources, making them more susceptible to economic instability and health risks.

This study aims to assess the most frequent climate hazards affecting the region, analyze their socio-economic impacts on indigenous and marginalized communities, and explore the barriers faced by these populations, particularly women, in adapting to climate change. Using a mixed-methods approach, the research incorporates both qualitative and quantitative data collection techniques, including surveys, key informant interviews, and focus group discussions. Findings reveal that climate variability has led to decreased agricultural productivity, water scarcity, displacement, and increased livelihood insecurities. Despite the presence of traditional adaptation strategies, such as community-led irrigation and rotational water distribution, these measures are becoming less effective due to the increasing severity of climate events.

Furthermore, the study highlights the inadequacy of current government disaster management programs, which suffer from poor implementation, lack of accessibility, and weak institutional coordination. The research underscores the urgent need for climate-resilient policies that integrate both scientific advancements and indigenous knowledge systems. Without immediate and targeted interventions, climate-induced hazards will continue to threaten the socio-economic stability and environmental sustainability of the Lower Karnali region. This study contributes to the growing body of research on climate vulnerability and resilience, offering practical insights for policymakers, development practitioners, and local communities striving to build a more sustainable and adaptive future.

CHAPTER: ONE

INTRODUCTION

1.1 Background of Study

Climate change describes the long-term alteration of global climate systems, largely caused by human activities like burning fossil fuels, deforestation, and industrial operations that emit greenhouse gases. Modern societies are confronted with a new global challenge, the changing climate. While the concept of the "greenhouse effect" has been known for over a century, scientists only recently considered the possibility of such significant climate change (Urray, 2015). Climate change has intensified socioeconomic and environmental challenges in regions already facing social and ecological vulnerabilities (Cheng, 2019) These gases retain heat in the atmosphere, resulting in global warming, rising sea levels, intensified extreme weather, and challenges to ecosystems and human societies.

Nowadays climate change is the biggest confrontation in human lives. It has affected many things around us. In many different parts of the world, people are at a huge risk in their day-to-day lives. Climate change is causing many natural calamities like floods, landslides, earthquakes, wildfires, drought, lightning and volcanoes, etc. An immense part of research proves that climate change is a very serious global risk, and it demands an urgent global response (Stern, 2007). Nepal's vulnerability to weather change is now universally confessed (Thapa & Upadhyaya, n.d.). The poor are hit hardest by climate change as they live in high-risk areas, rely on climate-sensitive livelihoods, and have limited ability to adapt. While understanding of vulnerability and adaptation has improved, quantitative data across countries, regions, and sectors remains limited (Heltberg & Osmolovskiy, 2011). Agriculture is one part of the enormous effects of climate change, interrogating the national food system and the livelihoods of dependents (Chaudhary et al., 2021). There are many parts of the world where people are facing several kinds of diseases such as; cholera, gastroenteritis, malaria, dengue, kala-azar, jaundice, and diarrhea, etc.

Addressing climate change requires quantifying issues within large-scale systems spanning health, society, ecology, and infrastructure. Building community resilience demands interdisciplinary, place-based approaches and impact-specific planning.

Vulnerability and risk assessments help researchers and communities evaluate climate impacts and management strategies for complex, interconnected systems (Cains, 2021).

There is an overabundance of authentication of man-made climate change and its effects on natural and human systems in many regions of the world (IIPC, 2013). Currently, several catastrophic natural hazards (OECD, 2013) in low and middle-income (LMIC) and developed nations. For instance, the 2004 Indian Ocean intercontinental tsunami, the 2005 Hurricane Katrina in the USA, the 2010 floods in Pakistan, the 2011 tsunami in Japan, and the 2013 Himalayan tsunami in India. Natural calamities have caused more damage to life and assets than many major wars. During the last two decades, over 2 billion people were harmed by weather-related disasters in developing countries (EM-DAI, 2013). According to the Global Climate Risk Index (GCRI, 2024), Nepal is one of the most vulnerable nations to hydrological hazards.

Nepal's geographic features are dynamic and surprising in the world. It has three regions such as mid-Hilly, Himalaya, and Terai. Nepal has huge water systems which drain south into India. The highest mountain lies here (8,848m) whereas the lowest point is in the Terai plains of Kachina Kawal in Jhapa (60m).

According to the Nepal Adaptation Programme of Action (NAPA, 2010) analysis data display consistent warming and a rise in the maximum temperature at an annual rate of 0.04 -0.06 c. Additionally, research shows that the country's warming tendency is not consistent. Climate change threatens to drop the effectiveness of development initiatives across Nepal. Likewise, drying added to the trend of warming will impair food security and affect the availability of water resources. In western Nepal, this will make poor and marginalized people more vulnerable in both rural and urban regions. Over the period of the monsoon season, floods derail the lives of thousands of people and rain large tracts of agricultural land (Katuwal et al., 2023). Whereas, the agriculture sector contributes one-third of the country's gross domestic product and gives opportunities to two-thirds of the population. Many studies comparing the farmer's ideas with instrumental observation have focused on little geographical sites. However, very few studies compared people's perceptions with scientific data covering multiple ecological regions (Dhimal et al., 2021).

Likewise this study focus on lower Karnali watershed region because these locations are crucial due to their susceptibility to climate impacts, as the region is heavily reliant on agriculture and faces significant threats from monsoon floods and rising

temperatures and particularly, this study located in two different areas, Geruwa-3 and Madhuwan-2 because these areas are home to marginalized and low-income communities with limited resources and adaptive capacities, making them particularly vulnerable to the impacts of climate change. Women, children, and indigenous populations bear the greatest burden, as they rely heavily on natural resources for their livelihoods.

Indigenous peoples are groups with unique cultural, linguistic, and historical identities, often closely connected to their ancestral lands and traditional ways of life (United Nations, 2023). They make up around 6.2% of the global population and play an essential role in preserving biodiversity and managing natural resources sustainably (ILO, 2020). However, these communities continue to face widespread marginalization due to historical injustices, including land dispossession, exclusion from decision-making processes, and socio-economic disadvantages.

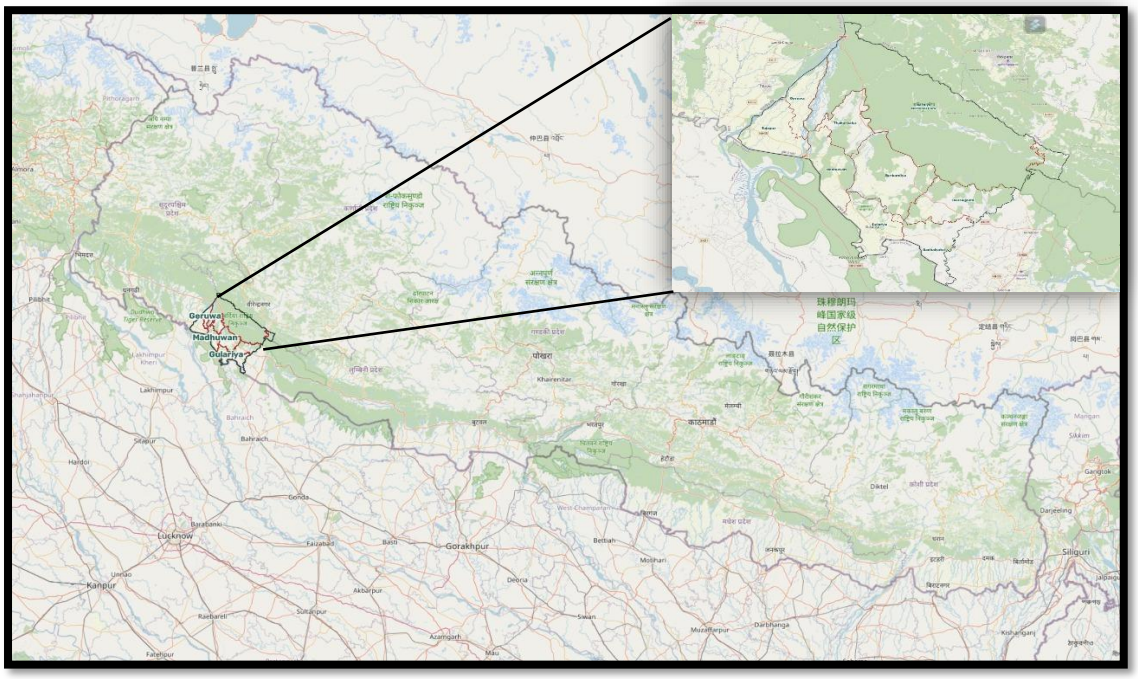
In Nepal, indigenous peoples, known as *Adivasi Janajati*, constitute approximately 36% of the total population (CBS, 2022). The Nepal Federation of Indigenous Nationalities (NEFIN) recognizes 59 indigenous groups, many of whom have long faced political, economic, and social marginalization. Limited access to land rights, education, and economic opportunities has made them particularly vulnerable. Additionally, climate change further threatens their well-being, as their traditional livelihoods heavily dependent on agriculture and forest resources are increasingly disrupted by rising temperatures, irregular rainfall patterns, and extreme weather events (Bhattachan, 2012).

The marginalization of indigenous groups in Nepal is closely linked to historical land ownership systems, entrenched caste hierarchies, and systemic discrimination. Many indigenous and marginalized communities, including Dalits and landless populations, do not have secure land ownership, making them more susceptible to displacement due to climate-related disasters (Maharjan et al., 2023). In the *Terai* region, the *Tharu community* has faced land encroachment and displacement due to large-scale development projects, while indigenous groups in the *Himalayan region*, such as the *Sherpas and Tamangs,* are increasingly affected by glacier retreat and unpredictable weather patterns that threaten their traditional ways of life (Gurung, 2021).

The ecological significance of the Karnali River basin, which supports diverse ecosystems and provides water for agriculture and hydropower, further highlights the need for sustainable management in this region. However, despite its vulnerability, there is limited research and data focused on this area. Studying Geruwa-3 and Madhuwan-2 is critical for understanding the local impacts of climate change, developing adaptive strategies, and informing policies to build resilience. Additionally, the region's challenges are part of broader transboundary issues, as the Karnali River flows into India, necessitating cooperation on water resource management and disaster preparedness. By addressing these gaps, this study aims to provide actionable insights for mitigating climate impacts and improving the livelihoods of those most at risk in the Lower Karnali watershed.

1.2 Introduction to Study Area

Figure 1: Map of Study Area



Source: Google Earth, 2024

Geruwa Rural Municipalities and Madhuwan Municipalities are located in the Bardiya District of Lumbini Province, Nepal as shown in **Error! Reference source not found.**. G eruwa lies on the western side of the Karnali River, while Madhuwan is situated in the southern part of Bardiya, both forming significant components of the Terai region's socio-ecological landscape. Geruwa Rural Municipality is divided into 6 wards, while

Madhuwan Rural Municipality consists of 9 wards. These municipalities are part of the buffer zone of Bardiya National Park, which plays a vital role in conservation and ecological sustainability (GoN, 2021).

As of the 2021 census, Geruwa and Madhuwan have a combined population of approximately 45,000 people Central Bureau of Statistics (CBS, 2021). The population is predominantly rural, with a diverse range of ethnicities and castes represented, including Bramin, Chhetri, Dalits and indigenous tharu is the largest indigenous group in both municipalities, forming the majority, while marginalized communities, such as Dalits, face significant social and economic challenges.

Agriculture is the primary source of livelihood for the residents of Geruwa and Madhuwan. The fertile floodplains of the Karnali and Babai rivers provide favorable conditions for growing staple crops such as rice, wheat, maize, and mustard (Singh & Dahal, 2022). Livestock farming is also common, with households keeping cows, goats, and buffaloes. Fishing along the rivers, particularly in Geruwa, is another significant livelihood strategy for many, especially marginalized groups such as the indigenous Tharu community (Karki et al., 2020).

The Geruwa River, a branch of the Karnali, flows through Geruwa Rural Municipality, providing not only water for irrigation but also supporting a range of biodiversity, including endangered species like the Ganges River dolphin and the gharial (Dahal & Thapa, 2021). The Babai River, located near Madhuwan, also contributes to the region's hydrology and supports local agriculture and fisheries. These rivers are integral to the ecosystem services that sustain the local communities, contributing to flood control, soil fertility, and the preservation of aquatic life.

Transportation in Geruwa and Madhuwan is underdeveloped, with a mix of earthen roads and seasonal tracks connecting the villages to the district headquarters, Gulariya. While some motorable roads have been constructed in recent years, monsoon rains frequently render them impassable, isolating communities for months at a time. Efforts to improve transportation infrastructure are ongoing, but the lack of reliable connectivity continues to hinder economic development and access to essential services (Poudel & Shrestha, 2020).

Community-based organizations and non-governmental efforts have been working to empower these local people through livelihood programs, awareness campaigns, and

policy advocacy to ensure greater social inclusion and participation in local governance (Bhusal & Chaudhary, 2021). Understanding the changing climate-induced hazards and socio-economic vulnerabilities in Geruwa-3 and Madhuwan-2 are crucial for developing effective adaptation strategies. These regions are particularly important because they exemplify the challenges faced by many rural communities in Nepal.

By focusing on these areas, the study aims to provide insights into how climate change is affecting both the environment and the social aspect people who depend on it, and to identify alternative solutions to enhance resilience in the face of these growing challenges.

Marginalized communities, particularly the ***Dalits*** and indigenous ***Tharu*** groups, face social and economic exclusion in Geruwa and Madhuwan. Limited access to land, education, and healthcare, coupled with systemic discrimination, restricts their opportunities for upward mobility.

1.3 Statement of the Problem

Although climate change and its impacts on Nepal have been the subject of various studies, existing literature often takes a broader or more generalized approach, failing to focus on the localized dynamics in areas such as Geruwa and Madhuwan. For instance, while Thapa and Upadhyaya (n.d.) highlighted Nepal's overall vulnerability to climate change, they did not delve into the specific challenges faced by marginalized communities in the Lower Karnali. Similarly, Katuwal et al. (2023) explored the effects of monsoon floods on agriculture and livelihoods in western Nepal but lacked a focus on socio-economic factors and the adaptation needs of vulnerable groups in this particular region. Furthermore, research by Heltberg and Osmolovskiy (2011) examined the vulnerabilities of marginalized populations globally but did not provide insights into localized climate impacts in rural Nepal.

This gap is further compounded by the limitations in quantitative data and localized studies that address how climate change specifically interacts with social, economic, and cultural factors in Geruwa and Madhuwan. For example, while Bhusal and Chaudhary (2021) discussed the role of community-based organizations in empowering marginalized groups, their work primarily focused on social inclusion and policy advocacy, without adequately addressing climate-induced hazards or adaptation

strategies for these communities. Similarly, the Nepal Adaptation Programme of Action (NAPA, 2010) and the Global Climate Risk Index (GCRI, 2024) highlighted Nepal's general vulnerability to climate change but did not provide sufficient place-based data or insights into the specific risks faced by the Lower Karnali region.

The gap identified lies in the limited research that systematically examines the evolving nature of climate hazards in Geruwa-3 and Madhuwan-2 and their combined socio-economic repercussions. Existing studies often overlook the intersection of environmental and social risks and the vulnerabilities of marginalized communities, such as ***Dalits*** and indigenous ***Tharus***, who face systemic challenges like limited access to resources and decision-making processes. This study aims to address these gaps by focusing on the localized impacts of climate change on the environment, livelihoods, and social structures of these communities. It also seeks to provide practical insights for policy interventions and adaptive strategies that can strengthen community resilience in the face of these growing challenges and raise some research questions as follows:

1. What are the most frequent types of hazardous conditions caused by climate change in the study area?
2. What are the direct and indirect socio-economic impacts of climate-induced hazards on indigenous communities in the study area?
3. How changing climate-related barriers and vulnerabilities faced by indigenous and marginalized women in the study area?
4. What is the status of practice of indigenous knowledge to conserve food and water management?

This study focuses on the escalating challenges posed by climate change in Geruwa-3 and Madhuwan-2 in the Lower Karnali region, a highly vulnerable area exposed to frequent and severe climate-induced hazards such as floods, droughts, and lightning, etc. These events are becoming increasingly intense and frequent, threatening not only the natural environment but also the socio-economic well-being of local communities, who rely heavily on agriculture and natural resources for their livelihoods. Despite the evident challenges, there remains a lack of comprehensive understanding of how these changing climatic conditions specifically affect this region and its communities.

1.4 Objective of Study

According to research questions, this general objective of this study is to identify the vulnerabilities of local community, particularly indigenous people, farmers and marginalized women in the Lower Karnali Watershed Region by climate-induced hazards and socio-economic vulnerabilities in Bardiya District. Based on this general objective, some specific objectives are generated as follows:

Specific Objectives of the study are:

1. To find out the most frequent types of hazardous conditions caused by climate change in the study area?
2. To assess the direct and indirect socio-economic impacts of climate-induced hazards in the study areas.
3. To explore changing climate related barriers and vulnerabilities faced by indigenous and marginalized women of the study areas.
4. To understand the status of the use of indigenous knowledge to conserve food and water management.

1.5 Significance of the study:

This study is academically significant as it addresses key gaps in understanding the localized effects of climate-induced hazards on vulnerable populations in the Lower Karnali region of Western Nepal. While considerable research has explored the broader impacts of climate change, there is a lack of focus on how environmental hazards intersect with socio-economic vulnerabilities in geographically and socially marginalized areas such as Geruwa-3 and Madhuwan-2. By concentrating on this underserved region, the research aims to provide fresh insights into the relationship between climate change and rural livelihoods, enriching the existing body of knowledge.

The academic importance of this study lies in several aspects. Firstly, it investigates how climate change intensifies existing vulnerabilities, offering a deeper perspective on the interconnectedness of environmental and socio-economic issues. Secondly, it critically assesses the effectiveness of current disaster management and adaptation efforts while identifying the obstacles that limit their success. Thirdly, it emphasizes the specific challenges faced by marginalized groups, including ***Dalits*** and ***Tharus***, who

are often overlooked in climate-related studies. By doing so, this research addresses a significant gap in understanding the localized impacts of climate change on rural and marginalized communities and provides tailored recommendations for addressing these challenges.

The outcomes of this study can serve as a valuable resource for future academic research on localized climate impacts, resilience strategies, and community-driven adaptation measures. Furthermore, its emphasis on combining environmental and social dimensions can encourage interdisciplinary approaches in fields such as environmental science, sociology, and disaster management. Ultimately, the study seeks to generate evidence-based knowledge that advances academic discourse while guiding practical and inclusive policies to strengthen resilience and sustainability in climate-vulnerable areas like the Lower Karnali.

1.6 Potential outputs of the Study:

The potential outputs of a study on "Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities in the Lower Karnali Watershed Region" include:

- Comprehensive Risk Assessment Report: A thorough report detailing the climate-induced hazards, vulnerabilities, and associated risks in the Lower Karnali Watershed region.
- Vulnerability and Resilience Analysis: An extensive evaluation of the socio-economic vulnerabilities and resilience capacities of local communities, identifying key disparities.
- Policy Recommendations for Local and National Authorities: Practical suggestions aimed at enhancing disaster risk reduction (DRR) and climate adaptation policies for both local and national governments.
- Climate Change Adaptation Framework: Contextualized strategies to strengthen adaptive capacities within vulnerable communities, fostering sustainable development.
- Educational and Awareness Campaigns: Development of campaigns, instructional resources, and toolkits to help local communities understand climate risks and adaptation measures.

- Data-Driven Mapping and Analytical Tools: Interactive datasets, GIS maps, and visual tools to monitor hazards, vulnerabilities, and interventions throughout the region.
- Scholarly Articles and Research Publications: Peer-reviewed journal articles and academic papers contributing to the global conversation on climate change and socio-economic vulnerabilities.
- Workshops, Training, and Capacity-Building Initiatives: Educational programs aimed at local stakeholders, including government officials, community leaders, and NGOs, to build climate resilience and adaptability.
- Documenting Case Studies and Effective Practices: Compilation of successful adaptation initiatives, community-based approaches, and key lessons to guide future interventions.
- Interactive Online Platform for Stakeholder Participation: A user-friendly digital platform for disseminating research findings, tools, and resources, enabling stakeholders to access current information and engage with ongoing projects.

These outputs are designed to advance academic understanding and provide practical solutions to benefit communities in the Lower Karnali Watershed region.

1.7 Organization of the Study

This study is organized into five chapters. The first chapter serves as a background of study, introduction to study area, Statement of the problem, objective of study, significant of the study, Potential output of the study and organization of the study. The second chapter is a review literature, focusing on Conceptual, Theoretical, Empirical, Policy and conceptual framework. The third chapter describes the research methodology applied in the study. The fourth chapter discuss about data and analysis. The fifth chapter provides summary, main finding, conclusion and recommendation. Finally, the appendix and references follow this chapter.

CHAPTER: TWO

LITERATURE REVIEW

2.1 Conceptual Review:

Climate change is a pressing global issue that disproportionately affects vulnerable regions, particularly those with fragile ecosystems and socio-economic constraints. It refers to long-term shifts in temperature, precipitation patterns, and the increased frequency of extreme weather events, largely driven by human activities such as greenhouse gas emissions (IPCC, 2021). These climatic changes contribute to a range of environmental hazards, including floods, droughts, and erratic weather patterns, which pose significant threats to both natural systems and human livelihoods. Climate-induced hazards, such as rising temperatures and shifting rainfall patterns, disrupt ecosystems, agriculture, and infrastructure, leading to economic and social instability (Dixit et al., 2019). The impacts of such hazards are not uniform; marginalized communities often bear the brunt due to their limited access to resources, lack of infrastructure, and economic dependence on climate-sensitive sectors like agriculture and fisheries. Socio-economic vulnerabilities are further compounded by factors such as poverty, inadequate healthcare and education, and social inequalities, making it difficult for these communities to adapt effectively to climate challenges (Poudel et al., 2022).

Cultural dimensions also play a critical role in shaping responses to climate-induced hazards. Indigenous knowledge systems, traditional agricultural practices, and community-based resource management strategies offer valuable insights into climate adaptation (Berkes, 2009). However, these cultural traditions are increasingly under threat from changing environmental conditions, leading to disruptions in social structures and the erosion of traditional knowledge. Environmental disasters such as floods, landslides, and prolonged droughts further exacerbate vulnerabilities by damaging critical infrastructure, depleting natural resources, and displacing populations. Vulnerability to these disasters is not only determined by environmental factors but also by human-induced actions such as deforestation, unsustainable land use, and inadequate disaster preparedness (Ojha et al., 2019). Among the most affected are marginalized communities, particularly indigenous groups like the Tharu

community in Nepal, who rely heavily on traditional livelihoods and have limited access to adaptation resources (Gentle & Maraseni, 2012). Their socio-economic conditions, coupled with their geographical exposure to climate hazards, make them highly susceptible to long-term environmental changes and economic hardship.

In the context of Nepal's Lower Karnali Watershed Region (LKWR), climate-induced hazards and socio-economic vulnerabilities are deeply interconnected. Rising temperatures and unpredictable rainfall patterns have intensified flooding and drought events, significantly impacting agriculture, water resources, and local livelihoods (Shrestha & Aryal, 2020). The Karnali River, a lifeline for the region, frequently overflows, causing damage to infrastructure, displacement of communities, and disruptions in socio-economic activities (Dixit et al., 2019). The indigenous Tharu community, which heavily depends on agriculture and fishing, faces heightened risks due to their reliance on climate-sensitive occupations and their limited adaptive capacity (Poudel et al., 2022).

Cultural factors also play a crucial role in shaping how communities respond to climate-related challenges. Indigenous knowledge, traditional agricultural techniques, and community-based resource management approaches provide valuable strategies for climate adaptation (Berkes, 2009). However, these cultural traditions are increasingly at risk due to changing environmental conditions, which disrupt social structures and lead to the loss of traditional knowledge. Environmental hazards such as floods, landslides, and extended droughts further heighten vulnerabilities by destroying essential infrastructure, depleting natural resources, and displacing populations. The degree of vulnerability to such disasters is not solely determined by environmental conditions but is also influenced by human actions such as deforestation, unsustainable land use, and inadequate disaster management planning (Ojha et al., 2019). Among the most affected are marginalized groups, including Nepal's Tharu community, who rely heavily on traditional livelihoods and have limited access to adaptation resources (Gentle & Maraseni, 2012). Their socio-economic conditions, coupled with their geographical exposure to climate risks, make them highly susceptible to environmental changes and long-term economic instability.

The Tharu community is one of Nepal's largest indigenous ethnic groups, primarily residing in the Terai region, particularly in areas like the Lower Karnali Watershed

Region (LKWR**)**. Historically, the Tharu people have been recognized for their deep-rooted connection to the land, particularly through agriculture, fishing, and forest resource management. Their long history in the Terai region and their distinct cultural and linguistic identity qualify them as an indigenous group under Nepal's classification of *Adivasi Janajati* (Nepal Federation of Indigenous Nationalities (NEFIN), 2021). Tharu communities have traditionally practiced sustainable land and water resource management, demonstrating extensive ecological knowledge that has allowed them to thrive in the flood-prone plains of Nepal (Müller-Böker, 1999).

Despite their indigenous status, the Tharu have faced systemic marginalization due to historical, socio-political, and economic factors. One of the primary reasons for their marginalization is the historical displacement and land dispossession they experienced, particularly after Nepal's malaria eradication program in the 1950s, which allowed large-scale migration of hill populations into the Terai (Guneratne, 2002). As settlers from the hills moved in, Tharu communities lost access to their ancestral lands, which were taken over by powerful landlords and elites, forcing many into bonded labor under exploitative systems like Kamaiya **(**Giri, 2021). Even after the abolition of bonded labor in 2000, many Tharu families remained landless and economically vulnerable, struggling to reclaim their rights and access economic opportunities (Bishwakarma, 2019).

Additionally, political exclusion and socio-economic disparities have further marginalized the Tharu people. They have historically been underrepresented in decision-making bodies and government institutions, limiting their ability to influence policies that affect their communities (Maharjan et al., 2023). Education and healthcare services in Tharu-majority regions remain inadequate, further reinforcing socio-economic inequalities. Furthermore, climate change has intensified their vulnerabilitie**s**, as many Tharu depend on agriculture and fishing both highly climate-sensitive sectors. Increasingly erratic monsoon patterns, frequent floods, and prolonged droughts disrupt their traditional farming cycles and threaten their livelihoods (Poudel et al., 2022)

2.2 Theoretical Review

Climate change-induced hazards, such as floods, landslides, and droughts, have profoundly impacted various sectors worldwide. A.E. Anselm et al. (2011) explored indigenous agricultural adaptations to climate change, emphasizing the increasing risks posed by extreme weather events. Similarly, Cid (2016) observed that weather-related hazards have reached historically high levels, with climate change further intensifying the frequency and severity of these events. Geological and geomorphological factors are also linked to climate change, with global warming contributing to higher rainfall, ice-mass loss, and rising sea levels, thereby influencing geosphere responses in diverse regions (Leggins, 2010). Furthermore, vulnerabilities are described as the anticipated shifts in ecosystem variables under hazardous and non-hazardous conditions, as highlighted in the study "Risk and Vulnerability of Mongolian Grasslands under Climate Change" (RVMGCC, 2021). Ground recharge indicators, which estimate total groundwater during wet seasons based on cumulative rainfall, enable water managers to predict low recharge years before the season concludes (Hund, 2018).

To analyze the socio-economic consequences of climate-induced hazards, several theoretical frameworks offer crucial perspectives. The Vulnerability Framework, as established by Blaikie et al. (1994) and Turner et al. (2003), assesses vulnerability by examining the extent of exposure to hazards, the sensitivity of communities, and their ability to adapt. This framework emphasizes the importance of evaluating these factors to develop effective adaptation strategies. Likewise, the Climate Change Impact Theory, extensively explored in reports by the Intergovernmental Panel on Climate Change (IPCC) (Field et al., 2014; Pachauri & Meyer, 2014), investigates how variations in climate patterns, particularly the increasing frequency and severity of extreme weather events, disturb ecosystems and human societies. This perspective contributes to a deeper understanding of climate change consequences, aiding in the development of appropriate mitigation and adaptation strategies.

Furthermore, the Sustainable Livelihoods Framework (SLF), initially introduced by Chambers and Conway (1992) and later expanded by Scoones (1998) and the UK Department for International Development (DFID, 1999), explores the impact of environmental transformations on livelihoods, resources, and survival strategies. This framework is particularly applicable to areas like Lower Karnali, where communities

rely significantly on natural resources. It highlights the necessity of sustainable practices to strengthen resilience. Additionally, the Resilience Theory, pioneered by Holling (1973) and further advanced by Gunderson and Holling (2002) and Folke et al. (2006), centers on the capacity of communities and ecosystems to endure, adapt to, and recover from climate-related disruptions. This theory underscores the importance of strengthening adaptive capacities and implementing disaster risk reduction measures to minimize prolonged socio-economic disturbances.

By incorporating these theoretical perspectives, this study offers a comprehensive analysis of climate change effects on vulnerable populations in the Lower Karnali region. The Vulnerability Framework facilitates the identification of specific at-risk groups, while the Climate Change Impact Theory provides insights into the environmental changes disrupting local ecosystems and livelihoods. The Sustainable Livelihoods Framework evaluates how climate change affects livelihood strategies, whereas the Resilience Theory emphasizes the need to enhance adaptive capacities. Collectively, these frameworks contribute to the development of inclusive and sustainable adaptation strategies, ensuring long-term resilience and socio-economic stability in regions prone to climate-induced hazards.

In Nepal, particularly in the Lower Karnali region, various theoretical frameworks play a crucial role in examining the intricate relationship between climate change and socio-economic vulnerabilities. The region is increasingly affected by shifting climate patterns, leading to a higher frequency of floods, droughts, and lightning strikes, which pose significant threats to livelihoods, infrastructure, and ecosystems.

Flooding, largely caused by irregular monsoon patterns and the overflowing of the Karnali River, presents major challenges to settlements, agricultural fields, and transportation systems. Recurrent floods result in soil erosion, community displacement, and severe damage to crops and livestock, worsening poverty and food insecurity. Similarly, prolonged droughts limit access to water for drinking, irrigation, and hydropower production, creating further difficulties for farmers who depend on rain-fed agriculture. The lack of efficient irrigation infrastructure worsens these conditions, increasing the vulnerability of local livelihoods.

Another emerging issue is the increasing frequency of lightning strikes, which have become more deadly in recent years due to shifting atmospheric conditions. Lightning poses a direct danger to human lives, livestock, and electrical infrastructure, particularly in rural areas with insufficient protective measures. The absence of well-developed early warning systems and inadequate preparedness further heighten the risks associated with these extreme weather events.

In addition to environmental threats, socio-economic vulnerabilities in the Lower Karnali region arise from limited access to education, healthcare, and economic opportunities. Many communities, including indigenous groups such as the Tharu people, rely on agriculture, fishing, and forest resources for their livelihoods. However, climate-induced hazards are disrupting these traditional economic activities, compelling people to migrate in search of alternative means of survival. The lack of adaptation strategies, coupled with landlessness, poverty, and weak institutional support, reduces their ability to cope with climate-related shocks.

Although climate adaptation policies such as the National Adaptation Programme of Action (NAPA, 2010), Climate Change Policy (2019), and Local Adaptation Plans of Action (LAPA) have been introduced at the national level, their effectiveness is often hindered by gaps in implementation, inadequate funding, and lack of coordination. Many adaptation initiatives remain top-down and fail to incorporate indigenous knowledge and locally driven solutions, which are essential for addressing community-specific climate challenges. To build long-term resilience, it is crucial to strengthen community-based adaptation efforts, enhance early warning systems, invest in climate-resilient infrastructure, and promote sustainable agricultural practices.

By applying the Vulnerability Framework, Climate Change Impact Theory, Sustainable Livelihoods Framework, and Resilience Theory to adaptation planning, a comprehensive approach to tackling climate-related challenges can be developed. Integrating scientific research, traditional knowledge, and policy interventions will help the Lower Karnali region strengthen its adaptive capacity, effectively reduce climate-related risks, and ensure sustainable socio-economic development for vulnerable populations.

2.3 Empirical Review

Climate change has amplified the socio-economic vulnerabilities of marginalized communities across South Asia, particularly those heavily reliant on agriculture and natural resources. In India, rural communities are grappling with the increasing frequency of extreme weather events such as droughts and floods, which lead to crop failures and reduced agricultural productivity, exacerbating poverty levels (Venkataraman et al., 2018). Similarly, in Bangladesh, coastal and low-lying areas are highly susceptible to rising sea levels and increased salinity, which disrupt local livelihoods, particularly among farmers and fisher folk. These communities often lack the necessary resources to diversify their incomes, making them more vulnerable to climate-induced hazards (Chowdhury et al., 2017). In Pakistan, the effects of climate change, such as irregular rainfall patterns and heatwaves, have severely impacted agricultural output, leading to food insecurity and financial hardship, especially for marginalized farming populations. Moreover, issues like gender and caste inequalities further deepen their vulnerability, limiting their capacity to adapt (Iqbal et al., 2020). In Sri Lanka, rural communities, especially smallholder farmers in flood- and drought-prone regions, are experiencing significant economic distress due to climate-induced disasters. These groups often lack the financial capacity to adopt effective adaptation measures, making them more susceptible to long-term climate impacts (Perera et al., 2019). Finally, in the Maldives, rising sea levels and intensifying storms pose a severe threat to marginalized island communities. These communities, with limited infrastructure and financial means, are unable to relocate or implement effective adaptation strategies, placing them at heightened risk of displacement and economic loss (Thompson et al., 2016).

According to the Nepal Living Standards Survey (2011), 42% of farm households experienced food insecurity, with limited dietary diversity. Regression analysis showed that climate-induced changes, such as altered water availability, seasonal shifts, increased hazards, and crop pest attacks, negatively impacted household food security. The study recommended strategies to enhance local food security in response to climate change, both in the study area and in similar regions (Hussain et al., 2021).

People in developing countries, especially indigenous communities, are more vulnerable to climate hazards due to their heavy reliance on climate-sensitive activities

and limited capacity to adapt. In Nepal, where indigenous peoples make up 35% of the population, they face significant risks from climate change because of the nature of their agricultural and livelihood practices (Buddhi et al., 2019). Indigenous people, particularly in developing countries like Nepal, are often more vulnerable to climate hazards due to their deep dependence on climate-sensitive livelihoods, such as agriculture, fishing, and natural resource management. These communities typically have limited access to resources, technology, and support systems that can help them adapt to climate change. Indigenous populations are often marginalized due to their cultural, social, and economic status, making them more susceptible to the negative impacts of climate change, including increased frequency of extreme weather events and disruption to traditional farming systems (Buddhi et al., 2019). In Nepal, indigenous groups such as the *Tharu, Magar,* and *Tamang*, along with marginalized women, face heightened vulnerabilities due to historical discrimination, lack of access to education, and limited decision-making power.

Women from marginalized communities are also particularly vulnerable, as they are often tasked with primary responsibility for water collection, food security, and household care, which are all directly affected by climate change. Their role in the family economy, particularly in rural areas, is vital yet often goes unrecognized, contributing to their increased exposure to climate-induced risks. A study by Shrestha and Shrestha (2019) highlights that climate change exacerbates gender inequalities, as women in these communities bear the brunt of climate-related challenges.

These climatic shifts have resulted in more frequent and severe floods, which are a predominant hazard in the region. The Himalayan River basin, characterized by complex topography and limited observational data, faces increasing extreme events. Similarly, the socio-economic consequences of climate change have been widely examined, particularly in relation to how marginalized communities are more severely impacted. Studies by Hussain and Siddiqui (2019) and Adger et al. (2014) underscore the economic challenges faced by rural populations, particularly those dependent on agriculture, as a result of shifting climate patterns. Additionally, research by Sharma (2018) and Iqbal (2020) explores the difficulties encountered by vulnerable groups in regions like Nepal and Pakistan, focusing on the adaptive strategies they implement. Reports from UNEP (2015), USAID (2017), and the World Bank (2019) stress the

necessity of robust adaptation measures to reduce the socio-economic effects of climate change, especially for vulnerable communities in South Asia.

This study aims to provide a detailed analysis of climate induced hazards within the Karnali River Basin, focusing on the frequency, intensity, and socio-economic impacts of such events. The Karnali River Basin, located in western Nepal, is a vital water source for millions of people, supporting agriculture, hydropower, and livelihoods. However, the region is highly vulnerable to droughts in winter season and flood in summer season. Due to its reliance on monsoon rains, limited irrigation infrastructure, and geographic variability in rainfall distribution. The study explores patterns of water scarcity, flood, reduced agricultural productivity, and the resulting socioeconomic consequences, particularly on vulnerable groups like farmers, indigenous communities, and women. Furthermore, it will investigate the adaptation strategies adopted by local communities and how effective they have been in coping with prolonged periods of water shortage. Through this comprehensive analysis, the study aims to contribute valuable insights into the nature of drought and flood risks in the Karnali River Basin and suggest region-specific adaptation strategies to mitigate the impacts of hazards. The findings will be useful for policymakers, local communities, and development practitioners aiming to strengthen resilience and improve water management strategies in the region.

2.4 Policy Review

At the national level, (NAPA, 2010) identifies key actions to address climate-related impacts, particularly in agriculture, water resources, and biodiversity. The policy emphasizes strengthening local adaptation capabilities and incorporating indigenous knowledge into climate change strategies. Similarly, the Climate Change Policy of Nepal (2011) focuses on improving resilience in communities affected by climate change, with a special focus on vulnerable groups such as those in the Lower Karnali region. The Agriculture Development Strategy (2015) further promotes sustainable farming and water management techniques to alleviate risks in rural areas dependent on agriculture.

International policies also play a key role in supporting adaptation in the region. The Paris Agreement (2015) calls for global action on climate change, particularly in

regions vulnerable to its impacts. The Sendai Framework for Disaster Risk Reduction (2015-2030) commits Nepal to enhancing community resilience and minimizing risks from climate-induced disasters. Organizations like the UNFCCC and UNDP provide technical and financial aid to help implement adaptation strategies in areas like the Lower Karnali Watershed.

Adaptation strategies in the lower Karnali watershed region involve a combination of traditional knowledge, government interventions and NGO support. Community based approaches, such water conservation practices and diversified cropping systems, have shown success in enhancing resilience.

Government and non- governmental organizations (NGOs) have also been active in implementing adaptation and mitigation strategies. The research draws on a comprehensive literature review and meta-analysis of existing studies on disaster risk reduction and management. The Constitution of Nepal (2015) designates disaster risk management as a collective responsibility across all government level federal, provincial, and local. Prior to 1982, disaster management efforts were conducted in a disorganized manner (Panta, et.al., 2014).

Nepal's policy framework for addressing climate change and disaster risk management has undergone significant development, with several key strategies and initiatives introduced to tackle these pressing issues. Notably, the National Adaptation Programme of Action (NAPA) and the Climate Change Policy of 2019 stand out as pivotal components of the country's response. These policies focus on promoting community-based adaptation, integrating disaster risk reduction measures, and advancing sustainable development to mitigate the adverse effects of climate change Ministry of Forests and Environment (MoFE, 2019).

The Local Adaptation Plans of Action (LAPA) further decentralize Nepal’s climate adaptation efforts, enabling community-specific interventions that address localized vulnerabilities and priorities. This approach is particularly critical for regions such as Lower Karnali, where the impacts of climate change are both severe and context-dependent (MoFE, 2019). However, Policy reviews indicate that, despite the existence of frameworks like the Climate Change Policy 2019 and the Disaster Risk Reduction and Management Act 2017, significant gaps remain in their implementation. These include ensuring that vulnerable populations can access the necessary resources and support to adapt effectively. Furthermore, while the Disaster Risk Reduction and

Management Act provides a robust legal framework for disaster management, challenges persist in integrating climate change adaptation measures with disaster risk management at the local level (MoFE, 2019 &UNDRR, 2019). The review of these policies underscores the need for more robust, well-coordinated, and adequately funded initiatives that can address the complex and interconnected challenges posed by climate change in the Lower Karnali Watershed region.

International policies and frameworks play a crucial role in addressing climate-induced hazards and building resilience globally. Key agreements such as the Paris Agreement (2015), under the United Nations Framework Convention on Climate Change (UNFCCC), aim to limit global warming and promote climate-resilient development pathways. The Sendai Framework for Disaster Risk Reduction (2015-2030) focuses on reducing disaster risks, particularly those arising from climate change, by enhancing the resilience of communities and improving disaster preparedness. Additionally, the 2030 Agenda for Sustainable Development, through its Sustainable Development Goals (SDGs), encourages countries to strengthen their climate resilience and integrate risk management across all sectors of development. The UN Convention to Combat Desertification (UNCCD) further emphasizes sustainable land management and restoration to mitigate climate-induced hazards, especially in arid and semi-arid regions.

Several international organizations are actively engaged in supporting these efforts. The UNFCCC serves as the central body for climate action, helping countries with financial and technical assistance to mitigate and adapt to climate change. The World Bank provides critical financial resources and technical expertise to build climate resilience, particularly in developing countries, through disaster risk management projects. Similarly, the United Nations Development Programme (UNDP) works on capacity-building initiatives and climate adaptation projects aimed at vulnerable communities, aligning with the SDGs to promote sustainable development. The Green Climate Fund (GCF) plays a key role in financing climate adaptation and mitigation projects, particularly in developing countries, focusing on building resilience in the most vulnerable regions. Organizations like the International Federation of Red Cross and Red Crescent Societies (IFRC) also contribute by enhancing disaster preparedness and reducing climate risks at the community level. Furthermore, the Global Environment

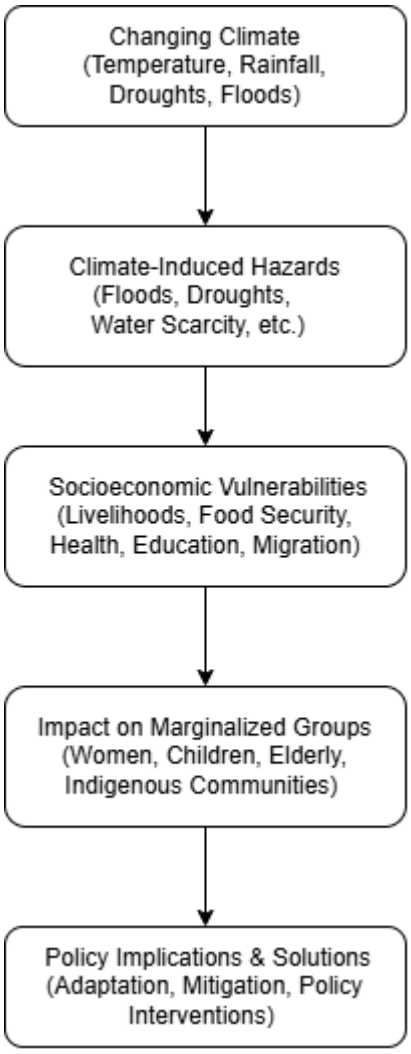
Facility (GEF) and the Adaptation Fund support climate resilience projects in sectors such as water management and agriculture, offering financial backing to countries facing the most severe climate impacts.

These international policies and organizations create a strong global framework for addressing the challenges posed by climate change. By providing essential support for both mitigation and adaptation efforts, they help vulnerable communities strengthen their resilience and adapt to the socio-economic impacts of climate-induced hazards. Through these collaborative efforts, communities can better manage climate risks and work towards long-term sustainable development.

From the literature review, it can be clearly seen that many people had done research before but cannot implement their study in practical life and never appealed for effective adaptation. I believe that whatever we do research or study, it should come to practice for long term achievements and meet the objectives. This requires comprehensive policies that address not only the immediate impact of climate hazards but also the underlying socio-economic vulnerabilities. The literature review on climate-induced hazards and socio-economic vulnerabilities in the lower Karnali watershed region is most significant to underscores the need for holistic and inclusive strategies for adaptation. This Research highlights the significant impacts of floods, drought and lightening on the region, as well as the socio- economic challenges which helps to developing and evaluating such integrated strategies and resilience in the face of climate change.

2.5 Conceptual Framework

Figure 2: Conceptual Framework



This conceptual framework offers a holistic perspective on the interconnected challenges brought about by climate change, emphasizing how environmental shifts contribute to socioeconomic vulnerabilities and disproportionately impact marginalized communities. Climate change, marked by variations in temperature, rainfall patterns, extended droughts, and recurring floods, serves as the primary driver of numerous issues. These changes, largely fueled by human activities such as deforestation and greenhouse gas emissions, give rise to various climate-related hazards, including floods, droughts, lightening, and water shortages. Such hazards severely affect infrastructure, agriculture, and access to essential resources, placing significant strain on communities with limited adaptive capacities. As these hazards become more frequent and severe, they deepen existing socioeconomic challenges by undermining

livelihoods, food security, healthcare, education, and driving migration. Communities that depend on agriculture face financial hardships due to declining crop yields and water scarcity, while health concerns escalate due to malnutrition and the spread of waterborne diseases. Furthermore, disruptions in education and forced displacement compel households to focus on short-term survival rather than long-term development. These adverse effects are felt most acutely by marginalized groups, such as women, children, the elderly, and indigenous populations, who often lack access to necessary resources and adaptation strategies. Indigenous groups, such as the Tharu community in Nepal's Lower Karnali Watershed Region, are particularly vulnerable as their traditional ways of life and cultural practices, which are closely tied to natural resources, face significant threats. Women are especially affected as they are primarily responsible for securing water and food, further intensifying their challenges. Addressing these complex issues requires well-designed policy measures and solutions. Adaptation strategies, such as strengthening infrastructure, implementing climate-smart agricultural techniques, and improving disaster preparedness, can help build resilience within communities. At the same time, mitigation efforts focus on tackling the root causes of climate change by encouraging renewable energy adoption and sustainable environmental practices. Ensuring inclusive governance and participatory decision-making is crucial for incorporating the perspectives of vulnerable communities into climate policies. This framework highlights the importance of an integrated approach that combines scientific insights, traditional knowledge, and robust policy frameworks to promote long-term climate resilience and sustainable development in regions at risk.

CHAPTER: THREE

RESEARCH METHODOLOGY

3.1 Rationale to selection of Field

Based on nature of study and obtained data from previous literature Geruwa rural municipality and Madhuwan municipality in Bardiya District, Lumbini Province, were selected as the study area due to their unique socio-economic and ecological characteristics, which align with the objectives of this research. These municipalities are in Nepal's Terai region and are adjacent to Bardiya National Park, providing a distinctive context where rural livelihoods are closely tied to agriculture, fishing, and forestry. The ecological richness of the area, coupled with the presence of rivers such as the Karnali and Babai, plays a critical role in shaping the economic activities of the local population. At the same time, the region faces environmental challenges, including frequent flooding, making it an ideal setting to explore the impact of environmental vulnerability on rural livelihoods. The selection of this area is also driven by the demographic composition, as it includes significant indigenous Tharu and marginalized Dalit populations, offering a vital opportunity to investigate issues of social inclusion and exclusion in rural Nepal.

The choice of respondents for this study is grounded in the need to capture a broad and representative view of the socio-economic dynamics within these municipalities. The primary respondents include local farmers, fishermen, and forest users, women as these groups directly depend on natural resources for their livelihoods. Indigenous ***'Tharu'*** and marginalized '***Dalit'*** communities are also central to the research.

This targeted respondent selection ensures that the study captures diverse perspectives, reflecting the multifaceted impacts of climate change on the socio-economic fabric of the Lower Karnali Watershed Region.

3.2 Research Design

The study focuses on analyzing changing climate-induced hazards and socio-economic vulnerabilities in Geruwa-3 and Madhuwan-2 within the Lower Karnali Watershed Region. It adopts a dual approach combining descriptive and exploratory research designs to achieve its objectives.

The descriptive research design aims to systematically document the types and frequencies of climate-induced hazards, such as floods and droughts, and their socio-economic impacts on local communities. Through this approach, the study seeks to provide a detailed and comprehensive account of the current situation, capturing the scope and scale of climate hazards and their direct and indirect effects on livelihoods, infrastructure, and well-being.

The exploratory research design involves exploring the unique barriers and vulnerabilities faced by indigenous and marginalized women in the region, as well as documenting traditional indigenous knowledge and practices related to water resource management and coping strategies for climate-induced hazards. By emphasizing local perceptions and experiences, this approach aims to uncover emerging climate-related issues and provide valuable insights into adaptive strategies rooted in indigenous knowledge systems.

3.3 Universe and Sampling

This study focuses on the communities within Geruwa-3 Rural Municipality and Madhuwan-2 Municipality, both located in the Lower Karnali Watershed Region of Bardiya District, Nepal. These areas are predominantly rural, with local residents primarily engaged in agriculture, fishing, and forest-related activities as their main sources of livelihood. The research specifically targets local farmers, fishermen, forest users, and women from indigenous Tharu communities and marginalized Dalit groups, as these populations are particularly vulnerable to climate-induced hazards and the socio-economic challenges associated with them.

Geruwa-3 Rural Municipalities has a total population of 33,514**,** comprising 4,906 households**.** The study employs a purposive sampling method to ensure a diverse representation of different social groups, including various ethnicities (such as Tharu, Dalit, and other marginalized communities), occupations (farmers, fishermen, forest users), and gender categories. A total of 60 households were selected from this municipality, purposively to ensuring that the sample reflects the lived experiences and vulnerabilities of the local population.

Similarly, Madhuwan-2 Municipalities has an estimated total population of 50,739**,** with approximately 5,807 households. The same purposive sampling method was applied to select 60 households from this municipality. This approach ensures that the

study captures the perspectives of various ethnic and occupational groups while maintaining gender inclusivity. The sample selection process was designed to reflect the diversity of the population and provide a comprehensive understanding of the socio-economic and environmental challenges faced by different groups within the municipality.

By employing a purposive sampling Method, this study ensures that both municipalities are adequately represented, capturing the diverse experiences and vulnerabilities of different social groups, particularly those most affected by climate hazards.

I determined the parameter of respondents from marginalized women, farmers, and elderly people from households.

3.4 Nature and Source of Data:

This study employs a mixed method approach, both qualitative and quantitative, to capture a comprehensive understanding of the socio-economic vulnerabilities and climate-induced hazards in the study areas. The qualitative component focuses on understanding the personal experiences and perspectives of individuals within the communities, while the quantitative aspect aims to identify broader socio-economic trends and patterns. Primary data were collected such as Semi-Structured Interviews, focus group discussion, and KII.

Secondary Data from existing records and reports were also used to supplement primary data. These sources were such as documents from local government bodies and NGOs, offer additional insights into past climate events and the effectiveness of government policies and interventions in the region.

3.5 Techniques and Tools for Primary Data Collection

According to the requirement of study, some techniques and tools which are applied for primary data collection are as follows: -

3.5.1 Key Informant Interview

The key informant's interview included five people from Geruwa-3 and five from Madhuwan-2 municipalities. These individuals were selected for their knowledge about climate change and vulnerabilities. A key informant interview checklist was used as a tool.

The respondents in the study represent a diverse range of individuals holding key positions within the community. Two Ward Chairpersons, Nirmal Chaudhary and Asharam Tharu, contributed their insights on local governance and community resilience. Hari Prasad Tharu, a School Principal, offered perspectives on education and its role in adaptation strategies. Amrita Kumari Shahi, a member of the Women Commission, provided valuable input on gender-specific vulnerabilities and adaptation measures. Four experienced farmers Shova Ram Tharu and Biddi Tharu, Ramannath Tharu, and Radha Chaudhary shared their knowledge of traditional agricultural practices and how they are being impacted by climate change. Lastly, Janak Singh Kharel and Dipendra Tharu, members of the Disaster Management team, contributed their expertise on disaster preparedness and risk reduction in the region. Together, these respondents offered a comprehensive understanding of the community's response to climate-induced challenges and their adaptive strategies.

3.5.2 Semi Structured Interview

Interviews were conducted in a semi-structured way to collect mixed types of data (qualitative and quantitative) from the respondents in the study area. The responses were either structured or in narrative form, depending on the objective of the study or the respondent's choice. A checklist was developed to keep the research on track and to meet the purpose of the study.

3.5.3 Focus Group Discussion

Focus Group Discussions (FGDs) were an essential tool for this study, providing a platform for gathering in-depth, collective insights from indigenous and marginalized women in Geruwa and Madhuwan. This method was particularly effective in exploring shared community experiences, as it allowed participants to discuss their perspectives and challenges in a group setting, fostering open dialogue and the exchange of ideas. FGDs proved especially valuable for understanding sensitive issues, such as the climate-related barriers faced by women, as the group environment often encouraged more candid discussions and a sense of solidarity among participants.

For this study, three FGDs were conducted and FGDs involved groups of (6-8) women from the Tharu and Dalit communities, who are disproportionately impacted by climate-induced hazards. The discussions centered on the specific challenges these women faced, including limited access to resources, social services, and participation

in decision-making processes, all of which were exacerbated by the effects of climate change. Bringing together women with similar socio-economic backgrounds highlighted how they collectively navigated vulnerabilities like flooding, droughts, and erratic weather conditions.

Furthermore, FGDs served as a crucial means for documenting the traditional knowledge and practices these women used to manage water resources and adapt to climate challenges. The interactive format of FGDs allowed participants to share a variety of experiences related to hazards and offering insights into both effective strategies and areas where further support was required.

By using FGDs, the study captured a comprehensive understanding of how indigenous and marginalized women are facing barriers and responded to climate-related challenges.

3.6 Data Analysis and Presentation Procedure

The collected data was rechecked to prevent any data errors in collaboration with another peer thesis writer. The final data was analyzed using simple statistical tools such as Microsoft Excel, while qualitative data and information were analyzed through narrative analysis techniques integrating with descriptive data according to the objective of the study.

3.7 Reliability and Validity

This research study was crucial for ensuring the accuracy and trustworthiness of the findings. While absolute reliability could not be claimed, several measures were taken to minimize errors such as under- or over-counting and false reporting by respondents. To enhance reliability, interviews and questionnaires were conducted in the national language to ensure clear communication with the participants. The researcher was actively involved throughout the entire process, including the preparation of the checklist, conducting interviews and discussions, and finalizing the report. This hands-on involvement helped maintain consistency and accuracy in data collection. Additionally, a close rapport was developed with the respondents to encourage open communication and ensure they provided the necessary information.

The research instruments were pre-tested, and necessary modifications were made based on feedback to improve their effectiveness. Furthermore, careful editing of the entered data was conducted to minimize data entry errors and maintain its accuracy.

Regarding the validity of the study, it primarily depended on the procedures followed during data collection. Triangulation of various data sources, including secondary information, field-level observations, and personal experiences, was used to confirm the validity of the findings. Any missing or doubtful information was identified and corrected during the research process to ensure the data's accuracy and reliability. These combined strategies ensured that the research findings were both reliable and valid, providing a solid foundation for understanding the socio-economic vulnerabilities and climate-induced hazards in the study areas.

3.8 Ethical Consideration

The key informants and others related to the field work were clearly informed about the purpose and objective of the study in the very beginning.

The success of the study depends on respondents and the researcher. Researcher was not biased in any case and kept themselves as honest observer throughout. The respondents were free to respond in their own way. Individual rights were protected and to maintain confidentiality, the researcher has not disclosed the identity of the respondents.

3.9 Limitation of the Study

The study entitled ″Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities in the Lower Karnali Watershed Region″ encountered several limitations that may have influenced the depth and generalizability of the findings. One significant limitation was the availability and consistency of data. The reliance on limited and inconsistent datasets could have affected the accuracy and reliability of the results. This was particularly evident in the cases of Geruwa-3 and Madhuwan-2, where gaps in historical records made it challenging to analyze long-term trends. As a result, the findings may not fully capture the evolving impacts of climate change and related vulnerabilities over an extended period.

Additionally, the scope of the study is limited to specific regions within the Lower Karnali Watershed, such as Geruwa-3 and Madhuwan-2, which might restrict the generalizability of the conclusions to other areas with different geographical, social, or economic contexts. The methodological approach also faced constraints, particularly in integrating diverse data sources, which introduced complexities in data harmonization and interpretation. This methodological limitation reduced the ability to conduct more comprehensive analyses that could incorporate a wider range of variables or dimensions.

The study also encountered theoretical limitations: Vulnerability Framework, Climate Change Impact Theory, Sustainable Livelihoods Framework, and Resilience Theory, as it primarily focused on socio-economic vulnerabilities and climate-induced hazards without fully exploring other intersecting dimensions, such as political, cultural, or institutional factors, which might also shape the region's resilience. This narrow focus may have left certain aspects underexplored, potentially impacting the broader understanding of how climate change affects these communities.

From a practical standpoint, resource limitations posed significant challenges. Limited funding, time constraints, and logistical difficulties in accessing remote areas like Geruwa-3 and Madhuwan-2 hindered the ability to conduct more in-depth field research. Moreover, external factors, such as political instability, lack of local infrastructure, and difficulties in effectively engaging local stakeholders, further disrupted research activities. These barriers not only affected data collection but also complicated the implementation and feasibility of some recommendations.

While the study provides valuable insights into climate-induced hazards and socio-economic vulnerabilities in the Lower Karnali Watershed, including Geruwa-3 and Madhuwan-2, these methodological, theoretical, and practical limitations should be acknowledged. Addressing these constraints in future research could enhance the robustness and applicability of findings, thereby providing a more comprehensive understanding of the region's challenges and resilience strategies.

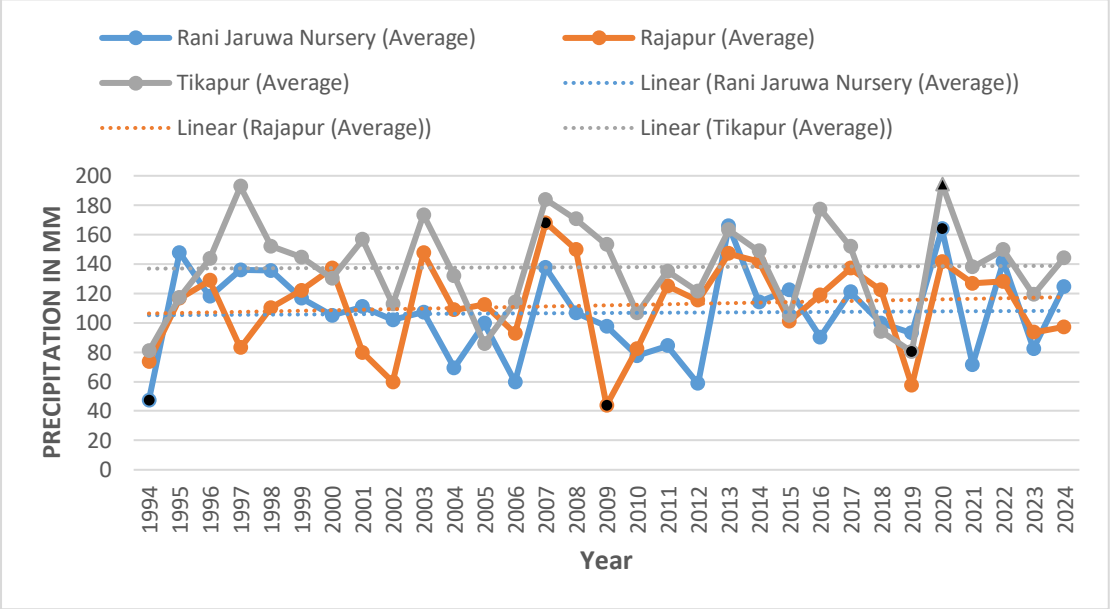
CHAPTER: FOUR

DATA PRESENTATION AND INTERPRETATION

Data analysis and interpretation involve systematically examining and processing collected data to extract meaningful insights. First, data analysis entails organizing, cleaning, and summarizing the data using descriptive analysis using MS Excel and Thematic analysis. Once the data is analyzed, interpretation involves contextualizing the results, identifying patterns, and drawing conclusions that answer the research questions. The final step is to report the findings in a clear and concise manner, providing evidence-based insights that inform decision-making or contribute to the research field.

4.1 Climate Change Scenario in Study Area

Figure 3: Pattern of Precipitation in the Study Area From 1994- 2024



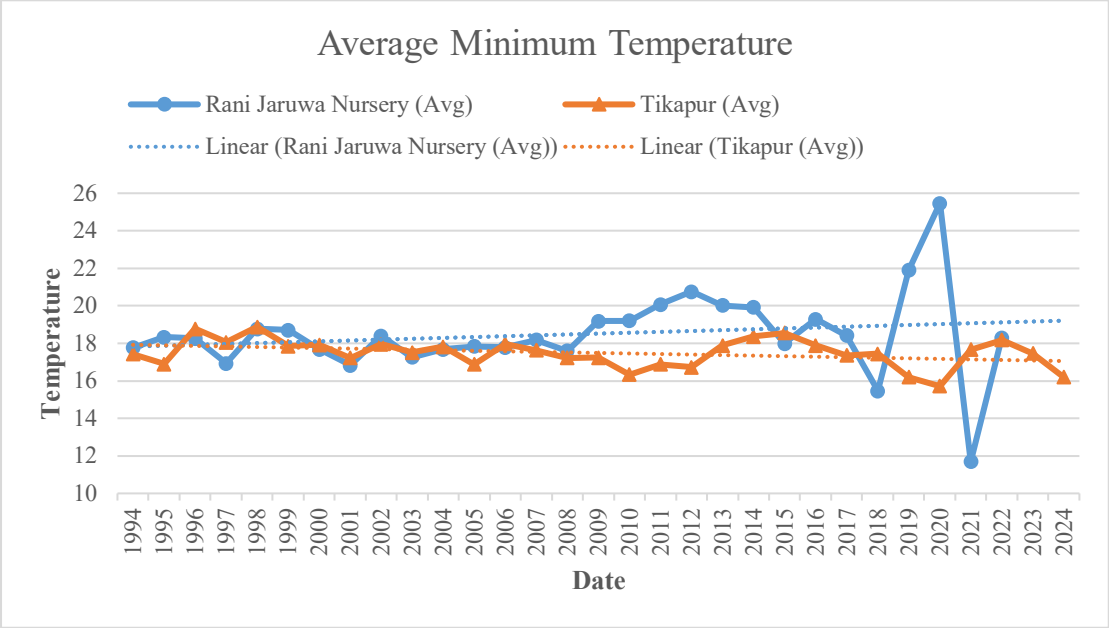
Source: Department of Hydrology and Meteorology, 2024

The above figure presents the average yearly precipitation sums for three locations: Rani Jaruwa Nursery, Rajapur, and Tikapur, with data sourced from the Department of Hydrology and Meteorology (DHM), Nepal. These stations are close to the study areas used to study the precipitation pattern. The table spans from 1994 to 2024, combining historical records and potentially future projections.

The trends in the table show significant fluctuations, indicating high variability in rainfall patterns over the years. Among the three datasets, Tikapur exhibits the highest peaks and variability, suggesting it experiences more extreme rainfall events. Rajapur follows a similar fluctuating trend but with moderate precipitation levels, while Rani Jaruwa Nursery tends to have more dips and relatively lower values at certain points.

If the post-2024 data represents projections, it suggests potential future changes in rainfall patterns, which could impact water availability, agriculture, and disaster risks such as floods and droughts. Overall, the precipitation varies over the years, with no consistent trend of increase or decrease. This data is crucial for understanding the hydrological impact of climate change and developing climate adaptation strategies in the affected regions.

Figure 4: Average Minimum Temperature in Study Areas from 1994-2024

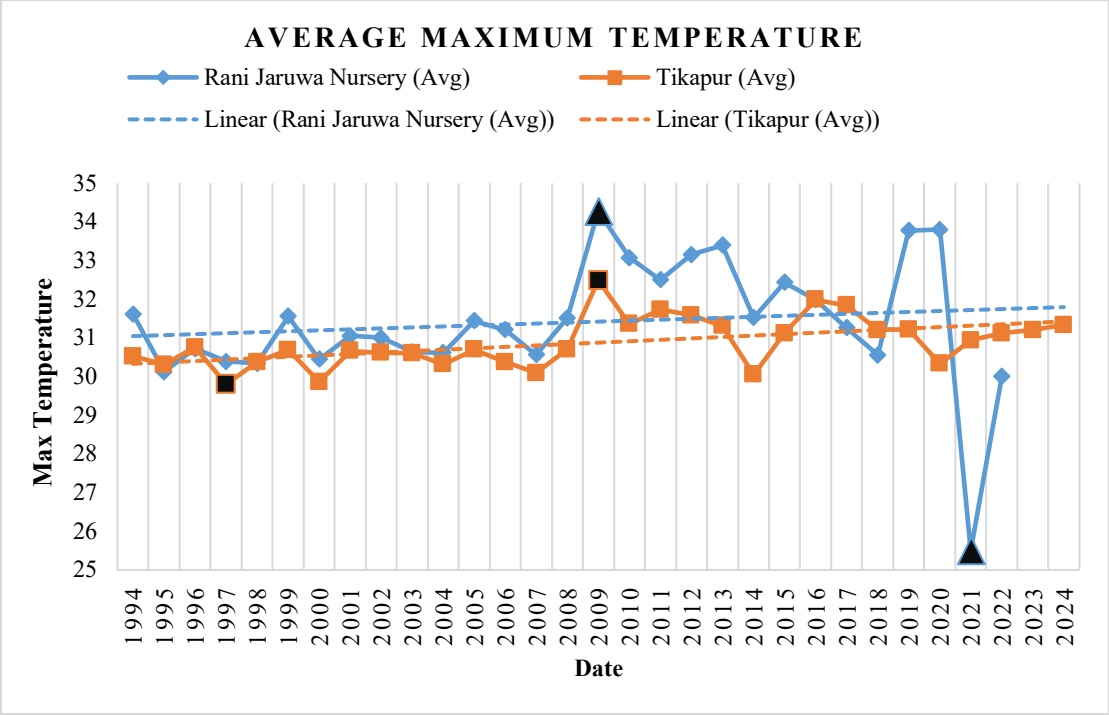


Source: Department of Hydrology and Meteorology, 2024

The graph titled "Minimum Average Temperature" presents temperature trends for Rani Jaruwa Nursery and Tikapur, with data sourced from the Department of Hydrology and Meteorology (DHM), Nepal. The x-axis represents years from 1994 to 2024, while the y-axis measures temperatures in degrees Celsius (°C). The blue line represents Rani Jaruwa Nursery, the orange line represents Tikapur, and a dotted trendline indicates the linear trend for Tikapur. The data shows fluctuations in the minimum average temperature, with periodic increases and decreases. However, the general trend appears to be relatively stable, with some dips in later years, particularly

in Rani Jaruwa Nursery. The trendline suggests a slight decreasing pattern in Tikapur's minimum temperature over time. These variations in temperature patterns are crucial for understanding climate change impacts in the Lower Karnali Watershed Region, influencing agriculture, biodiversity, and local livelihoods.

Figure 5: Average Maximum Temperature



Source: Department of Hydrology and Meteorology, 2024

The graph titled "Maximum Average Temperature" displays temperature trends for Rani Geruwa Nursery and Tikapur, with data sourced from the Department of Hydrology and Meteorology (DHM), Nepal. The x-axis represents years from 1994 to 2018, while the y-axis measures temperature, likely in Celsius. The blue line represents Rani Jaruwa Nursery, the orange line represents Tikapur, and a dotted trendline shows the linear trend for Tikapur. The data shows fluctuations in maximum average temperature, with both locations experiencing periodic rises and drops. Despite these variations, Tikapur's trendline suggests a relatively stable or slightly increasing pattern over time. However, Rani Geruwa Nursery exhibits sharp declines in some years, indicating possible extreme weather events or inconsistencies in data collection. These temperature patterns are important for assessing climate change impacts on agriculture, water resources, and local ecosystems in the Lower Karnali Watershed Region.

4.2 Socio-Demographic Profile of Respondents

Socio-demographic factors encompass the various characteristics of a population that shape social and economic behaviors. These factors include age, gender, education, occupation, income, marital status, ethnicity, religion, household composition, and geographical location.

Table 4.2: Socio-Demographic Profile of Respondents

S. N	Categories	Frequency	Total	Percent
1	**Age**			
	15-24	30	120	25%
	25-34	25	120	21%
	35-44	35	120	29%
	45-54	21	120	18%
	55-above	9	120	8%
2	**Sex**			
	Male	45	120	38%
	Female	75	120	63%
3	**Disability**			
	Yes	3	120	3%
	No	117	120	97%
	Religion			
	Hindu	118	120	98%
	Christian	2	120	2%
5	**Caste**			
	Brahmin/Chhhetri	7	120	6%
	Janajati	109	120	91%
	Dalits	4	120	3%
6	**Marital Status**			
	Unmarried	4	120	3%
	Married	112	120	93%
	Widow	4	120	3%
7	**Family Type**			
	Nuclear Family	120	120	100%
8	**Education Status**			
	Unable to read and write	57	120	48%
	Able to read and write	27	120	23%
	Primary Education (1-8)	13	120	11%
	Secondary Education (9 -12)	13	120	11%
	Higher Education (Bachelor, Master)	9	120	8%
	Informal Education	1	120	1%
9	**Occupation**			
	Business	9	120	8%
	Skilled Laborer	33	120	28%

	Unskilled laborer	55	120	46%
	Worker in factory	13	120	11%
	Office Staff	10	120	8%
10	**Number of Children**			
	Zero to Two	18	120	15%
	Two to Four	50	120	42%
	Four to Six	50	120	42%
	Six to Eight	2	120	2%
11	**Annual Income**			
	0-10000	6	120	5%
	10000-20000	7	120	6%
	20000-30000	8	120	7%
	30000-40000	3	120	3%
	40000-50000	8	120	7%
	50000 & above	88	120	73%
12	**Health Status**			
	Excellent	13	120	11%
	Good	30	120	25%
	Fair	60	120	50%
	Poor (Chronic Disease)	17	120	14%
13	**Temporary Migration during Flood**			
	Yes	106	120	88%
	No	14	120	12%
14	**Housing Status**			
	Own Home	50	120	42%
	Temporary housing	70	120	58%

Source: Field Survey, 2024

The socio-demographic data of the respondent highlight key trends in various aspects of their lives. In terms of age distribution, the majority fall within the 35-44 age group (29%), while the smallest proportion is from the 55 and above category (8%). The gender breakdown shows a higher percentage of females (63%) compared to males (38%), with no respondents identifying as other genders as shown in **Error! Reference s ource not found.**. Regarding disability, only 3% reported having a disability, whereas 97% stated they did not.

In terms of religion, the respondents are predominantly Hindu (98%), with a small percentage identifying as Christian (2%). The caste composition reveals that the majority belong to Janajati (91%), while Brahmin/Chhetri (6%) and Dalit (3%) form a smaller portion. Marital status data indicate that the majority are married (93%), with only 3% each being either unmarried or widowed. The family structure is exclusively nuclear (100%), with no respondents living in joint or other family types.

Education levels show that 48% are unable to read and write, while only 8% have pursued higher education. In terms of occupation, the largest group consists of unskilled laborers (46%), followed by skilled laborers (28%), whereas office staff and business owners each make up 8% of the respondents.

When looking at family size, most respondents have two to four children (42%), with an equal percentage having four to six children (42%), while only 2% have more than six. Annual income data suggest that a significant 73% earn above 50,000, while the lowest-income category (0-10,000) represents only 5%. Health status varies, with 50% rating it as fair, while 14% suffer from chronic diseases.

Temporary migration during floods is a common occurrence, as 88% of respondents relocate, while only 12% remain in place. Finally, housing status shows that the majority live in temporary housing (58%), whereas 42% own homes, and none reported living in rental housing or being homeless. These findings highlight significant socio-economic vulnerabilities and resilience factors within the surveyed population.

4.3 Deadly Hazards and its Frequency in Study Area

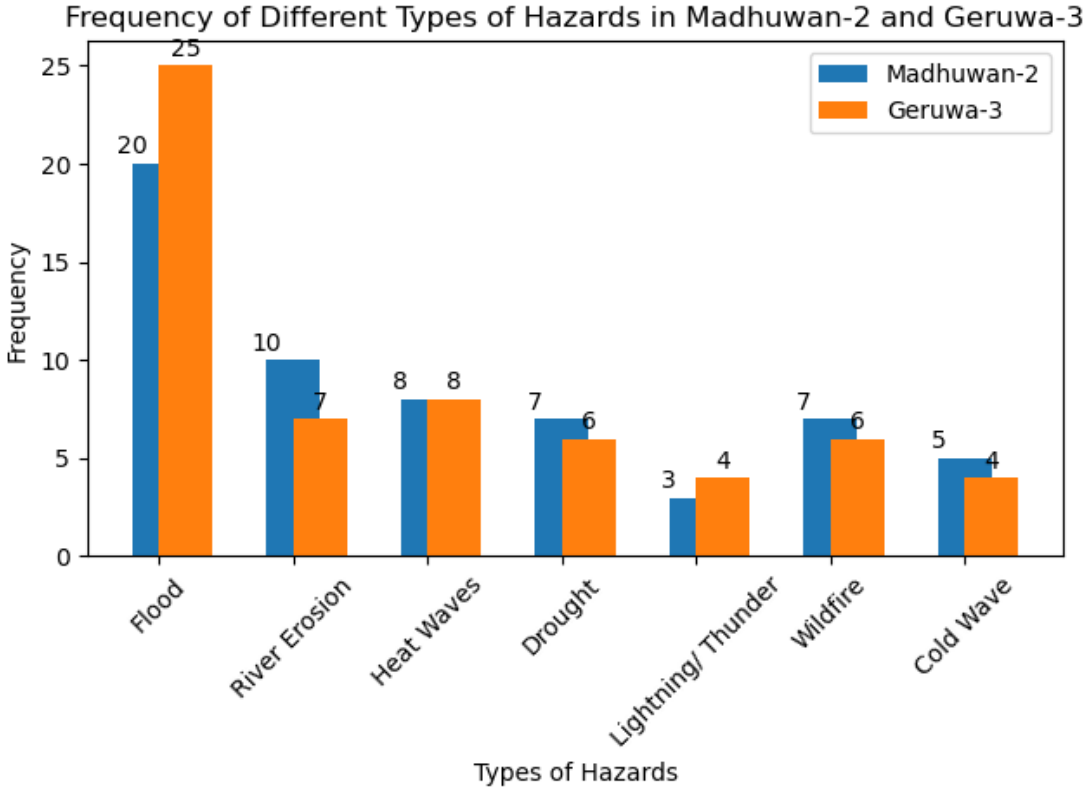
Deadly hazards are natural or human-made events that can lead to severe damage to people, property, and the environment. These include disasters such as floods, River Erosion, droughts, heat weaves, and lightening etc. The frequency of these hazards indicates how often they occur in Geruwa-3 Rural Municipalities and Madhuwan-2 Municipalities.

Table 4.3: Type of Hazards in Study Area

S. N	Types of Hazards	Madhuwan-2		Geruwa-3	
		Response Frequency	Percent	Response Frequency	Percent
1	Flood	20	33%	25	42%
2	River Erosion	10	25%	7	18%
3	Heat Waves	8	13%	8	13%
4	Drought	7	12%	6	10%
5	Lightning/ Thunder	3	5%	4	7%
6	Wildfire	7	12%	6	10%
7	Cold Wave	5	8%	4	7%
Total		**60**	**100%**	**60**	**100%**

Source: Field Survey, 2024

Figure 6: Climate Hazards from 2011- 2024 in the study Areas



Source: Bipat Portal, 2024

The first table provides information on the types and frequency of hazards in two specific areas, Madhuwan-2 and Geruwa-3. In both locations, floods are the most common hazard, affecting 33% of respondents in Madhuwan-2 and 42% in Geruwa-3. Other hazards, such as river erosion, heat waves, drought, lightning, wildfires, and cold waves, occur less frequently. River erosion is more prominent in Madhuwan-2 (25%) than in Geruwa-3 (18%), while lightning and heat waves are reported more often in Geruwa-3.

The bar chart from the Bipat Portal, showing climate hazards on a broader scale. It indicates that floods are the most frequent hazard, with 51 recorded incidents. Heavy rainfall (29 incidents) and thunderbolts (28 incidents) are also significant, while forest fires are less common, with only eight recorded cases. Unlike the first dataset, which provides percentages for specific study areas, this dataset offers absolute numbers for a wider region.

Moreover, comparing the datasets highlights flooding as the most frequent and serious hazard. However, the first dataset focuses on two specific areas and includes hazards like river erosion and cold waves, which are not mentioned in the second dataset. In contrast, the second dataset includes heavy rainfall and thunderbolts, suggesting a broader perspective on climate hazards. Despite these differences, both sources confirm that floods are a major concern in the region.

Similarly, Mr. Chaudhary said *"In 2078, our village in Geruwa suffered severe losses due to floods. For two days, we had to survive without food, and everything was washed away. Even thinking about that time still brings fear. Floods come every year, but this year has been less severe compared to previous years. However, our village faces flooding more frequently than others because we live along the riverbank, and there are no embankments. What can we do but endure this life? A proper embankment would make everything better."*

Mr. Tharu shared, "*June 24 was the most heartbreaking day of my life. My cousin, Rohit Tharu, lost his life after being struck by lightning while plowing his farm in Ganeshpur, Geruwa-3 Rural Municipality. Lightning is one of the most dangerous hazards in our area, and many people are afraid to even go to work because it can strike at any moment, making life feel uncertain and risky. Since childhood, my grandfather always advised us to take shelter under a tree and stay low on the ground during a lightning storm.* However, when my cousin was working in the field, there were no trees nearby, leaving him completely exposed. We have no formal training or knowledge on how to stay safe, only the wisdom passed down from our elders. If there are better ways to protect ourselves from lightning, we would greatly appreciate learning about them. Overall, the findings call for better disaster preparedness, infrastructure improvements, and community awareness programs to reduce vulnerabilities.

4.4 Occurrence of Hazards

The term "occurrence of hazards" refers to how often and where natural or human-made hazards happen in study areas.

Table 4.4: Occurrence of Hazards in study Areas

Response	Madhuwan-2		Geruwa-3	
	No. of respondents	Percent	No. of respondents	Percent
Once a Year	40	67%	50	83%
Multiple times a year	12	20 %	5	8.33%
Every few years	8	13%	5	8.33%
Total	**60**	**100%**	**60**	**100%**

Source: Field Survey, 2024

The table presents data on the frequency of hazard occurrences in two study areas, Madhuwan-2 and Geruwa-3, based on responses from 60 individuals in each location. In Madhuwan-2, a majority (67%) of respondents reported experiencing hazards once a year, while 20% indicated that hazards occurred multiple times within a year. A smaller portion (13%) mentioned that such events took place only once every few years. Similarly, in Geruwa-3, most respondents (83%) stated that hazards occurred annually, whereas 8.33% experienced them more frequently within a year. Another 8.33% reported facing hazards only once in several years. This data highlights that both areas experience hazards regularly, with Geruwa-3 showing a slightly higher frequency of annual occurrences.

Mr. Tharu said, "*In our Geruwa, hazards come every year, we can't even make predictions. Earlier, even my father knew, but now it's becoming difficult to know because the weather patterns have changed a lot these days*."

Overall, the challenges of adapting to changing weather patterns, emphasizing the need for improved early warning systems and preparedness measures.

4.5 Trend and Intensity of Hazards

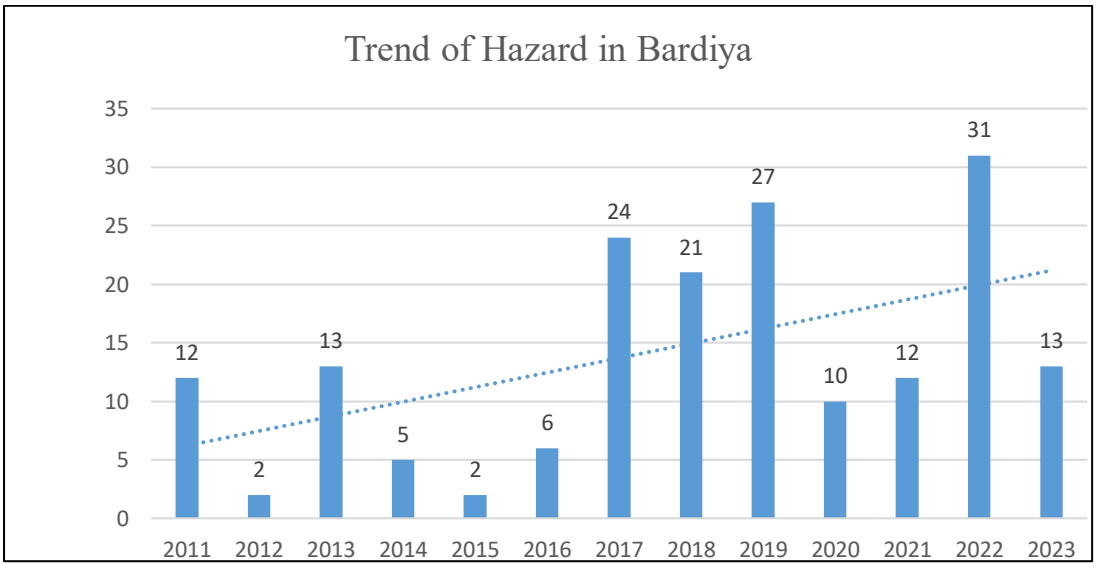
The trend of hazards describes the frequency of their occurrence over time, whether it is rising, declining, or remaining constant.

Table 4.5: Trend and Intensity of Hazards in Study Area.

Response	Madhuwan-2		Geruwa-3	
	Frequency	**Percent**	**Frequency**	**Percent**
Increased	30	50%	41	69%
Decreased	20	33%	10	17%
Stayed the same	10	17%	9	15%
Total	**60**	**100%**	**60**	**100%**

Source: Field Survey, 2024

Figure 7: Trend of Hazard in Bardiya from 2011- 2023



Source: Bipat Portal, 2024

Table 4.5 illustrates changes in the frequency of hazards as reported by respondents from two study areas, Madhuwan-2 and Geruwa-3. In Madhuwan-2, half of the respondents (50%) observed an increase in hazard occurrences, while 33% noted a decrease. The remaining 17% indicated that the frequency of hazards had remained unchanged. In Geruwa-3, a larger proportion (69%) reported an increase in hazards, whereas 17% stated that the frequency had declined. Meanwhile, 15% of respondents believed that the occurrence of hazards had stayed the same. These findings suggest that both areas have experienced changes in hazard patterns over time, with a more significant rise reported in Geruwa-3 compared to Madhuwan-2.

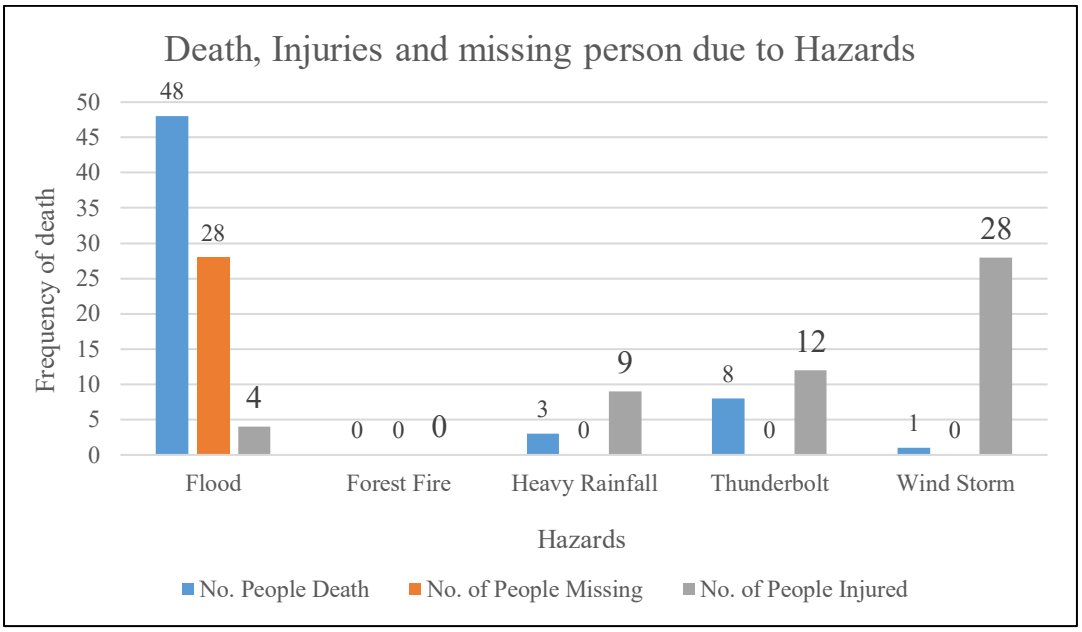
Figure 7, derived from secondary data (Bipat Portal), provides an actual recorded trend of hazards in Bardiya from 2011 to 2023. The bar chart indicates fluctuations in hazard occurrences, with a general increasing trend over the years. There were fewer hazards

recorded between 2011 and 2016, followed by a significant rise from 2017 onwards, peaking in 2019 and 2021 with 27 and 31 events, respectively.

The study findings and the secondary data from the Bipat Portal both indicate an increasing trend in hazard occurrences, although with some variations. In the study areas, a majority of respondents, especially in Geruwa-3, reported that hazards have become more frequent over time. This aligns with the recorded data for Bardiya from 2011 to 2023, which shows a general rise in hazard occurrences, particularly after 2016. While the respondents' perceptions suggest a growing impact of hazards, the actual recorded data highlights specific years, such as 2019 and 2021, when hazard events peaked. The combination of survey responses and historical data reinforces the observation that hazard occurrences have been increasing over the years, reflecting both personal experiences and documented trends in the region.

The findings highlight both personal perceptions and recorded data, emphasizing the growing impact of hazards in the region. This trend underscores the need for enhanced disaster preparedness and mitigation efforts.

Figure 8: Impact of Different Hazards on Human Casualties and Incidents



Source: Bipat Portal, 2024

The bar chart illustrates the human impact of different natural hazards, specifically focusing on the number of deaths, missing persons, and injuries. The data highlights

that floods have the most severe consequences, resulting in 48 deaths, 28 missing persons, and 4 injuries. Forest fires have no recorded casualties. Heavy rainfall caused 3 deaths and 9 injuries but no missing persons. Thunderbolts led to 8 deaths and 12 injuries, while wind storms resulted in 1 death and the highest number of injuries (28). The chart demonstrates the varying degrees of human loss and harm caused by different hazards, emphasizing the need for disaster preparedness and mitigation measures.

4.6 Seasons of Hazards

Seasons of Hazard refer to specific times of the year when particular hazards or disasters are more likely to occur due to climatic or environmental conditions. Different hazards have seasonal patterns depending on factors such as weather, temperature, rainfall, and natural cycles.

Table 4.6: Seasons of Hazards in Study Area

Response	Madhuwan-2		Geruwa-3	
	Frequency	**Percent**	**Frequency**	**Percent**
Monsoon	50	83%	55	92 %
Winter	2	3%	5	8%
Summer	3	5%	5	8%
Total	**60**	**100%**	**60**	**100%**

Source: Field Survey, 2024

The table above presents data on the seasonal occurrence of hazards in the study areas of Madhuwan-2 and Geruwa-3. In both locations, the majority of respondents identified the monsoon season as the period when hazards are most frequent. In Madhuwan-2, 83% of respondents reported experiencing hazards during the monsoon, while in Geruwa-3, this figure was even higher at 92%. In contrast, very few respondents associated hazards with winter, with only 3% in Madhuwan-2 and 8% in Geruwa-3 reporting occurrences during this season. Similarly, the summer season was linked to hazards by 5% of respondents in Madhuwan-2 and 8% in Geruwa-3. These findings suggest that hazards in both areas are primarily concentrated in the monsoon season, likely due to heavy rainfall and related environmental factors, while winter and summer pose significantly lower risks.

The key implication of the findings is that hazards in the study areas, particularly in Madhuwan-2 and Geruwa-3, are strongly seasonal, with the highest occurrences during

the monsoon season. This suggests that hazards are likely linked to weather-related factors such as heavy rainfall, flooding, or landslides. Additionally, the increasing trend in hazard occurrences, as reported by respondents and supported by secondary data, indicates a growing vulnerability in these regions. The higher frequency of hazards in Geruwa-3 compared to Madhuwan-2 further suggests that certain areas may be at greater risk, possibly due to geographical or environmental differences. These findings highlight the need for targeted disaster preparedness and mitigation strategies, especially before and during the monsoon season, to minimize risks and protect communities from recurring hazards.

Mrs. Tharu shared*, in our area, floods are the biggest problem. During the monsoon, water enters our fields and spreads everywhere. Every year, this situation worsens, leading to a food crisis that threatens our survival. Along with this, conflicts with wildlife also increase, such as elephants destroying our crops and putting our lives at risk. We have been following traditional farming methods, but it seems that this approach is no longer as effective as it used to be*.

These findings emphasize the need for targeted disaster preparedness, improved farming practices, and mitigation strategies to protect communities, especially during the monsoon season.

4.6.1 Shelter Areas During Flood in Study Areas

A shelter area is a designated safe space where people seek refuge during emergencies, such as natural disasters, conflicts, or crises. These areas provide temporary protection, basic necessities, and support to affected individuals.

Table 4.6.1: Shelter Areas During Flood in Study Areas

Description	Frequency	Total	Percent
Government Office	1	120	1%
Orali Bazar, Madhuwan	35	120	29%
Municipalities ground	17	120	14%
Higher School	7	120	6%
Nepalgunj	9	120	8%
Public Shelters	5	120	4%
Public Space	2	120	2%
Schools	28	120	23%
Shelter House	1	120	1%
Gulariya	15	120	13%
Total	**120**		**100%**

Source: Field Survey, 2024

The data on shelter areas during floods in the study areas highlights the various locations where affected individuals seek refuge. The most commonly used shelter is Orali Bazar, Madhuwan, where 29% of respondents reported taking shelter during floods. This indicates that Orali Bazar serves as a major evacuation site, likely due to its accessibility and relatively safer conditions. Schools also play a crucial role in providing temporary refuge, with 23% of respondents seeking shelter in school buildings, demonstrating the importance of educational institutions in disaster response.

Other frequently used shelter areas include municipalities' grounds (14%) and Gulariya (13%), suggesting that open spaces and nearby urban centers are also considered safe havens during flooding. Nepalgunj, a larger urban area, was identified by 8% of respondents as a shelter location, indicating that some people may relocate to more distant but secure areas during severe floods.

Less commonly used shelter options include higher schools (6%), public shelters (4%), public spaces (2%), government offices (1%), and shelter houses (1%). The low percentage of people seeking refuge in designated shelter houses and government offices suggests a potential gap in formal disaster relief infrastructure.

Overall, the findings emphasize the reliance on markets, schools, and open public spaces as primary flood shelters. This underscores the need for improved disaster preparedness, permanent shelter facilities, and infrastructure development to enhance the safety and well-being of affected communities during flood events.

KII, from Disaster Risk Management Community Member Mr. Tharu reported that: "*When floods occur, most people leave their homes to seek shelter elsewhere because the floods submerge their houses. For those near Geruwa, Rajapur becomes one of the closest destinations, and many even go all the way to Gulariya on the other hand, near for Madhuwan is* Orali Bazar*. Others take refuge in schools or shelter houses, but there aren't enough shelter houses, and those that do exist are often in poor condition. Since life is precious, people prioritize safety, and this is why many do not return home during the monsoon season, fearing the floods."*

Similarly, Mr. Tharu said that *"The shelter house in our village is very weak, and the water level also reaches there. The shelter house built by the government is not reliable at all. Instead of going there, we feel safer staying at home because even if we go, the water still reaches the shelter*."

Overall, the government should urgent need for improved disaster preparedness, better infrastructure, and more permanent shelter facilities to ensure community safety during floods. Strengthening evacuation plans and expanding formal shelter options are crucial for enhancing resilience in flood-prone areas.

4.7 Organization Support for Hazards Mitigation

Organizations play a crucial role in hazard mitigation by providing resources, planning strategies, and implementing programs to reduce the impact of disasters. Various governmental, non-governmental, and international organizations work together to enhance community resilience and minimize risks associated with natural and man-made hazards.

Table 4.7: Organization Support for Hazards Mitigation

S.N.	Working Organization in Study Areas	Response Frequency	Total	Percent
1	Care Nepal	5	120	4%
2	Bheri Environmental Excellence Group	15	120	13%
3	Tharu Women Upliftment Center	3	120	3%
4	UNDP Initiatives	6	120	5%
5	United States Agency for International Development	2	120	2%
6	Plan International	2	120	2%
7	Red Cross Society	5	120	4%
8	Banke UNESCO	2	120	2%
9	Center for Social Development and Research	30	120	25%
10	Tayar Nepal	1	120	1%
11	Practical action	49	120	41%
Total		120		100%

Source: Field Survey, 2024

The data from the 2024 field survey highlights the contributions of various organizations in hazard mitigation efforts within the study areas. Among the organizations involved, Practical Action emerged as the leading contributor, accounting for 41% of the total responses. This suggests that Practical Action plays a significant role in disaster risk reduction and community resilience-building initiatives. Following this, the Center for Social Development and Research (CSDR) also demonstrated substantial engagement, with 25% of respondents acknowledging its support in hazard mitigation efforts.

Other organizations had a relatively lower level of involvement. The BEE Group accounted for 13% of the responses, indicating its moderate contribution to disaster response and preparedness. Meanwhile, organizations such as UNDP Initiatives (5%), Care Nepal (4%), and the Red Cross Society (4%) were also recognized for their support, though their impact was less pronounced compared to the leading contributors.

Several organizations reported minimal engagement in hazard mitigation activities. These include TWUC (3%), USAID (2%), Plan International (2%), and Banke UNESCO (2%), each representing only a small fraction of the total responses. Tayar

Nepal had the lowest reported involvement, with just 1% of the responses, suggesting limited activity in the study areas.

KII from Mr. Joshi, NGO Program coordinator of BEE Group: "*Our BEE Group, in collaboration with Practical Action, has been working in Bardiya's five municipalities and Kailali since 2014 on climate-related projects. Our objectives include addressing climate-related disasters, early warning systems, and the use of Climate Risk Management and Measurement (CRMC) tools. For instance, we use these tools to measure the extent of floods in Geruwa and Madhuwan villages, and we even apply them directly in the rivers. This helps create awareness among the local people about the risks they face."*

Overall, the findings indicate that while Practical Action and CSDR are the primary organizations involved in hazard mitigation, other organizations play supporting roles with varying degrees of engagement. The results emphasize the need for a more coordinated and integrated approach among all stakeholders to strengthen disaster preparedness and response efforts in the region.

4.8 Information about Hazards

A hazard is a potential threat or event that can cause harm to people, property, or the environment. Hazards can be natural, human-made, or a combination of both. Understanding hazards is essential for risk reduction, preparedness, and effective disaster management.

Table 4.8: Information About Hazards received in the Study Areas

S.N.	Information of Hazards	Frequency	Percent
1	Community Meeting	14	11.7%
2	Radio	14	11.7%
3	Mobile Alerts	70	58.3%
4	Not any medium/information	7	5.8%
5	Word-of-Mouth	15	12.5%
Total		120	100%

Source: Field Survey, 2024

The data on sources of hazard-related information in the study areas reveals that mobile alerts are the most widely used method for disseminating warnings, with 58.3% of

respondents reporting receiving information through this channel. This suggests that mobile technology plays a crucial role in early warning systems, allowing communities to receive timely updates on potential hazards. Other sources of information include word-of-mouth (12.5%), community meetings (11.7%), and radio broadcasts (11.7%), indicating that traditional communication methods still play a significant role in spreading awareness. The similar percentage of respondents relying on community meetings and radio suggests that these platforms are equally important for hazard communication, particularly for individuals who may not have access to mobile alerts. However, 5.8% of respondents reported not receiving any hazard-related information, highlighting a potential gap in the dissemination of critical warnings. This underscores the need for more inclusive and accessible communication strategies to ensure that all community members are informed and prepared for potential hazards. Overall, the findings suggest that while mobile alerts are the dominant source of hazard information, traditional methods such as radio, community meetings, and word-of-mouth continue to play an important role, particularly in areas with limited digital access. Strengthening these communication channels and ensuring widespread coverage can significantly enhance community preparedness and response to hazards.

Mrs. Chaudhary said: "*In the year 2071 B.S, there was one of the biggest floods in history, but no lives were lost due to an effective flood early warning system. Here, if the water level rises by 11 meters within 3 hours, we move all belongings to a safe place. In 2071, the water level reached 15-16 meters, and although everything except human lives was destroyed, early warnings helped prevent loss of life."*

KII from Badh Ghar Community Head Mr. Tharu said that *"In our village, nowadays we receive hazard information through mobile alerts. However, in the past, we had a village watchman, and we still have one, who would go from house to house sharing the news orally. This also created activity in the village and at the ward level. Those who receive information on time are usually those who have mobile phones, but for those who do not, the watchman delivers the message to them…*"

Overall, the effectiveness of early warning systems in saving lives, as seen during the 2071 B.S. flood. The continued role of village watchmen in delivering warnings ensures broader reach but also highlights gaps in accessibility. Strengthening both digital and

traditional communication channels is essential for improving disaster preparedness and ensuring no one is left uninformed.

4.8.1 Mural Art

Mural art consists of large-scale works created directly on walls, ceilings, or other fixed surfaces. These artworks can be made using various methods, including painting, mosaics, graffiti-style spray paint, or digital printing. Murals serve multiple purposes, such as storytelling, conveying cultural or political messages, enhancing public spaces, and reflecting the identity of a community.

Figure 9: Mural Art

Students of Kalika School dressed in traditional cultural attire contribute to a mural art showcasing the flood impact on their municipality in the first-ever scientific mural art organised in Nepal at Rajapur in Bardiya, on Wednesday.

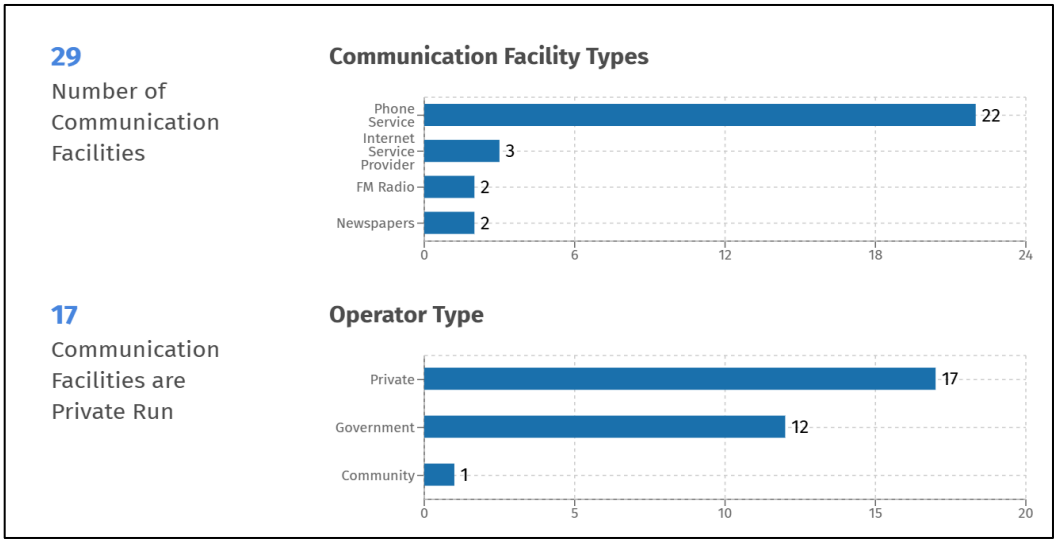
Source: The Himalayan Times, 2024

As the nation anticipates the arrival of the monsoon season responsible for nearly 80% of its annual rainfall, it is essential to equip communities with the knowledge and resources needed to effectively respond to potential floods. Rajapur municipality, situated between the Geruwa and Karnali rivers, frequently experiences flooding, disrupting daily life and leaving residents in constant fear. In recent years, climate change has intensified rainfall patterns, causing water levels to rise and increasing the risk of floods. Even minor flooding can force the Budhi Kulo River to deviate from its natural path, leading to the inundation of farmland and residential areas.

Despite the presence of early warning systems in Rajapur, severe economic losses continue to impact the community due to the flooding of homes and agricultural land, affecting livelihoods. After that, disasters have lasting consequences, and effectively communicating critical information can be challenging. Murals, however, can be a powerful medium for educating the public on flood preparedness. They can visually depict crucial steps to take before, during, and after a flood, such as utilizing early warning systems, understanding flood risks, identifying evacuation routes, and locating safe shelters. Through such visual storytelling, murals can play a vital role in raising awareness and enhancing community resilience against flooding.

Overall, effective communication is crucial for disaster preparedness, and murals art offer a powerful visual tool to educate communities on flood response measures. By illustrating key actions before, during, and after floods, murals can enhance awareness, promote safety, and strengthen community resilience and it should be promoted in every school of both areas.

Figure 10: Communication Facility and Operation Types in Study Area

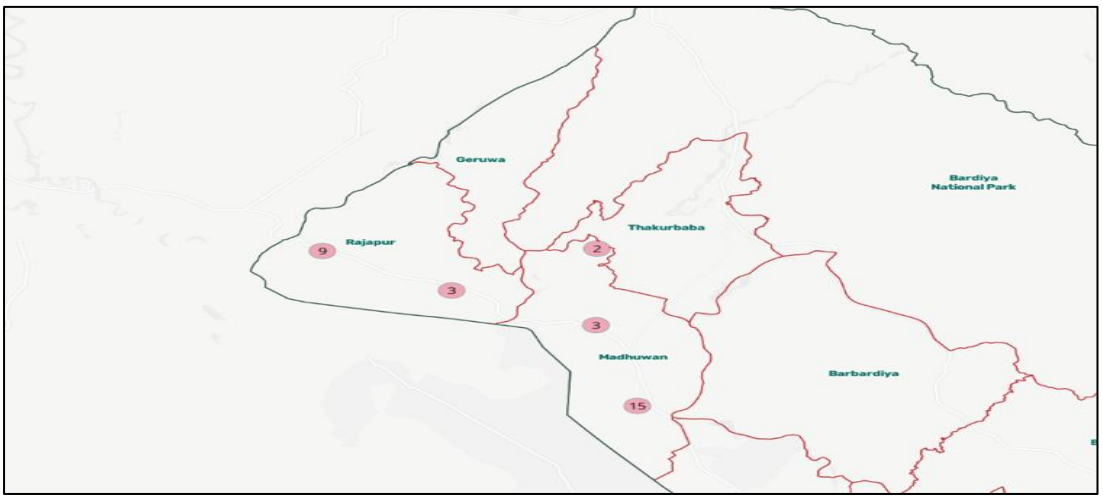


Source: Bipat Portal, 2024

The figure presents data on communication facilities and their operation types in the study area. A total of 29 communication facilities are available, categorized into different types. Among them, phone services dominate with 22 facilities, followed by internet service providers with 3, while FM radio and newspapers each have 2 facilities. In terms of operational control, 17 of these facilities are privately run, while 12 are

operated by the government, and 1 is community-run. This indicates that private entities play a significant role in the communication infrastructure of the area, though the government also has a notable presence. The data source is cited as the Bipat Portal.

Figure 11: Communication Facilities in Bardiya District



Source: Bipat Portal, 2024

The map shows very clearly in Geruwa-3 there was no communication access before 24 years ago and people were more vulnerable if there was no infrastructure. And others areas had full communication due to that they are less vulnerable in Bardiya. So, Geruwa and Madhuwan need more innovate and scientific way of communication which help them from disasters.

4.9 Financial Support for Coping with Hazards

Financial support for coping with hazards refers to financial assistance provided to individuals or communities to help them manage and recover from the impact of hazards, such as natural disasters (e.g., floods, droughts, or earthquakes). This funding is aimed at supporting recovery efforts, mitigating damage, and addressing the immediate needs of those affected by such events. It may come from various organizations, such as government agencies, NGOs, or international bodies, and is intended to help vulnerable populations cope with the aftermath of a disaster.

Table 4.9.1: Financial Support for Coping with Hazards

Category	Response	Frequency	Percent
Received fund	Yes	33	27.5%
	No	87	72.5%
Total		**120**	**100**

Source: Field Survey, 2024

The data shows that only 27.5% of respondents received financial support, while the majority (72.5%) did not. This indicates a significant gap in financial assistance, suggesting that many affected individuals may struggle to recover from disasters without adequate support.

Table 4.9.2: Fund Amount

Category	Response	Frequency	Percent
Fund Amount	15000.00	98	81.67%
	100000.00	14	11.67%
	150000.00	8	6.66%
Total		**120**	**100**

Source: Field Survey, 2024

The data reveals that the majority (81.67%) of recipients received financial aid of NPR 15,000, while a smaller portion received NPR 100,000 (11.67%) and NPR 150,000 (6.66%). This suggests that most financial assistance provided was relatively low, potentially limiting recovery efforts. The funds were distributed by various organizations, including BEE group municipalities, the Red Cross, and CDRS, aiming to support disaster-affected individuals. However, the disparity in fund amounts highlights the need for more equitable and sufficient financial assistance to ensure effective disaster recovery.

Table 4.9.3: Funding Organization

Category	Response	Frequency	Percent
Funding organization	BEE Group	70	58%
	CSDR	25	20.83%
	Nepal Red Cross Society	15	12.5%
	Municipalities	10	8.33%
Total		**120**	**100%**

Source: Field Survey, 2024

The data shows that the BEE Group provided the largest share of financial support (58%), followed by CSDR (20.83%), Nepal Red Cross Society (12.5%), and municipalities (8.33%). This indicates that non-governmental organizations played a major role in disaster relief efforts, while municipal contributions were the lowest. The significant support from external organizations highlights their importance in providing aid, suggesting the need for greater involvement from local authorities to enhance financial assistance and disaster recovery efforts.

4.10 Impact of Climate Change and Socio-Economic Aspects

Climate change impacts economies and societies by leading to agricultural decline, health challenges, and infrastructure damage. It exacerbates inequalities, with vulnerable communities being the most affected. Implementing sustainable policies and adaptation measures is crucial for stability.

4.10.1 Impact of Climate Change on Social Aspect

Climate change significantly affects livelihoods by disrupting jobs, income sources, and economic stability, particularly in communities dependent on natural resources. Rising temperatures, extreme weather events, and environmental changes threaten agriculture, fishing, tourism, and other industries, pushing many people into poverty and forcing migration.

Table 4.10.1: Impact of Climate Change on Social Aspect

S. N	Categories	Frequency	Total	Percent
1	Education disruption	20	120	17%
2	Water scarcity	30	120	25%
3	Increased inequality	2	120	2%
4	Migration and displacement	13	120	11%
5	Loss of traditional livelihood	30	120	25%
6	Resource scarcity to make local craft	25	120	21%
Total		**120**		**100%**

Source: Field Survey, 2024

Climate change is having a major impact on people's lives, especially in communities that depend on natural resources like farming, fishing, and tourism. Rising temperatures, unpredictable weather, and environmental changes are making it harder for people to earn a living, pushing many into poverty and even forcing them to leave their homes. One of the biggest challenges is water scarcity, affecting 25% of cases, as droughts and changing rainfall patterns reduce access to clean water for drinking,

farming, and daily needs. Similarly, loss of traditional livelihoods (25%) is a significant issue, as changing weather conditions make it difficult for people to continue farming, fishing, or other traditional jobs, leading to unemployment and economic struggles.

Another major effect is education disruption, which affects 17% of cases. Schools may be damaged by extreme weather, transportation becomes difficult, or families are forced to move, preventing children from getting a proper education. Climate change also leads to resource scarcity for local crafts (21%), making it harder for artisans and small businesses to find the materials they need for their work. Migration and displacement (11%) occur when people can no longer sustain their lives in their hometowns, forcing them to move elsewhere in search of better opportunities. Lastly, while increased inequality affects fewer cases (2%), it is still an important issue, as poorer communities struggle the most to recover from climate-related disasters, widening the gap between rich and poor.

Overall, water shortages and job losses are the biggest challenges, causing a chain reaction that disrupts education, forces migration, and worsens poverty. Climate change is not just an environmental issue it directly impacts livelihoods, stability, and the future of communities around the world.

Mr. Regmi, a farmer from Geruwa Rural Municipality, said that "*Geruwa has been facing irrigation problems during both summer and winter. The drought begins around the month of Chaitra, and unlike before, there is hardly any rainfall. As a result, drinking water sources dry up, hand pumps stop working, and streams and canals no longer provide sufficient water. Nowadays, people are forced to buy drinking water instead of relying on natural resources. However, when clean water is available, they collect and store it in bottles for later use…"*

Additionally, Mr. Poudel, a park ranger, mentioned that "*water scarcity is also making life difficult for wildlife during the dry season. Most streams and canals are drying up, making it hard for animals near Geruwa, such as tigers, rhinos, deer, and elephants, etc. to find drinking water. He added that due to the lack of water, not only human livelihoods but also wildlife habitats are being severely affected, leading to a decline in animal populations."*

Mr. Tharu, one of the KII respondents said*, "In our village, most people are farmers, and this area is known for producing rice, maize, and wheat. We grow crops both for our own consumption and for sale because we need to support our families. In this time of high prices, it is very difficult to afford education for our children. On top of that, the cost of water has risen, and during the hot summer months, the sun dries up the land, ruining our crops. Flooding is also a frequent problem here. There is a severe shortage of clean drinking water, so we collect it in bottles to make sure we have safe water to drink*."

Another KII Respondent, a farmer Mr. Tharu said, *"Our village has mostly lowland dry soil, and it is no longer as fertile and productive as before. We are very worried because our maize and rice crops are of poor quality due to the fall armyworm infestation. Additionally, when talking about the soil floods, drought and heat waves have further worsened agricultural conditions*."

Addressing these challenges requires urgent action, including sustainable water management, climate-resilient farming techniques, and policies that support vulnerable communities. Without immediate intervention, the impact of climate change will continue to deepen inequalities and threaten the future of rural communities worldwide.

4.10.2 Impact of Climate Change on Economic Condition

Climate change has significant economic consequences, affecting industries, employment, and overall financial stability. Rising temperatures, extreme weather events, and environmental changes lead to direct and indirect economic losses worldwide.

Table 4.10.2: Impact of Climate Change on Economic Condition

S. N	Categories	Frequency	Total	Percent
1	Agriculture loss	40	120	33%
2	Livestock decline	25	120	21%
3	Increased food prices	20	120	17%
4	Job less	12	120	10%
5	Infrastructure damage	5	120	4%
6	Higher disaster recovery costs	18	120	15%
Total		120		100%

Source: Field Survey, 2024

Climate change is causing serious economic problems, affecting industries, jobs, and overall financial stability. One of the biggest impacts is on agriculture, which accounts for 33% of economic losses. Rising temperatures, droughts, and unpredictable weather make it harder for farmers to grow crops, leading to lower harvests and financial struggles. Similarly, the decline in livestock (21%) is another major issue, as extreme heat, lack of water, and food shortages affect animals, reducing meat and dairy production and causing further economic setbacks.

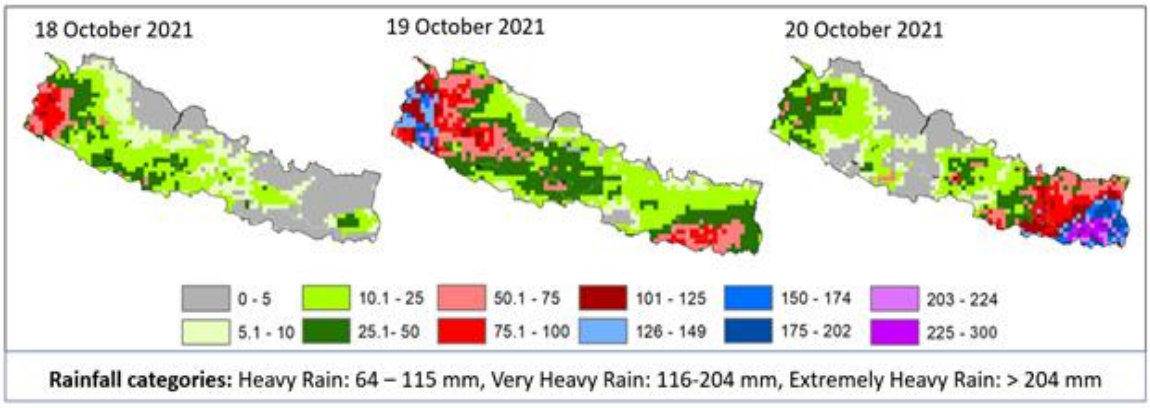
As a result of these agricultural losses, food prices are increasing (17%), making it more expensive for people to afford basic necessities. Climate change is also leading to job losses (10%), especially in industries like farming, fishing, and tourism, where people depend on stable weather conditions to earn a living. Additionally, infrastructure damage (4%) is another concern, as floods, storms, and extreme weather destroy roads, bridges, and buildings, requiring expensive repairs.

Another major economic burden is the high cost of disaster recovery (15%). When floods, droughts, and storms hit, governments and communities have to spend huge amounts of money on rebuilding, medical aid, and emergency relief. These combined effects show that climate change isn't just an environmental issue it's also a financial crisis, making life more expensive, reducing job opportunities, and threatening the stability of entire economies.

Mr. Tharu said "In our village, when the floodwaters rose, around 50-60 houses were affected. Many people from the flooded area sat nearby, crying, thinking about what to do. It was heartbreaking to see them in pain. No one could remain unmoved by their suffering. Even the money earned during the rainy season was not enough to rebuild their homes. It was very difficult to get a loan from the bank, and there was no help available from anywhere."

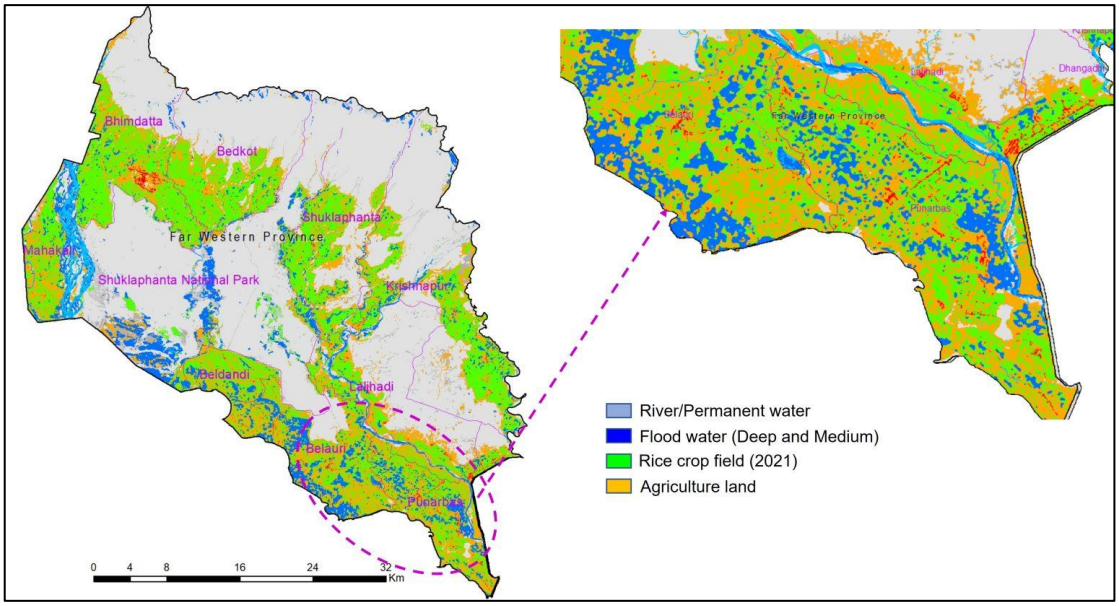
Overall, to protect communities and economies, investments in climate-resilient infrastructure, sustainable agriculture, and financial aid programs are essential. Without immediate intervention, the growing economic burden of climate change will continue to push vulnerable populations into deeper poverty, threatening long-term economic stability.

Figure 12: Rainfall distribution during 18-20 October 2021 based on the GPM IMERGE satellite precipitation data



Source: ***CIMMYT agriculture loss blog***

Figure 13: Flood extent on 21 October 2021 in Bardiya district based on the Sentinel-1 satellite data



Source: ***CIMMYT agriculture loss blog***

As climate change-driven disasters continue to escalate worldwide, the most severe consequences are seen by populations in the least developed countries. Data from the International Disaster Database indicate a 74.5% increase in global disaster occurrences when comparing 19-year periods 1980–1999 and 2000–2019, with projections suggesting further rises due to evolving climate change scenarios. The Intergovernmental Panel on Climate Change (IPCC) highlights that Nepal faces mounting economic losses from these climate-related events, particularly affecting the agricultural sector.

For instance, in October 2021, unseasonal and excessive rainfall triggered severe flooding, causing extensive damage to ready-to-harvest rice crops in Nepal's primary rice-producing regions. This unexpected disaster posed a significant threat to food security and the livelihoods of farmers.

To assess the extent of seed production losses and devise anticipatory strategies for seed management and distribution in the following season, a damage assessment was conducted by CIMMYT. In collaboration with the International Maize and Wheat Improvement Center and the International Center for Integrated Mountain Development (ICIMOD), a rapid loss assessment was carried out through farmer surveys. Utilizing the Geoffrey mobile application, the USAID-funded Nepal Seed and Fertilizer (NSAF) project, led by CIMMYT, surveyed 253 rice farmers across six districts in the mid and far western regions. This assessment provided crucial data to inform the Nepali government's response efforts, enabling timely interventions to mitigate the disaster's impact on future rice cultivation.

One study takes a localized approach, focusing on the direct impact of extreme weather on rice farmers in Nepal, detailing Agriculture losses and the necessity of rapid assessments to inform government responses. The other provides a broader global perspective on climate change's economic consequences, emphasizing agricultural decline, rising food prices, job losses, and infrastructure damage. While one highlights immediate disaster response and mitigation strategies, the other underscores long-term financial instability and economic burdens. Addressing these challenges requires both short-term and long-term solutions, including anticipatory measures like rapid loss assessments, seed distribution, and improved climate-resilient farming techniques. Additionally, financial safety nets, easier access to loans, disaster relief programs, and investments in resilient infrastructure are essential to protect vulnerable communities from the escalating socioeconomic impacts of climate change.

According to Mr. Tharu, "*In October 2021, severe flooding in the Karnali catchment area of western Nepal resulted in the loss of at least 103 lives. In the Mahakali River basin, the disaster displaced 2,600 people and caused significant agricultural damage, affecting more than 126,282 hectares of paddy fields. High-value crops like vegetables and aquaculture were also heavily impacted*."

Overall, as climate-related disasters continue to escalate, a proactive approach combining emergency response with long-term resilience-building efforts is necessary. Strengthening adaptation strategies and investing in sustainable agriculture will be critical to safeguarding both livelihoods and economic stability in the face of an increasingly unpredictable climate.

4.11 Impact of Hazards on Health Aspect in the Study Area

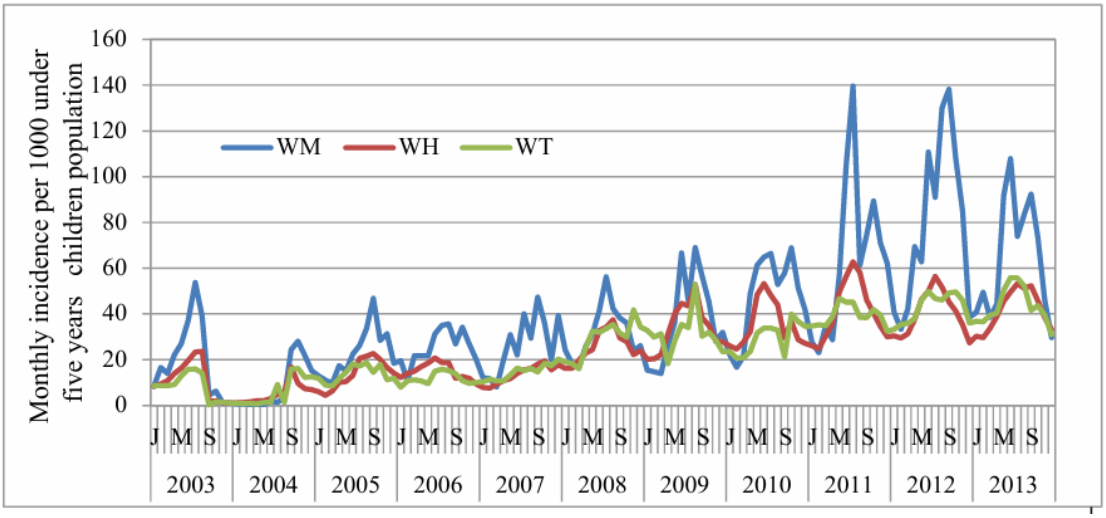
Climate change has severe consequences for human health, increasing the risk of diseases, worsening environmental conditions, and straining healthcare systems. Rising temperatures, extreme weather events, and pollution contribute to a variety of health issues, particularly for vulnerable populations like children, the elderly, and low-income communities.

Table 4.11: Impact of Climate change on Health Aspect

S. N	Categories	Frequency	Total	Percent
1	Heat related illness	12	120	10%
2	Waterborne disease	55	120	46%
3	Chronic disease	11	120	9%
4	Vector Borne disease	25	120	21%
5	Mental illness	3	120	3%
6	Respiratory Disease	14	120	12%
Total		**120**		**100%**

Source: Field Survey, 2024

Figure 14: Monthly Diarrheal Incidence in Under Five Children in Western Development Region



Source: HMIS Data, 2003 – 2013

The first study presents data on various health conditions influenced by climate change, focusing on a surveyed population of 120 individuals. The most prevalent issue reported is waterborne disease (46%), followed by vector-borne disease (21%) and respiratory disease (12%). Other health impacts, such as heat-related illnesses (10%), chronic diseases (9%), and mental illness (3%), also highlight the diverse ways climate change affects public health.

The second study, based on HMS data from 2003 to 2013, examines monthly diarrheal incidence in children under five in the Western Development Region. The graph shows fluctuations in cases over time, with a noticeable rise in diarrheal incidence in later years, suggesting increasing vulnerability to climate-related factors, possibly due to worsening water quality, sanitation challenges, and rising temperatures.

Both studies emphasize the health risks posed by climate change, particularly the increased prevalence of waterborne diseases. While the first study provides cross-sectional survey data highlighting how climate change affects different health conditions in a specific population, the second study offers a longitudinal perspective on diarrheal disease trends in children. The complementary nature of these studies strengthens the argument that climate change disproportionately affects vulnerable groups, such as children and low-income communities, due to their heightened exposure to contaminated water, inadequate healthcare access, and environmental stressors. For the thesis, integrating these findings can support arguments on the long-term health impacts of climate change, particularly its role in exacerbating infectious diseases. The rising trend of diarrheal cases over a decade aligns with the survey findings, reinforcing the need for urgent interventions in public health, water management, and climate adaptation policies.

It refers to the changes, often negative, that human activities and natural events cause to the environment. These impacts can affect air, water, land, ecosystems, wildlife, and even human health. They result from activities such as deforestation, pollution, industrialization, and climate change.

4.12 Impact of Climate Change on Environment Aspect

Table 4.12: Impact of Climate Change on Environment Aspect

S. N	Categories	Frequency	Total	Percent
1	Loss of biodiversity	32	120	27%
2	Deforestation	20	120	17%
3	Soil degradation	12	120	10%
4	Rising temperature	19	120	12%
5	Disruption of Ecosystem	15	120	20%
6	Extreme weather Events	22	120	18%
	Total	**120**		**100%**

Source: Field Survey, 2024

The table depicts that Climate change has significantly affected the environment in Geruwa-3 and Madhuwan-2, leading to biodiversity loss (27%)**,** as changing weather patterns disrupt habitats and threaten local species. Deforestation (17%) has also increased, driven by the need for land and resources, further exacerbating environmental degradation. Soil degradation (10%)**,** caused by erosion and unsustainable agricultural practices, has reduced land fertility, impacting crop production.

Additionally, rising temperatures (12%**)** have altered local climate conditions, affecting water availability and increasing heat stress. Disruption of ecosystems (20%) has been observed, as shifts in climate patterns disturb the natural balance of flora and fauna. Extreme weather events (18%)**,** including floods and droughts, have intensified, posing long-term risks to both the environment and human settlements.

Addressing these challenges requires sustainable environmental policies, afforestation programs, and climate adaptation measures to mitigate further ecological degradation and enhance resilience.

Mr. Tharu said that "*our village is close to the boundary of the national park. In the past, people used to hunt deer and small wild animals. Later, human greed increased, leading to the illegal trade of large wild animals such as rhinos, Asian elephants, and royal Bengal tigers. Many incidents have occurred, and numerous cases have been reported in the news. These wild animals are extremely important because if they disappear, it will severely impact the ecosystem and disrupt the climate."*

Mr. Tharu said that "*when we were young, this place used to have many birds. In the past, when an animal died, vultures would come and feed on it, but now it has been a long time since we have seen vultures. This might be due to the excessive use of chemicals. Many different bird species have disappeared, and even the oxygen level in the area has decreased. At the local level, natural conservation efforts have been quite effective, leading to increased greenery. However, people are altering rivers and streams according to their desires, extracting sand from the riverbanks and using it for construction. The government needs to pay more attention to this issue. In the name of waste management and development, infrastructure such as roads is being built along river paths. In the past, the temperature used to be around 25°C, but now it has risen to 45-46°C. However, this change is also within our control."*

Additionally, Mr. Mainali mentioned that "*human-wildlife conflict is a serious issue, especially as conservation efforts lead to an increasing animal population. As tigers and elephants expand their ranges, they come into more frequent contact with local communities, often causing severe consequences. Tigers prey on livestock, while elephants can destroy crops and homes. In Madhuban Wards 1, 2, and 3, nearly 15 to 20 people have been killed by tigers. Because of this, I believe tigers should not be bred, as they pose a significant threat to everyone. The government should consider the geography and capacity of the national park, as the available area is too small to accommodate the growing wildlife population."*

Climate change and human activities have caused biodiversity loss, deforestation, and rising temperatures in Geruwa-3 and Madhuwan-2. Human-wildlife conflict and resource exploitation further threaten the environment. Sustainable policies, conservation efforts, and climate adaptation are essential to protect both nature and communities.

4.13 Water Related Crisis and Conflicts in Study Area

Table 4.13 Water Related Crisis and Conflicts in Study Area

S. N	Categories	Frequency	Total	Percent
1	Drying Up Water Sources	25	120	21%
2	Reliance on Underground Water	15	120	12.5%
3	Impact on Agricultural Irrigation	45	120	37%
4	Wildlife Migration due to Water Scarcity	20	120	17%
5	Human-Wildlife Conflict	15	120	12.5%
Total		120		100%

Source: Field Survey, 2024

Water scarcity is a critical challenge in Geruwa-3 and Madhuwan-2, affecting agriculture, livelihoods, and local ecosystems. The study reveals that 37% of respondents identified reduced agricultural irrigation as the most severe consequence, leading to declining crop yields and food insecurity. Additionally, 21% reported the drying up of natural water sources, forcing communities to travel further for water.

To adapt, 12.5% of respondents rely on underground water extraction, but overuse raises concerns about depletion and contamination. 17% observed wildlife migration due to water shortages, disrupting biodiversity, while 12.5% reported an increase in human-wildlife conflict, as animals encroach on settlements in search of water.

Addressing these issues requires sustainable water management, improved irrigation infrastructure, and policies that protect both human and ecological needs.

Miss Thapa said, *"Due to the dirty water, everyone in the village, from the elderly to the children, suffers from unclean conditions. The water from the hand pump is also contaminated, leading to different waterborne diseases. Our mother and father used to digest water however, nowadays we could not digest water because of such an environment. Everything seems mixed up, and when we look around, many people suffer from diarrhea and go to the health clinic. We provide life-saving water for free from the health post, going from village to village. We try to help as much as we can…"*

Water scarcity in Geruwa-3 and Madhuwan-2 severely impacts agriculture, livelihoods, and local ecosystems, leading to reduced irrigation, drying water sources, and increased human-wildlife conflict. Contaminated water further threatens public health, causing widespread waterborne diseases. Addressing these challenges requires sustainable water management, improved irrigation systems, and better access to clean water to protect both human and environmental well-being.

4.14 Impact of Hazards: Damage and Loss

Table 4.14: Impact of Hazards: Damage and Loss

S.N.	Hazard	Estimated loss (NPR)
1	Flood	3781985700
2	Forest Fire	0
3	Heavy Rainfall	4156000
4	Thunderbolt	995000
5	Windstorm	19746082
Grand Total		**3806882782**

Source: Bipat Portal, 2024

According to data from the Bipad Portal (2024), climate change-related hazards have resulted in significant financial losses, totaling NPR 3.8 billion. Among these, floods have caused the most severe damage, accounting for approximately NPR 3.78 billion, making them the most financially devastating disaster. Windstorms follow with losses of around NPR 19.7 million, while heavy rainfall and thunderbolts have led to damages of NPR 4.1 million and NPR 995,000, respectively. Interestingly, forest fires report no recorded financial loss in this dataset, which could be due to either the absence of major incidents or insufficient documentation. The financial losses from these climate-induced hazards directly correlate with the socio-economic and health impacts observed. Economic impacts such as crop loss (48%) and asset destruction (21%) align with the severe financial toll of floods, which destroy farmlands and homes. Additionally, land degradation (4%) may be a consequence of repeated flooding and windstorms. In terms of social impacts, agriculture loss (25%) and water scarcity (25%) highlight the struggles caused by extreme weather events like floods and droughts, while migration and displacement (11%) can be linked to recurring disasters forcing people to relocate. The health impacts of climate change are also evident, with

waterborne diseases (46%) likely resulting from floods contaminating water supplies, and vector-borne diseases (21%) increasing due to stagnant water creating breeding grounds for mosquitoes. In conclusion, floods emerge as the most destructive hazard, causing widespread economic and social damage, particularly to agriculture and infrastructure. The economic burden of climate change is immense, as reflected in financial losses and socio-economic struggles such as crop loss, income reduction, and displacement. Additionally, health impacts are closely linked to climate disasters, with an increase in waterborne and vector-borne diseases due to changing environmental conditions. To mitigate these long-term consequences, urgent measures such as disaster resilience strategies, improved healthcare access, and climate adaptation policies are essential. Addressing these challenges proactively can help protect vulnerable communities and build a more sustainable future.

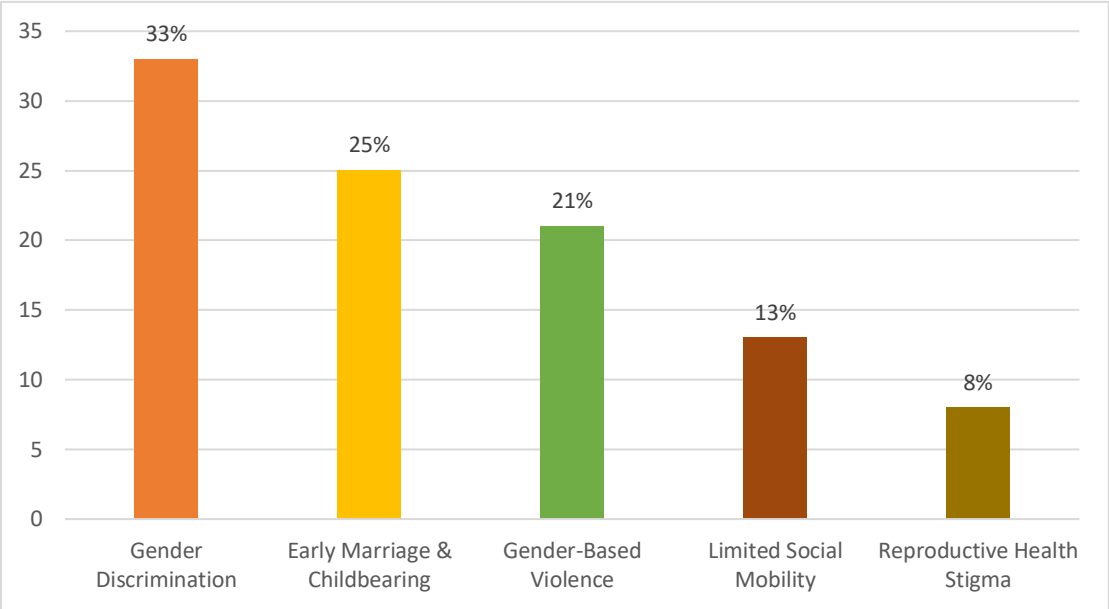
4.15 Barriers and Vulnerabilities Faced by Women due to Climate Change

Barriers refer to obstacles or challenges that prevent individuals or groups from accessing opportunities, resources, or support. These can be social, economic, environmental, or political in nature. Vulnerabilities refer to weaknesses or risks that make individuals or groups more susceptible to harm or difficulties, especially during crises like climate change.

4.15.1 Social Barriers & Vulnerabilities

Social barriers are cultural and societal obstacles, such as gender discrimination and rigid norms, that limit marginalized groups' access to education, employment, and rights.

Figure 15: Social Barriers & Vulnerabilities



Source: Field Survey, 2024

The Bar Graph highlights the various social barriers and vulnerabilities that hinder marginalized groups from accessing education, employment, and basic rights. These barriers are deeply rooted in social norms, cultural traditions, and structural inequalities, making it difficult for individuals, particularly women and marginalized communities, to break free from cycles of poverty and discrimination. The data reveals how factors such as gender discrimination, early marriage and childbearing, gender-based violence, and limited social mobility create significant obstacles that limit opportunities and reinforce socio-economic disparities.

Gender discrimination, reported by 33% of respondents, is the most prominent barrier, reflecting deep-seated societal biases that restrict marginalized individuals—especially women—from fully participating in economic and social spheres. Discriminatory practices in education, workplaces, and leadership roles prevent women from pursuing higher education or securing well-paying jobs. This exclusion reinforces financial dependence, making it harder for them to achieve economic independence and social mobility. Women who face discrimination often find themselves stuck in low-paying or informal jobs, with limited opportunities for advancement. This reality forces many to remain dependent on male family members, further perpetuating gender-based economic disparities.

Early marriage and childbearing, affecting 25% of respondents, serve as another critical barrier that restricts education and employment opportunities. Many young girls are forced into marriage at an early age, leading to interrupted education, early pregnancies, and a lifetime of financial dependence. In many cultures, young brides are expected to prioritize household responsibilities over personal or professional growth, limiting their ability to pursue higher education or join the workforce. This results in fewer economic opportunities and contributes to generational cycles of poverty, as these women often struggle to support themselves and their families without access to financial resources or stable employment.

Gender-based violence (GBV), reported by 21% of respondents, acts as a significant deterrent to education, employment, and overall well-being. The fear of violence—whether at home, in the workplace, or in public spaces prevents many women and marginalized individuals from seeking education, job opportunities, or leadership positions. Survivors of domestic violence, workplace harassment, or sexual exploitation may find themselves unable to leave abusive situations due to financial dependence on their abusers. This cycle of violence and dependence reinforces social and economic inequalities, making it difficult for women to escape poverty or achieve financial stability.

Limited social mobility, affecting 13% of respondents, further exacerbates the challenges faced by marginalized groups. Many individuals are trapped in low-income households with little access to quality education, vocational training, or economic resources. The lack of opportunities for higher education and skill development makes it nearly impossible for them to compete for better-paying jobs. Additionally, systemic discrimination in hiring practices, wage gaps, and exclusion from leadership roles hinder upward mobility, keeping marginalized groups in the same socio-economic conditions across generations. Without access to education and economic opportunities, individuals remain vulnerable to exploitation and are unable to improve their living standards.

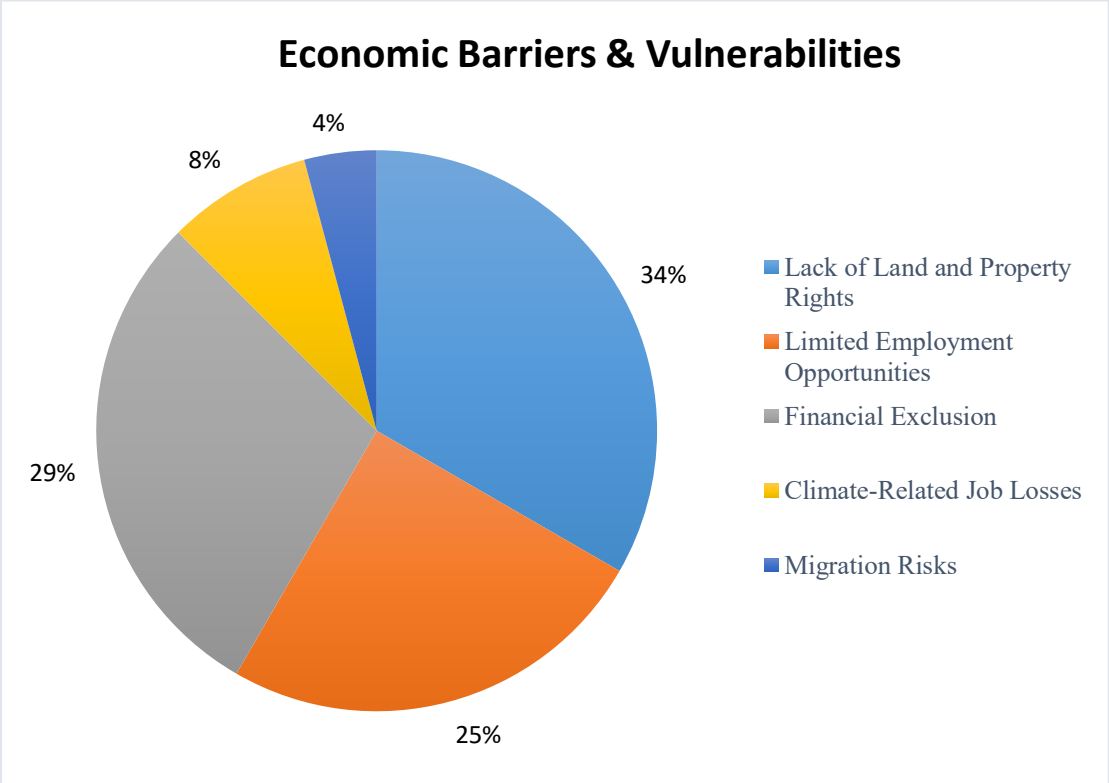
Women's existing social and economic disadvantages significantly heighten their vulnerability to climate change. Restricted mobility, financial dependence, limited educational opportunities, and increased exposure to environmental hazards place a disproportionate burden on women, especially in regions most affected by climate

change. To break this cycle of vulnerability, it is essential to implement gender-responsive policies that prioritize women's empowerment, climate adaptation strategies, and fair resource distribution**.** Without targeted action, climate change will continue to worsen gender disparities, keeping marginalized women at the center of both environmental and socio-economic crises.

4.15.2 Economic Barriers & Vulnerabilities

Economic Barriers are obstacles that prevent women from fully participating in economic activities, earning income, or accessing financial resources. These barriers limit their financial independence and ability to adapt to challenges like climate change. Economic Vulnerabilities refer to risks and weaknesses that make women more financially unstable or dependent, especially in times of crisis, such as natural disasters or economic downturns.

Figure 16: Economic Barriers & Vulnerabilities



Source: Field Survey, 2024

The pie chart shows the Economic Barriers and Vulnerabilities presents a breakdown of the key economic challenges women face due to climate change, based on a field survey conducted in 2024 in Geruwa and Madhuwan. The data is visually represented

in a pie chart, categorizing the economic barriers into five major components: lack of land and property rights (34%), limited employment opportunities (25%), financial exclusion (29%), climate-related job losses (8%), and migration risks (4%). The findings indicate that the most significant economic barrier is the lack of land and property rights, which limits women's access to financial security and sustainable livelihoods. Financial exclusion, which comprises 29% of the reported challenges, further exacerbates economic vulnerability by restricting access to banking services, credit, and financial independence. Limited employment opportunities (25%) reflect systemic barriers that hinder women's participation in the labor market, while climate-related job losses (8%) highlight the adverse impact of environmental changes on income stability. Migration risks (4%) emerge as the least prevalent but still relevant factor, emphasizing the uncertainties and insecurities faced by women in climate-affected regions. Overall, the figure underscores the intersection of gender and economic precarity, emphasizing the need for policy interventions that promote women's economic empowerment and resilience in the face of climate change.

4.15.3 Environmental Barriers

It refers to challenges that arise due to environmental degradation and climate change, which disproportionately affect women and the following shows (4.17). These barriers limit their access to natural resources, increase their workload, and expose them to greater health and livelihood risks.

Table 4.15.3: Environmental Barriers

S. N	Categories	Frequency	Total	Percent
1	Water Scarcity	45	120	37%
2	Natural Disasters (Floods & Drought)	15	120	12%
3	Increased Agricultural Burden	25	120	21%
4	Deforestation & Resource Depletion	20	120	17%
5	Health Risks from Poor Sanitation	15	120	12 %
Total		**120**		**100%**

Source: Field Survey, 2024

Climate change has intensified environmental challenges, disproportionately affecting women due to their dependence on natural resources for daily survival. Among the most significant barriers, water scarcity (37%) emerges as the most pressing issue. Women, especially in rural areas, are often responsible for collecting water, and prolonged

droughts or reduced water sources increase their workload and health risks. Increased agricultural burden (21%) is another major challenge, as changing weather patterns reduce crop yields, forcing women to work harder to secure food for their families.

Deforestation and resource depletion (17%) further strain women's lives by limiting access to firewood, food, and medicinal plants, making daily survival more difficult. Additionally, natural disasters such as floods and droughts (12%) displace communities, destroy livelihoods, and disproportionately impact women who have fewer resources to recover. Lastly, health risks from poor sanitation (12%) worsen due to water shortages and climate-induced disasters, increasing the spread of diseases and negatively affecting women's well-being, particularly during pregnancy and menstruation.

Overall, these environmental barriers worsen gender inequalities and increase women's vulnerability to climate change. Addressing these challenges requires better access to clean water, sustainable agriculture, and policies that empower women in climate adaptation efforts

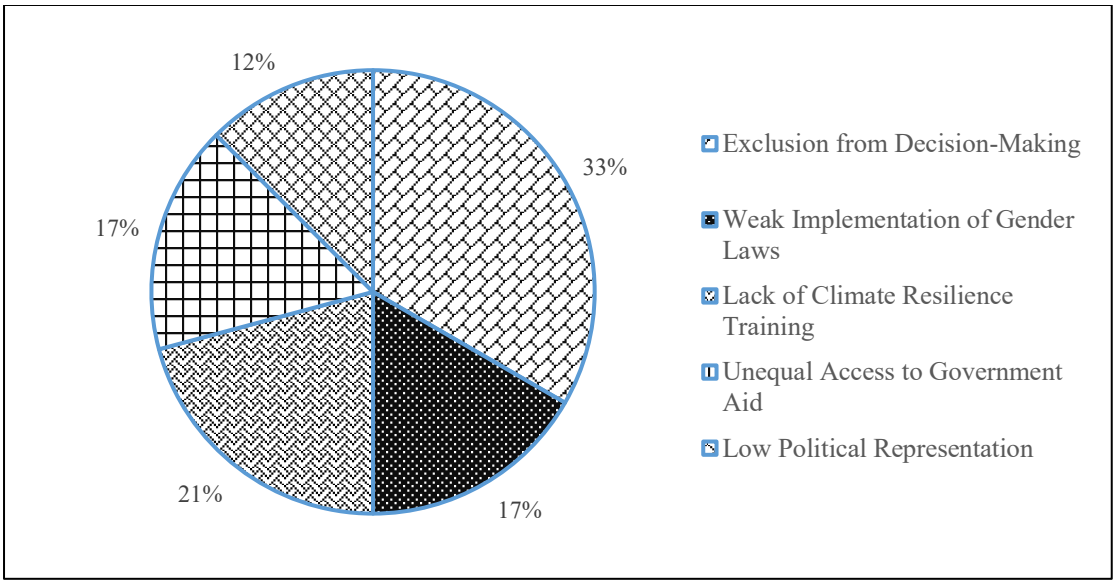
Miss Tharu said *"when floods come, they have to go far to fetch clean water. Sometimes, they even end up drinking water they've bought after walking long distances. Often, they have to hide and store water in bottles or pitchers to save it for later. Although there is a hand pump in their home, during floods, the water becomes extremely muddy, and they have to go elsewhere to fetch water to avoid getting sick. Similarly, when floods come, it becomes very difficult for children and the elderly. They require special care. Last year, during the flood, while trying to transfer an elderly person on a buffalo, both the buffalo and the elderly person fell into a ditch. The elderly person was injured and took a long time to recover. However, what we really need are better services, such as proper transportation facilities."*

Climate change worsens gender inequalities, with women facing severe challenges like water scarcity, increased agricultural workload, and resource depletion. Natural disasters further strain their daily lives, affecting health and livelihoods. Urgent action is needed to improve access to clean water, sustainable agriculture, and support systems that empower women in climate adaptation efforts.

4.15.4 Political and Institutional Barriers

It refers to obstacles that prevent women from fully participating in decision-making processes, accessing government support, and benefiting from climate-related policies and programs. These barriers limit their ability to influence policies that directly impact their lives, making them more vulnerable to the effects of climate change.

Figure 17: Political and Institutional Barriers



Source: Field Survey, 2024

The Pie- chart illustrates the challenges that prevent women from fully participating in decision-making processes, accessing government support, and benefiting from climate-related policies and programs. Based on data from a field survey conducted in 2024, the pie chart categorizes these barriers into five key areas: exclusion from decision-making (33%), weak implementation of gender laws (21%), lack of climate resilience training (17%), unequal access to government aid (17%), and low political representation (12%). The most significant barrier is the exclusion of women from decision-making, which restricts their ability to influence policies that directly affect their lives and communities. Weak enforcement of gender laws (21%) further exacerbates gender disparities by failing to provide institutional protections. Additionally, the lack of climate resilience training (17%) limits women's capacity to adapt to climate-induced challenges, while unequal access to government aid (17%) hinders their ability to recover from climate-related shocks. Low political representation (12%) remains a critical issue, reducing women's influence in governance structures. Collectively, these findings highlight the systemic nature of

political and institutional barriers, emphasizing the need for policy reforms to promote gender-inclusive governance and equitable climate adaptation strategies.

Miss Tharu said, *"We only get to do household chores, and we are not allowed to make decisions on big matters at home. Only our in-laws and husbands make the decisions, and we just have to accept them. We were not even allowed to study because there is so much work at home. If we had studied, people would have listened to us, and we would have had the right to make decisions. But what can we do? In the village, most people are not educated, and they follow old traditions. They believe that giving decision-making power to women is a sin, so they don't listen to us. It's better to just stay silent."*.

Women face significant barriers in decision-making, government support, and climate adaptation due to exclusion, weak gender law enforcement, and limited political representation. Cultural norms and lack of education further restrict their voices. Addressing these challenges requires policy reforms, gender-inclusive governance, and empowerment programs to ensure women can actively participate in shaping their communities' future.

4.15.5 Health and Nutrition Barriers

It refers to the obstacles that prevent individuals or communities from accessing adequate healthcare and proper nutrition.

Table 4.15.5: Health & Nutrition Barriers

S. N	Categories	Frequency	Total	Percent
1	Poor Menstrual Hygiene Management	60	120	50%
2	Malnutrition & Food Insecurity	25	120	21%
3	High Maternal Mortality Rates	10	120	8%
4	Mental Health Burden	15	120	12%
5	Limited Access to Healthcare	10	120	9%
Total		**120**		**100%**

Source: Field Survey, 2024

Health and nutrition barriers are significant challenges that hinder individuals and communities from accessing proper healthcare and adequate nutrition. Based on the data, poor menstrual hygiene management is the most common issue, affecting 50% of cases. This suggests that many individuals, particularly women and girls, face difficulties in maintaining proper hygiene due to a lack of resources, awareness, or

societal stigma. Malnutrition and food insecurity account for 21%, indicating that a significant portion of the population struggles to access nutritious food, leading to health complications. High maternal mortality rates make up 8% of the total, highlighting the risks faced by pregnant women due to inadequate healthcare services or poor nutrition. The mental health burden**,** affecting 12%**,** suggests that psychological well-being is a growing concern, possibly due to stress, poverty, or social factors. Lastly, limited access to healthcar**e** represents 9% of the cases, demonstrating that healthcare facilities and services remain insufficient or difficult to reach for many people. Addressing these barriers requires a multi-faceted approach, including education, policy changes, and community support to improve health and nutrition outcomes.

Miss Tharu said "*When floods occur during menstruation, they are unable to use pads or cloth. There is no dry place to dry the cloth used during menstruation, and because of this, infections occur in the uterus. During such times, when the situation worsens, they don't even have access to clothes. While food is provided during disasters, if they had access to sanitary pads during menstruation, it would be much better for them. Even now, during menstruation, people treat them as if they are untouchable. If temples are used as shelters during menstruation, they are made to feel as if they have committed a sin or violated religious norms. They are not allowed to enter, and they feel as if their lives are considered less valuable. Many women suffer from infections, and some even develop cancer, but many women do not speak up about their struggles"*

Similarly, Miss Shah "*In 2040 B.S., during the monsoon, the water level in the Karnali River rose significantly, causing all the villages to be submerged. At that time, there were 9 cases, mostly pregnant women, who faced extreme difficulties in getting check-ups and deliveries done. Due to the fear of flooding, deliveries had to be conducted in shelter houses. One sister had to be referred to the hospital Nepalgunj Medical college Kohalpur for assistance. The baby and the mother both suffered from infections after birth. Additionally, during that time, we couldn't even provide proper maternal care or nutritious food. When more people arrived, the women became extremely anxious and went to Shamen, but it didn't help. In such situations, the government should provide timely assistance with emergency vehicles or helicopters to support them."*

Miss Chaudhary said, "*In our area, especially during the summer months of Baisakh and Jestha (April–June), we experience extreme heat wave called "luk", which make both household and agricultural work very difficult. Many people suffer from heat exhaustion, and some even faint. In our village, a young woman collapsed while working in the field, and when we took her to the health post, the doctor said it was due to heat stroke. He advised us to drink plenty of water and stay in cool places during heat waves. However, to avoid heat inside our homes, we pour water on the roofs, which helps reduce the intensity of the heat. "As for the cold wave called "sit lahar", it starts from Mangsir to Magh (November–January), making it extremely difficult for us to work. The cold is so intense that we shiver, and sometimes, the sun doesn't appear for days, sometimes even for an entire week. The cold wave also affects our crops, including wheat, vegetables, and lentils. But what can we do? It is all nature's play, and we have no control over it."*

Similarly, Miss Tharu said, *"In our village, wild animals have severely affected our farming. From November to October, we cultivate sugarcane, and as soon as Dashain ends, we start harvesting it. However, no matter how hard we try to protect our crops, elephants come and eat everything. In addition to elephants, tigers, monkeys, and rhinos also cause us a lot of trouble. Because of these wild animals, we live in constant fear, worrying that our crops might be destroyed at any time. We also have to go to the forest to collect grass and firewood, but there is always a fear of being attacked by a tiger. We leave for the forest chanting the name of God, as we have no other option—our cows, buffaloes, and goats need fodder, and we need firewood for cooking. Although gas stoves are available now, they are expensive and difficult to afford. Since we have always cooked on traditional stoves, it feels easier for us, and the forest is nearby. However, life has become much more difficult than before, and many villagers have even left the village and moved elsewhere."*

Miss Tharu said, *"In our village, wild animals have severely affected our farming. From November to October, we cultivate sugarcane, and as soon as Dashain ends, we start harvesting it. However, no matter how hard we try to protect our crops, elephants come and eat everything. In addition to elephants, tigers, monkeys, and rhinos also cause us a lot of trouble. Because of these wild animals, we live in constant fear, worrying that our crops might be destroyed at any time. We also have to go to the forest to collect*

grass and firewood, but there is always a fear of being attacked by a tiger. We leave for the forest chanting the name of God, as we have no other option our cows, buffaloes, and goats need fodder, and we need firewood for cooking. Although gas stoves are available now, they are expensive and difficult to afford. Since we have always cooked on traditional stoves, it feels easier for us, and the forest is nearby. However, life has become much more difficult than before, and many villagers have even left the village and moved elsewhere."

Health and nutrition challenges, intensified by climate change and socio-economic factors, severely impact vulnerable communities, particularly women. Poor menstrual hygiene, malnutrition, maternal health risks, and limited healthcare access remain critical concerns. Extreme weather conditions, such as heat waves and cold waves, further threaten health and agricultural productivity. Additionally, human-wildlife conflict endangers both livelihoods and safety, forcing some villagers to relocate. Addressing these issues requires urgent government intervention, improved healthcare services, climate adaptation strategies, and better support systems to enhance community resilience and well-being.

4.15.6 Educational Barriers

It refers to obstacles that prevent individuals or communities from accessing quality education. These barriers can be social, economic, infrastructural, or personal, limiting learning opportunities and overall academic success.

Table 4.15.6: Educational Barriers

S. N	Categories	Frequency	Total	Percent
1	School Absenteeism Due to Floods & Droughts	50	120	42%
2	Loss of School Infrastructure	20	120	17%
3	Limited Access to Higher Education	15	120	12%
4	Economic Loss Leading to Dropouts	15	120	12%
5	Limited Vocational Training	5	120	4%
6	Malnutrition Impacting Learning Ability	15	120	12%
Total		**120**		**100%**

Source: Field Survey, 2024

Educational barriers significantly impact access to quality learning, particularly in areas facing environmental and economic challenges. The most prevalent issue is school absenteeism due to floods and droughts**,** affecting 42% of students. Extreme weather

conditions disrupt education by making travel difficult or damaging school infrastructure. Loss of school infrastructure, accounting for 17%**,** further worsens the situation, as floods, storms, or inadequate facilities leave students without proper learning environments**.** Limited access to higher education affects 12%**,** highlighting the challenges students face in continuing their studies beyond basic schooling, often due to financial constraints or lack of institutions. Similarly, economic loss leading to dropouts also stands at 12%, indicating that many students are forced to leave school to support their families financially**.** Malnutrition impacting learning ability, also at 12%**,** shows how poor nutrition affects concentration, cognitive development, and academic performance. Lastly**,** limited vocational training, at 4%, suggests that there are few opportunities for students to gain practical skills that could help them secure employment. Addressing these barriers requires investment in resilient school infrastructure, financial support for students, and improved nutrition and vocational training programs to ensure a more inclusive and sustainable education system.

Mrs. Tharu said, "*We have to be absent from school a lot when there is a flood or drought. This is because if our crops are washed away by the flood, our parents have to go far away to work as laborers to support us. During that time, all the household responsibilities fall on the daughters, so how can we go to school and study? Our teachers always ask why we are absent, and sometimes we even get punished for missing school*."

Similarly, Miss Tharu said, "*Floods destroy the road to school and even damage the school building, preventing us from studying for months. Because of this, we start losing interest in education. This is a big problem in our village. As we grow older, our families arrange our marriage at a young age, hoping that we will have a better life in towns or markets where conditions are slightly better*."

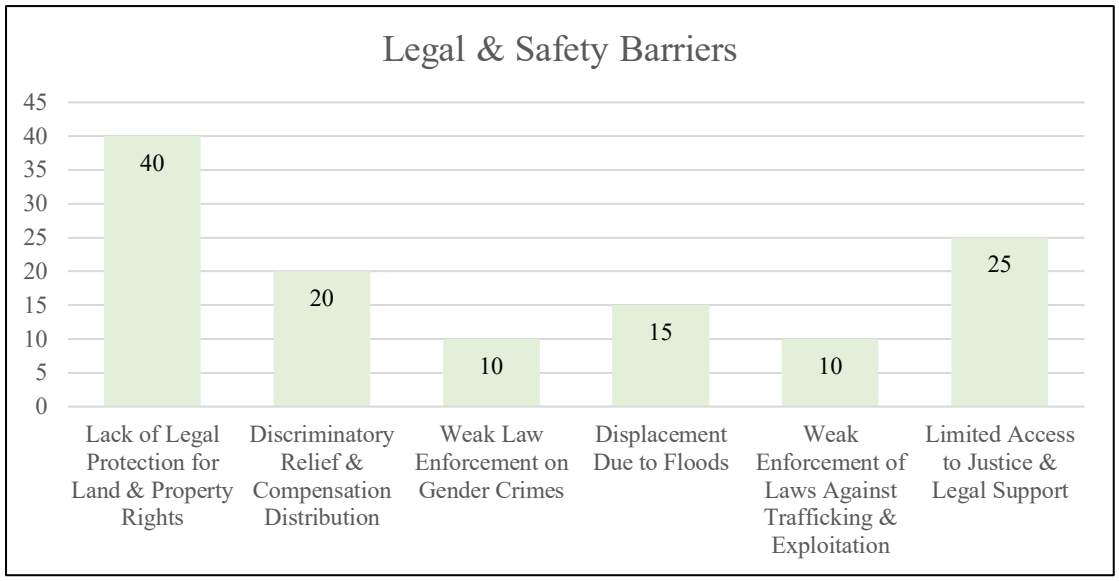
Mrs. Khatri one of the KII Respondent said that "F*loods have a severe impact on students. When flooding occurs between their homes and schools, their studies are greatly disrupted. It also affects them psychologically, causing fear, and many students, especially those from marginalized backgrounds, suffer from food shortages. If a student's home is severely affected by flooding, we also provide school rooms as shelters for them*.

Educational barriers, worsened by environmental and economic challenges, significantly disrupt students' learning opportunities. Floods and droughts lead to absenteeism, infrastructure damage, and financial struggles, forcing many to drop out or take on household responsibilities. Malnutrition further impacts academic performance, while limited access to higher education and vocational training restricts future opportunities. Addressing these issues requires resilient school infrastructure, financial aid, and nutrition programs to ensure inclusive and sustainable education for all.

4.15.7 Legal and Safety Barriers

It refers to obstacles that prevent individuals or communities from accessing justice, security, and protection under the law. These barriers can arise from weak legal systems, lack of enforcement, social discrimination, or unsafe environments, leading to increased vulnerability and injustice.

Figure 18: Legal & Safety Barriers



Source: Field Survey, 2024

The Bar graph illustrates the various obstacles that hinder individuals and communities from accessing justice, security, and legal protection. These barriers arise due to weak legal systems, lack of enforcement, social discrimination, and unsafe environments, increasing vulnerability and injustice. The chart presents six key legal and safety barriers: lack of legal protection for land and property rights (40%), discriminatory relief and compensation distribution (20%), weak law enforcement on gender crimes (10%), displacement due to floods (10%), weak enforcement of laws against trafficking

and exploitation (10%), and limited access to justice and legal support (25%). Among these, the most significant barrier is the lack of legal protection for land and property rights, affecting 40% of individuals or communities. Limited access to justice and legal support is also a major challenge at 25%, while discriminatory relief distribution stands at 20%. The remaining three factors weak enforcement of laws on gender crimes, displacement due to floods, and weak laws against trafficking each account for 10%. These barriers collectively contribute to increased social and economic inequalities, making it difficult for vulnerable populations to secure their rights and protection under the law.

Floods create severe challenges for communities, and marginalized women often bear extra responsibilities due to their social roles, economic status, and lack of resources. These additional burdens increase their vulnerability while also making them central figures in disaster response and recovery.

Mrs. Chaudhary said, "*We don't have any land in our own name. Even after marriage, we hope to have land through our husbands, but our parents give the dowry land in our husband's name. Because of this patriarchal and conservative social setup, we women remain vulnerable. And even if someone does have land, the flood washes it all away. No matter what, we are trapped by circumstances from all sides*."

Legal and safety barriers, including lack of land rights, limited access to justice, and weak law enforcement, disproportionately impact vulnerable communities, especially women. Discriminatory practices and displacement due to floods further worsen inequalities, leaving many without protection or support. Addressing these challenges requires stronger legal frameworks, equitable relief distribution, and better enforcement of laws to ensure justice and security for all.

4.16 Women Are More Affected Than Men During Flood

Women face greater risks during floods due to social, economic, and biological factors. Responsibilities like caregiving make evacuation harder, while cultural dress codes can limit mobility. Limited access to resources and decision-making, along with increased risk of violence in shelters, further heighten their vulnerability.

Table 4.16: Women Are More Affected Than Men

S. N	Categories	Respond	Frequency	Percent
1	Female	Yes	80	66%
2	Male	No	40	37%
	Total		120	100%

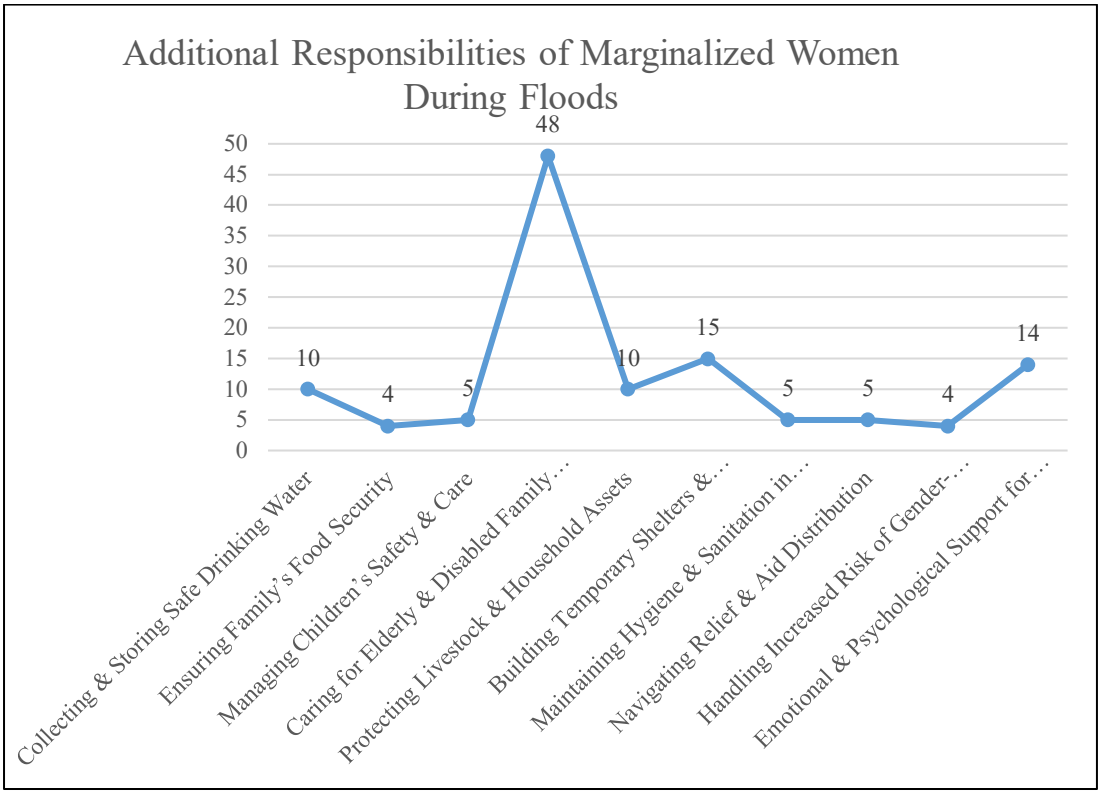
Source: Field Survey, 2024

The study reveals that women in Geruwa-3 and Madhuwan-2 face greater hardships during floods than men, with 66% of female respondents reporting significant challenges compared to 37% of males**.** This disparity is driven by socio-economic and cultural factors, as women bear primary responsibilities for caregiving, household management, and water collection, which become more difficult during floods. Limited mobility, restricted access to emergency resources, and economic instability further exacerbate their vulnerability. In contrast, men, with greater financial independence and mobility, are better able to cope through migration or alternative income sources. Addressing these inequalities requires inclusive disaster response strategies, improved resource access for women, and targeted interventions to enhance their resilience in flood-affected areas.

Mrs. Tharu one of KII said, "W*omen have more challenge and likely to be responsible for tasks like farming fetching water and collecting firewood in many developing nations women the make up the majority of agricultural workers they rely on natural resources to feed their families and sustain their livelihoods when drought hit crops fail when water sources dry up the journey to find water becomes longer and hard to walk long distance*."

Women in Geruwa-3 and Madhuwan-2 face greater hardships during floods due to socio-economic and cultural factors. Their responsibilities in caregiving, farming, and resource collection become more challenging, while limited mobility and financial instability increase their vulnerability. In contrast, men have more coping options. Addressing these inequalities requires inclusive disaster response strategies, improved resource access, and targeted support to enhance women's resilience in flood-affected areas.

Figure 19: Additional Responsibilities of Marginalized Women During Floods



Source: Field Survey, 2024

The figure titled "Additional Responsibilities of Marginalized Women During Floods" illustrates the various burdens that women, particularly those from marginalized communities, shoulder during flood disasters. Due to their social roles, economic constraints, and limited access to resources, these women face increased responsibilities, making them more vulnerable while also placing them at the center of disaster response and recovery. The graph highlights multiple responsibilities, including collecting and storing safe drinking water, ensuring family food security, managing children's safety and care, caring for elderly and disabled family members, protecting livestock and household assets, building temporary shelters, maintaining hygiene and sanitation in crisis situations, navigating relief aid distribution, handling increased risks of gender-based violence, and providing emotional and psychological support to their families. Among these, certain tasks, such as caring for children and vulnerable family members, ensuring food security, and managing household assets, appear to be the most demanding. These additional responsibilities significantly impact women's physical and mental well-being, exacerbating gender inequalities in disaster-stricken areas. The data suggests the need for gender-sensitive disaster management

policies that recognize and address these burdens to support marginalized women effectively.

Governments play a crucial role in addressing the challenges faced by marginalized women by implementing policies and programs that promote their rights, well-being, and opportunities. These strategies focus on education, healthcare, economic empowerment, and legal protection to improve their overall quality of life.

4.17 Traditional Water Management Activities

Traditional water management activities have played a vital role in ensuring water availability in Geruwa-3 and Madhuwan-2, particularly as climate change increase water scarcity. These methods, passed down through generations, are sustainable, cost-effective, and adapted to local environmental conditions**.**

Tables 4.17: Traditional Water Management Activities

S. N	Traditional Water Management	Frequency	Total	Percent
1	Canal water	81	120	67.5%
2	Dams and Ponds	12	120	10%
3	Traditional Wells	10	120	8%
4	Water Storage in Clay Pots	8	120	7%
5	Water Recycling in Households	5	120	4%
6	Water sharing communities	4	120	3%
	Total	**120**		**100%**

Source: Field Survey, 2024

Indigenous water management practices have played a crucial role in maintaining water availability in Geruwa-3 and Madhuwan-2, especially as climate change boost water scarcity. These age-old methods, passed down through generations, are environmentally sustainable, cost-efficient, and tailored to local conditions.

Table 4.22 outlines the primary traditional water management techniques utilized in these areas. Canal water emerges as the most prevalent method, used by 67.5% of respondents, underscoring its importance in both irrigation and household needs. Dams and ponds, accounting for 10%, serve as vital water reservoirs. Traditional wells make up 8%, demonstrating their continued role in groundwater extraction.

Furthermore, water storage in clay pots (7%) remains a practical and efficient means of preserving drinking water, while household water recycling (4%) signifies efforts toward sustainable domestic water use. Lastly, water-sharing communities (3%) highlight the significance of collective resource management, promoting cooperation among residents.

Mr. Tharu Said "O*ver a century ago, their ancestors successfully built a canal from the Karnali River, and to this day, they continue practicing the Kulopani Chaudhariya tradition to sustain and develop their water management system. Each village has a local leader known as a Badghar or Bhalmansa, responsible for overseeing community affairs*. Similarly, Mrs. Tharu explained that *thirteen villages are governed by an administrative leader, with the Kulopani Chaudhariya serving as the head. The Chaudhariya is elected through a democratic process by all the village Badghars, granting him the authority to manage canal water efficiently*."

Mr. Tharu one of the KII from Badghar Head further elaborated that any canal damage or necessary repairs are carried out under Chaudhariya's supervision. His primary duty is to ensure water quality remains optimal while the *Badghars* oversee water distribution through the sub-canal network. In cases of water scarcity, adjustments may be made to the main canal. If this does not resolve the issue, it becomes the *Chaudhariya's* responsibility to establish a rotational water access schedule for farmers. To address any canal damage, the *Chaudhariya* calls a meeting with the *Badghars* and *Bhalmansas*, during which farmers from each village bring tools like spades, pickaxes, and sickles to contribute to maintenance work. Some villages have around 100 farmers, while others have as few as 25. In such cases, the *Chaudhariya* distributes the workload fairly through a system known as *Naan*, where farmers dig assigned sections of the canal according to the planned structure. If someone refuses to participate in the maintenance work, they must pay a penalty called *Khara*. Additionally, if a farmer demands extra water because they contributed to canal digging or misuses water irresponsibly, their access may be restricted, and they can be fined an amount determined by the village committee, ranging from NPR 500 to 1,500.

Mrs. Tharu confirmed that *both men and women actively take part in canal maintenance.* Furthermore, Mr. Tharu mentioned that *they have successfully diverted water from the Surya Patawa and Thakurbaba Community Water Canal, significantly*

improving agriculture in the region. He also highlighted the cultural importance of rituals, explaining that even the simplest tasks begin with Puja (worship). The same applies to their water management practices, where they honor nature and their ancestors, viewing water as a deity (Devta). The ritual starts with Dhodiya Puja, followed by Hereri Puja, which is performed for the well-being of people, land, and future crops. Farmers offer cow's milk and incense to the water, believing that spreading incense around the fields and pouring milk at the canal's center helps protect crops from pests.

These results emphasize the need to safeguard and integrate traditional water management techniques into modern conservation strategies to enhance resilience against the growing challenges of climate-induced water shortages.

4.18 Traditional Food Security Activities in Study Area

Table 4.18 Traditional Food Security Activities in Study Area

S. N	Traditional Method	Frequency	Percent
1	Food Storage & Preservation (Bhakari, Mud Silos, Drying, Pickling)	55	45.83%
2	Indigenous Farming (Crop Rotation, Organic Fertilizers, Diversified Crops)	30	25%
3	Community-Based Food Sharing (Guthi System like Barghar, Bartering, Grain Banks)	20	16.67%
4	Forest and Wild Food Utilization (Wild Edibles, Fishing, Livestock)	15	12.5%
Total		120	100%

Source: Field Survey, 2024

The research on traditional food security practices in the study area demonstrates that local communities rely on indigenous techniques to ensure food availability and adapt to climate-induced challenges. Among 120 respondents, the most widely used approach is food storage and preservation, practiced by 45.83% (55 respondents). This includes methods such as Bhakari (bamboo grain bins), mud silos, drying, and pickling, which enable long-term food storage. These techniques help ensure food remains accessible during off-seasons or periods of scarcity. Additionally, dried and fermented foods, like Gundruk and Sinki, provide essential nutrients, particularly when fresh produce is unavailable. The second most common method is indigenous farming, adopted by 25% (30 respondents). This approach involves crop rotation, the use of organic fertilizers,

and diversified farming systems, all of which contribute to maintaining soil fertility and minimizing crop failure risks. By cultivating a variety of crops such as rice, maize, millet, and legumes, farmers reduce reliance on a single harvest, enhancing the sustainability of their food sources.

Furthermore, 16.67% (20 respondents) engage in community-based food-sharing systems, including the Guthi system (Badghar), bartering, and grain banks. These traditional systems promote collective food storage and distribution, particularly during periods of scarcity, helping to prevent food shortages within the community. Bartering allows households to trade surplus food, decreasing dependence on external markets and fostering food security. Lastly, 12.5% (15 respondents) rely on forest and wild food utilization, such as gathering wild edibles, fishing, and livestock rearing. Families often collect wild fruits, yams, mushrooms, and medicinal plants to supplement their diet when farmed crops are unavailable. Additionally, fishing and livestock farming serve as alternative protein sources, supporting household nutrition.

Miss Tharu said, "*When floods come or during droughts, we prepare and store dry foods like sukha roti (dried bread), fish, pickles, and roasted maize. During floods, everyone in the household faces food shortages, including small children and elderly family members like our in-laws. To ensure they have food, we carefully store rice and lentils in Bhakari (traditional grain storage bins) found in almost every home in our village. If we had to buy food instead, it would be difficult because our ancestors taught us the importance of securing food, and we still follow those teachings today. That is why, no matter what disaster strikes, we never forget our traditional ways of working and preserving food. After all, we depend on our land for food if we had nothing to eat, how would we survive?*"

In conclusion, the study emphasizes that traditional food security strategies remain vital for sustainability and resilience. While food storage and preservation are the most widely practiced techniques, community-based food-sharing, indigenous farming, and the utilization of forest resources also play significant roles in maintaining food security. Although these methods have been effective for generations, combining traditional knowledge with modern agricultural innovations could further enhance food resilience in the face of climate change.

4.19 Traditional Knowledge is Importance for Water Management

Table 4.19 Traditional Knowledge Importance for Water Management

Municipalities	Response	Frequency	Percentage
Geruwa-3 Madhuban-2	Yes	90	75%
	No	30	25%
Total		120	100

Source: Field Survey, 2024

The survey conducted in Geruwa-3 and Madhuban-2 municipalities emphasizes the importance of traditional knowledge in water management. Among 120 respondents, 90 individuals (75%) consider traditional water management practices essential, while 30 respondents (25%) disagree. The strong support for traditional methods suggests that they are valued for being sustainable, cost-effective, and well-suited to local environmental conditions. These practices have been passed down through generations, playing a crucial role in water conservation, preventing shortages, and maintaining ecological balance.

However, one-fourth of the respondents (25%) do not view traditional knowledge as the most effective approach. This may be due to the increasing demand for modern infrastructure, scientific innovations, and large-scale water management solutions. Some believe that traditional methods may be outdated or inadequate in addressing contemporary challenges such as climate change, urbanization, and rising water demands.

Despite these differing perspectives, traditional knowledge remains highly regarded. A balanced approach that integrates traditional wisdom with modern technology could be the key to achieving sustainable and efficient water management. By combining both approaches, communities can effectively tackle local and large-scale water challenges, ensuring long-term benefits for future generations.

4.20 Adaptation Practices for Climate Change Induced Hazards

4.20.1 Traditional Coping Strategies

Traditional adaptation strategies refer to indigenous and time-tested methods used by communities to adapt to and mitigate the impacts of natural hazards, climate change,

and environmental challenges. These strategies are rooted in local knowledge, cultural practices, and historical experiences**,** enabling communities to survive and sustain their livelihoods despite recurring disasters.

Table 4.20.1 Traditional Coping Strategies

S. N	Traditional Coping Strategies	Geruwa-3	Madhuwan-2	Total	Percent
1	Building makeshift embankments with sandbags, bamboo, and mud.	18	15	33	28%
2	Planting flood-resistant or drought-tolerant traditional crops/ plants such *as khar(thatching grass), Amriso(saccharum grass).*	14	13	27	23%
3	Using traditional water conservation techniques (e.g., rainwater harvesting, pond digging)	10	12	22	18%
4	Storing grains, firewood, and water in elevated areas	8	9	17	14%
5	Raising houses on stilts or using elevated foundations	6	5	11	9%
6	Depending on communal support and resource-sharing	4	6	10	8%
	Total	60	60	120	100%

Source: Field Survey, 2024

Communities in Geruwa-3 and Madhuwan-2 have long relied on traditional coping strategies to mitigate the effects of climate-induced hazards such as floods and droughts. The most widely practiced method, used by 28% of respondents, is building makeshift embankments using sandbags, bamboo, and mud to protect homes and farmlands from floodwaters. Additionally, 23% of respondents adapt by planting flood-resistant or drought-tolerant crops, ensuring food security even under extreme weather conditions.

18% utilize traditional water conservation techniques, including rainwater harvesting and pond digging, to secure water for irrigation and household use. To safeguard essential supplies, 14% store grains, firewood, and water in elevated areas, reducing

losses during floods. Additionally, 9% of respondents raise their houses on stilts or use elevated foundations, minimizing damage from rising water levels.

Communal cooperation also plays a vital role, with 8% of respondents engaging in resource-sharing systems, where families support each other with food, water, and shelter during climate crises. These traditional methods demonstrate the resilience and adaptability of local communities in dealing with environmental challenges. However, integrating modern disaster management techniques with these indigenous practices could further strengthen climate resilience and long-term sustainability.

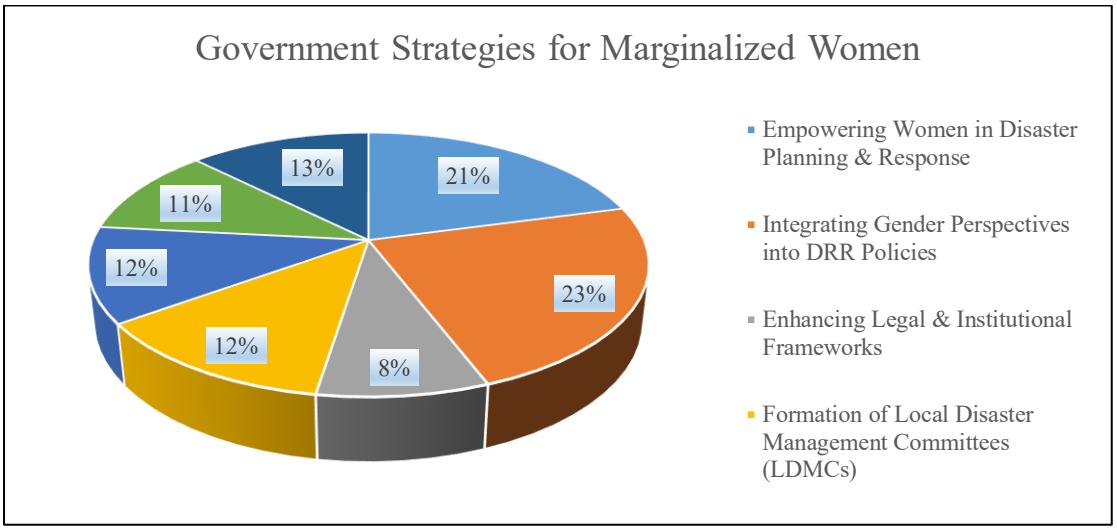
Mr. Tharu one of the KII said¸ "*In our Tharu culture, bamboo plays a significant role we cannot imagine our lives without it. Bamboo is used in almost everything, from roofing houses to even the smallest daily tasks. However, nowadays, bamboo has become scarce, possibly due to excessive use. Additionally, the devastating flood of the year 2040 B.S wiped out most of it. To address this, our community has started a bamboo conservation project to preserve and protect the remaining bamboo for future generations."*

Miss Chaudhary said, **"***In the past, our village had a lot of Ameriso (saccharum grass) and Khar (thatching grass), which helped protect us during floods. But nowadays, wild animals eat them all, making us more vulnerable to flooding. Our village is also close to the river, which increases the risk for us from both sides. Despite this, there is still no proper solution to the problem***."**

Communities in Geruwa-3 and Madhuwan-2 have long relied on traditional coping strategies, such as makeshift embankments, drought-resistant crops, rainwater harvesting, and communal resource-sharing, to mitigate climate-induced hazards. However, environmental changes, resource depletion, and increasing flood risks are making these methods less effective. Integrating modern disaster management techniques with indigenous practices is essential to enhance climate resilience and ensure long-term sustainability.

4.20.2 Government Strategies for Marginalized Women

Figure 20: Government Strategies for Marginalized Women



Source: Field Survey, 2024

The figure titled "Government Strategies for Marginalized Women" outlines the key policies and initiatives implemented by governments to address the challenges faced by marginalized women. These strategies aim to enhance their rights, well-being, and opportunities by focusing on education, healthcare, economic empowerment, and legal protection. The pie chart presents various strategies with different levels of emphasis: empowering women in disaster planning and response (21%), integrating gender perspectives into disaster risk reduction (DRR) policies (23%), enhancing legal and institutional frameworks (8%), and forming local disaster management committees (LDMCs) (12%). Other notable strategies include improving access to resources, promoting leadership roles for women, and ensuring their protection during crises. The largest focus appears to be on integrating gender perspectives into DRR policies, highlighting the importance of considering women's unique vulnerabilities and contributions in disaster management. By implementing these strategies, governments aim to create a more inclusive and resilient society where marginalized women can actively participate in decision-making and recovery efforts, ultimately improving their overall quality of life.

4.20.3 Effectiveness of Government Strategies for Marginalized Women

Government strategies for marginalized women can be effective if properly implemented, addressing education, healthcare, legal protection, and economic opportunities. However, their success depends on factors like political will, proper

funding, and overcoming cultural barriers. While some programs improve women's lives, more work is needed to ensure full access for all marginalized women.

Table 4.20.3 Effectiveness of Government Strategies for Marginalized Women

S. N	Categories	Effectiveness (Findings)	Frequency	Total	Percent
1	Women's Participation in DRR Programs	Limited participation, mostly symbolic.	22	120	18%
2	Access to Disaster Relief & Aid	Unequal distribution: male heads prioritized.	20	120	16.7%
3	Inclusion of Gender in Disaster Policies	Policies exist but implementation is weak.	18	120	15%
4	Legal Protection for Marginalized Women	Laws exist, but awareness is low.	17	120	14.2%
5	Training & Capacity Building for Women	Some progress, but training doesn't reach all women.	15	120	12.5%
6	Support for Livelihood & Economic Recovery	Limited job opportunities for disaster-affected women.	14	120	11.7%
7	Emergency Health & Hygiene Services	Health services are inadequate in disaster-prone areas.	14	120	11.7%
Total			120		100

Source: Field Survey, 2024

Government strategies for marginalized women in Bardiya show mixed effectiveness. Women's participation in disaster risk reduction (DRR) programs is limited, with mostly symbolic involvement (18%). Access to disaster relief is unequal, often prioritizing male heads of households (16.7%). While gender-inclusive disaster policies exist, implementation is weak (15%). Legal protection for marginalized women is hindered by low awareness (14.2%), and training programs reach only a portion of women (12.5%). Economic recovery support is limited, with few job opportunities for disaster-affected women (11.7%). Additionally, emergency health and hygiene services are inadequate in disaster-prone areas (11.7%).

Government strategies for marginalized women face challenges such as weak implementation, unequal distribution of resources, and cultural barriers. Many women are unaware of their rights and available support, while education and skills programs often miss rural areas. Economic opportunities and health services remain inadequate, especially in disaster-prone regions. These gaps highlight the need for more inclusive and effectively enforced policies to ensure equitable access to resources, education, and healthcare for marginalized women.

4.20.4 Gaps & Challenges in Existing Government Strategies

Table 4.20.4: Gaps & Challenges in Existing Government Strategies

S. N	Categories	Gaps & Challenges (Findings)	Frequency	Total	Percent
1	Lack of Women's Participation in Decision-Making	Women's voices are often ignored in DRR planning.	22	120	18.3%
2	Weak Implementation of Gender Policies	Policies exist but enforcement is poor.	20	120	16.7%
3	Limited Access to Disaster Relief & Aid	Relief distribution favors male heads of households.	18	120	15%
4	Inadequate Legal Awareness & Protection	Many women are unaware of their rights.	17	120	14.2%
5	Poor Economic Recovery Support for Women	No targeted programs for women's livelihood recovery.	15	120	12.5%
6	Insufficient Health &Hygiene Services	Limited access to maternal healthcare & sanitation.	14	120	11.7%
7	Exclusion of Highly Marginalized Groups	*Dalit*, indigenous, and disabled women lack proper support.	14	120	11.7%
Total			120		100%

Source: Field Survey, 2024

Government strategies for marginalized women face several key challenges. Women's participation in decision-making, especially in disaster risk reduction (DRR), is often ignored, with only 18.3% actively involved. Although gender policies exist, enforcement is weak (16.7%), and disaster relief is unequally distributed, favoring male heads of households (15%). Many women lack awareness of their legal rights (14.2%), and there are few targeted programs to support women's economic recovery (12.5%).

Health and hygiene services, especially maternal healthcare and sanitation, are inadequate (11.7%), and highly marginalized groups such as Dalit, indigenous, and disabled women receive insufficient support (11.7%). These gaps highlight the need for more inclusive and effective policies.

4.20.5 Community-Based Adaptation & Women's Role in DRR

Community-based adaptation (CBA) involves women in developing strategies to adapt to climate change and reduce disaster risks. Women play a key role in managing resources like water and food, supporting community resilience. Their inclusion in decision-making ensures DRR strategies are more effective and address the needs of vulnerable groups, enhancing community preparedness and adaptability.

Table 4.20.5: Community-Based Adaptation & Women's Role in DRR

S. N	Categories	Community-Based Adaptation Strategies & Women's Role	Frequency	Percent
1	Women-Led Disaster Preparedness Groups	Women form local committees for disaster response & relief.	25	21%
2	Traditional Knowledge in Disaster Resilience	Women apply indigenous techniques to manage floods, droughts, and crops.	20	17%
3	Water Resource Management & Conservation	Women take the lead in rainwater harvesting & sustainable water use.	25	21%
4	Women's Role in Food Security & Livelihoods	Women engage in climate-smart agriculture & alternative income sources.	15	12%
5	Community Health & Hygiene Management	Women promote hygiene awareness, especially during floods.	5	4%
6	Disaster Risk Awareness & Education	Women participate in awareness campaigns & early warning systems.	20	17%
Total			**120**	**100**

Source: Field Survey, 2024

Women play a vital role in community-based adaptation (CBA) and disaster risk reduction (DRR). They lead disaster preparedness groups (21%) and apply traditional knowledge to manage floods, droughts, and crops (17%). Women also spearhead water resource management and conservation efforts (21%), engage in climate-smart agriculture and alternative livelihoods (12%), promote hygiene during floods (4%), and participate in disaster awareness campaigns and early warning systems (17%). These contributions enhance community resilience and disaster preparedness.

CHAPTER: FIVE

SUMMARY, MAJOR FINDING, THEORETICAL INTERPRETATION, CONCLUSION AND RECOMMENDATION

5.1 Summary

The thesis entitled *"Climate Change-Induced Hazards and Socio-Economic Vulnerabilities in the Lower Karnali Watershed Region, Bardiya"* investigates the increasing risks associated with climate change in Nepal's Lower Karnali region. It examines the socio-economic challenges faced by marginalized groups, particularly indigenous Tharu and other communities, due to climate hazards like floods, droughts, and erratic weather patterns. Given the region's reliance on agriculture and natural resources, environmental shifts significantly threaten livelihoods and food security.

The study categorizes and analyzes climate hazards, documenting their frequency and intensity while highlighting their disproportionate impact on marginalized populations, especially women. It also assesses local adaptation methods and government policies aimed at mitigating these risks. Through a combination of qualitative and quantitative research methods including surveys, key informant interviews, and focus group discussions the thesis provides an in-depth examination of the vulnerabilities faced by these communities.

The research findings indicate that although traditional coping mechanisms exist, they are inadequate without strong governmental intervention and climate-resilient infrastructure. The study concludes by offering policy recommendations to enhance disaster preparedness, improve climate adaptation strategies, and promote sustainable development in the region.

5.2 Major Finding

The findings of this study align with existing literature on climate change-induced hazards and socio-economic vulnerabilities, particularly in marginalized and rural communities. The increasing frequency of floods, droughts, and river erosion in the Lower Karnali Watershed Region reflects global climate change trends that have intensified extreme weather events (IPCC, 2021). Studies suggest that such hazards

disproportionately affect community's dependent on climate-sensitive livelihoods, exacerbating economic hardship and food insecurity (Heltberg & Osmolovskiy, 2011; Chaudhary et al., 2021).

The study confirms that marginalized communities, particularly the indigenous Tharu and Dalit populations, face heightened vulnerabilities due to their dependence on agriculture and limited access to resources. Research by Gentle & Maraseni (2012) and Buddhi et al. (2019) also highlights how indigenous groups in Nepal are disproportionately impacted by climate hazards, as they often lack financial resources and institutional support. Women, in particular, experience additional socio-economic burdens due to their roles in securing water, food, and household management. This finding is consistent with Shrestha & Shrestha (2019), who emphasize how climate change exacerbates gender inequalities by increasing women's workloads and limiting their adaptive capacity.

Despite these challenges, indigenous adaptation strategies remain central to climate resilience in the Lower Karnali region. Traditional irrigation systems and community-led water management practices have historically played a crucial role in sustaining agriculture, aligning with Berkes (2009), who stresses the importance of indigenous knowledge in environmental management. However, as observed in the study, these coping mechanisms are becoming less effective due to the intensifying impacts of climate change, similar to findings by Poudel et al. (2022), which indicate that shifting weather patterns threaten the sustainability of traditional agricultural practices. Additionally, cultural rituals such as *Dhodiya Puja* and *Hereri Puja* continue to be performed to seek protection from natural calamities, reflecting the deep-rooted connection between indigenous traditions and environmental resilience.

The limited effectiveness of government disaster mitigation programs in the study area mirrors global challenges in climate governance. As highlighted by the Global Climate Risk Index (GCRI, 2024) and reports from UNEP (2015), developing countries often struggle with inadequate implementation of climate adaptation policies, particularly in rural and marginalized areas. The study further aligns with findings by Thapa & Upadhyaya (n.d.), who acknowledge Nepal's vulnerability to climate change but note the absence of localized, community-centered interventions.

To address these challenges, the study underscores the urgent need for integrated climate resilience policies that combine modern technology with indigenous knowledge. Strengthening early warning systems, improving flood mitigation infrastructure, and ensuring financial aid for adaptation efforts are essential strategies, as recommended by Sharma (2018) and Iqbal (2020), who emphasize the role of government intervention in reducing climate-induced risks. Moreover, targeted policies aimed at empowering marginalized women and promoting sustainable agricultural practices align with recommendations from USAID (2017) and the World Bank (2019), which advocate for inclusive and community-driven adaptation approaches.

Without immediate and coordinated action, climate risks will continue to undermine the socio-economic stability and environmental sustainability of the Lower Karnali region. The integration of traditional knowledge with modern scientific approaches, along with stronger institutional support, is essential for building long-term resilience in climate-vulnerable communities.

5.3 Theoretical Interpretation

The findings of this study align with several established theoretical frameworks that explain the socio-economic and environmental impacts of climate change on vulnerable communities. The Climate Change Impact Theory is particularly relevant, as it emphasizes how rising temperatures, erratic rainfall patterns, and extreme weather events disrupt ecosystems and human societies. The increasing frequency of floods, droughts, and river erosion in the Lower Karnali Watershed Region directly correlates with these changing climate patterns, causing significant damage to agriculture, infrastructure, and livelihoods. The study confirms that climate change is not only an environmental crisis but also a socio-economic challenge, as marginalized communities face heightened risks due to their dependence on climate-sensitive livelihoods.

The Vulnerability Framework further supports the study's findings by highlighting the interconnectedness of exposure, sensitivity, and adaptive capacity in determining a community's vulnerability to climate hazards. The research indicates that indigenous Tharu and Dalit communities are particularly vulnerable due to their economic marginalization, limited access to financial resources, and reliance on traditional farming methods. Women in these communities face additional barriers, as they are

responsible for securing water, food, and household necessities, making them disproportionately affected by water scarcity and declining agricultural productivity. The lack of strong institutional support further exacerbates their vulnerability, as government adaptation programs often fail to reach the most at-risk populations.

Additionally, the Sustainable Livelihoods Framework (SLF) is applicable, as it examines how climate-induced hazards affect livelihood strategies and resources. The study shows that floods and erratic weather patterns disrupt farming cycles, reduce agricultural yields, and increase financial instability. Despite these challenges, local communities employ traditional coping strategies, such as community-led irrigation systems and rotational water management, to maintain agricultural productivity. However, these indigenous adaptation techniques are becoming less effective due to increasing climate variability. The study underscores the need to integrate modern technology with traditional knowledge to enhance resilience and promote sustainable livelihoods.

Lastly, the Resilience Theory is critical in understanding how communities in the Lower Karnali region respond to climate-induced hazards. This theory emphasizes the ability of societies to absorb, adapt, and recover from environmental shocks. The study highlights that while the Tharu community has a history of adapting to climate challenges through indigenous practices and cultural rituals like *Dhodiya Puja* and *Hereri Puja*, their resilience is weakening due to the escalating intensity of climate events. Limited access to disaster preparedness resources and weak government intervention hinder their ability to recover from recurring floods and water shortages. Strengthening community resilience through improved infrastructure, early warning systems, and capacity-building programs is essential for long-term sustainability.

In conclusion, the study's findings strongly align with these theoretical frameworks, demonstrating that climate change is not just an environmental phenomenon but a multi-dimensional crisis affecting social structures, economic stability, and cultural practices. Addressing these challenges requires a holistic approach that integrates climate science, socio-economic policies, and community-driven adaptation strategies to build a more resilient and sustainable future for the Lower Karnali Watershed Region.

5.4 Conclusion

This study on *Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities in the Lower Karnali Watershed Region, Bardiya* highlights the severe and escalating impacts of climate change on marginalized communities, particularly in Geruwa-3 and Madhuwan-2. Climate hazards such as floods, droughts, river erosion, and heatwaves have become more frequent and intense, posing significant threats to agriculture, livelihoods, and overall socio-economic stability. The study finds that the indigenous Tharu and Dalit communities, who rely heavily on climate-sensitive occupations like farming and fishing, are among the most vulnerable. Limited access to financial resources, infrastructure, and disaster preparedness further exacerbates their vulnerability, making adaptation challenging.

Women, especially those from marginalized backgrounds, face additional burdens due to their roles in household water collection, food security, and caregiving. Climate change has intensified these responsibilities, increasing economic insecurity and health risks. While traditional coping mechanisms such as community-led irrigation, rotational water distribution, and cultural rituals (*Dhodiya Puja* and *Hereri Puja*) remain prevalent, their effectiveness is diminishing due to the increasing unpredictability of climate patterns. The lack of strong institutional support and gaps in the implementation of government policies further weaken the region's resilience to climate-induced hazards.

The theoretical interpretation of the study aligns with key climate change theories, including the Climate Change Impact Theory, Vulnerability Framework, Sustainable Livelihoods Framework (SLF), and Resilience Theory. These frameworks collectively illustrate how climate change exacerbates socio-economic inequalities, disrupts traditional livelihoods, and challenges the adaptive capacity of vulnerable populations. The findings emphasize the urgent need for integrated climate adaptation strategies that combine indigenous knowledge with modern technological solutions.

To mitigate the adverse effects of climate change in the Lower Karnali region, the study recommends strengthening early warning systems, improving flood control infrastructure, and promoting sustainable agricultural practices. Additionally, targeted policies should focus on empowering marginalized women, increasing access to

education, and enhancing government intervention in disaster risk management. Without immediate and coordinated efforts, the worsening climate crisis will continue to threaten the region's environment, economy, and social well-being. Investing in community-driven climate resilience initiatives and fostering inclusive adaptation strategies will be crucial in ensuring a sustainable future for the people of the Lower Karnali Watershed Region. The successful implementation of these recommendations requires a collaborative effort involving the government, NGOs, local communities, and international organizations. By enhancing disaster preparedness, promoting sustainable livelihoods, and integrating traditional knowledge with modern climate adaptation strategies, the Lower Karnali Watershed Region can strengthen its resilience to climate-induced challenges. Prioritizing marginalized communities, particularly women and indigenous populations, will ensure a more inclusive and effective approach to climate adaptation and sustainable development in the region.

5.5 Recommendations

Based on the study's findings, several recommendations have been outlined to enhance climate resilience, minimize socio-economic vulnerabilities, and improve disaster response mechanisms in the Lower Karnali Watershed Region, particularly in Geruwa-3 and Madhuwan-2. These suggestions emphasize strengthening climate adaptation measures, advancing infrastructure development, and empowering marginalized communities to effectively cope with the rising occurrence and severity of climate-related hazards.

1. **Enhancing Early Warning Systems and Disaster Preparedness**
   - Strengthen early warning systems for climate hazards such as floods and droughts by integrating technological advancements with indigenous knowledge.
   - Expand community awareness programs and training sessions to ensure that all residents, particularly women and marginalized groups, are well-informed about evacuation plans and risk management strategies.
   - Establish well-equipped local disaster response units to facilitate immediate action during emergencies.
2. **Developing Flood Control and Water Resource Management**
   - Construct and maintain embankments in high-risk flood zones to reduce river erosion and protect farmland and settlements.

- Implement sustainable water conservation methods, such as rainwater harvesting and small-scale irrigation projects, to address worsening water shortages.
- Strengthen community-based water management practices by combining traditional Tharu irrigation techniques with government-supported initiatives.

3. **Boosting Agricultural Resilience and Promoting Sustainable Livelihoods**

- Encourage climate-adaptive farming techniques, including the cultivation of drought-resistant crops, agroforestry, and organic agricultural practices, to maintain food production despite changing weather patterns.
- Provide financial assistance, subsidies, and access to credit for small-scale farmers to support their transition to climate-resilient agriculture.
- Diversify livelihood opportunities by promoting eco-tourism, handicrafts, and small-scale businesses to reduce dependency on climate-sensitive occupations.

4. **Empowering Marginalized Groups, Especially Women**

- Develop policies that support economic inclusion for marginalized communities, particularly indigenous Tharu and Dalit populations.
- Ensure women's active engagement in decision-making processes related to climate resilience, natural resource management, and disaster response.
- Expand access to education and skill development programs for women, enabling them to secure diverse income sources and better withstand climate-related challenges.

5. **Strengthening Governance and Institutional Support**

- Improve collaboration between local governments, non-governmental organizations (NGOs), and international agencies to effectively implement climate adaptation programs.
- Increase public investment in climate resilience projects, particularly in rural areas that are highly vulnerable to environmental hazards.
- Ensure transparency and fairness in disaster relief efforts so that financial aid and necessary resources reach the most affected households without delays or discrimination.

6. **Integrating Indigenous Knowledge with Modern Climate Adaptation Approaches**

- Recognize and incorporate indigenous climate adaptation practices into national and regional climate policies.

- Encourage local participation in conservation efforts and sustainable land-use planning by leveraging traditional ecological wisdom.
- Safeguard cultural traditions and rituals, such as *Dhodiya Puja* and *Hereri Puja*, as part of broader environmental sustainability initiatives while complementing them with scientific advancements.

7. Enhancing Climate Education and Community Awareness

- Conduct ongoing awareness campaigns to educate communities about the causes, consequences, and mitigation strategies of climate change.
- Incorporate climate change education into school curriculums to ensure future generations adopt sustainable environmental practices.
- Provide specialized training for farmers, disaster response teams, and local youth to strengthen community-driven climate adaptation efforts.

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APPENDIXES

APPENDIX A: Semi-structured Interview Checklist

"Changing Climate-Induced hazards and Socio-Economic Vulnerabilities in Lower Karnali Watershed Region"

Namaste!

I am Samikchhya Gurung, I am a student of Sociology, fourth year, studying in Tri-Chandra Multiple Campus, Kathmandu. The study is being conducted as a partial requirement for the Humanities and Social Science.

This study involves no forcibly risks or harms. Your participation in this study is totally voluntary and you can decide whether to participate or not to participate. Information will be collected through face-to-face interviews using a semi-structured interview schedule. Interviews will be conducted at feasibility of the participants by the researcher herself. The information obtained from you will be kept confidential and will be used only for study purposes. The researcher will be grateful if you help her by participating in the study and want to assure that your personal identity will not be disclosed through this information. If you do not wish to participate either now, or later during the interview, you are free to say no.

Name of Participant: …… Date: ……

Part I: Socio-Demographic Data

1. Geographic Location: ☐Geruwa, ☐Madhuban
2. Name of the Respondents:
3. Age: (in completed years) .....
4. Sex:☐ Male ☐ Female ☐ Others (please specify): .....
5. Ethnicity: ☐ Brahmin/Chhetri ☐Janjati ☐Dalit☐ Muslim☐ Madhesi☐ Others (please specify): .....
6. Religion:☐ Hindu ☐ Buddhism ☐ Muslim ☐ Christian☐ Others (please specify):
7. Educational Level:☐ Not able to read and write ☐ Able to read and write
   If able, please specify the level of education: .....☐ No formal education ☐Primary (1-8 grade) ☐ Secondary (9-12 grade) ☐ Higher education (Bachelor, Master, PhD)
8. Marital Status: ☐ Single ☐ Married ☐ Divorced ☐ Widowed ☐Separated

9. Employment Status:☐ Employed full-time☐ Employed part-time ☐Unemployed ☐ Retired ☐ Homemaker
10. Annual Income (Estimated): .....
11. Family Type:☐ Living alone☐ Joint ☐ Nuclear ☐ Extended
12. Number of Children: .....
13. Disability Status:☐ Yes ☐No (if yes, mention type and cause of disability): .....
14. Nationality: .....
15. Language Spoken at Home: .....
16. Housing Status:☐ Own home ☐ Rent ☐ Temporary housing ☐ Homeless
17. Occupation Status/Position: ☐Professional ☐Skilled labor ☐Unskilled labor ☐Industry worker ☐ Managerial ask
18. Migration Status: ☐ Migrated ☐ Native Indigenous ☐ Don't know
19. IT Accessibility: ☐ Regular access ☐ Occasional access ☐ No access
20. Type of devices used: .....
21. Health Status:☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐Chronic diseases specify name):
22. What types of climate-related hazards have you experienced?.....
23. How frequently do these hazards occur in your community? ☐ Once a year ☐ Multiple times a year ☐ Every few years
24. How has climate change affected your daily responsibilities (e.g., farming, collecting water, household chores)? .....
25. Have you noticed changes in the frequency or intensity of these hazards over the past 10 years?☐ Increased☐ Decreased☐ Stayed the same☐ Don't know
26. Which season(s) do these hazards occur most frequently?☐ Monsoon (Rainy season)☐ Winter☐ Summer☐ Other (please specify): .....
27. Has climate change impacted your ability to find food?☐ Yes☐ No
28. Which traditional food security method is most commonly practiced?
    a. Food Storage & Preservation
    b. Indigenous Farming
    c. Community-Based Food Sharing
    d. Forest and Wild Food Utilization
29. What are the water related crisis and conflicts in study areas?
    a. Drying Up of Water Sources
    b. Reliance on Underground Water
    c. Impact on Agricultural Irrigation

d. Wildlife Migration due to Water Scarcity
e. Human-Wildlife Conflict

30. Which traditional water management method is most frequently used in the study area?
    a. Canal water
    b. Dams and Ponds
    c. Traditional Wells
    d. Water Storage in Clay Pots
    e. Water Recycling in Households
    f. Water sharing communities
31. Which traditional coping strategy is most frequently used to cope with climate-induced hazards?
    a. Building makeshift embankments
    b. Planting flood-resistant crops
    c. Using traditional water conservation techniques
    d. Storing grains in elevated areas
32. Have these events caused any displacement or migration in your family or community?☐ Yes (If yes, please describe): .....☐ No
33. What is the estimated economic loss caused by these hazards in your household or community?.....
34. Have you or your community received any financial assistance or other support to cope with these hazards? ☐ Yes ☐ No
    If yes, from which sources (e.g., government, NGOs)?
35. How have these hazards impacted your access to essential services like water, electricity, or healthcare? ……
36. Have there been any long-term economic consequences of these hazards in your community? If so, what are they? ……
37. How have climate-induced hazards affected children's access to education in your community? ……
38. How have climate-related hazards uniquely impacted women in your community? ……
39. Have women in your household or community faced any health issues due to these hazards? ☐Yes ☐ No If yes, please describe these health issues. …….

40. Can you describe any specific challenges you face in accessing resources like water, food, or healthcare due to changing weather patterns? ……
41. Do women in your community have the same access to resources (e.g., land, credit) as men for coping with climate impacts? If not, why? ☐ Yes ☐ No If no, please explain the barriers. ……..
42. Are there any local organizations or programs that help women cope with the impacts of climate change? ☐ Yes ☐ No
43. How do social or cultural norms in your community influence women's participation in decision-making related to climate adaptation? …….
44. Have women had to take on additional responsibilities because of climate-related hazards? If yes, what kind of responsibilities? ☐ Yes ☐ No If yes, please describe.
45. What barriers do women face in adapting to climate changes in your area?
46. Have women in your community developed specific strategies to cope with these hazards? If yes, please describe. ☐ Yes ☐ No If yes, please explain……
47. Are there any organizations or programs working specifically to support women in addressing climate-related challenges? ☐ Yes ☐ No If yes, please provide detail….
48. What measures have you or your community taken to reduce the impact of climate-related hazards? ……..
49. Have local authorities or organizations provided any training or awareness programs on climate change or disaster preparedness? ☐ Yes ☐ No If yes, what kind of programs?.....
50. How do you receive information about upcoming climate-related hazards? (e.g., radio, community leaders, government alerts) ……
51. Do you believe that women in your community are more affected by climate change than men? ☐ Yes ☐ No
52. What changes or improvements could help your community better cope with climate-induced hazards?
53. What role do you think the government and NGOs should play in reducing the risks of climate change, particularly for women and marginalized groups?
54. Can you describe any traditional water management techniques used in your community?

55. Does your community still use traditional water management techniques? ☐ Yes ☐ No
56. What strategies does your community use to cope with climate-induced hazards such as droughts or floods? ……
57. Has your community experienced more climate-related hazards (like floods or droughts) in the last 10 years compared to before? ☐ Yes ☐ No
58. How have water management practices in your community changed over time? ……
59. What are the Government made Strategies for Marginalized Women?
    - Empowering women in DDR
    - Integrating Gender Perspectives
    - Enhancing Legal and Institutional
    - Formation of Local Disaster Disaster Management Committees
60. What effectiveness of government strategies made for Marginalized Women?
    - Participation in DRR program me
    - Access to Disaster Relief
    - Inclusion of Gender Policies
    - Training and Capacity building for women
    - Support for livelihood and economic recovery
    - Emergency health and hygiene Services
61. What are the gaps and Challenges in Existing Strategies?
    - Lack of women's participation in decision making
    - Weak implementation of gender policies
    - Limited access to disaster relief and aid
    - Inadequate legal protection
    - Poor economic recovery support for women
    - Insufficient health and hygiene services
    - Exclusion highly marginalized groups
62. What are the community based adaptation and women role in DRR?
    - Women-led Disaster Preparedness Group
    - Traditional knowledge in Disaster Resilience
    - Water resources Management and conversation

- Women role in food security and livelihood
- Community health and Hygiene Management
- Disaster Risk Awareness and education

Thank you for your time and immense support!

APPENDIX B: Informed Consent Scheduled Form for KII

Namaste!

I am Samikchhya Gurung, I am a student of Sociology, fourth year, studying in Tri-Chandra Multiple Campus, Kathmandu. The study is being conducted as a partial requirement for the Humanities and Social Science.

This study involves no forcible risks or harms. Your participation in this study is totally voluntary and you can decide whether to participate or not to participate. Information will be collected through face-to-face interviews using a semi-structured interview schedule. Interviews will be conducted at feasibility of the participants by the researcher herself. The information obtained from you will be kept confidential and will be used only for the study purpose. The researcher will be grateful if you help her by participating in the study and want to assure that your personal identity will not be disclosed through this information. If you do not wish to participate either now, or later during the interview, you are free to say no. The Objective to the study the types and most frequent hazardous conditions caused by climate change in the Geruwa-3, lower Karnali Western Region (LKWR).

Consent:

By signing below, you indicate that you have read and understood the information provided above, and you voluntarily agree to participate in this research study. You also acknowledge that you have the right to withdraw from the study at any time without penalty.

Participant Name:……..

Position:……

VDC/Municipality Name:…….

Signature:……

Date:…….

Researcher Signature:……

This academic consent form ensures that VDC and municipal officials are fully informed about the nature and purpose of the research, the confidentiality of their

participation, and their rights as participants. It also provides a formal and ethical approach.

1. What are the key functions of your VDC/municipality in managing local development and disaster risk reduction?
2. What changes in climate patterns have you observed in your area over the past decade?
3. How do you believe these climatic changes are impacting on the local environment (e.g., water sources, soil fertility, forest cover)?
4. What types of natural hazards have affected your community in recent years?
5. Can you describe the most significant natural disaster your VDC/municipality has faced?
6. How have climate-induced hazards affected the local economy, particularly in sectors like agriculture, livestock, and fishing?
7. How have traditional water management practices helped ensure sustainable agricultural production and food security in your community?
8. What challenges are traditional water management systems facing, and how do these challenges affect food security in your area?
9. What challenges do residents face in maintaining their livelihoods in the context of these hazards?
10. What are the main socio-economic challenges facing your community?
11. How are vulnerable groups (e.g., women, children, the elderly, marginalized communities) affected by climate-induced hazards?
12. What strategies have been implemented by your VDC/municipality to cope with and adapt to climate-induced hazards?
13. How do local residents typically cope with the impacts of natural disasters?
14. How does your VDC/municipality coordinate disaster preparedness and response efforts?
15. What kind of support have you received from the national government, NGOs, or international agencies in dealing with natural disasters?
16. What policies or plans are currently in place within your VDC/municipality to address climate change and disaster risk reduction?
17. How does your VDC/municipality engage with residents in planning for disaster risk reduction and climate adaptation?

18. What is your primary concern regarding future climate risks for your VDC/municipality?
19. What additional resources or support do you believe are necessary to enhance your community's resilience to climate change?
20. What are your recommendations for improving disaster preparedness and climate resilience in your VDC/municipality?
21. Can you share any personal experiences or observations that highlight the challenges or successes in dealing with climate-induced hazards?

Thank you for your time and immense support for this research.

APPENDIX C: Focus Group Discussion (FGD) Guide

Topic: *Changing Climate-Induced Hazards and Socio-Economic Vulnerabilities In Lower Karnali Watershed Region, Bardiya*

Target Participants: Indigenous and marginalized communities, especially women, local leaders, and other stakeholders

Duration: 1.5 – 2 hours

1. Introduction

"Welcome and thank you for taking the time to participate in this discussion. My name is Samikchhya Gurung and I am here to learn from your experiences and insights about climate change and its impacts on your community."

2. Discussion Questions

1. What types of hazardous conditions related to climate change (e.g., floods, droughts, landslides, extreme heat) are most common in your area?
2. Have you observed any changes in the frequency and intensity of these hazards over the past 5-10 years? If so, what changes have you noticed?
3. Which seasons are most affected by climate-related hazards, and how do they impact your daily activities?
4. Which areas or communities are most vulnerable to these hazards? Why do you think they are more affected?
5. How have these hazards affected your livelihoods, such as farming, fishing, or small businesses?
6. What are some of the indirect impacts you have experienced, such as food shortages, health issues, or forced migration?
7. Has climate change led to economic challenges such as increased debt, loss of employment, or reduced income opportunities?
8. How have these impacts affected the education and well-being of your children and families?
9. What unique challenges do women in your community face due to climate change impacts?
10. Are there any cultural, social, or economic barriers that prevent women from coping effectively with climate hazards?
11. Do women have access to information, resources, and decision-making opportunities related to climate adaptation?

12. What kind of support do women need to better cope with climate-related challenges?
13. What traditional practices or indigenous knowledge do you use to manage water resources (e.g., rainwater harvesting, irrigation techniques)?
14. How effective have these traditional coping strategies been in dealing with climate-related hazards?
15. Are there any traditional early warning systems or forecasting methods that your community relies on?
16. Have any modern technologies or interventions improved or replaced traditional methods? If yes, how have they been received by the community?
17. Do you think combining traditional and modern approaches could help your community better cope with climate change? Why or why not?

Thank you all for sharing your valuable experiences and insights.

APPENDIX D: Related Photographs during Field Study

Glimpse of Geruwa-3 Rural Municipality, Shantibazar, Bardiya

FGD with Marginalized Women

KII in Geruwa -3

FGD with Youth Club of Geruwa-3 and Madhuban -2

Watershed area of Geruwa-3

FGD with Local Stakeholder in Geruwa -3

Flooded Area

FGD with farmers in Madhuwan -2

FGD with Marginalized Women of Madhuwan-2, Municipality

Map of Vulnerable Area of Geruwa -3

House of Indigenous People using Traditional Materials

Shelter house of Geruwa-3

Traditional Food Storage Method

Water Management of Geruwa and Madhuwan (Canel)

Researcher at Ward Office of Madhuwan -2

Traditional Climate Change Story of Local Geruwa -3

Tharu Traditional Fish Dry for the upcoming Season

Local Food of Tharu (Dhikri) of Madhuwan -2

Researcher in Flooded area of Geruwa -3

Border area of Geruwa -3 with Karnali River

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AUTHOR

Samikchhya Gurung

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