Thesis for the Degree of Master of Science in Environmental Science & Management

INDIGENOUS ADAPTATION STRATEGIES ON FLOOD BY THARU COMMUNITIES IN RAJAPUR, BARDIYA, NEPAL

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Supervised by Prof. Dr. Sanjay Nath Khanal

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Environmental Management

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DECLARATION

I hereby declare that this study entitled **INDIGENOUS ADAPTATION STRATEGIES ON FLOOD BY THARU COMMUNITIES IN RAJAPUR, BARDIYA, NEPAL** is based on my original research work. Related works on the topic by other researchers have been duly acknowledged. I owe all the liabilities relating to the accuracy and authenticity of the data and any other information included hereunder.

Signature

Name of the Student:

P.U Registration Number:

Date:

RECOMMENDATION

This is to certify that this thesis entitled **INDIGENOUS ADAPTATION STRATEGIES ON FLOOD BY THARU COMMUNITIES IN RAJAPUR, BARDIYA, NEPAL** prepared and submitted by [**Jeni Dahal**], in partial fulfillment of the requirements of the degree of Bachelor of Science (MSc.) in Environmental Management awarded by Pokhara University, has been completed under my/our supervision. I/we recommend the same for acceptance by Pokhara University.

………………………..

Prof. Dr. Sanjay Nath Khanal

Professor, SchEMS

November,

CERTIFICATE

This thesis entitled **INDIGENOUS ADAPTATION STRATEGIES ON FLOOD BY THARU COMMUNITIES IN RAJAPUR, BARDIYA, NEPAL** prepared and submitted by **Jeni Dahal** has been examined by us and is accepted for the award of the degree of Master of Science (M.Sc.) in Environmental Management in by Pokhara University.

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ABSTRACT

Flooding is a significant natural hazard in Nepal, particularly affecting the Terai region. The Rajapur municipality of Bardiya district is highly vulnerable to climate-induced floods. This study investigates the indigenous flood adaptation strategies employed by the Tharu community focusing on wards identified as highly vulnerable to flooding, specifically wards 1, 3, 4 (highly vulnerable) and 7, 9, 10 (very highly vulnerable) (LDCR,2022) due to their proximity to the Karnali and Geruwa rivers where previous incidents resulted in catastrophic loss and damages, ensuring that the study captures the experiences of those most affected. The research employs a mixed-methods approach, integrating qualitative and quantitative data collection techniques, including a semi-structured questionnaire with 210 households, 30 key informant interviews with community heads (Barghar) and ward leaders, and a focus group discussion with the Sana Kisan Women's group. The study evaluates adaptation strategies across pre-, during-, and post-flood phases, using tools like the Likert scale, weighted average index (WAI), and chi-square tests to assess effectiveness and socio-demographic influences.

Key practices include building embankments with local materials like bamboo & soil, diversifying livelihoods through various crops and livestock, creating temporary shelters from wood & thatch for safety, and managing resources sustainably with techniques like crop rotation. Socio-demographic factors, such as gender, age, education, income, and proximity to rivers, significantly influence adaptation strategies in Tharu communities. Research shows that men engage in fishing and diversifying their incomes, while women focus on food security through seed preservation. Age affects practices, with older individuals relying on traditional farming methods and younger individuals combining these methods with new ideas. Education enhances the application of traditional knowledge, and income levels determine the capacity for investing in sustainable practices. Communities near rivers experience more flooding but benefit from fertile land, while those farther away grow drought-resistant crops and seek alternative livelihoods. Traditional knowledge is vital but faces challenges from resource constraints and social pressures.

Keywords: *Flood, Indigenous Adaptation Strategy, Knowledge Transformation*

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ABBREVIATIONS AND ACRONYMS

DRRM	Disaster Risk Reduction Management
FRM	Flood Risk Management
GDP	Gross Domestic Product
IC	Indigenous Communities
IK	Indigenous Knowledge
IP	Indigenous People
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Plans for Action
LDCRP	Local Disaster & Climate Resilience Plan
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NFDIN	National Foundation for Development of Indigenous Nationalities
UN	United Nation
UNDRR	United Nation Office for Disaster Risk Reduction
UNEP	United Nation Environment Program
UNO	United Nation Organization
WAI	Weighted Average Index
WB	World Bank
WMO	World meteorological Organization

CHAPTER I: INTRODUCTION

1.1 Background

Flooding is a significant natural hazard in Nepal, exacerbated by anthropogenic climate change, which alters weather patterns and increases the frequency and severity of extreme weather events (Calvin et al., 2023). The Intergovernmental Panel on Climate Change (IPCC) defines floods as occurrences where water overflows or accumulates in areas not typically prone to flooding. The impact of floods is particularly pronounced in Asia, with countries such as India, China, the Philippines, Iran, Bangladesh, and Nepal being especially vulnerable (Devkota and Shrestha, 2021). Previous forecasts indicated that a warming of approximately 1.54 °C (2.77 °F) above the average from 1850 to 1900 was expected by 2023, signifying a substantial warming trend. Generally, regions with high rainfall were becoming wetter, while those with low rainfall were experiencing increased (Rohde, R.,2024). According to Global Climate Highlights (2023), projections indicated that mean annual precipitation could significantly vary over the coming decades, with potential decreases of up to 34% or increases of up to 22% by 2030, decreases of up to 36% or increases of up to 67% by 2060, and decreases of up to 43% or increases of up to 80% by 2090. These changes in precipitation patterns are likely to lead to more frequent and severe climate extremes, including droughts, floods, and unpredictable monsoon patterns.

Nepal is the eleventh most disaster-prone country in the world, with about half of its population constantly at risk from floods and other natural disasters (Breen et al., 2012). The country experiences frequent flooding, especially during the monsoon season, making it the second most vulnerable nation in South Asia to floods. Between 1972 and 2011, floods caused the deaths of 3,329 people, affected approximately 3.9 million individuals, and incurred economic losses of around US$5.8 billion, with an average of around 300 fatalities each year. Significant flood events include the devastating floods of 1993, the Koshi embankment breach in 2008, and the floods that occurred in 2013, 2014, and 2021 (Shrestha et al., 2020). The southern lowlands of Nepal receive substantial rainfall during the three-month monsoon season; for instance, the floods of 2017 were particularly severe, resulting in an estimated crop loss of NPR 8.1 billion and leaving 160 people dead and 29 missing (Kshetri, 2024). Overall, Nepal's geography and climate make it highly susceptible to flooding, which poses significant risks to lives, property, and livelihoods

Indigenous populations in Nepal are particularly vulnerable to climate change, facing heightened risks from rising temperatures and associated social, cultural, and health challenges. Globally, Indigenous people's number between 250 million and 600 million, representing over 5,000 distinct tribes across various climate zones (Dudley et al., 2010). Their traditional knowledge has been invaluable for centuries in adapting to environmental changes and managing resources sustainably. According to the Central Bureau of Statistics' 2021 Census, Indigenous Peoples make up 35.08% of Nepal's total population, amounting to approximately 29.16 million individuals. Among these groups, the Tharu people primarily reside in the Terai region and constitute about 6.2% of the population, making them the second-largest Indigenous nationality in the country after the Magar. The Tharu people are considered one of the oldest inhabitants of Nepal's Terai region, known for their rich cultural heritage that includes various sub-groups, each with its own distinct languages and customs (Khadka, N.B., 2016). Traditionally, they have engaged in agriculture, often working as tenant farmers or laborers for landlords. Their social structure is characterized by a joint family system and a governance model called Barghar-Mukhiya, which focuses on resolving conflicts within the community and maintaining harmony. Despite facing historical marginalization, the Tharu continue to uphold their traditions and rituals, which are vital to their identity and community cohesion. They are also recognized as guardians of biodiversity, deeply connected to their ancestral lands.

Rajapur municipality is predominantly inhabited by the Tharu community, which makes up about 80% of the local population. They are recognized as one of the oldest Indigenous groups in the Terai region, known for their agricultural practices and strong connection to their ancestral lands (Upadhyay, 2019). This municipality is particularly susceptible to flooding due to its location between the Geruwa and Karnali rivers, which are prone to heavy rainfall and rising water levels. The region consists mainly of sedimentary deposits formed as the Karnali River emerges from the Himalayas, making it vulnerable to recurrent floods (Khabarhub, 2020). Notable flood events, such as those in August 2017 and October 2022, have caused significant damage, affecting thousands of households and leading to substantial agricultural losses (Sharma et al., 2022).The area faces serious flooding during the monsoon season, made worse by climate change, which is causing more rain and higher river levels.

As climate change threatens Rajapur Municipality through resource degradation and extreme weather events, there is an urgent need for adaptation strategies that respect traditional knowledge and enhance resilience (Nursey-Bray & Palmer, 2018). According to the IPCC Sixth Assessment Report (AR6), adaptation involves adjusting to actual or expected climate impacts to minimize harm or take advantage of beneficial opportunities in both human and natural systems (Calvin et al., 2023). The Tharu people in Rajapur have adopted various traditional practices to cope with flooding. They utilize crop rotation and mixed-crop systems, build homes with sturdy materials like concrete and brick, and raise house foundations to reduce flood damage. Additionally, they implement agricultural management techniques such as relay cropping, direct seed sowing, planting early-maturing rice varieties, and growing flood-resistant crops. The Tharu community also cultivates drought-tolerant crops like tomatoes and groundnuts, uses organic compost to improve soil fertility, stores seeds in elevated areas for protection, builds raised cattle barns for livestock safety, and practices agroforestry to stabilize the soil. Therefore, these adaptation strategies help reduce the effects of flooding and strengthen the Tharu community against climate challenges. By combining traditional practices with new methods, they are better prepared to handle the impacts of climate change and protect their livelihoods.

1.2 Statement of problem

Nepal is highly susceptible to flooding due to its topography and geographic position, ranking 10th globally in terms of physical exposure to fluvial flooding. This vulnerability suggests that physical assets worth approximately 1.4% of the country's GDP may be at risk of damage (Karki et al., 2019). The Terai region, particularly Bardiya District, was severely impacted by monsoon floods in 2017, with continuous rainfall from August 11 to 14 causing extensive flooding across 35 out of 77 districts. Some areas experienced the highest rainfall recorded in over 60 years, resulting in Bardiya being ranked fourth for damages and loss of life among the affected districts.

Rajapur Municipality, home to 80% of the indigenous Tharu population, is particularly prone to flooding due to its location between the Karnali and Geruwa rivers. With a total agricultural area of 108.97 square kilometers, the local economy heavily relies on agriculture (Sharma et al., 2022). Each year, the residents of Rajapur face recurrent flooding events that lead to significant agricultural losses and impact their livelih. Recently, in

October 2022, nearly 700 families were displaced by floods in the Tikapur and Janaki municipalities of Kailali, while over 800 families in Rajapur and Geruwa municipalities were similarly affected (Breen et al., 2012).

Despite the implementation of adaptation strategies, local communities continue to experience substantial agricultural losses and disruptions to their livelihoods due to frequent inundation of their lands and homes. This study aims to investigate and evaluate the effective indigenous practices employed by these communities regarding flood adaptation strategies. By examining these traditional methods, the research seeks to identify effective and culturally appropriate strategies for managing floods before, during, and after they occur.

1.3 Research questions

- What types of indigenous adaptation strategies does the Tharu community employ to safeguard their livelihoods and agriculture in the face of flooding?
- What factors influence the indigenous adaptation strategy among the Tharu community in Rajapur Municipality?
- How is indigenous knowledge related to flood adaptation transformed and transmitted across generations within the Tharu community?

1.4 Objectives

1.4.1 General objectives

- To study indigenous adaptation strategies on flood by Tharu communities in Rajapur, Bardiya on Agriculture and livelihood.

1.4.2 Specific objectives

- To study the indigenous adaptation strategy on agriculture and livelihood in Tharu community.
- To assess the factors influencing indigenous adaptation strategies in Tharu community.
- To study indigenous knowledge transformation across generation in Tharu community.

1.5 Rationale of the study

Indigenous people are particularly vulnerable to flooding due to limited resources, social and economic challenges, lack of awareness and planning, and unequal access to relief and recovery support. These factors increase their risk and hinder their ability to cope effectively with flood disasters, leading to significant consequences for their communities. The Tharu community in Rajapur was selected for this study because of their deep connection to the land and extensive traditional knowledge of flood adaptation strategies. Having lived in flood-prone areas for generations, they have developed unique methods to address the challenges posed by recurrent flooding. Their practices include various adaptive strategies such as crop diversification, constructing homes with elevated plinth levels, alternative farming techniques, and building embankments to withstand future flood events.

The Terai region, including Bardiya district, is Nepal's agricultural heartland, with rice as the primary staple crop. Approximately 80% of Bardiya's Tharu population relies on agriculture for their livelihoods. However, frequent flooding poses a significant threat to agricultural output (Gadal et al., 2019). For instance, in October 2022, nearly 700 families were displaced by floods in Tikapur and Janaki municipalities of Kailali, while over 800 families in Rajapur and Geruwa municipalities suffered substantial losses in paddy production (Breen et al., 2012). I have chosen wards 1, 3, 4, 7, 9, and 10 of Rajapur Municipality for my study because wards 1, 3, and 4 are highly vulnerable to flooding, while wards 9 and 10 frequently experience recurring floods that damage agriculture and local livelihoods.

Studying the effectiveness of adaptation strategies in Rajapur is crucial as it helps identify which methods work best for the Tharu community in coping with flooding. This process encourages community members to share their knowledge and experiences, strengthening social bonds and empowering individuals. Further research is essential on indigenous communities across Nepal that are susceptible to flooding since these groups possess distinct knowledge developed over generations to address climate challenges. Understanding how different indigenous populations adapt can help identify effective strategies that can be shared and implemented in other vulnerable areas. This research fills a gap by documenting effective ways that communities like the Tharu adapt to flooding. Many traditional practices are often overlooked despite their potential to improve disaster management and climate policies. By incorporating this knowledge into future planning, we can better support indigenous communities, ensuring their practices are recognized and utilized, ultimately enhancing their ability to handle flooding and other environmental issues.

1.6 Limitation of the study

- The study selected only highly vulnerable wards 1, 3, and 4, along with vulnerable wards 7, 9, and 10, for the research area.
- Focusing only on the Tharu community made it hard to understand their language and culture, which limited our appreciation of their traditional knowledge.

CHAPTER II: LITERATURE REVIEW

2.1 Overview of Flood & Adaptation strategy

A flood is characterized as a temporary situation where the water level or discharge of surface water (such as rivers, lakes, or seas) surpasses a specific threshold, causing it to overflow its usual boundaries (Munich-Re, 1997). Of the more than 7,000 natural disasters that have taken place in recent decades, roughly 75% were related to water. Among these incidents, floods were the most common, representing about one-third of the total (Dutta, 2003).

Rentschler, Salhab, and Jafino (2022) highlights that flooding posed a significant natural hazard, particularly in low-income countries, with 1.81 billion people (23% of the global population) at risk of flooding once every 100 years. Most at-risk individuals (1.24 billion) resided in South and East Asia, especially in China and India, which accounted for over a third of the exposure. Notably, 89% of those at risk lived in low- and middle-income countries, with Sub-Saharan Africa representing 44% of the 170 million individuals living in extreme poverty (under $1.90 per day). Additionally, around 780 million people earning less than $5.50 daily faced significant flood risks, highlighting the urgent need for tailored flood mitigation strategies to foster resilient development.

Yue et al. (2020) defined adaptation as the measures taken to address the impacts of climate change on a rapidly warming planet. Both the environment and human society faced immediate threats from climate change. The World Bank (2016) noted that eliminating all natural disasters could save hundreds of billions in damages annually and lift 26 million people out of extreme poverty. However, since not all disasters can be prevented, effective adaptation to increasing flood risks requires a comprehensive approach that includes structural flood defenses, early warning systems, risk-informed land-use planning, nature-based solutions, social protection measures, and risk financing schemes. In particular, physical flood protection measures like dikes and levees are crucial; for instance, the Netherlands relies on a dike system designed for floods occurring once every 10,000 years, ClimateChangePost (2021).

According to Molnar-Tanaka and Surminski (2024), governments around the world are increasingly adopting nature-based solutions to manage flooding. These solutions include widening natural floodplains, protecting wetlands, restoring oyster and coral reefs, and investing in urban green spaces to reduce runoff.

According to National Adaptation Plan (NAP) 2021-2050, Nepal is vulnerable to various natural and human-induced hazards, including floods, landslides, forest fires, and climate change impacts. According to the World Meteorological Organization (2024), an average of 647 people die annually from climate-induced disasters, which accounts for about 65% of total disaster-related deaths. Floods are particularly deadly, causing over 50% of these fatalities and 30% of economic losses. The 2017 floods affected 80% of the Tarai region, resulting in damages estimated at USD 584.7 million. These disasters contribute to food insecurity, property damage, and rising living costs while straining national resources. Factors like rapid population growth, poverty, and limited awareness further increase vulnerability.

The Disaster Risk Reduction and Management (DRRM) framework in Nepal emphasizes collaboration among federal, provincial, and local governments under the DRRM Act (2017), focusing on preparedness, mitigation, response, and rehabilitation. However, local data collection and management remain inadequate. To address these challenges, six priority adaptation programs are being implemented to empower local governments in DRRM activities and enhance community resilience. These programs include building climate resilience through local disaster risk management guidelines, creating adaptive social protection frameworks for vulnerable populations, maintaining early warning systems for timely information, developing federal and provincial disaster risk reduction strategies in forest areas, promoting fire control regulations for safety and resilience, and formulating climate risk-sensitive land use planning guidelines (Government of Nepal, 2021).

2.2 Indigenous Adaptation Strategy in global context

Morton (2007) found that traditional agricultural farmers in southeast Nigeria employ various adaptation strategies to mitigate climate change effects, primarily relying on face-to-face discussions with neighbors (76.0%), fellow farmers (66.7%), and radio (54.7%) for information. Traditional practices, such as using organic manure (mean = 3.89) and mixed farming, are prevalent; however, constraints like poor extension services and limited access to climate information hinder effective adaptation.

Mavhura et al. (2013) highlighted the significant role of indigenous knowledge systems in reducing flood impacts in Muzarabani, Zimbabwe, emphasizing customary leadership, cultural beliefs, and traditional practices, alongside indigenous early warning signs based on animal behavior.

Altieri and Nicholls (2013) examined the adaptation and mitigation potential of traditional agriculture across Latin America, Africa, and Asia, finding that diverse and integrated farming systems enhance smallholder resilience to climate change. Key strategies include diversifying crops and livestock, integrating trees into farming systems, using locally adapted varieties, and implementing soil and water conservation techniques.

Lema and Majule (2009) studied the impacts of climate change on agriculture in Tanzania's semi-arid Manyoni District, emphasizing the importance of diversifying species and implementing conservation techniques to enhance resilience.

Nyong et al. (2007) discussed the significance of indigenous knowledge in climate change mitigation and adaptation in the African Sahel, advocating for the integration of local strategies like zero tillage and agroforestry with modern climate policies.

Cobbinah and Anane (2015) revealed that smallholder farmers in rural Ghana adopt various coping strategies against climate change impacts, including diversification of crops and income sources while facing severe climate risks influenced by socio-cultural factors.

Alam (2016) investigated factors influencing resource-poor households in Bangladesh regarding riverbank erosion adaptation strategies, finding migration to be vital for small farmers. Barriers included limited credit access and insufficient information on effective strategies.

Kodirekkala (2018) explored cultural adaptation strategies among the Konda Reddis in India, noting a significant transition from using jeelugu to tati as a response to climate change.Makondo and Thomas (2018) emphasized integrating indigenous knowledge with Western scientific methodologies for effective adaptation in African societies, revealing that traditional knowledge enhances awareness and informs robust adaptation strategies through qualitative research methods.

Marie et al. (2020) examined local adaptation strategies in Ethiopia’s Gondar Zuria District, identifying socio-economic factors influencing farmers' decisions amid challenges like crop failure and water shortages.

Singh et al. (2023) discussed adaptation strategies employed by farmers in Gujarat, utilizing data from 400 farmers to assess the impact of these strategies on agricultural productivity. Findings indicated that changes in crop sowing times and mixed cropping positively influenced productivity while highlighting the importance of socio-economic factors such as education level and government support in enhancing resilience against climate change impacts within agriculture.

2.3 Indigenous Adaptation Srategy in National Context

Khanal et al. (2019) investigate the impacts of climate change on the Chepang community in Dhading district, Nepal, revealing significant alterations in temperature and rainfall patterns that negatively affect agricultural practices and food security. In response, the Chepang people have implemented adaptation strategies such as transitioning to resilient crop varieties, practicing agroforestry, diversifying income sources, and leveraging traditional knowledge. Despite challenges like limited resources and inadequate support, integrating indigenous knowledge into adaptation planning is essential for enhancing community resilience.

Devkota, Cockfield, and Maraseni (2014) explore community-based flood adaptation strategies in the West Rapti River Basin of Nepal. The study finds that local communities utilize traditional ecological knowledge to predict floods through techniques like monitoring rainfall patterns and assessing temperature variations. Preferred adaptation strategies include creating flood management plans pre-flood, effective communication during floods, and mutual assistance post-flood. The findings emphasize the importance of integrating traditional ecological knowledge with community-based strategies for effective flood management.

Karki et al. (2020) examine adaptation strategies among subsistence-oriented smallholder farmers across three agro-ecological zones in Nepal: Terai, Hill, and Mountain. The research reveals diverse adaptation practices, including modifying crop types, applying fertilizers, embracing new technologies, and managing soil and water resources. Climatic and non-climatic factors significantly influence these practices, highlighting the need for collaboration among farmers, community organizations, and government entities to promote effective adaptation strategies.

Shreevastav and Tiwari (2022) analyze rainfall dynamics' impact on flood perception and indigenous adaptation practices in Sarlahi and Rautahat districts of Nepal. The study finds significant declines in annual rainfall from 1990 to 2019. Communities perceive floods as critical issues and have developed indigenous practices for flood prediction and response. Their findings underscore the need to integrate these practices into flood management strategies to enhance resilience.

Hossain (2024) focuses on smallholder farmers' perceptions of climate change in Mustang district, Nepal. The study identifies various adaptation strategies employed by farmers to enhance livelihood security and conserve biodiversity. Socio-economic and environmental factors significantly influence adaptive capacity and decision-making processes. The findings highlight the inter-dependencies among adaptation strategies, emphasizing the need for tailored interventions that address diverse aspects of farmers' adaptive capacity.

2.4 Indigenous Adaptation Strategy in Local Context

Chaudhary (2021) investigates the Tharu community's responses to climate change-related water hazards in Nepal's western Tarai region. The study reveals that the Tharu utilize traditional practices such as crop rotation, intercropping, and water harvesting to mitigate the impacts of climate change. However, increasing vulnerabilities from water scarcity and agricultural failures have led them to adapt by diversifying crops, using drought-resistant varieties, and implementing community-based water collection activities. The research underscores the need to integrate traditional knowledge with modern scientific methods to enhance resilience and adaptation among the Tharu population.

Dhungel (2011) explores the indigenous knowledge and practices of the Tharu community in Bardiya, Nepal, focusing on flood disaster mitigation. As disasters become more frequent, the Tharu's self-developed forecasting methods and embankment techniques are found insufficient against rapidly changing climatic patterns. The study emphasizes the necessity of combining scientific strategies with local knowledge for effective disaster risk reduction.

Ojha (2023) highlights various adaptation strategies employed by agricultural communities in flood-prone regions, particularly in Rajapur Municipality. The study indicates that farmers often take on temporary jobs due to limited livelihood options and adopt proactive strategies like acquiring new skills for income diversification. Migration is noted as a common strategy, allowing individuals to maintain occupations or gain new skills. However, reliance on loans can impede financial recovery. The findings stress the importance of understanding and supporting effective adaptation strategies for long-term resilience in flood-affected communities.

CHAPTER III: METHODOLOGY

3.1 Study area

Rajapur is located in the southern plains of Nepal, known as Terai. It is an agricultural area bordered by India to the south and surrounded by the Karnali and Geruwa rivers on its eastern and western borders which is approximately 30 kilometers far from the Karnali River and about 25 kilometers far from the Geruwa River. Geographically, it is bound by latitude 28°21’25.16”N to 28°29’43”N and longitude 81°03’25.63”E to 81°12’52”E. The municipality is situated at an elevation of 142 to 154 meters above sea level, while the Karnali River flows through a lower elevation area, making it susceptible to flooding and erosion.

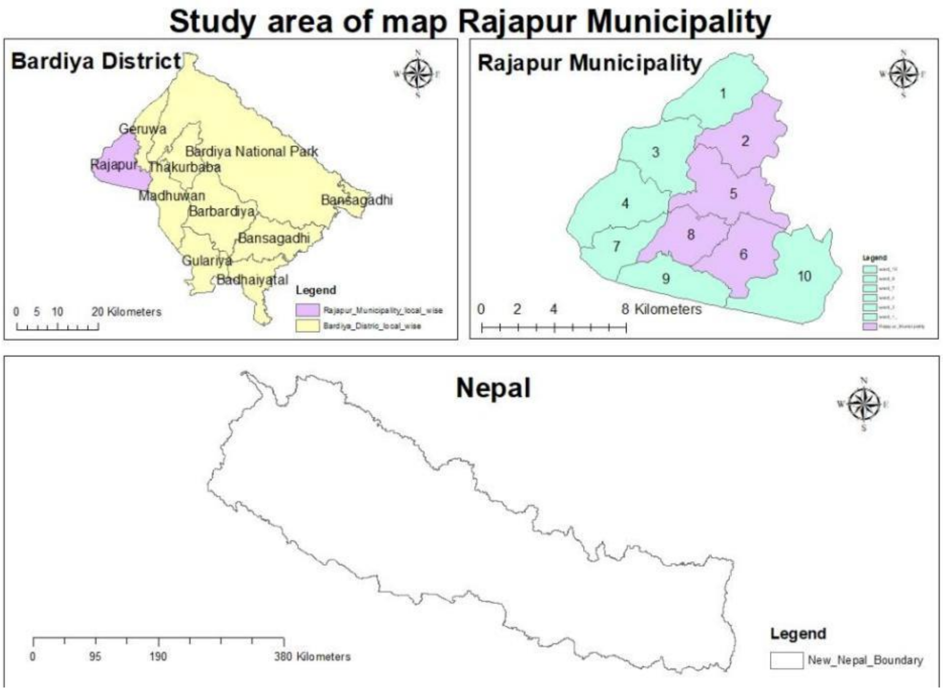

Figure 1: Study area map of Rajapur Municipality

According to the CBS 2021 of Nepal, Rajapur Municipality is home to approximately 60,831 people, with different castes and ethnicities comprising 32,224 females and 28,607 males. The largest indigenous ethnic group in Rajapur is the Tharu, making up 77.8% of the population. According to the LDCRP report (2022), the municipality comprises 10 wards among which 1, 3,4,7,9, and 10 were selected as study areas that are very highly vulnerable (7, 9, and 10) and highly vulnerable (1, 3, and 4) because they are located along the branches of the Karnali River and Geruwa River, where previous incidents resulted in catastrophic loss and damages. Most of the land in the study area is used for agriculture, with 57.89% dedicated to this purpose. Agriculture is the most important activity in the area, with the majority of people practicing subsistence farming (Ghimire et al. 2023).

3.2 Research Design

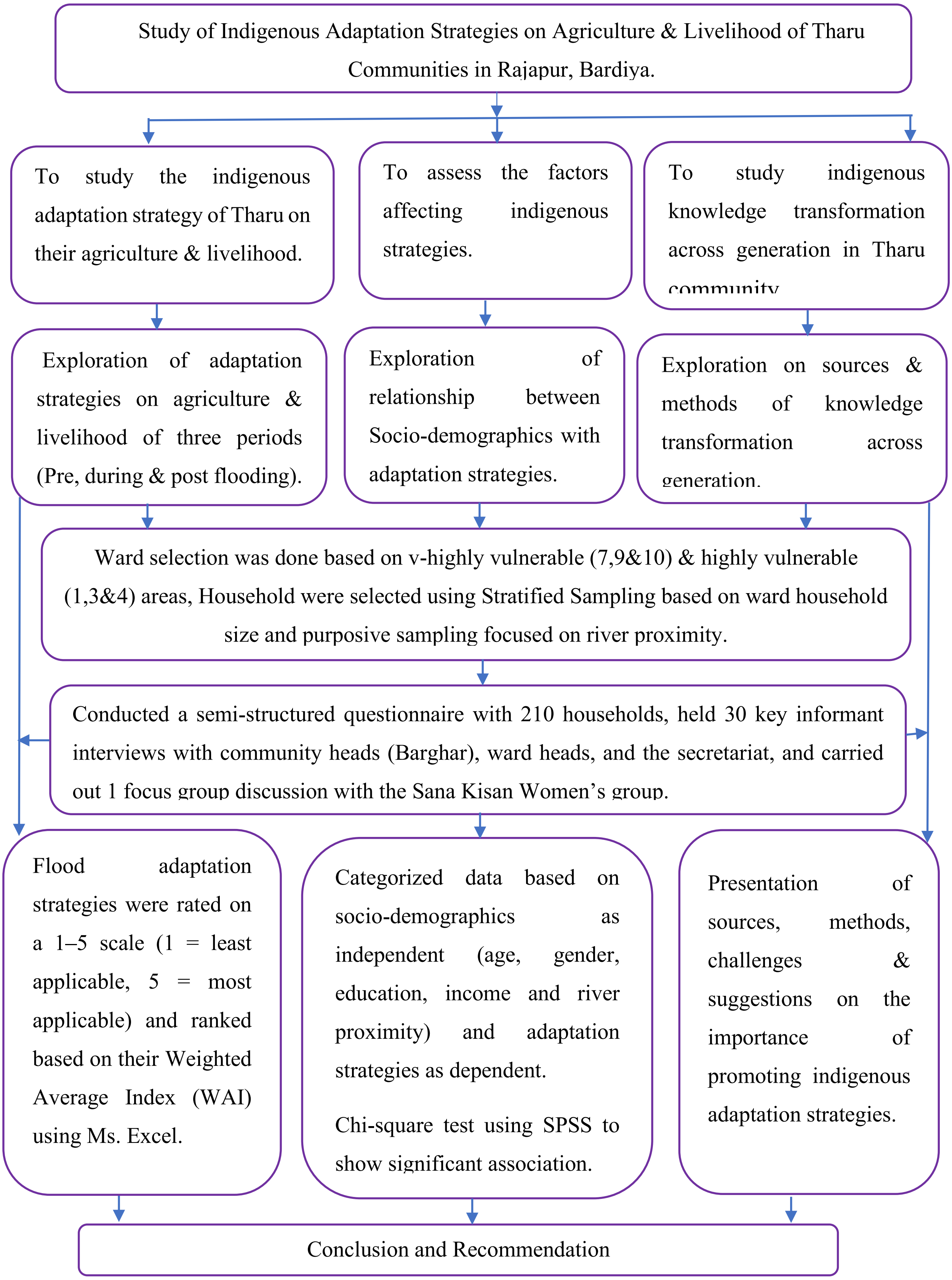

Figure 2: Flowchart of Research Design

3.3 Objective-wise Research Design

Table 1: Objective-wise Research Design

S. N	Objectives	Data required	Data collection methods	Data analysis method
1.	To study the indigenous adaptation strategies on livelihood and agriculture in Tharu community.	Demographic information of households Livelihood & Agriculture strategies and adaptation Adaptation strategies used during three periods: Pre-flooding, during flooding, and Post-flooding.	Household Survey (HHS), Focus Group Discussion (FGD), Key Informant Interview (KII)	Likert scale (1-5points), Microsoft Excel Weight Average Index (WAI)
2.	To assess the factors influencing indigenous adaptation strategies in Tharu community.	Socio-demographic data of respondents (age, gender, education level, income, river proximity).	Focus Group Discussion & KII. Household survey	Statistical Package for the Social Sciences (SPSS), Chi-square test
3.	To study indigenous knowledge transformation across generation in Tharu community.	Data on methods and challenges in traditional knowledge transmission over the generation.	Household survey Focus Group Discussion & KII.	Microsoft Excel

3.4 Sampling Techniques

The sampling was conducted using a multi-stage sampling method. First, a stratified random sampling approach was employed to select a ward that were classified as highly and very highly vulnerable, specifically wards 1, 3, 4, 7, 9, and 10. This was followed by purposive sampling based on the proximity to the river.

3.4.1 Sample size Selection

n_0 = required sample size for unknown population

n = required sample size for known population

Z = Z-score corresponding to the confidence level = 1.96 for a 95% confidence level

P = the (estimated) proportion of the population which has the attribute in question (0.05)

e = margin of error =7%= 0.07 (sufficient level of accuracy for the research study)

N = total number of households in the study area = 7,647

Calculations for sample size:

Using Cochran (1977) formula when population size is unknown,

$n_0 = (Z^2 \times p \times (1\text{-}p)) / e^2$

$n_0 = (1.96^2 \times 0.5 \times (1\text{-}0.5)) / 0.07^2$

$n_0 = 0.9604/0.0049$

$n_0 = 196$

Using Cochran (1977) formula when population size is known,

$n = n_0 / [1 + \{(n_o - 1)/N\}]$

$n = 196 / 1 + \{(196 - 1)/7{,}647\}]$

$n = 191.199$

$n \sim 192$

As a minimum of 192 samples was statistically significant for this research, I selected to include 210 households.

3.4.2 Sample Size Based on ward

To estimate the sample size based on the wards of the selected study area:

Sample size (ss) = (total household in a ward / total household in the municipality) × n

Table 2: Stratified Sample Size for different wards

Ward no.	**Households based on ward**	**Sample size**	**Adjusted sample size**	**Actual sample taken for study**
1	1,271	31.91	32	34
3	1,233	30.96	31	34
4	1,751	43.96	44	47
7	822	20.64	21	26
9	1,098	27.57	28	31
10	1,472	36.96	36	38
Total	7,647		192	210

3.4.5 Spatial Distribution of Household Survey

Figure below illustrates the distribution of households surveyed in the Rajapur district. The green dots represent individual households, while the light blue area outlines the district boundaries.

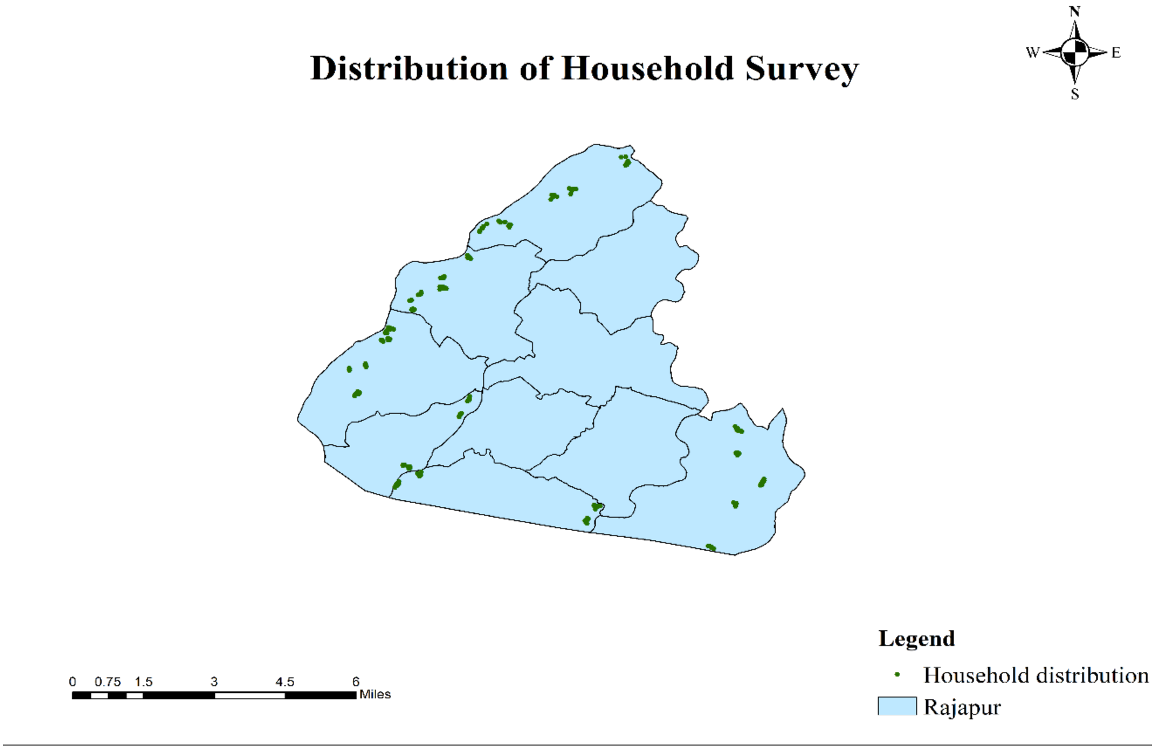

Figure 3: Spatial Distribution of Household Survey

3.5 Data collection

The research conducted in Rajapur used a mixed-methods approach, combining both qualitative and quantitative data collection techniques. This combination provided a thorough understanding of the research topic by gathering both numerical data and detailed insights.

3.5.1 Primary data collection

The methods applied in this study includes a Key Informant Interview (KII), Focus Group Discussion (FGD) and Household Surveys (HHS).

1. Key Informant Interview (KII): A total of 26 Key Informant Interviews (KIIs) were conducted with the ward heads and secretaries from wards 1, 3, 4, 7, 9, and 10 and mainly focusing Barghar (The head of community) from each community of selected ward. These interviews focused on gathering insights from community leaders who possess extensive knowledge about indigenous adaptation strategies. The primary purpose of the KIIs was to

identify the indigenous adaptation strategies currently employed within the community to cope with a flood.

2. Focus Group Discussion: Only one Focus Group Discussion (FGD) was organized throughout my study. This discussion took place on August 16th with a Sana Kissan Women's Group. During the FGD, open-ended questions were posed to explore the major adaptation strategies they employ in their daily lives to cope with flooding. The purpose of conducting this Focus Group Discussion was to gather qualitative insights and firsthand experiences from the community, allowing for a deeper understanding of how they cope with the annual disaster of flooding.

3. House Hold Surveys (HHS): A total of 210 household surveys were conducted in my study to understand the most applicable adaptation strategies adopted in livelihoods and agriculture over the past 30 years, categorized into three periods: pre-flooding, during flooding, and post-flooding. Additionally, the survey aimed to explore how knowledge is being passed down to future generations and to identify factors influencing these adaptation strategies. The survey employed a stratified sampling method based on wards and purposive sampling based on river proximity, prioritizing all age groups. The semi-structured questionnaire was designed with cultural sensitivity and respect for indigenous knowledge, ensuring that local perspectives were considered. Each interview lasted approximately 20 to 30 minutes to collect the necessary information. The primary goal of the survey was to identify the adaptation strategies that participants applied in their daily lives and to rank these strategies using a Likert scale from 1 to 5. The survey also gathered information on knowledge transformation across generations within the Tharu community and addressed factors influencing their adaptation strategies.

3.5.2 Secondary data collection

Secondary data were collected from different journals, published and unpublished articles, books, thesis reports, and websites.

3.6 Data Analysis

The analysis employed both qualitative and quantitative methods, indicating that the variables encompassed measurable data (quantitative) as well as descriptive or categorical information (qualitative) gathered from various sources.

3.6.1 Identification of indigenous adaptation strategies on livelihood and agriculture of Tharu community.

In the beginning, respondents were asked to prepare a list of flood adaptation strategies in livelihood and agriculture during three periods (pre-flooding, during flood, and after flooding) that had been most commonly adopted over the past many years through Key Informant Interviews and Focus Group discussions. They were then further requested to identify those adaptation strategies that were most relevant. During the Household survey, the key person of the household was asked to rank selected flood adaptation strategies against a 1–5 scale, where 1 was the least applicable option and 5 was the most applicable option. The adaptation strategies for each period were ranked based on the weighted average index (WAI) (Devkota and Cockfield 2014).

$$WAI = \frac{F_1 \times W_1 + F_2 \times W_2 + F_3 \times W_3 + F_4 \times W_4 + F_5 \times W_5}{F_1 + F_2 + F_3 + F_4 + F_5}$$

$$WAI = \frac{\sum Fi \times Wi}{\sum Fi}$$

where

F frequency of the respondents

W weight of each scale

i weight (5 = highly applicable, 4 = applicable, 3 = moderately applicable, 2 = less applicable and 1 = very less applicable).

3.6.2 Factors influencing adaptation strategies

The Chi-Square Test was used to examine socio-demographic factors and adaption strategies because it efficiently evaluates whether categorical variables have a significant relationship. This test enabled us to evaluate the connections between various socio-demographic factors, such as age, gender, and income, education, river proximity and their related adaption techniques, thereby finding trends and relationships in the data.

The formula for the chi-square statistic (χ2) is:

$\chi2=\sum(Oi-Ei)/Ei$

Where:

Oi = Observed frequency for each category

Ei = Expected frequency for each category (calculated based on the assumption of no association)

Degrees of Freedom

The degrees of freedom (df) for a chi-square test are calculated as:

$df=(r-1)(c-1)$

Where:

r = Number of rows in the contingency table

c = Number of columns in the contingency table

Hypotheses for Chi-Square Test

For each variable used in my study, I had set up null and alternative hypotheses:

Example Hypothesis

For Socio-Demographic & Economic Factors (Age, education, income, gender, river proximity)

Null Hypothesis (H0): There is no significant association between socio-demographic & economic factors and the adoption of indigenous adaptation strategies.

Alternative Hypothesis (Ha): There is a significant association between socio-demographic & economic factors and the adoption of indigenous adaptation strategies.

3.6.3 Indigenous knowledge transformation across generation

Data analysis was carried out by collecting information from household surveys, focus group discussions, and key informant interviews (KII), with an emphasis on traditional knowledge transmission and community members' challenges. The obtained data was organized in Microsoft Excel for easy sorting and categorization, and basic statistical methods were used to describe knowledge transmission patterns. The findings were then presented using charts and graphs.

CHAPTER IV: RESULT AND DISCUSSION

4.1 Results

4.1.1 Socio-demographics profile of study respondents.

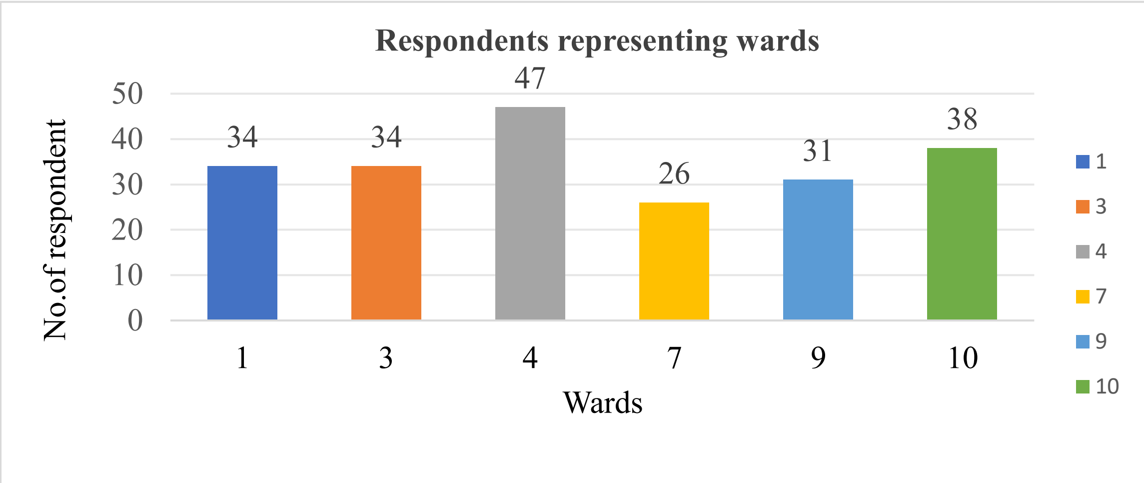

Figure 4: Respondents representing the wards

Figure 4 represents the distribution of respondents from 6 selected wards out of 10 in Rajapur Municipality. Ward 4, known for its higher population density, had the highest number of respondents at 45. Ward 10 followed with 37 respondents, while both Ward 1 and Ward 3 each attracted 33 respondents. In contrast, Ward 7 recorded the lowest representation with only 23 respondents, likely due to its lower population density

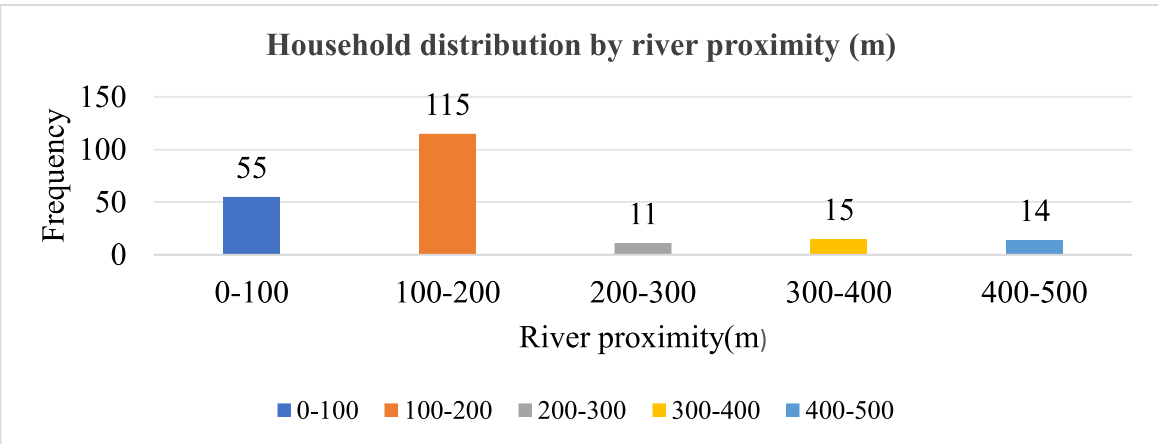

Figure 5: Distribution of households by river proximity (m)

Fig 5 shows the distribution of households based on their proximity to the river, highlighting the decision to focus the survey on those living closer to it. The largest group was in the 100-

200 meter range, with 115 households, followed by 55 households in the 0-100 meter range. These households were chosen for the survey because living near the river significantly impacted various socio-economic factors, such as community resilience and resource management. In contrast, only 11 households were selected in the 200-300 meter range, with even fewer in the 300-400 and 400-500 meter ranges. This distribution underscored the rationale for targeting households closer to the river to better understand their experiences and the adaptation strategies they had applied to cope with flooding.

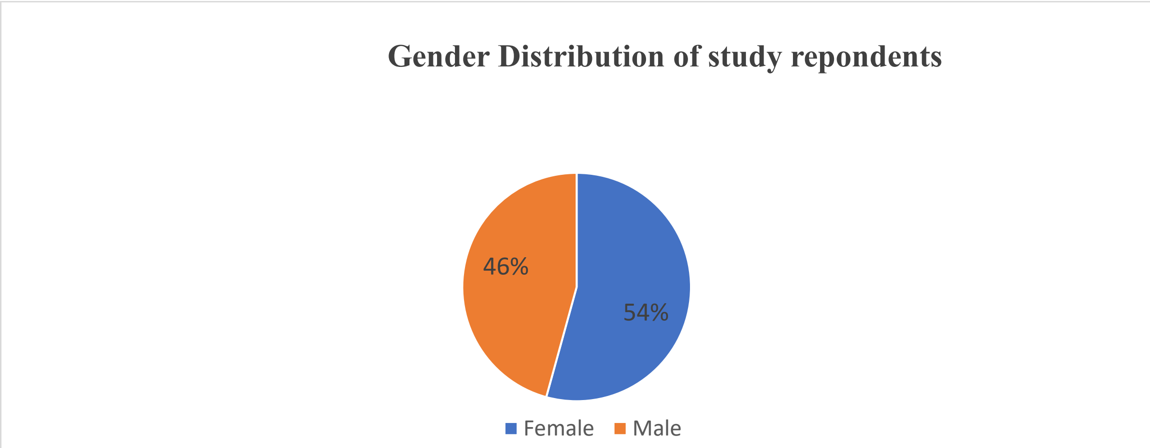

Figure 6: Gender distribution of respondents

Figure 6 depicts the gender distribution of respondents, showing that 54% of respondents were female and 46% were male, indicating a slight majority of female participants. This higher representation is likely due to women's involvement in household activities, such as childcare and cooking, which often made them more accessible for surveys conducted in household.

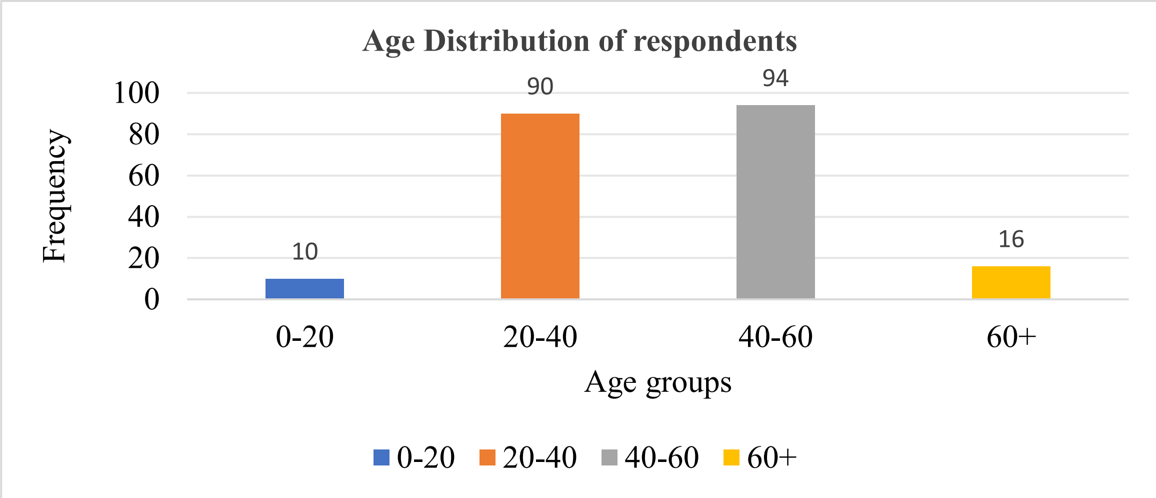

Figure 7: Age distribution of respondents

Fig 7 Age distribution of participants in Rajapur municipality demonstrated a diverse demographic profile among the 210 individuals surveyed. The most significant segment was individuals aged 40-60, representing 44.7% (94 participants), followed closely by those in the 20-40 age range at 42.8% (90 participants). In contrast, the smallest demographic was the 0-20 age group, which comprised only 4.7% (10 participants). Furthermore, individuals aged 60 and older accounted for 7.6% (16 participants) of the population, indicating a notable presence of older adults within the community. This analysis revealed that approximately 87.5% of participants fell within the working-age categories of 20-60 years, suggesting a predominantly younger population while also highlighting a significant representation of older individuals.

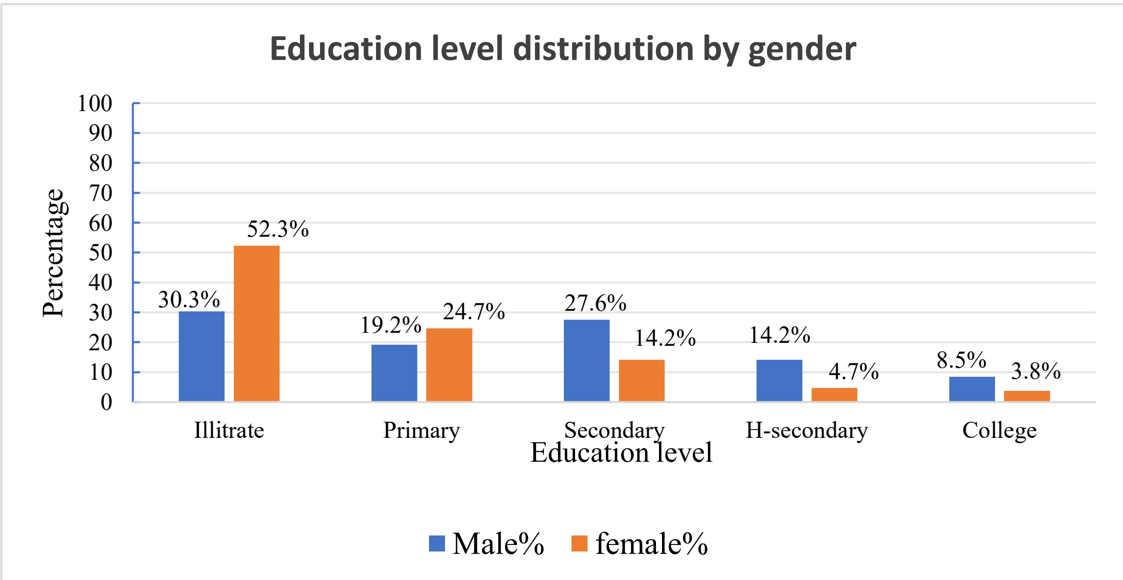

Figure 8: Education level distribution of respondents by gender

Fig 8 Educational distribution of respondents by gender highlights significant disparities, particularly in the illiterate and primary education categories where females outnumbered males. The largest group was illiterate, consisting of 87 individuals—32 males (30.3%) and 55 females (52.3%). Primary education included 46 respondents, with 20 males (19.2%) and 26 females (24.7%). In secondary education, there were 44 respondents: 29 males (27.6%) and 15 females (14.2%). Higher secondary education comprised 20 respondents, featuring 15 males (14.2%) and 5 females (4.7%). The smallest group was college-educated, with only 13 respondents: 9 males (8.5%) and 4 females (3.8%). As education levels increased, the percentage of females decreased, indicating potential barriers for women pursuing higher education.

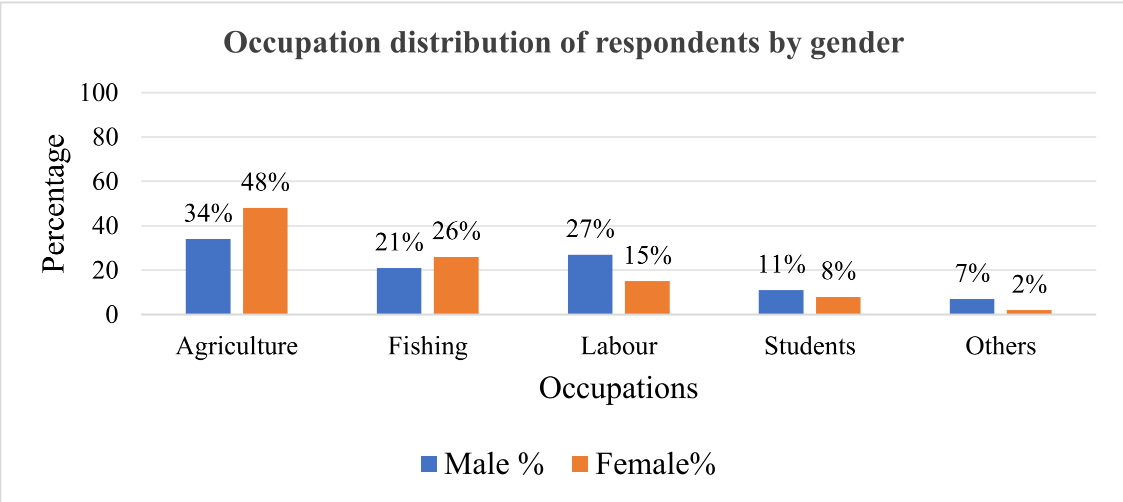

Figure 9: Occupation distribution of respondents by gender

Fig 9 highlights occupational distribution of respondents by gender in Rajapur, with men tending to occupy roles considered suitable for them, while women were often relegated to lower-paid or informal sector jobs. Agriculture employed the largest group, with 85 individuals—48 females (56.5%) and 34 males (40%), indicating a strong female presence likely due to traditional roles. In fishing, there were 49 respondents, comprising 26 females (53.1%) and 21 males (42.9%), reflecting women's participation in accessible jobs. Labour accounted for 45 individuals, dominated by men with 27 males (60%) and 15 females (33.3%), showcasing societal expectations for physically demanding roles. The student category included 21 respondents: 11 males (52.4%) and 8 females (38.1%), suggesting that educational access was influenced by gender norms. Lastly, in the "Others" category, men occupied 7 out of 10 roles (70%), indicating male dominance in diverse occupations.

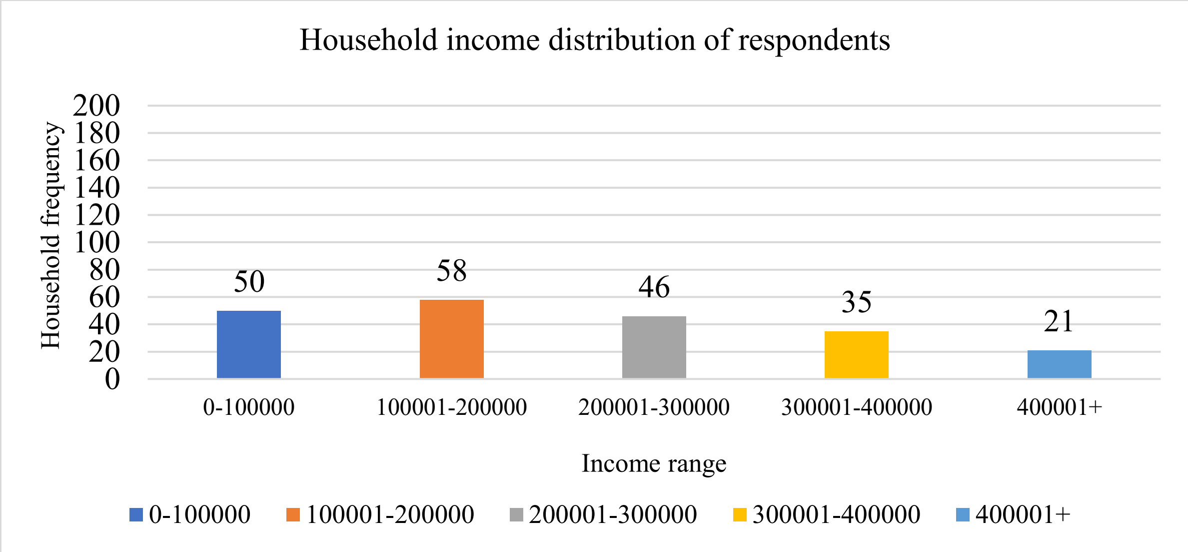

Figure 10: Household income distribution of respondents

The above bar graph shows the income distribution of 210 households in Rajapur, highlighting significant economic challenges. Only 21 households earn more than 400,000, which shows that wealth is concentrated in a few families. There are 35 households in the upper-middle income range and 46 in the middle-income range. The lower-middle income group has 58 households, while the largest group, with 50 households, earns less than 100,000. This situation points to issues like few job opportunities and a heavy reliance on farming.

4.1.2 Indigenous Adaptation Strategy Used in Rajapur

During field studies conducted in Rajapur Municipality, I identified various Indigenous Adaptation Strategies employed by Tharu communities to cope with flooding. This understanding was initially developed through Key Informant Interviews (KII) and focus group discussions, which helped us listing the adaptation strategies followed by the people in Rajapur. These strategies reflect the community's deep-rooted connection to the flood dynamics in their region and their proactive measures to mitigate its impacts. The residents have established specific approaches for pre-flood, during-flood, and post-flood scenarios, showcasing their resilience and adaptability in the face of unpredictable rainfall and flooding events mainly focusing in livelihood and agriculture. The listed indigenous adaptation strategies is mention in table below;

Table 3: List of indigenous adaptation strategy used in Rajapur municipility

Pre-Flood Adaptation Strategy	
Sector	Adaptation Strategy
Livelihood	Constructing River Embankment
	Built raised storage (Thati Ghr)
	Diverse livelihoods
	Use of local resources
	Construct Machang Ghar
	Weather forecasting
	Elevated house
	Plantation along riverside
Agriculture	Earlier plantation
	Selecting water resistance crops
	Alternative farming
	Built deheri (grains storing pots)
	Built earthen ponds (Pokhari)
	Construct irrigation channel (Kulo)
During-Flood Adaptation Strategy	
Livelihood	Built temporary shelter at higher place
	Staying in evacuation shelter
	Hanging belongings in a roof
	Moving toward relative's house
Agriculture	Fishing in agriculture field

	Keeping belongings in Thati ghar
	Hangings storage grains in a roof of house using khatiya
Post-Flood Adaptation Strategy	
Livelihood	Food management
	Improved water management
	Collecting fuel wood
	Repairing damage house
Agriculture	Adopting mixed farming (crops + psciculture)
	Crop diversification
	Use organic fertilizer
	Focusing off-season farming (Chaite Dhan)
	Use local instrument for cleaning a agriculture field field

4.1.2 WAI Ranking of Indigenous Adaptation Strategies

4.1.2.1 WAI Ranking of Pre-Flood Adaptation Strategies in Livelihood and Agriculture

The table below presents various pre-flood adaptation strategies in livelihood and agriculture employed by Tharu communities, highlighting their applicability & effectiveness based on a weighted average index (WAI) and ranking.

Table 4: Pre-flooding indigenous adaptation strategy in livelihood of Tharu community in % (N=210)

Adaptation Strategy (Livelihood)	Most applicable	Very applicable	Moderately applicable	Least applicable	Less applicable	WAI	Rank
Constructing river embankment	44.76	33.33	13.81	1.43	0	4.1	I
Built raised storage (Thati Ghr)	41.9	32.86	14.29	2.86	0.48	3.9	II
Diverse livelihoods	41.43	34.76	10	3.81	3.33	3.8	III
Use of local resources	31.43	40	16.67	3.81	1	3.7	IV
Construct Machang Ghar	22.86	62.38	5.71	1.43	1	3.6	V
Weather forecasting	10.48	29.52	33.81	19.52	1	3.5	VI
Elevated house	10.48	29.52	33.81	19.52	2.1	3.3	VII
Plantation long riverside	26.67	29.52	20.48	10	6.67	3.2	VIII

The table above analyzes various pre-flood adaptation strategies used by the Tharu community to support their livelihoods, highlighting their perceived applicability and effectiveness based on a survey of 210 respondents. The strategy "Constructing River Embankment" ranked first with a Weighted Average Index (WAI) of 4.1, indicating that 44.76% of respondents considered it "Most Applicable," while 33.33% rated it as "Very Applicable," showing strong community support for this important flood prevention measure. The second strategy, "Building Raised Storage (Thati Ghar)," received a WAI of 3.9, with 41.9% marking it as "Most Applicable" and 32.86% as "Very Applicable," demonstrating the community's awareness of the need to protect essential resources from flooding. The third strategy, "Diverse Livelihoods," had a WAI of 3.8, with 41.43% rating it as "Most Applicable," suggesting that diversifying income sources is seen as a proactive way to reduce economic vulnerability during floods. The fourth strategy, "Use of Local Resources," achieved a WAI of 3.7, indicating significant support from respondents who value the sustainability and accessibility of local materials and knowledge. The fifth-ranked strategy, "Constructing Machang Ghar," had a WAI of 3.6, reflecting its importance in providing elevated living spaces above potential floodwaters, with 62.38% rating it as "Very Applicable." The sixth strategy, "Weather Forecasting," received a WAI of 3.5, emphasizing its role in enabling timely flood responses; however, it ranks lower due to dependence on external information sources. The seventh strategy, "Elevated House," also had a WAI of 3.3, similar to Machang Ghar but possibly less favored due to concerns about cost or feasibility. Finally, "Plantation Along Riverside" ranked eighth with a WAI of 3.2; while this strategy is acknowledged for stabilizing riverbanks and providing additional resources, it may not be prioritized compared to more immediate protective measures.

Table 5: Pre-flooding indigenous adaptation strategy in agriculture of Tharu community in %(N=210)

Adaptation Strategy (Agriculture)	Most applicable	Very applicable	Moderately applicable	Least applicable	Less applicable	WAI	Rank
Earlier plantation	71.9	16.67	2.86	1.43	1.48	4.1	I
Selecting water resistance crops	56.67	20.48	12.86	2.86	0.48	3.7	II
Alternative farming	30	33.33	17.14	10.48	2.38	3.7	III
Built deheri (grains storing pots)	16.19	44.29	21.9	8.57	2.38	3.4	IV
Built earthen ponds (Pokhari)	6.19	30.95	33.33	17.14	5.24	3.4	IV
Construct irrigation channel (Kulo)	3.81	20	42.38	21.43	5.71	3.0	V

The above table presents an analysis of various pre-flooding indigenous adaptation strategies in agriculture employed by the Tharu community, based on a survey of 210 respondents. The strategy "Earlier Plantation" ranked first with a Weighted Average Index (WAI) of 4.1, indicating that 71.9% of respondents found it "Most Applicable," and 16.67% rated it as "Very Applicable." This strong preference suggests that early planting is viewed as a crucial method for mitigating flood impacts on crops. The second-ranked strategy, "Selecting Water Resistant Crops," achieved a WAI of 3.7, with 56.67% marking it as "Most Applicable" and 20.48% as "Very Applicable," reflecting the community's recognition of the importance of choosing resilient crop varieties to withstand flooding conditions. The third strategy, "Alternative Farming," also received a WAI of 3.7, with 30% rating it as "Most Applicable" and 33.33% as "Very Applicable," indicating that diversifying farming practices is seen as a viable approach to enhance agricultural resilience against floods. Both "Built Deheri (Grains Storing Pots)" and "Built Earthen Pond (Pokhari)" ranked fourth with a WAI of 3.4; the former had 16.19% rating it as "Most Applicable" and 44.29% as "Very Applicable," while the latter had lower support with only 6.19% marking it as "Most Applicable" and 30.95% as "Very Applicable." This suggests that grain storage solutions are more favored than earthen ponds for flood mitigation purposes. Lastly, the strategy "Construct Irrigation Channel (Kulo)" ranked fifth with a WAI of 3, where only 3.81% rated it as "Most Applicable" and a significant portion, 42.38%, considered it "Moderately Applicable.

4.1.2.2 WAI Ranking of During-Flood Adaptation Strategies in Livelihood and Agriculture

The table below presents various during-flood adaptation strategies in livelihood & agriculture employed by Tharu communities, highlighting their applicability based on a weighted average index (WAI) and ranking.

Table 6: During flooding indigenous adaptation strategy in livelihood of Tharu community in % (N=210)

During Flood Adaptation Strategy (Livelihood)	Most applicable	Very applicable	Moderately applicable	Least applicable	Less applicable	WAI	Rank
Built temporary shelter at higher place	57.62	19.05	9.05	9.05	9.05	4	I

Staying in evacuation shelter	7.2	51.9	20.95	10.95	2.86	3.3	II
Hanging belongings in a roof	6.19	51.9	20.95	20.95	2.86	3.2	III
Moving toward relatives' house	5.3	21.43	31.43	25.24	10.48	2.6	IV

Table 4.3 highlights that the most favored strategy during floods in livelihoods is "Building Temporary Shelters at Higher Places," with a WAI of 4, indicating that a significant majority (57.62%) considers it the most applicable. This reflects a strong preference for proactive measures that enhance safety during floods. In contrast, "Staying in Evacuation Shelters" ranks second with a WAI of 3.3, as over half of the respondents (51.9%) rate it as very applicable, suggesting reliance on community support systems during emergencies. "Hanging Belongings on a Roof" follows closely with a WAI of 3.2, demonstrating practical adaptations to safeguard possessions, while "Moving Toward Relatives' Houses" ranks lowest with a WAI of 2.6, indicating less reliance on familial networks during floods.

Table 7: During flooding indigenous adaptation strategy in agriculture of Tharu community in % (N=210)

Adaptation Strategy (Agriculture)	Most applicable	Very applicable	Moderately applicable	Least applicable	Less applicable	WAI	Rank
Fishing in Agriculture Field	40.95	11.9	23.33	15.24	1.9	3.5	I
Keeping Belongings in Thati Ghar	18.1	45.24	21.9	6.19	1.43	3.4	II
Hanging the Storage grains in a roof using Khatiya	6.19	51.9	20.95	10.95	2.86	3.2	III

The above table presents different adaptation strategies in agriculture used by Indigenous communities, showing their relevance as measured by a weighted average index (WAI) and rankings. The strategy considered most relevant is "Fishing in Agriculture Field," which has a WAI of 3.5. This means that a significant number of respondents (40.95%) find this method very important, while 23.33% see it as moderately relevant. This indicates that combining fishing with farming is viewed as an effective way to improve food security and resilience. Next is the strategy "Keeping Belongings in Thati Ghar," which has a WAI of 3.4; here, 45.24% of respondents rated it as very applicable, highlighting the need for secure storage options to protect belongings from environmental threats. This approach shows the community's focus on safeguarding their possessions during difficult times. The third-ranked strategy, "Hanging the Storage Grains in a Roof Using Khatiya," has a WAI of 3.2, with 51.90% of respondents rating it as very applicable. This method demonstrates practical steps taken to preserve food supplies and reduce losses from flooding or pests.

4.1.2.3 WAI Ranking of Post-Flood Adaptation Strategies in Livelihood and Agriculture

The table below presents various post-flood adaptation strategies in livelihood & agriculture employed by Tharu communities, highlighting their applicability based on a weighted average index (WAI) and ranking.

Table 8: Post-flooding indigenous adaptation strategy in livelihood of Tharu community in % (N=210)

Adaptation Strategy (Livelihood)	Most applicable	Very applicable	Moderately applicable	Least applicable	Less applicable	WAI	Rank
Managing food	41.9	32.86	14.29	2.86	0.48	3.7	I
Improved water management	24.29	33.81	25.24	8.57	0.95	3.5	II
Collecting Fuel-wood	20	31.9	27.14	11.9	1.9	3.3	III

Repairing damage house	5.71	38.1	33.81	15.71	0	3.1	IV

Table 4.5 presents various post-flood adaptation strategies used by Tharu communities, focusing on their applicability measured by a weighted average index (WAI) and rankings. The strategy deemed most applicable was "Managing Food," with a WAI of 3.7, indicating that many respondents (41.90%) found this method highly applicable, while 32.86% considered it very applicable. This suggested that affected families could effectively address immediate food shortages caused by flood damage to crops and stored food supplies. Following closely was "Improved Water Management," which had a WAI of 3.5; here, 24.29% of respondents rated it as most applicable, and 33.81% rated it as very applicable, highlighting the importance of effective water management practices in mitigating flood impacts. The third-ranked strategy, "Collecting Fuel-wood," received a WAI of 3.3, with 20% of respondents considering it most applicable and 31.90% rating it as very applicable, showing its significance for energy needs in post-flood recovery. Lastly, "Repairing Damaged Houses" ranked fourth with a WAI of 3.1; although only 5.71% rated it as most applicable, a substantial 38.10% found it very applicable, reflecting the ongoing need for housing repairs after flooding events.

Table 9: Post-flooding indigenous adaptation strategy in agriculture of Tharu community in % (N=210)

Adaptation Strategy (Agriculture)	Most applicable	Very applicable	Moderately applicable	Least applicable	Less applicable	WAI	Rank
Adopting mixed farming (crops + pisciculture)	65.71	14.29	9.05	3.81	0.48	3.9	I
Crop diversification	15.24	40.48	26.67	7.62	2.38	3.4	II
Use organic fertilizer	16.67	16.67	25.71	11.43	1.43	3.3	III

Focusing offseason farming (Chaite Dhan)	1.9	31.43	33.33	7.14	1.9	3	IV
Use local instrument for cleaning a field	3.81	22.86	29.52	27.62	9.52	2.8	V

Table 4.6 presents various post-agricultural adaptation strategies employed by Tharu communities, showcasing their applicability as assessed through a weighted average index (WAI) and rankings. The most favored strategy was "Adopting Mixed Farming (Crops + Pisciculture)," which received a WAI of 3.9, indicating that a substantial majority of respondents (65.71%) considered this method highly applicable, while only 0.48% viewed it as least applicable, suggesting that integrating crop and fish farming is seen as an effective approach to enhancing food security and resilience. The second-ranked strategy, "Crop Diversification," had a WAI of 3.4; here, 15.24% rated it as most applicable, and 40.48% rated it as very applicable, reflecting its importance in managing risks associated with climate variability and market fluctuations. The third strategy, "Use of Organic Fertilizer," received a WAI of 3.3, with 16.67% of respondents rating it as most applicable and another 16.67% as very applicable, indicating a growing preference for sustainable agricultural practices. "Focusing on Off-Season Farming (Chaite Dhan)" ranked fourth with a WAI of 3.0; although only 1.90% rated it as most applicable, 31.43% found it very applicable, highlighting its relevance for maximizing production during off-seasons. Lastly, "Using Local Instruments for Cleaning Fields" ranked fifth with a WAI of 2.8; here, 3.81% rated it as most applicable, while a significant portion (27.62%) viewed it as less applicable, suggesting that traditional tools are somewhat valued but may not be the primary focus for adaptation strategies.

4.1.3 Relationship Between Adaptation Strategies and Socio-demographic Factors (Chi-Square Test)

4.1.3.1 Relationship Between Pre-Flood Adaptation Strategies and Socio-demographic Factors

The following table summarizes the chi-square test results, displaying the connections between socio-demographics & economic factor (such as age group, education level, income, and river proximity) and adaptation strategy.

Table 10: Relationship between pre-flood adaptation strategies & scio-demographic factors

Pre-adaptation strategy						
Independent variable	Dependent Variable	Value	df	Pearson Chi-square	Description	Remarks
Gender	Adaptation Strategy (livelihood)	27.59	16	0.03	p- value >0.05	Significant
	Adaptation Strategy (agriculture)	33.16	10	0.001	p- value >0.05	Significant
Age Group	Adaptation Strategy (livelihood)	41.34	27	0.04	p- value >0.05	Significant
	Adaptation Strategy (agriculture)	27.59	15	0.02	p- value >0.05	Significant
Education level	Adaptation Strategy (livelihood)	43.77	28	0.02	p- value >0.05	Significant
	Adaptation Strategy (agriculture)	36.41	20	0..02	p- value >0.05	Significant
Income	Adaptation Strategy (livelihood)	54.59	28	0.02	p- value >0.05	Significant

	Adaptation Strategy (agriculture)	182.48	20	0.00	P value >0.05	Significant
River proximity	Adaptation Strategy (livelihood)	41.8	14	0.00	P value >0.05	Significant
	Adaptation Strategy Agriculture	22.57	10	0.01	P value >0.05	Significant

Table 10 highlights the relationship between various socio-demographic factors—such as gender, age group, education level, income, and river proximity—and adaptation strategies for both livelihoods and agriculture. For gender, the adaptation strategy for livelihood showed a chi-square value of 27.59 with 16 degrees of freedom and a p-value of 0.03, indicating a significant link between gender and livelihood adaptation choices. In agriculture, the relationship was stronger, with a chi-square value of 33.16 and a p-value of 0.001, highlighting the important role gender plays in agricultural practices. Regarding age group, the analysis revealed a chi-square value of 41.34 for livelihood strategies with 27 degrees of freedom and a p-value of 0.04, suggesting that different age groups significantly influence adaptation strategies in both areas. For agriculture, the chi-square value was 27.59 with 15 degrees of freedom and a p-value of 0.02, reinforcing that age affects adaptive decisions. When examining education level, the chi-square value for livelihood strategies was 43.77 with 28 degrees of freedom and a p-value of 0.02, emphasizing education's crucial role in effective adaptation strategies due to varying knowledge levels. Similarly, for agriculture, the chi-square value was 36.41 with 20 degrees of freedom and a p-value of 0.02, further confirming education's importance in adaptation. The factor of income showed a chi-square value of 54.59 for livelihood strategies with 28 degrees of freedom and a p-value of 0.02, indicating that higher income levels significantly influence the adoption of effective adaptation measures; in agriculture, the chi-square value was much higher at 182.48 with 20 degrees of freedom and an extremely low p-value of 0.00, suggesting a very strong connection between income and agricultural adaptation strategies. Lastly, river proximity had a chi-square value of 41.80 with 14 degrees of freedom and a p-value of 0.00, indicating a highly significant relationship.

4.1.3.2 Relationship Between During-Flood Adaptation Strategies and Socio-demographic Factors

The following table summarizes the chi-square test results, displaying the connections between socio-demographics factor (such as age group, education level, income, and river proximity) and adaptation strategy.

Table 11: Relationship between during flood adaptation strategies & socio-demographic factors

During Adaptation Strategy						
Independent Variable	Dependent Variable	Value	df	Pearson Chi-square Test	Description	Remarks
Gender	Adaptation Strategy (Livelihood)	17.53	8	0.02	p- value >0.05	significant
	Adaptation strategy (Agriculture)	22.45	6	0.001	p- value >0.05	Significant
Age	Adaptation Strategy (Livelihood)	16.91	9	0.05	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	12.59	6	0.05	p- value >0.05	Significant
Education Level	Adaptation strategy (livelihood)	21.02	12	0.03	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	17.53	8	0.02	p- value >0.05	Significant
Income	Adaptation strategy (Livelihood)	24.37	12	0.01	p- value >0.05	Significant

	Adaptation strategy (Agriculture)	23.53	8	0.00	p- value >0.05	Significant
River proximity	Adaptation strategy (livelihood)	29.21	6	0.00	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	4.87	4	0.03	P value >0.05	Significant

Table 4.8 reveals significant associations between various socio-demographic factors—such as gender, age, education level, income, and river proximity—and during adaptation strategies for livelihoods and agriculture. The study employed Pearson Chi-square tests to determine significance, with degrees of freedom (df) provided for each comparison. For gender, the adaptation strategy for livelihood had a chi-square value of 17.53 with 8 degrees of freedom and a p-value of 0.02, indicating a significant relationship between gender and livelihood adaptation strategies. In agriculture, the relationship was stronger, with a chi-square value of 22.45 and a p-value of 0.001, showing that gender significantly influences agricultural practices. Regarding age, the chi-square value for livelihood strategies was 16.91 with 9 degrees of freedom and a p-value of 0.05, while for agriculture it was 12.59 with 6 degrees of freedom and a p-value of 0.05, suggesting significant associations between age demographics and adaptation choices in both contexts. The analysis of education level revealed a chi-square value of 21.02 for livelihood strategies (df = 12, p = 0.03), highlighting education's importance in shaping effective adaptation strategies; for agriculture, the chi-square value was 17.53 (df = 8, p = 0.02), reinforcing the significance of education in adaptive practices. Income also showed significant influence on adaptation strategies, with a chi-square value of 24.37 for livelihood strategies (p = 0.01, df = 12) and 23.53 for agricultural strategies (p = 0.00, df = 8), indicating that higher income levels are linked to more effective adaptation measures. Lastly, river proximity demonstrated notable relationships, with a chi-square value of 29.21 for livelihood (p = 0.00, df = 6) and 4.87 for agriculture (p = 0.03, df = 4), suggesting that being closer to rivers may enhance adaptive capacity in these contexts. Overall, these findings emphasize how socio-demographic factors significantly influence adaptation strategies in response to environmental changes in both livelihoods and agricultural practices.

4.1.3.3 Relationship between post-flood adaptation strategies and socio-demographic factors

The following table summarizes the chi-square test results, displaying the connections between socio-demographic factors (such as age group, education level, income, and river proximity) and adaptation strategy.

Table 12: Relationship between post-flood adaptation strategies & socio-demographic factors

Post- Adaptation Strategy						
Independent Variable	Dependent Variable	Value	df	Pearson Chi-square Test	Description	Remarks
Gender	Adaptation Strategy (Livelihood)	22.36	12	0.02	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	21.66	9	0.01	p- value >0.05	Significant
Age	Adaptation Strategy (Livelihood)	21.02	12	0.03	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	26.29	16	0.05	p- value >0.05	Significant
Education Level	Adaptation strategy (livelihood)	22.36	12	0.03	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	18.30	9	0.03	p- value >0.05	Significant
Income	Adaptation strategy (Livelihood)	19.98	12	0.05	p- value >0.05	Significant

	Adaptation strategy (Agriculture)	21.36	16	0.00	p- value >0.05	Significant
River proximity	Adaptation strategy (livelihood)	70.8	6	0.00	p- value >0.05	Significant
	Adaptation strategy (Agriculture)	8.17	8	0.04	p- value >0.05	Significant

Table 4.9 highlights the relationships between socio-demographic factors—such as gender, age, education level, income, and river proximity—and post adaptation strategies. The study utilized Pearson Chi-square tests to assess significance, with degrees of freedom (df) provided for each comparison. For gender, the adaptation strategy for livelihood had a chi-square value of 22.36 with 12 degrees of freedom and a p-value of 0.02, indicating a significant connection between gender and livelihood adaptation strategies. Similarly, in agriculture, the relationship was significant as well, with a chi-square value of 21.66 and a p-value of 0.01, highlighting the important role gender plays in agricultural practices. Concerning age, the chi-square value for livelihood strategies was 21.02 with 12 degrees of freedom and a p-value of 0.03, while for agriculture it was 26.29 with 16 degrees of freedom and a p-value of 0.05, both showing significant associations between age demographics and adaptation choices in both contexts. The analysis of education level indicated a chi-square value of 22.36 for livelihood strategies ($df = 12$, $p = 0.03$), emphasizing the significance of educational attainment in developing effective adaptation strategies; for agriculture, the chi-square value was 18.30 with 9 degrees of freedom and a p-value of 0.03, further confirming the importance of education in adaptive practices. The factor of income also demonstrated a notable impact on adaptation strategies, with a chi-square value of 19.98 for livelihood strategies ($p = 0.05$, $df = 12$) and 21.36 for agricultural strategies ($p = 0.00$, $df = 16$), suggesting that higher income levels are associated with more effective adaptation measures. Finally, river proximity exhibited significant relationships, with a chi-square value of 70.80 for livelihood ($p = 0.00$, $df = 6$) and 8.17 for agriculture ($p = 0.04$, $df = 8$), indicating that being closer to rivers may enhance adaptive capacity in these contexts. Overall, these results underscore the significant influence of socio-demographic factors on

adaptation strategies in response to environmental changes within both livelihood and agricultural practices.

4.1.4 Knowledge Transformation (sources, methods, importance, challenges & steps to preserve)

4.1.4.1 Indigenous Knowledge Transmission Sources for Flood Adaptation Strategies among Respondents

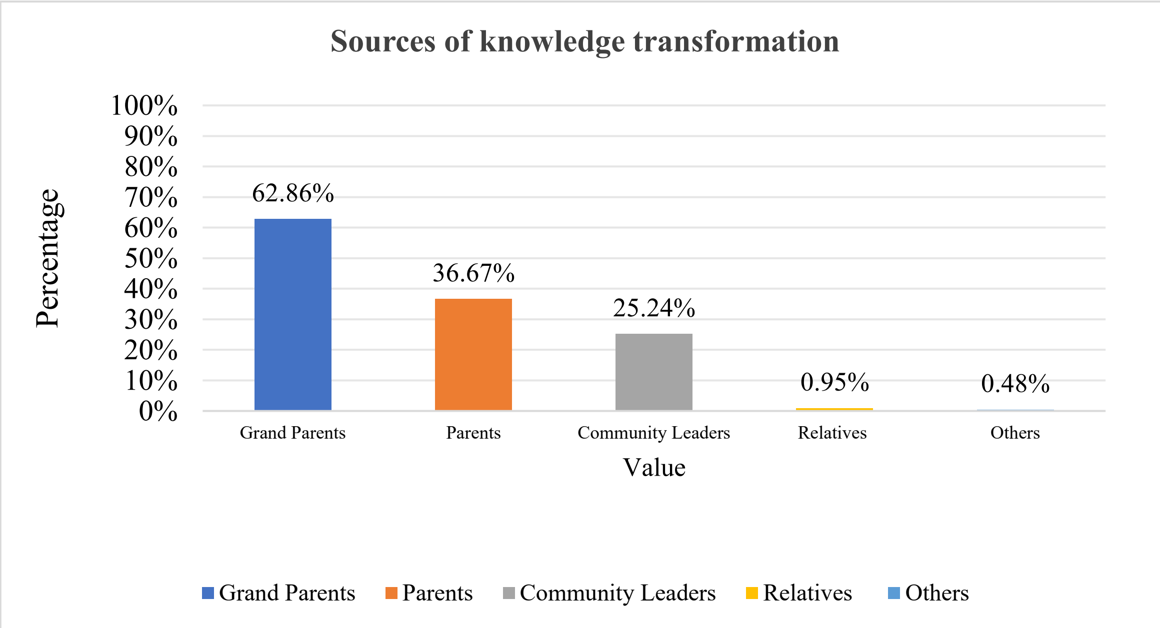

Figure 11: Sources of knowledge transformation

The above bar graph shows that grandparents are the main source of knowledge for flood adaptation in Rajapur Municipality, contributing 62.86%, which highlights their commitment to passing down important traditional knowledge. Parents follow with 36.67%, reinforcing their role in continuing this knowledge within families. Community leaders contribute 25.24%, while relatives account for only 0.95%, indicating that immediate family members are much more influential in sharing knowledge. The external sources contribute minimally at 0.48%. Overall, this data emphasizes the crucial role of family structures in preserving Indigenous knowledge and ensuring that younger generations have the skills needed to handle flooding challenges effectively.

4.1.4.2 Methods of Learning for Flood Indigenous Adaptation Strategies among Respondents

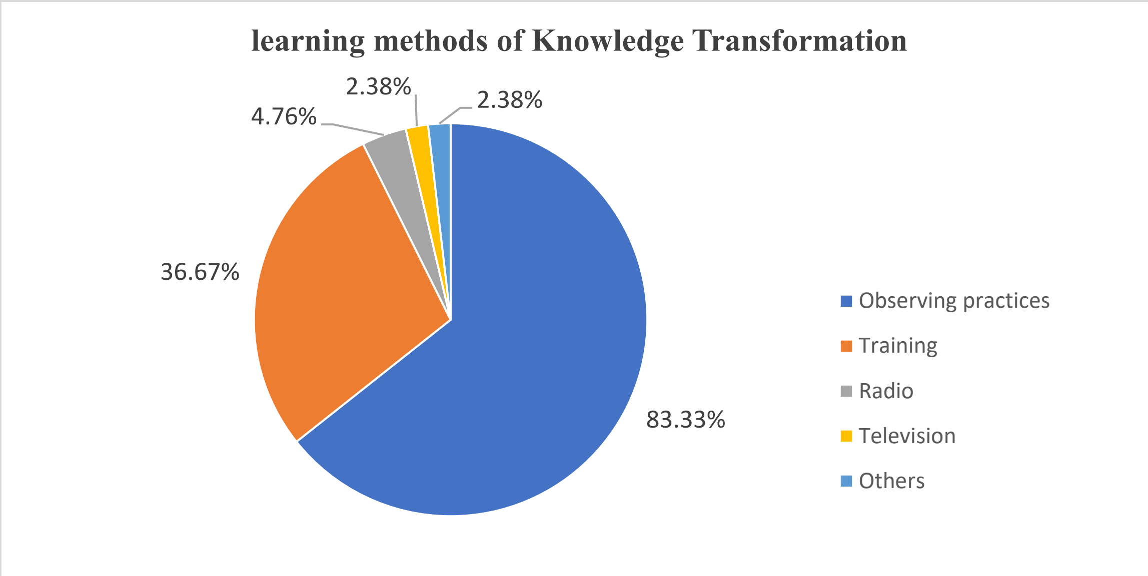

Figure 12: Learning methods of knowledge transformation

The data on Methods of Learning for Indigenous Adaptation Strategies to Flooding highlights how individuals acquire knowledge and skills for effective flood management. Observing practices is the most significant method, accounting for 83.33%, indicating that firsthand experience with traditional techniques is crucial for learning. Training follows with 36.67%, suggesting that structured educational programs also enhance knowledge and skills related to flood adaptation. In contrast, media sources such as radio and television have minimal influence, with radio contributing only 4.76% and television at 2.38%. While these media can be helpful, they are not primary learning sources in this context. Additionally, the category labeled "Others" accounts for 2.38%, indicating that alternative learning methods exist but are not widely utilized.

4.1.4.3 Importance of Preserving Indigenous Adaptation Strategies for Future Generations

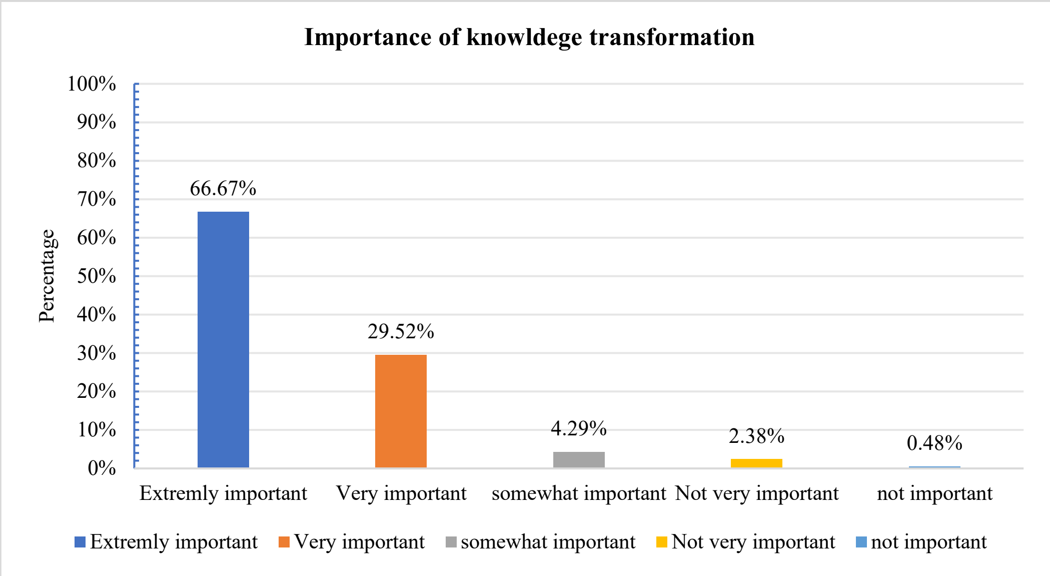

Figure 13: Importance of knowledge transformation

The above results affirm that the applied traditional techniques in Rajapur municipality by Tharu communities are essential for addressing current challenges and safeguarding local adaptation strategies for future generation. A significant 66.67% of respondents believe these techniques are extremely important, while 29.52% consider them highly vital, indicating robust support for their preservation. Conversely, only 4.29% view these strategies as somewhat significant, with 2.38% and 0.48% considering them not very important and not important, respectively.

4.1.4.4 Challenges for Adapting Indigenous Strategy

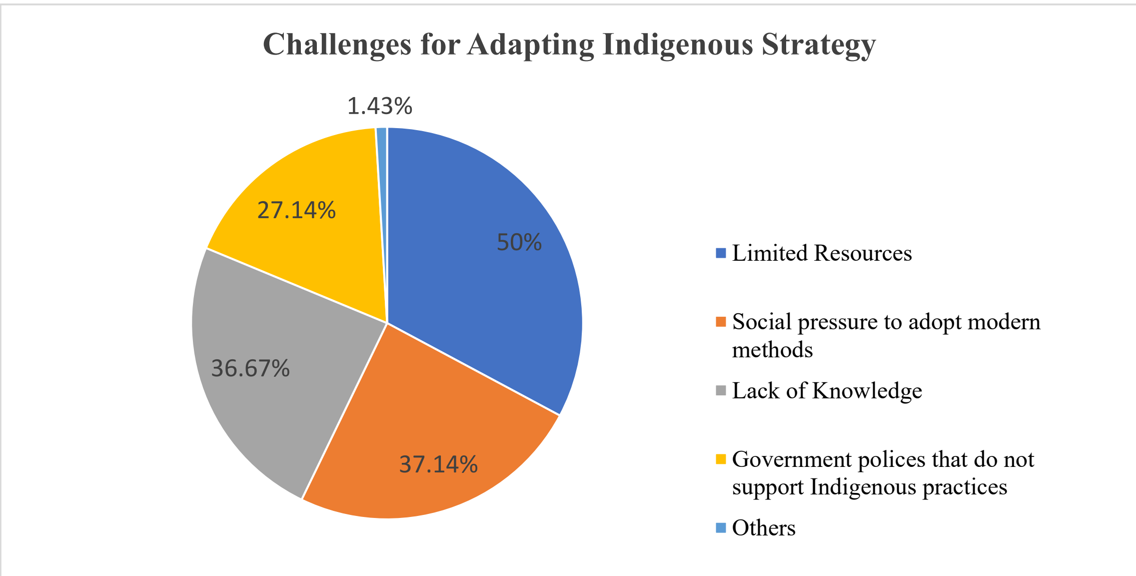

Figure 14: Challenges for adapting indigenous strategy

The above pie chart illustrating the challenges faced by the Tharu community in adapting Indigenous strategies reveals significant barriers. A notable 50% of respondents identify limited resources as a primary challenge, indicating that financial and material constraints hinder the effective implementation of traditional practices. Additionally, 37.14% report social pressure to adopt modern methods, suggesting that external influences may discourage the use of Indigenous strategies. Lack of knowledge is also a challenge, with 36.67% highlighting this issue, which may stem from insufficient education or awareness about traditional practices. Furthermore, 27.14% point to government policies that do not support Indigenous practices, indicating a systemic barrier that undermines these strategies. Lastly, only 1.43% mention other unspecified challenges.

4.1.4.5 Strategies for Enhancing the Preservation of Indigenous Adaptation Practices

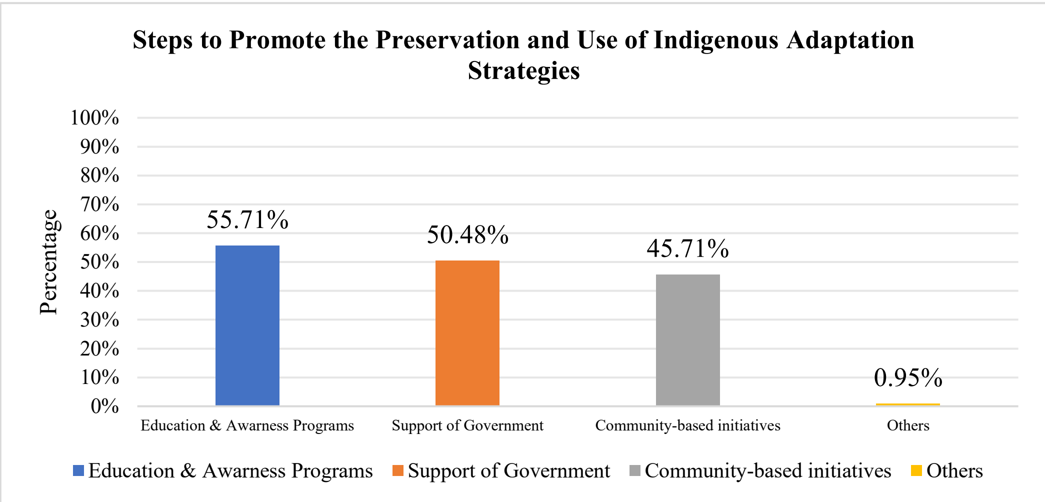

Figure 15: Strategies for enhancing the preservation of indigenous adaptation practices

The bar graph illustrates key steps to promote the preservation and use of Indigenous adaptation strategies. Education and awareness programs are identified as the most important step, with 55.71% of respondents emphasizing their role in informing communities about traditional knowledge. Following closely, 50.48% recognize the support of government as crucial for providing resources and policies that facilitate the integration of Indigenous strategies. Community-based initiatives are also vital, with 45.71% advocating for local engagement to ensure that adaptation strategies are relevant and effective. Lastly, only 0.95% mention other unspecified steps, indicating that while the primary methods are clear, there may be additional avenues worth exploring.

4.2 Discussion

4.2.1 Indigenous Adaptation strategies

The Tharu community employed various adaptation strategies across different phases of flooding, reflecting a high level of community engagement and prioritization. In the pre-flood phase, the top-ranked strategy was "Constructing River Embankments," which is made of locally available materials such as soil, bamboo, and stones to build embankments that protect their agricultural lands & livelihood from flooding had a Weighted Average Index (WAI) of 4.1 the study evaluated strategies across pre-, during-, and post-flood adaptation strategies adapted to control the impact of flood. The pre-flood adaptation strategies adapted by the Tharu community are constructing elevated storage structures, locally referred to as "Thati Ghar," to secure their belongings. Similarly, during flood events, the construction of "Machang Ghar," elevated platforms, serves as a critical adaptation strategy, providing a safe refuge for vulnerable groups such as elderly individuals and children. Furthermore, traditional weather forecasting practices, particularly among the elder members of the community, include observing cloud formations, interpreting bird and animal sounds, and analyzing the movement of ants to anticipate weather changes.

Farmers in Bardiya employed a variety of pre-adaptation techniques in agriculture to strengthen their resilience against flooding. The highest-ranked strategy was earlier plantation, which had a Weighted Average Index (WAI) of 4.1, demonstrating the community's proactive approach to crop management. The study found that earlier plantation allowed farmers to harvest before the monsoon started, reducing the risk of losing agricultural production, particularly paddy. This practice also helped maintain soil health and fertility, as crops could absorb nutrients before heavy rains washed them away. Additionally, farmers implemented water-resistant crop types and alternative farming practices to mitigate the risk of crop failure caused by erratic rainfall and flooding. Traditional grain storage containers, known as Deheri, protected harvested crops from pests and moisture, considerably lowering post-harvest losses. Furthermore, the creation of earthen ponds (Pokhari) provided a long-term water source for irrigation and groundwater recharge, while irrigation channels (Kulo) enabled effective water distribution throughout fields. Together, these techniques helped farmers sustain production and safeguard their agriculture and livelihoods in the face of climate change.

During floods, the people of Rajapur prioritized the safety of children, the elderly, and disabled individuals to protect them from rising waters. The important strategies they employed included building temporary shelters at higher places, which ranked highest and allowed families to safeguard themselves from flooding. Additionally, families often raised their beds to keep children safe and dry during floods. They also utilized evacuation shelters, demonstrating their commitment to community support during emergencies, where vulnerable individuals were rescued and kept safe in two-storey evacuation shelters. To protect their belongings, many residents hung their possessions on house roofs, ensuring that valuable items remained safe from water damage. While some individuals chose to move to relatives' houses for safety during floods, this option was less common compared to others in Rajapur. Overall, these proactive measures reflected the resourcefulness and determination of the Rajapur community in facing the challenges posed by flooding. In the agricultural sector, the community implemented essential strategies such as fishing in agricultural fields, which enabled families to catch fish in flooded areas, providing an emergency food source when crops were destroyed. Keeping belongings in Thati Ghar emphasized secure storage, helping residents prevent valuables (stored food) from water damage. Hanging storage grains on a roof using Khatiya ensured that food supplies and seeds were protected from flooding and pests.

The Tharu communities employed various post-flood adaptation strategies that effectively illustrated their applicability across both livelihood and agricultural sectors. In terms of livelihood, strategies such as managing food and enhancing water management were prioritized, reflecting the community's urgent need to address immediate food shortages and ensure access to clean drinking water following floods. The collection of fuelwood also emerged as a significant strategy, underscoring the critical importance of energy resources during the recovery phase. Furthermore, the ongoing necessity of repairing damaged houses highlighted the community's steadfast commitment to rebuilding after flooding events. In the agricultural domain, the adoption of mixed farming—integrating crops and fish farming—stood out as a preferred approach for bolstering food security and resilience against climate variability. Strategies like crop diversification and the use of organic fertilizers further exemplified the community's proactive measures to manage risks associated with shifting weather patterns. Overall, these findings revealed how the Tharu communities adeptly implemented diverse strategies to navigate post-flood challenges, thereby ensuring their resilience and sustaining food security amid environmental changes.

The adaptation strategies employed by the Tharu community during flooding events revealed similarities and differences when compared to those in the West Rapti basin. Study done by both communities emphasized community engagement and proactive measures, recognizing the importance of effective planning and resource management to mitigate flood impacts, such as constructing river embankments and implementing flood management plans. During floods, both prioritized the safety of vulnerable populations through temporary shelters and effective communication. Post-flood, they managed food supplies and coordinated recovery efforts, demonstrating a collective rebuilding approach. However, differences arose in specific strategies; the Tharu community utilized traditional methods like raised storage (Thati Ghar) and local weather forecasting based on natural observations, whereas the study done in west Rapti basin by Devkota, Cockfield, and Maraseni (2014) revealed that people living in west Rapti basin relied more on structured communication channels. However, the west Rapti basin emphasized planning and communication, whereas the Tharu community in Rajapur focused on indigenous structural solutions to cope with floods.

The Rajapur flood adaption strategy research findings are very similar to the Rapti basin study observations done by Devkota et al., (2014). Both studies emphasize the relevance of community-driven flood management measures that incorporate local knowledge and abilities. People of Rapti basin have developed various techniques for pre-flood, during flood, and post-flood periods to mitigate the impacts of flooding.

4.2.2 Factor Influencing Indigenous Adaptation Strategies

The findings from the study on the relationship between socio-demographic factors and adaptation strategies in Tharu communities highlight that variable such as gender, age, education level, income, and proximity to rivers significantly influence the indigenous approaches used to cope with floods. Gender emerged as a particularly impactful factor, with men typically engaging in economically beneficial activities such as fishing and diversifying livelihoods, while women focus on ensuring household food security. Women's strategies include preserving seeds in traditional grain storage pots locally called as “Deheri”, hanging belongings from roofs to protect them from water damage, utilizing local resources, and employing sustainable farming techniques. Age also plays a critical role in shaping adaptation strategies. Older individuals predominantly rely on traditional farming practices passed down through generations, whereas younger people often integrate these traditional techniques with innovative approaches to address flooding more effectively. Education is another key determinant, as individuals with higher levels of education are better equipped to apply indigenous knowledge effectively, enabling them to make informed decisions and enhance their adaptability.

Income levels further influence the extent to which families maintain and invest in indigenous practices. Wealthier households have greater capacity to diversify their activities and adopt sustainable methods, while resource-constrained families struggle to sustain traditional farming practices. Proximity to rivers also shapes adaptation strategies; communities near rivers face heightened vulnerability to flooding but simultaneously have better access to resources such as fertile land and fishing opportunities. These communities develop more robust adaptation mechanisms to mitigate flood risks. Conversely, those living farther from rivers focus on cultivating drought-resistant crops or exploring alternative livelihoods less impacted by flooding.

Comparing, a study done by Mequannt Marie (2024) on farmers in northwestern Ethiopia similarly found that socio-demographic factors significantly influence the choice of climate change adaptation strategies. Younger and more educated farmers are more likely to adopt innovative practices, while wealthier individuals access superior resources for adaptation. Gender also plays a role in determining the types of strategies employed. Both studies underscore the importance of socio-demographic characteristics in shaping adaptation strategies; however, the specific practices and challenges vary across communities (Mequannt et al., 2024).

Similarly, a study done by Mohammed Nasir Uddin et al. (2014) in Bangladesh revealed differences in the role of age in adaptation strategies. Older farmers were less likely to adopt new practices, while education positively influenced adaptation efforts. Similarly, the findings from the Tharu communities emphasize the critical role of socio-demographic factors, such as gender, age, education, income, and proximity to rivers, in influencing flood adaptation strategies. While the Bangladesh study highlights broader climate change adaptation trends, the Tharu study focuses on the significance of local knowledge and cultural practices in responding to specific environmental challenges, such as flooding.

4.2.3 Knowledge Transformation

The Tharu community in Rajapur Municipality of Bardiya District has traditionally relied on indigenous adaptation techniques and strategies to mitigate the impacts of floods. This valuable traditional knowledge is primarily transmitted within families, with grandparents being the primary source (62.86%), followed by parents (36.67%), who continue to uphold this legacy. Additionally, community leaders, locally referred to as "Barghar," play a significant role (25.24%) in fostering collective action and facilitating informed decision-making processes. Field observations and focus group discussions (FGDs) revealed that the acquisition of local adaptation strategies is predominantly experiential.

The study found that observation and practice are the most significant methods of knowledge transfer, adopted by 83.33% of respondents. Formal training programs are utilized by 36.67%, while media sources such as radio (4.76%) and television (2.38%) play a relatively minor role in this process. The effectiveness of these knowledge transfer mechanisms is highly regarded, with 66.67% of respondents considering them extremely important and 29.52% viewing them as highly significant, indicating a strong consensus on their value. However, the implementation of these strategies faces several challenges. Limited resources (50%), societal pressures to adopt modern methods (37.14%), a lack of awareness about traditional techniques (36.67%), and government policies unsupportive of indigenous practices (27.14%) were identified as key barriers. To address these issues and enhance the preservation and application of indigenous knowledge, a multi-pronged approach is necessary. This includes educational and awareness programs (55.71%) to emphasize the value of traditional knowledge, governmental support (50.48%) to provide resources and foster enabling policy environments, and community-based initiatives (45.71%) to ensure local engagement and relevance in decision-making processes.

A study done by Calvin et al. (2023) underscores the critical role of indigenous knowledge in climate change-induced flood adaptation in Nepal, emphasizing its transmission to younger generations. Elders play a pivotal role as key transmitters of traditional ecological knowledge, enabling youth to acquire essential coping strategies and culturally relevant practices. The study highlights various methods of knowledge transfer, including storytelling, hands-on experiences, and community engagement, which equip younger generations with practical skills and cultural values essential for resilience against climate challenges. Inter-generational transmission is deemed vital for maintaining cultural identity and enhancing community resilience in the face of environmental changes

CHAPTER V: CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Effective flood adaptation strategies are crucial for vulnerable communities such as the Tharu community in Rajapur, as they face increasing challenges from seasonal flooding intensified by climate change. This research investigated the indigenous adaptation strategies employed by the Tharu people to protect their livelihoods and agricultural practices from flooding. The findings revealed that the community employs diverse methods, including constructing traditional type of river embankments, diversifying crops, and building raised storage structures to safeguard belongings from floodwaters. Additionally, the study examined the transmission of indigenous knowledge related to flood adaptation within the Tharu community. It was found that this knowledge is predominantly shared through oral traditions and hands-on experiences, equipping younger generations with practical strategies to effectively manage flooding. Finally, the research identified key factors influencing these indigenous strategies, emphasizing the critical roles of community engagement, local resource utilization, and cultural practices in shaping their responses to climate challenges.

This study underscores the importance of integrating indigenous knowledge into broader climate adaptation initiatives. By recognizing and valuing the traditional practices of the Tharu community, solutions can be developed that are both effective and culturally appropriate for addressing the impacts of climate change. As climate change continues to present substantial challenges, learning from the experiences of the Tharu community offers valuable insights for assisting other vulnerable populations facing similar issues.

Future research should explore how diverse indigenous groups adapt to climate change, ensuring their voices are heard and their knowledge preserved for future generations. This approach not only enhances our understanding of effective flood management strategies but also contributes to the preservation of indigenous cultural heritage.

5.2 RECOMMENDATION

Some highlighted recommendations based on my study for strengthening indigenous adaptation strategies to climate-induced flooding in Tharu communities in Rajapur are given below;

- Promote collaboration between indigenous communities and researchers to find effective adaptation strategies that respect traditional knowledge while addressing current climate challenges.
- Set up programs to record indigenous knowledge, practices, and stories about climate adaptation, including oral histories and local ecological insights.
- Develop educational programs that combine indigenous knowledge with modern scientific methods for climate adaptation, helping to connect traditional practices with contemporary approaches.
- Support policies that acknowledge and protect indigenous knowledge as a valuable resource in climate adaptation efforts, ensuring that indigenous voices are included in decision-making processes.

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APPENDICES

A Focus Group Discussion (FGD) was conducted on August 16th with a group of women from the Sana Kissan community. During this discussion, open-ended questions were posed to learn about the main strategies they used to adapt to flooding in their daily live. A total of 26 Key Informant Interviews (KIIs) were conducted with the ward heads and secretaries from wards 1, 3, 4, 7, 9, and 10 and mainly focusing Barghar (The head of community) from each community of selected ward. The list of participants in the FGD and KII is provided in the table below;

Appendices A: Participates in Focus Group Discussion

Name	Age	Gender	Organization
Sujana Tharu	22	Female	Sana Kissan Women's Group
Aakriti Tharu	30	Female	Sana Kissan Women's Group
Lakxmi Tharu	32	Female	Sana Kissan Women's Group
Maiya Tharu	21	Female	Sana Kissan Women's Group
Radha Tharu	18	Female	Sana Kissan Women's Group
Sarmila Tharu	35	Female	Sana Kissan Women's Group
Goma Tharu	43	Female	Sana Kissan Women's Group
Pushpa Tharu	33	Female	Sana Kissan Women's Group
Mallika Tharu	22	Female	Sana Kissan Women's Group
Rama Tharu	24	Female	Sana Kissan Women's Group
Kali Tharu	32	Female	Sana Kissan Women's Group

Appendix B: list of Key Informant Interviewer

Key personnel	Name	Organization	Designation
Ward level	Ms. Ranju Chaudary	Ward no.1	Ward secretary
	Mr. Prasadu Tharu	Ward no.3	Ward chairperson
	Mr. Bidur Pokhrel	Ward no.4	Ward chairperson
	Mr. Ramu Tharu	Ward no.7	Ward chairperson
	Mr. Bishnu Prasad Tharu	Ward no.9	Ward chairperson
	Mrs. Jamuna Shahi	Ward no.10	Ward secretary
Village head *(Barghar)*	Mr. Kesuram Tharu	Ward no. 1	Tihuni
	Mr. Jiudhal Tharu	Ward no. 3	Nangapur
	Mr. Nukal Tharu		Tighra
	Mr. Jaguwa Tharu		Chakkapur
	Mr. Risman Tharu		Tediya
	Mr. Karna Bahadur Tharu	Ward no. 4	Anantapur
	Mr. Khusiram Tharu		Sangarsanagar (Muktakamaiya Tol)
	Mr. Bhupendra Tharu	Ward no. 7	Bhaluphata
	Mr. Man Bahadur Ale		Sankharpur
	Mr. Govinda Rana		Lalchipur
	Mr. Min Bahadur Gurung		Lahure Tol
	Mr. Siddha Ram Tharu	Ward no. 9	Chainpur
	Mr. Dhani Ram Tharu		Durganagar
	Mr. Dharti Ram Tharu		Goddiyana

	Mr. Salik Ram Tharu		Chhotki Bhimapur
	Mr. Nok Bahadur Gharti Magar	Ward no. 10	Majhra
	Mr. Jit Bahadur Tharu		Jhapti
	Mr. Diule Tharu		Pahadipur
	Mr. Thakur Raj Tharu		Lalpur

Appendix C: Questionnaire

1. Name:

Ethnic group:
Age:
Gender:
ward:
Occupation:
X- Co-ordinate:
Y- Co-ordinate:
River proximity:

2. How long have you lived in Rajapur Bardiya? (years)

   . 5-10
   a. 10-15
   b. 15-20
   c. 20-above

2. How much land he/she possesses? What farming is done, what is the house type?
3. How many people live in your household?
4. What is your family's annual income?
5. What is your highest level of education?
6. Do you own or have access to land? If so, how much?
7. In the past 20 years, have you noticed any changes in the weather patterns in your area? (e.g., temperature, rainfall, extreme weather patterns)
8. Flood inundation regularly or occasionally? How far it comes from the river bank, how many days flood remains?
9. What were the farming practices earlier and how it is done now, what is changed?
10. Have you observed any changes in the types of plants that thrive in your area due to climate change? (Yes/No)
    - If yes, please elaborate.
11. In your opinion, what are the biggest challenges in transmitting traditional ecological knowledge to younger Tharu farmers?(list)
12. How is this knowledge passed to younger generations? (sources, methods)
13. What are the methods they received their knowledge? E.g. TV, radio

Pre-Flooding (3-5 years before a major flood):

1. What are some of the common practice's farmers in Bardiya use to prepare for potential floods before the rainy season begins? (List & rank them)
2. Which are most effective and most commonly used these pre-flooding practices in mitigating the impact of floods on crops? (Ranking)
3. Can you elaborate on any challenges or limitations?
4. Have you observed any changes in these pre-flooding practices over the past 10 years?
   If so, what are the reasons behind these changes…………………………

During Flooding (during the peak flooding period):

1. What are the most critical challenges farmers face during a major flood event related to their agricultural activities?
2. Can you list any specific strategies farmers use to manage their crops during a flood?
3. In your opinion, how effective are these strategies in minimizing flood damage to crops and agricultural land? How it could be better done?

Post-Flooding (after the floodwaters recede):

1. What are the main activities farmers undertake after a flood to restore their agricultural land and resume cultivation? (List & rank them)
2. Are there any specific techniques or practices used to improve soil fertility after a flood? (storage, Crop pattern).
3. Have you noticed any changes in how farmers recover their land after a flood compared to 10 years ago? (Yes,No)
4. If so, what are the reasons for these changes? What are the changes farmers made to recover land?
5. What support required? What is thought to be done?

Knowledge Transfer:

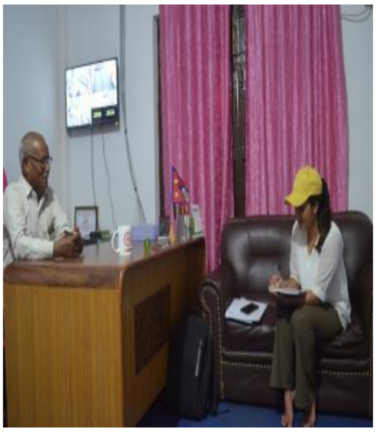
1. From whom did you learn about traditional practices for dealing with floods and climate change?
2. In what ways is this knowledge traditionally passed down through generations?
3. How is this knowledge passed to younger generations?
4. What are the methods they received their knowledge? E.g. TV, radio

Factors influencing Adaptation Strategy

1. What factors do you think have influenced the choice of adaptation strategies in your community? (List & Rank)
2. How important are the following factors in decision-making about adaptation?
3. What are the main barriers preventing your community from adopting more effective adaptation strategies?
4. Are there any specific policies or programs that you think would help overcome these barriers?

Appendix D: Photographs

Focus Group Discussion with Sana Kissan Women's Group (Ward 3)



KII with Ward Heads

KII with Ward Secretariat



KII with *Barghar*-The head of Tharu community



Pictures of household survey during data collection

Flooded Bajura Village

Flooded paddy field

Flooded Karnali river

Flood-affected mango grove

Flooded agricultural fields

Flooded residential area

Some captured picture of adaptation strategies in Rajapur


Traditional raised house (Thati Ghar)


Traditional fishing strategy


Temporary tent house


Concrete evacuation tower


Traditional evacuation tower


Raised water pump


Women collecting fuel wood in flooded Karnali river


Men collecting fuel wood in flooded Karnali river


Traditional grain storage pots (Deheri)

Diverse Livelihoods