Thesis for the Degree of Master of Science in Environmental Management

# ASSESSMENT OF THE FLOOD-INDUCED LOSS AND DAMAGE TO AGRICULTURAL CROPS IN RAJAPUR BARDIYA

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**Pokhara University, Nepal**

**July, 2022**

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**Supervised by Prof. Dr. Sanjay Nath Khanal**

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

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# Declaration

I declare to the School of Environmental Science and Management (SchEMS), affiliated to Pokhara University that the research work **"Assessment of the Flood-Induced Loss and damage to agricultural crops in Rajapur, Bardiya"** was submitted as a partial fulfillment for the degree of Master of Science in Environmental Management, has been composed solely by myself and has not been submitted for any other previous application of degree or professional qualification. Due references have been provided and acknowledged in all supporting literatures and resources.

…………………………………….

Shristi Paudel

P.U. Registration Number: 2019-1-25-0068

July, 2022

# Recommendation

This is to recommend that the thesis entitled **“Assessment of the Flood-Induced Loss and damage to agricultural crops in Rajapur, Bardiya”** has been carried out by Ms. Shristi Paudel for the partial fulfilment for the degree of Master of Science in Environmental Management. This original work was conducted under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree.

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Prof. Dr. Sanjay Nath Khanal

School of Environmental Science and Management (SchEMS)

July, 2022

# Certification

This is to certify that the thesis entitled **“Assessment of Flood-Induced Loss and damage to Agricultural crops in Rajapur, Bardiya”** submitted by Shristi Paudel is examined and accepted as partial fulfillment for the degree of Master of Science in Environmental Science and Management. The thesis in part or full is the property of the School of Environmental Science and Management and should not be used to award any other academic degree in any other institutions.

**Approved by:**

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# Letter of Approval

This dissertation paper submitted by Ms. Shristi Paudel entitled **“Assessment of the Flood-Induced Loss and Damage to Agricultural Crops in Rajapur, Bardiya**” has been accepted for the partial fulfillment of Master of Science in Environmental Management from Pokhara University.

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Asso. Prof. Ajay Bhakta Mathema

Principal

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July, 2022

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**Shristi Paudel**

**July, 2022**

# Abstract

More frequent and severe extreme climate events have caused economic and non-economic losses and damages to local communities living in disaster-prone areas due to climate change. This study sought to understand the economic loss and damage to agriculture caused by the unseasonal flood that occurred on October 18–20, 2021 in the Rajapur Municipality alongside the bank of the Karnali River. The lower region of the Karnali basin where Rajapur Municipality lies often experiences floods. The Municipality is situated in between the two arms of the Karnali River and has a long history of flooding. Based on the household survey, FGD, KII, and secondary literature, the region witnessed floods in the years 1995, 1998, 1999, 2000, 2003, 2007, 2008, 2009, 2012, 2013, 2014, 2017, 2020, and 2021. The study was mainly focused on the loss and damages experienced by small, medium, and large farmers residing along the bank of the Karnali River. The loss and damage were estimated mainly based on the proposed indicators by BIPAD (Building Information Platform against Disaster) in the agricultural sector. The selected indicators were agricultural land, paddy production, stored grains, livestock, and farm machinery. In 2021 October, due to the flooding event in Rajapur, the small farmers had a total economic loss of $ 21709.769 and medium farmers had a total economic loss of $50225.239 and large farmers had a total economic loss of 32393.491 in the agricultural sector. Among these production loss was $45888.774 in total.

From the people's perception, the 2021 October flood was the worst hit flood in terms of agricultural loss and damages as the flood swept away the paddy that was ready to be harvested. Small and medium farmer's livelihood, income, and food security were found greatly impacted in compare to the large farmers. The study tried to explore the coping mechanisms of how the different farmers were coping with the loss and damages to support their livelihood and food security. They are dealing with L&D related to food security and income by buying rice, consuming wheat, education abandonment, loan taking, doing labor work, cultivating spring season rice, etc. The study also found that the adaptation measures like early warning system and embankment have helped them to prevent human casualties, however, it is challenging to control agriculture-based L&D.


**Keywords:** flood, loss and damage, economic loss, agriculture, coping mechanisms

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## List of Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| BIPAD | Building Information Platform against Disaster |
| CBS | Central Bureau of Statistics |
| COP | Conference of Parties |
| CRED | The Centre of Research on Epidemiology of Disaster |
| DEOC | District Emergency Operation Centre |
| DHM | Department of Hydrology and Meteorology |
| DWIDP | Department of Water Induced Disaster Prevention |
| EM-DAT | Emergency Events Database |
| FAO | Food and Agricultural Organization |
| FGD | Focused Group Discussion |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gas |
| GoN | Government of Nepal |
| IPCC | Intergovernmental Panel on Climate Change |
| KII | Key Informant Interview |
| LDCs | Least Developed Countries |
| LMICs | Low and Middle Income Countries |

| | |
|---|---|
| L&D | Loss and Damage |
| MoFE | Ministry of Forest and Environment |
| MoHA | Ministry of Home Affairs |
| mt | Metric Ton |
| NDC | Nationally Determined Contribution |
| NPR | Nepalese Rupee |
| PCP | Precipitation |
| PMAMP | Prime Minister Agricultural Modernization Project |
| SNLD | Santiago Network on Loss & Damage |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USD | United State Dollar ($) |
| WHO | World Health Organization |
| WIM | Warsaw International Mechanism |

## Units and conversions

| | |
|---|---|
| 1 Bigha | 20 Kattha |
| 1 Kattha | 0.0338 hectare |
| 1 NPR | USD 0.0082 |
| 1 kg | 0.001 mt |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Floods are one of the most prevalent disasters, posing a serious threat to millions of people all over the world. In the IPCC SREX report glossary the flood is defined as “the overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged” [1]. The frequency of floods is increasing resulting in massive losses of lives, livelihoods, agriculture, infrastructure, public services, and property along with the scale of damage is also growing each year [2]. The sixth assessment report by the Intergovernmental Panel on Climate Change (IPCC) says the human impact on the climate system is ‘unequivocal’ as people are experiencing widespread loss and damage [3]. With the increase of every degree of temperature, the cost of loss and damage due to climate change will continuously rise [4]. Due to this both the life of the people and the economy of the country are at stake. The concept of Loss and Damage evolved as scientific evidence made clear that "adaptation has a limit”. Loss and damage refer to, "negative effects of climate variability and climate change that people have not been able to cope with or adapt to” [5]. It also refers to both climate-related impacts and risks including both sudden-onset catastrophic events like flooding and cyclones, as well as slow-onset phenomena like sea-level rise, glacial retreat, desertification, and others [6]. Loss is associated with irreversibility and damage is associated with the impacts that can be repaired or recovered [7].

Loss includes permanent and irrevocable losses such as lives, livelihoods, homes and territories and, land erosion. It also includes non-economic consequences such as loss of culture, identity, ecosystem services, and biodiversity, which cannot be quantified in monetary terms In terms of agriculture, loss accounts for the decline in crop production, loss of agricultural land, decline in income from livestock and crops, overall agricultural reduction, and increase in input prices [8].

Climate change is increasing the frequency of river floods as well as drought [9] [10]. Nepal is considered as one of the global hot spots for climatic disasters. In the top twenty poorest countries, Nepal ranks fourth and 30th positions in terms of climate change impacts and flood risk impact respectively [11]. Nepal has also been subjected to several floods, many of which have resulted in significant loss of life as well as the economy. Nepal's rugged topography, haphazard land use, melting of snow caps and outburst of the glacier lake, and concentrated monsoon rain are a few key causes of water-induced disaster [13]. Flooding and extensive inundation are major issues in the Terai, as a result of river course changes, bank erosion, and erosion in river meanders also due to the suspended load carried by the rivers. Each year, they widen and slash their banks[14]. Climate change and variability have a greater impact on rain-fed agriculture and subsistence farmers. It has a direct impact on food production and livelihood. Terai has experienced the worst climate change in recent decades, with severe drought, extreme and repeated floods, landslides, and other natural disasters [15].

The intensity, frequency and magnitude of both extreme events and slow onset events are expected to increase in coming years particularly in the backdrop of warming climate and change of land use pattern. [16] [17]. Extreme events like heat waves (very likely), heavy precipitation (high confidence), and slow onset events like glacial melt and extreme events agricultural and ecological droughts in some regions are expected to increase. In recent years seasonal and unseasonal heavy rains have also become more frequent [18].

The rainfall that occurred from 17 to 21 October in 2021 in Lumbini Province of Nepal had destroyed thousands of hectares of paddy fields. Due to this massive loss of paddy, the local government had declared to provide agricultural relief packages to the farmers as compensation [19][20]. For the compensation schemes, farmers were categorized into three categories. The first one is small farmers who have a total land up to 10 kattha, medium farmers having land up to 60 kattha, and the farmers who hold land more than 60 kattha are categorized as large farmers [21]. Where the 1 hectare of land is equal to 30 kattha [22].

Rice is Nepal's most important staple food crop, contributing significantly to the majority of people's livelihoods and the national economy. It ranks first in terms of area coverage, production, productivity, and preferences, contributing to 15.35% of the AGDP in the fiscal year 2075/76 B.S., (2018/19) with an average productivity of 3.76 mt/ha [23] [24]. Rajapur municipality and Geruwa rural municipality in the Bardiya district have been designated as rice super zones by the Prime Minister Agriculture Modernization Project (PMAMP) [25] due to their high agricultural productivity. People of this area are highly dependent on agriculture, which is the main source of their income. Frequent flooding can have an adverse impact on agricultural production and threaten food security.

### 1.2 Statement of the problem

According to the latest report by Intergovernmental Panel on Climate Change (IPCC) in August 2021, every region of the earth has been facing changes in its climate. Climate impacts are increasing and becoming more visible. Flood is the second most impactful disaster in terms of their impact on agriculture after drought. It has caused a loss of USD 21 billion in Least Developed Countries (LDCs) and Low Middle Income countries (LMICs) from 2008 to 2018. Climate factors like temperature rise, melting of glaciers, extreme precipitation, sea level rise, etc., and anthropogenic factors like development work, land use and land change, encroachment of river areas, etc., have also contributed to flooding events. [15] [26] [27].

Nepal is one of the world's most vulnerable countries to disasters [28]. Extreme precipitation during the monsoon season causes floods in Nepal every year. In the mountains and hills, flash floods and landslides are major climate-related hazards, while riverine flooding and inundation of low-lying areas put the lives and economies of the people of the Terai region at risk [29][30][31]. Nepal is an agricultural country with 66 percent of the population predominantly engaged in farming [32]. Strong scientific evidence shows that the annual economic loss from climate-induced disasters is roughly 0.08 percent of GDP. (2018/19 figures at current prices) whereas in 2017 the loss and damage in Terai from flooding was approximately 2.08 percent of GDP (2017/18 figures) [33].

The Karnali river basin of Rajapur municipality is a vulnerable area in terms of river erosion and inundation. In recent years, the Karnali River has eroded riverside land and settlement areas due to natural, humanitarian, and climatic disasters. Overall, looking at the historical details of the various disasters within the Rajapur Municipality over the last 30 years, there is a risk of multiple disasters such as floods, fires, hurricanes, droughts, and wild animal attacks, where flooding is the most prevalent one. Due to recurring flooding events in Rajapur, disasters affect human physical, economic, social, and psychological well-being every year [34]. Thus, it is necessary to take mitigative and adaptive measures to reduce the risk of such disasters in the future. Loss and damage in Nepal easy to understand but is challenging to cope with. Floods are one of the most devastating events in Nepal, accounting for 7,599 deaths and costing billions of dollars between 1954 and 2018. [35].

### 1.3 Research Questions

1. What is the trend of flood events occurring in Rajapur and Bardiya?

2. What loss and damage has the flood caused in agriculture in Rajapur?

3. How are the farmers of Rajapur coping with the loss and damage in agriculture after the flooding events?

### 1.4 Research Objectives

#### 1.4.1 General objective

To study the loss and damage to agricultural crops caused by the floods in Rajapur Municipality, Bardiya.

#### 1.4.2 Specific objectives

- To analyze the trend of flood events that occurred in the Karnali River (Rajapur, Bardiya).
- To assess the loss and damage to crops caused by the floods in Rajapur, Bardiya.
- To explore the coping mechanisms of farmers to deal with the agricultural loss and damage.

### 1.5 Rationale of the Study

The lower region of Karnali is prone to flooding and has a long history of flooding [36]. The river's annual overflow has had an economic and non-economic impact on the livelihoods of people in the Karnali basin. Despite the scale of disaster that occurs in a community, the local people suffer the most which increases their vulnerability and intensifies the inequality gap between the rich and poor [3] [34]. Bardiya district is one of the most flood prone regions in Nepal where the district has been worst hit by floods in 1983, 2009, 2013, 2014, 2017, and 2021 [30]. Every year people in Rajapur must live in fear of floods as the monsoon season begins.

Various action-oriented studies have been conducted in Rajapur municipality related to floods but academic research has been poorly explored on loss and damage to agriculture. This study is crucial to fill in the gap which has been left by previous studies in assessing the Loss and damage to agricultural crops that are caused by the unseasonal flooding events. Indigenous 'Tharu' community, Sukumbasi (squatter settlements), Mukta Kamaiya, Sonaha community, of Rajapur Municipality are often exposed to flood who have poor adaptive capacity to cope with the hazard. The loss and damage assessment help to provide information to the community about the extent, amount, and area of the damage. Thus, helping stakeholders to address, assess, and minimize the risk of flood-induced loss and damage particularly in the backdrop of climate change.

## 1.6 Limitation of the Study

Even though the research's goal was achieved, there were some limitations. Consideration of these limitations in future study would provide in-depth knowledge on climate induced loss and damage in agricultural sector.

- Climatological and hydrological data were collected from only one station.
- Loss and damage was assessed only of a single year
- Non-economic loss and damage couldn't be assessed
- Focused to paddy only
- Insurance data is missing

# CHAPTER 2

# LITERATURE REVIEW

## 2.1. Contextual Background on Loss and Damage

The loss and damage (L&D) discourse started in 1991 within the global climate change negotiations when an Alliance of Small Island States (AOSIS) proposed an international insurance pool to compensate about the losses of sea level rise that was irrecoverable and beyond physical and social adaptation limits [37]. Almost after 20 years the issue of Loss and Damage re-emerged in the 'Bali Action Plan' in 2007 at (COP 13), which highlighted the need for increased action on adaptation, including "disaster risk reduction strategies and means to address loss and damage". The Work Programme on Loss and Damage was formed under the Subsidiary Body for Implementation (SBI) at COP 16 in Cancun, Mexico in 2010. In 2012 at COP 18 in Doha, parties decided to consider institutional arrangements to address L&D for the first time [38]. In 2013, negotiators at COP 19 to UNFCCC made the most substantial progress to establish "Warsaw International Mechanism (WIM)" for loss and damage associated with climate change and its executive committee. In 2015 at COP 21, new elements and dimension of loss and damage was formed under the Paris Agreement (Article 8). The WIM executive committee has a five year rolling work plan which covers wide range of activity areas. Action areas are focused to the vulnerable countries, population and ecosystem that are dealing with both slow-onset processes and rapid-onset events also working to avert, minimize and address loss and damage [39].

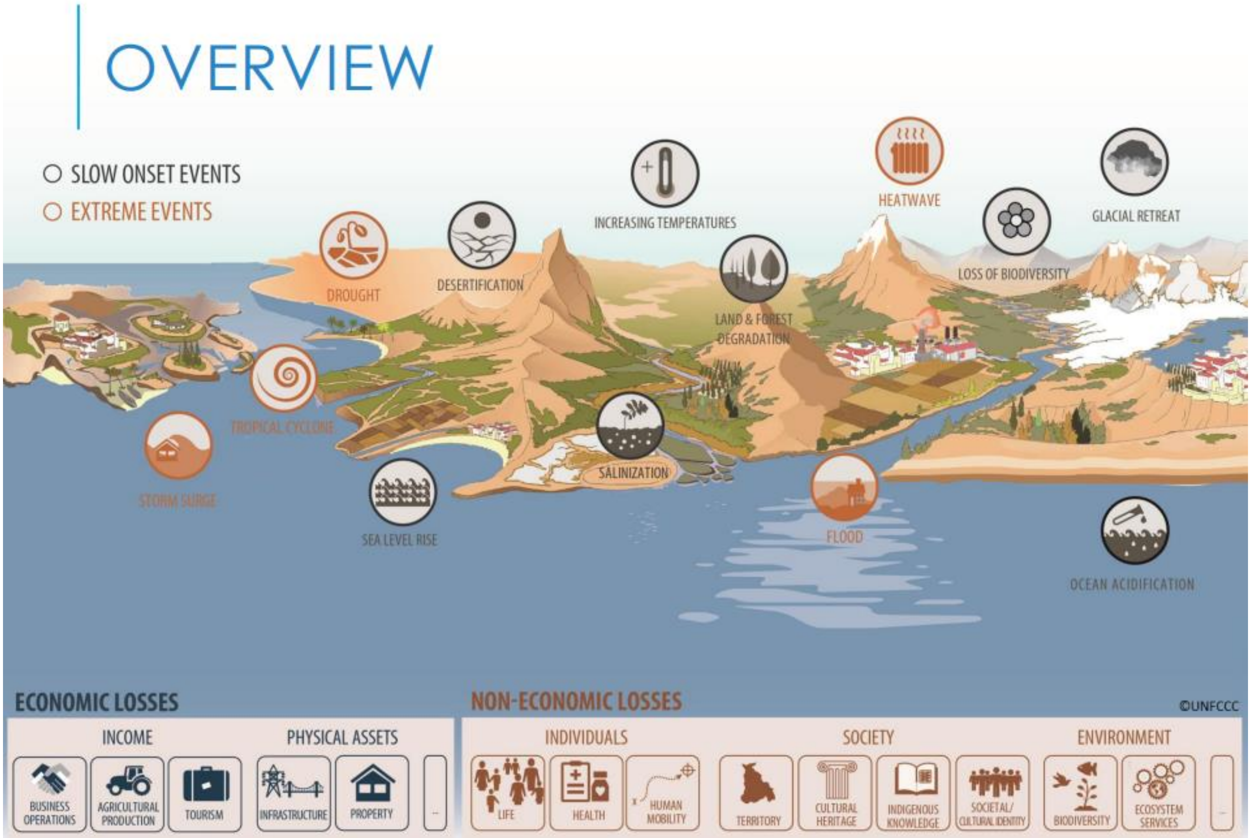



Figure 1: Concept of climate induced loss and damage. Source: UNFCCC

One of the heated debates for the UNFCCC COP 25 negotiations in 2019 was loss and damage. The WIM was due for consideration, and the member countries have differing perspectives on how to make it work. Several developing-country factions argued for the establishment of a distinct and specialized arm to finance loss and damage. The COP agreed to consider loss and damage financing using the convention's financial instruments, such as the Green Climate Fund and formed the Santiago Network on Loss and Damage to help developing nations with technical support [40]. The Santiago Network was established as a key outcome of the WIM at COP25 to avert, minimize and address loss and damage (SNLD). This is an important step toward strengthening the WIM and increasing action and assistance to vulnerable developing countries. This increases the urgency to build up efforts to avert, minimize and address loss and damage in the backdrop of continued global warming and its significant impacts. The SNLD mandate—is to catalyze the technical assistance of relevant organizations, bodies, networks, and experts for the implementation of relevant approaches at all levels in vulnerable developing countries. However, the function and modalities of SNLD are yet to be discussed [41].

Over 300 civil society organizations called on COP26 to provide finance for L&D on a large scale, in addition to the US$100 billion committed but not yet delivered by developed countries to developing countries to support adaptation and mitigation. It is expected that the economic cost of L&D in developing countries will be between $290 and $580 billion a year by 2030 [42].

At COP 26 in Glasgow, developing countries demanded that SNLD be more than just a website. Furthermore, to robust the SNLD, the developing countries expected the institutional arrangements for mobilizing and channeling L&D finance. Based on an earlier proposal developed by AOSIS, the G77 and China proposed a Glasgow Loss and Damage Facility to provide finance for L&D for vulnerable developing countries. They demanded that the outcome of the L&D discussion be treated equally by the COP and the Paris Agreements Conference of Parties (CMA). In contrast, developed countries believe that the WIM should be governed solely by CMA. As a result, the Glasgow Dialogue on Finance for Loss and Damage was established as a platform for both parties to discuss funding arrangements to avert, minimize, and address L&D. However, developed countries were opposed to the proposal. Since no agreement on WIM governance was reached at COP 26, the discussion will continue at COP27 [43] [42].

The UNFCCC has classified loss and damage as economic and non-economic [44]. Where economic loss is characterized as the loss of common resources, goods, and services traded through markets. It defines five forms of economic loss and damage as business operations, agriculture production, tourism, infrastructure and property. Whereas, non-economic losses refer to losses and damages that are difficult to quantify in monetary terms. Non-economic losses according to the UNFCCC occur in three levels: individuals, society, and environment.

R. Verheyen [45] classified loss and damage into three different categories: avoided, unavoided and unavoidable. Avoided loss and damages are those that can be avoided by adapting climate change mitigation measures and adaptive measures. Unavoided means those avoidable losses and damages that are and will not be addressed by further mitigation and/or adaptation measures, even though avoidance would be possible. Financial, technical, and political constraints, as well as case-specific risk preferences narrow down the adaptation space. Whereas, Losses and damages that cannot be avoided and adapted to through further mitigation and/or adaptation measures, for instance, impacts from slow onset processes that have kicked off already, such as sea level rise and melting glaciers.

### 2.2 Evolution of Loss and Damage Discourse in Nepal

In Nepal, the concept of loss and damage is relatively new in the context of climate change policy. Only a few references have been made in legal and policy documents, where more emphasis is given on research and studies to enhance the knowledge of climate-induced loss and damage, which failed to have a clear understanding among adaptation and loss and damage [46]. Nepal has recently developed a framework for assessing climate induced loss and damage in Nepal, however it is yet to be operationalized. National Framework on Climate Induced Loss and Damage (2021) defines L&D as "the actual and/or potential negative manifestations of climate change on sudden onset extreme events, such as heat wave and extreme rainfall and slow-onset events such as snow loss, droughts, glacial retreat to which people in Nepal's mountains, hills, and Terai are not able to cope with or adapt to as the country's natural ecosystem, infrastructure and institutions are overwhelmed, leading to the losses of life, livelihoods, including losses of cultural heritage" [17]. Nepal has submitted its second Nationally Determined Contributed NDC in 2020 to meet the stipulation of the Paris Agreement. Assessing climate-induced loss and damage is a critical area of interest for the GoN as part of the NDC revision (L&D) [17]. Although, losses are defined in the National Policy for Disaster Risk Reduction as loss of lives, livelihoods, health, economy, social, and physical infrastructure, cultural, and environmental assets of individuals, communities, and the nation. Whereas, the damage is defined as impacts to the physical infrastructures and livelihood that can be repaired or recovered [47]. National Climate Change policy 2019 [48] stated that Nepal is vulnerable to climate change and climate induced disaster are expected to become more common in future and is working towards the mitigation and adaptation. It lays emphasis on the importance of conducting research on climate induced L&D and put measures to reduce climate related vulnerabilities [28]. The 2018 National Policy on Disaster Risk Reduction aims at reducing disaster-related losses to life and property, health, productivity, physical and social infrastructure, and cultural and natural heritage [29]. One of the fundamental principles of Nepal's Disaster Risk Reduction, National Strategic Plan of Action (2018 - 2030) is that disaster risk reduction and management work will be undertaken with the participation and cooperation of Federal, Provincial, and Local-level authorities, stakeholder organizations, and communities [47].

It emphasized the development of strategic activity through rapid assessment procedures for loss and damage. The collection of loss and damage disaggregated data using modern information technology. In terms of policy, Nepal's Nationally Determined Contribution (NDC) and Climate Change Policy 2019, lay emphasis on the importance of conducting research and studies on the loss and damage caused by climate change impacts, as well as developing and implementing mitigation measures to reduce the vulnerability to climate change [49]. Furthermore, Schedule 7 of Nepal's Constitution lists the federal and provincial governments' responsibilities for disaster preparedness, rescue, relief, and rehabilitation activities caused by natural and non-natural disasters. Similarly, Schedule 8 assigns sole responsibility for disaster management to the local government, and Schedule 9 includes the concurrent powers of the federal, provincial, and local governments. However, lack of contextual knowledge, inadequate research has been obstacles in comprehending, evaluating and institutionalizing loss and damage. As stated in its second NDC report, Nepal has committed to developing a National Strategy and Action Plan on Loss and Damage. It has carried out a loss and damage assessment specific to Nepal and drafted a future action plan [33].

## 2.3 Loss and Damage caused by Flood

### 2.3.1 Global Context

According to the IPCC's sixth assessment report with high confidence says that, human influence has warmed the global climate at an unprecedented rate in at least the last 2000 years [16]. The rise in the mean global temperature has driven extreme weather events to become more frequent and intense. Water cycle is intensifying which leads to more intense rainfall associated with flooding, also more intense drought in many regions [3]. Faster warming leads to intense precipitation and intense drought, melting of glaciers and ice sheets, sea level rise, coastal flooding, coastal erosion, heat wave etc. are expected to become more frequent in coming days which have major impact on economies, livelihoods, infrastructures, public health etc. The Centre of Research on Epidemiology of Disasters in Brussels (CRED) in co-ordination with United States office for Foreign Disaster Assistance (OFDA), examined number of flood events that occurred between January 1975 to June 2002, on the basis of which [50] found that the highest death rate was due to flash flood. Average mortality rate was somehow similar in all Continents, however impacts were varied. Asian River found to be more devastating in terms of deaths and displacements. In 2020 only, floods cost over one billion USD in terms of property and crop damage [51].

According to a World Bank Climate Change Group, flooding is not only the most common disaster, but it is also the disaster with the greatest financial and humanitarian impact in terms of the number of people affected and financial asset exposures [52]. About 1.46 billion people in the world are directly exposed to flood hazard among which about 1.37 billion are in south and East Asia [52]. European Environmental Agency in 2022 has written about the economic impacts of climate induced hazards. In between 1980 to 2020, natural hazards cost €487 billion in European states, where the floods are responsible for more than half of the losses [53].

Food and Agricultural Research domain studied about the economic losses when flood impacted in agricultural sector in between 2008-2018. Reduction in crops and livestock production has caused loss billions of dollars. In the Sub-Saharan and North Africa $30 billion was lost in declining crop production. Similarly, $29 billion in Latin America and the Caribbean, $8.7 billion in Small Island Developing States, $49 billion alone in the USA was lost due to flood. Whereas, in Least Developed Countries (LDCs) and Low Middle Income Countries (LMICs) flood accounts for the loss of USD 21 billion due to the reduction of the crops and livestock production [54].

Extreme climate events have threatened the global food security. Worldwide extreme events like flooding in U.S in 2019, 2010 Pakistan floods, 2017 south Asian floods have shown negative impacts on crop production [55].

### 2.3.2 Flood effect on Rice Production in Asia

Rice is one of the most important global staple food. Asia is the largest global rice producer and consumer in the world [23]. South Asia has the major rivers like Brahmaputra, Ganges and situated in the Hindu Kush Himalayan region. In the rainfed lowlands of South and Southeast Asia, flash floods that completely submerge plants for 10–15 days which reduces the rice production [56]. Bangladesh is prone to flood as it lies in the coast of sea. Due to the recurring phenomenon of flood, the country has to face loss in agricultural sector including reduction in crop yields, river erosion, biodiversity loss and other extreme events almost every year [57]. Every year around USD 2 billion is lost mostly due to agricultural losses [58].

In India, flash flooding affects 30% of the rice-growing area (12–14 M ha), with an average production of only 0.5–0.8 t ha [59]. Assam, Bihar, Uttar Pradesh, Kerala, Karnataka, Tamil Nadu, coastal Odisha are some India's most flood-prone places, with flash floods frequently destroying rice crops due to large excess or heavy rainfall in the short period of time in these states, which forces farmers to abandon paddy agriculture or revert to low-yielding traditional landraces [60].

[61] Performed a trend analysis and preparedness of flood disaster in India in between July 2005 to 2013. He described about the economics strains led due to flood related hazards. The frequency of the flood has been discovered to be increasing quickly i.e. year 2005, 2006, 2007, 2007, 2008, 2009, 2009, 2011, 2013 recorded intense rainfall and flood.

### 2.3.3 Flood effect in Nepal

A report published by Ministry of Forest and Environment, 2018 describes about Nepal's vulnerability due to climate change and disasters [62]. Nepal ranks 10th in position in the Long-Term Climate Risk Index (CRI): The 10 countries most affected from 2000 to 2019 [63] 50 out of 77 districts are vulnerable to the effects of climate change [64].

According to a report published by ADB in 2019, flood is found to be the most prominent disaster [65]. In terms of physical exposure to fluvial flooding, Nepal ranks tenth posing loss and damage to lives and physical assets which is equivalent to 1.4% of its GDP. Annually in an average economic losses due to flood and other disasters is more than USD 140 million [65]. Especially in the Terai region of Nepal which is recognized as agricultural hub. Historical evidences shows Terai region has been exposed to major flooding events causing human casualties, infrastructure damage, agricultural production loses impact in public health, settlement displacement etc. Some of the most devastating flooding year are: 1785, 1806, 1871, 1902, 1934, 1960, 1962, 1981, 1987, 1993, 1998, 2002, 2004, 2008 [66].

The research domain by Aryal and his colleagues in 2019 had mapped hazard and assessed risk areas on both the east and west banks of the Karnali River that is vulnerable to flooding for different returns year period. They found the flood erosion of agricultural land poses a threat to food security and causes a direct impacts on livelihood of people [67]. In 2017 flood losses in in agricultural sector were valued around USD 69.5 million, whereas for recovery needs 61.6 million was estimated [68].

Rajapur has a long history of flooding with the records available for years 1963, 1983, 2008, 2013, 2014 and 2017 [46]. These flooding events caused multiple deaths, severe infrastructural damages, agricultural damages which poses a serious threat to food security, putting local's livelihoods at risk. 2014 flood was the worst flood in the history of flooding, equivalent to a 100-year return period (YRP), had impact on human lives and economy. Land erosion caused $239335.41 agriculture, 5653 ha of agricultural land with major crops (rice, maize, vegetables, aquaculture) worth $3.7 million, stored seed and food $8 mil, infrastructures like road, bridge, irrigation canal were damaged [69]. All of the communities downstream were flooded, killing 220 individuals and affecting 120,000 people [46].

After the flooding in Western Terai in October 2021, the Ministry of Agriculture and Livestock Development made a press release stating Lumbini province was worst hit by unseasonal rainfall and witnessed the worst damage. Over 161,000 tons of paddy worth $4.51 billion was damaged by the strong rains. The flood swept away or submerged paddy fields on more than 42,000 hectares in the impacted areas of Bardiya, Kapilvastu, Banke, and Nawalparasi districts. Due to this massive loss of paddy, the local government had declared to provide agricultural relief packages to the farmers as compensation [19] [20]. For the compensation schemes, farmers were categorized into three categories. The first one is small farmers who have a total land up to 10 kattha, medium farmers having land up to 60 kattha, and the farmers who hold land more than 60 kattha are categorized as large farmers [21]. Where the 1 hectare of land is equal to 30 kattha [22].

### 2.4 Review of the existing methods for assessing loss and damage of agricultural crops due to flood

Majority of research methodologies that have been developed to assess the agricultural loss and damage are focused on post disaster consequences. Food and Agricultural Organization of the United States has developed a globally standardized computation methodology to assess the loss and damage in agricultural sector. Which includes three components: Production loss, production damage and asset damage. And in each components five subsectors are included: crops, livestock, forestry, aquaculture and fisheries [8].

Loss and damage in agricultural sector can be assessed by using high resolution data from Earth observing satellites [70]. Flood causes a change to crop land and crop condition. A study was carried in USA using Cropland Data Layer (CDL) of USDA National Agricultural Statistics Service out to estimate the damage in crops. The damage was assessed using normalized difference vegetation index (NDVI), vegetation condition index (VCI), mean vegetation condition index (MVCI), ratio to median vegetation condition index (RMVCI), and Moderate Resolution Imaging Spectroradiometer (MODIS) was used to derive the product [71]. The study shows that crop condition profiles can efficiently identify flood damage and estimate flood damage. An integrated model physically based distributed hydrologic model and a distributed flood loss estimation model was used for flood loss estimation in a river basin was performed [72].

There are two school of thoughts for assessing and addressing climate induced loss and damage. One is evaluating past trends (ex post) and anticipating future loss and damage (ex ante) [73]. DRR and CCA school of thoughts have developed different approaches to address loss and damage induced due to climate change. To assess the loss and damage, particularly 3 frameworks are important.

A. Framework presented by IPCC 4$^{th}$ AR.

B. Framework developed by DRR community and,

C. Analysis provided by IPCC SREX report.

Emergency Management Australia (EMA) has established Disaster Loss Assessment guideline 2002, which clearly states the difference between direct and indirect loss and tangible and intangible. The guidelines for assessing L&D based on a. an averaging concept b. synthetic approach based on damage curve and c. survey approach [74]. Other method includes Catastrophe Risk Models, CATSIM methodology, CAPRA a scientific methodology, Probabilistic Risk Models, The world link index, UK climate change Risk Assessment Methodology [73].

In Nepal to assess loss and damage due to disaster Initial Rapid Assessment (IRA), Multi-Cluster Initial Rapid Assessment (MIRA), Cluster Specified Detailed Assessment (CSDA), Post-Disaster Needs Assessment (PDNA) are performed [46].

**CHAPTER 3**

## MATERIALS AND METHOD

### 3.1 Study site

The selected study area is Rajapur Municipality in Bardiya district in the Terai region of Lumbini Province, which is around 527 km west of the capital city, Kathmandu. The study area is situated between two flood-prone branches of the Karnali River and shares the border with Geruwa Rural Municipality to the east, Kailali District and Geruwa Rural Municipality to the west, and Uttar Pradesh State of India to the south. The Karnali River rises on the Tibetan plateau, runs through Nepal, and eventually joins the Ganges in India. It is geographically 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 (Source: LDCRP, 2021*) and is located between 142 and 154 meters above sea level covering an area of 127.08 $km^2$. For the study, wards 1, 3, 4 and 7 were selected, which are alongside the right branch of the Karnali River. The villages lie in these wards falls under flood prone areas and have been subjected to various flooding events, where populations dependent on agriculture have been severely affected [46] [34]. Rajapur Municipality is vulnerable to flooding. Most of the land in the study area is used for agriculture. Out of the total land, 57.89% is used for agriculture. Agriculture is the most important activity being carried out in the area, with the majority of people living practice subsistence farming. Agricultural land is dominated by rice, wheat, maize, mustard, and pulses (DEOC, 2021) [34].

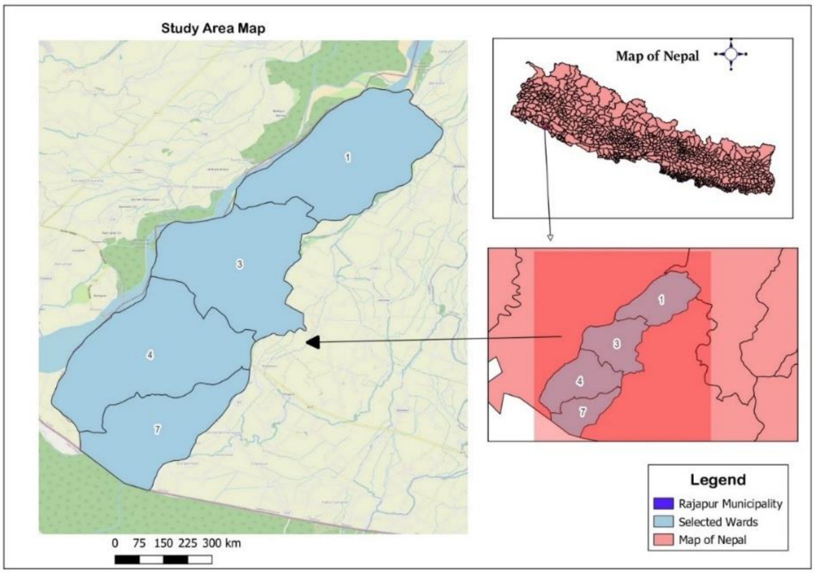



Figure 2: Map of Study area.

### 3.2 Research Design

The study was guided by a research plan. Study began with the site selection based on problems as published in articles, journals and newspaper. Then the objectives were set accordingly based on which questionnaire was prepared. Primary data collected from the field and secondary data were collected from DHM and other sources. Data was analyzed and appropriate charts, tables and graph were prepared to present the findings. Relevant literatures were reviewed during the entire study.

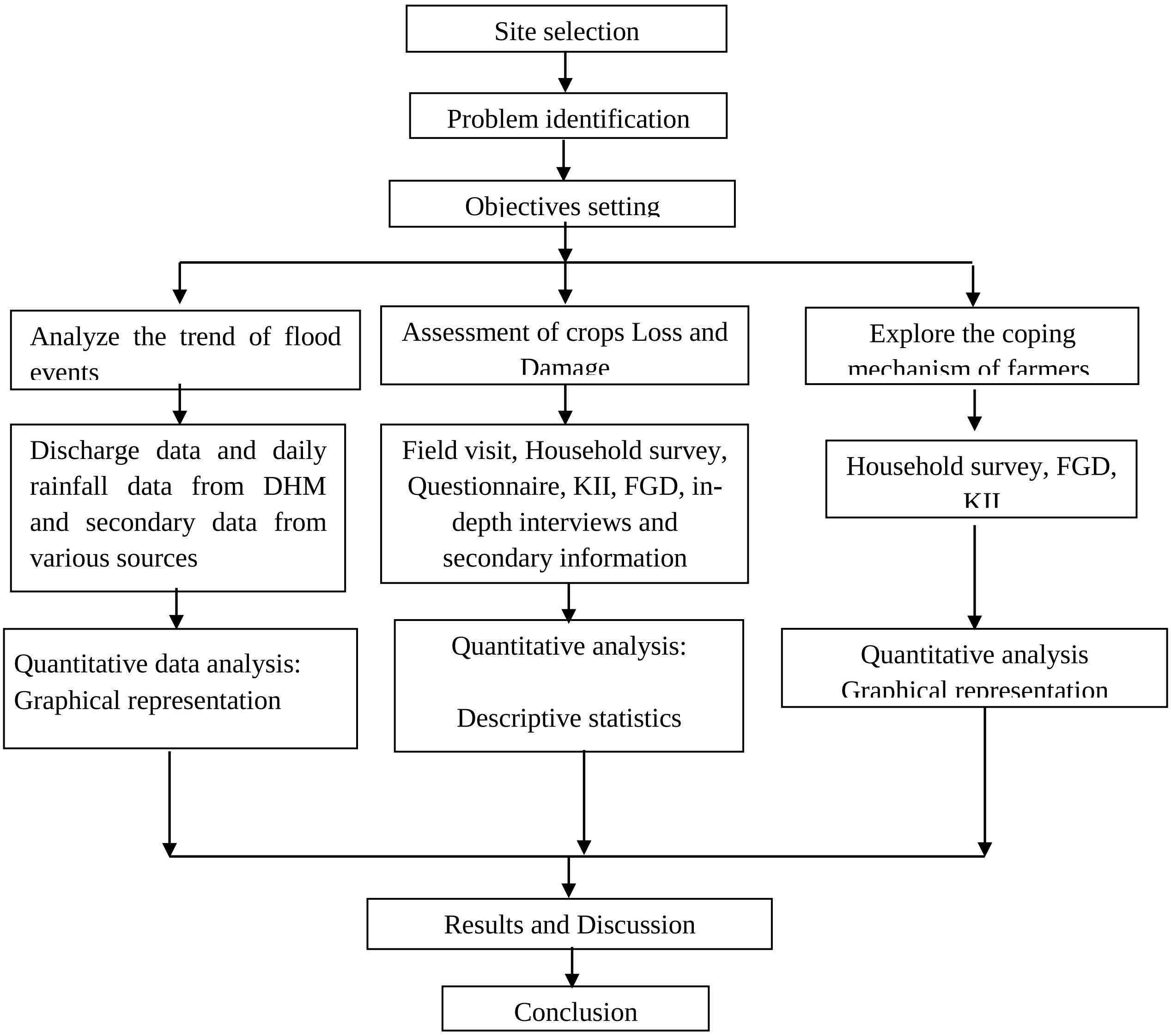



Figure 3: Flowchart of Research Design

## 3.3 Research Method

3.3.1 Sampling technique and data collection

Sample size was calculated using Cochran's formula,

$$n_o=Z^2pq/e^2$$

Where,

Z= statistical value corresponding to level of confidence required (1.96)

p= the (estimated) proportion of the population which has the attribute in question (0.95)

q= 1 – p (0.05)

e= the margin of error (5%)

Modification for the Cochran Formula for Sample Size Calculation in Smaller Populations

$$n= [n_0/(1+((n_0-1)/N)].$$

Where,

$n_0$= Cochran sample size

N= household number

n= sample size

In total 152 household were selected from wards 1, 3, 4 and 7. Required data and information were collected from all these households.

A multistage sampling technique was applied for the collection of samples. In the first stage, a total of 160 samples were collected from 4 different wards based on Cochran formula, 40 in each ward. And in the second stage, all the samples were divided into three farmer's types namely large, medium, and small. Among 160 households, 20 were large farmers, 54 were medium farmers, and 86 were small farmers. The proportion of the large farmers was comparatively lesser than the medium and the small farmers in the study area. However, for the uniformity, per farmer L&D was calculated.

Primary data collection:

Fieldwork plays an important role in collecting primary data. Information was gathered through a questionnaire-based household survey (HHS) and personal observation using a basic random sample technique. Information was gathered directly from respondents in order to obtain precise information.

Focused group discussion (FGD): For the FGD, a total of 3 groups were formed where the first was conducted with local farmers. The second FGD was done with the stakeholders including the members of wards, barghars (community heads) as well as flood affected farmers. And the third interview was taken with the members of Kamaiya Mahila Jagaran Samaj (KMJS). KMJS is an association of freed kamaiya women that was established in 2010. The Kamaiya Mahila (Freed Kamaiya Women) are significant members of society who hold the land of 0.167ha (5 kattha) provided by the government of Nepal. KMJS is an organization that has been working in the field of disaster risk management in Rajapur since its establishment. Also, during the hazards, these members are actively engaged in rescue and relief. Open-ended questions were asked to understand the issues related to flood loss and damage, coping mechanisms, financial and other support from the government and I/NGOs, food security etc.

Key informant interviews (KII**)**: Senior citizen, administrative officer of Rajapur Municipality, Sub-Engineer of Karnali River Management Committee, expert working in the field of Rajapur flood, INGOs person, and disaster (bipad) focal person of Rajapur Municipality were interviewed. Flood events trend, river course change, possible causes of frequent flooding, and the impact of climate change at the local level, local adaptation strategies, government and river management committee strategies, and future plans were discussed during this interview.

3.3.2 Secondary data collection:

The secondary information was collected from published or unpublished articles, documents, reports, thesis, journals and websites. The hydrological and meteorological data were collected from Department of Hydrology and Meteorology (DHM). Other published and unpublished reports were gathered from Rajapur Municipality, Department of Agriculture (Rajapur Municipality), District Emergency Operation Centre (DEOC), and other I/NGOs.

### 3.3.3 Data analysis

For the data analysis mainly quantitative and statistical analysis were performed. Both the qualitative and quantitative data collected from the field survey were transcribed. The climatological time-series data from the year 1992 to 2021 were analyzed in four different seasons. Nepal has four seasons based on the rainfall and temperature pattern [75] namely:

- Winter season(January, February, and December)
- Pre-monsoon season (March, Aril, and May)
- Monsoon season (June, July, August, and September)
- Post-monsoon season (October and November)

MS Excel and Statistical Program for Social Sciences (SPSS) were used to analyze the data and the obtained result that are presented in graphs and tables.

*i. Analysis of Hydrological and Meteorological data:*

The temperature, precipitation, and discharge data from the year 1992-2021 were collected from DHM. The minimum and maximum trend for each season were analyzed. The total minimum temperature days below average and the total maximum temperature days above average for each season was observed and linear trendline was performed. The data for precipitation was obtained and categorized into three indices developed by the Expert Team on Climate Change Detection and Indices (ETCCDI) [70] ,where the total wet-day precipitation when precipitation concentration period (PCP) $\geq$ 1 mm, days with heavy precipitation when PRCP $\geq$ 10 mm and days with very heavy precipitation when PRCP $\geq$ 20 mm. The data were then categorized seasonally and linear trendline was performed. For discharge, seasonal average discharge trend was performed and the graphs are presented through MS-Excel.

Based on the rainfall and discharge analysis, field survey and secondary information flood events trend was analyzed from the year 1992-2021.

*ii. Analysis of Loss and Damage:*

The household data collected from the field were organized and coded under the themes namely agricultural land, agricultural production, stored grains, livestock, and farm machinery. Other data of input including sowing seeds, fertilizers used, labor wages as well as the total sell and income information, financial support and other compensation information have been evaluated. Loss and damage was estimated by following the indicators developed by BIPAD (Building Information Platform against Disaster) for mainly agricultural land, agricultural production (paddy), stored grains, livestock and asset damage (farm machinery) [47] [8]. BIPAD is an integrated and comprehensive Disaster Information Management System (DIMS) initiated by the Government of Nepal, Ministry of Home Affairs. Data collection of land and unit for currency was provided in local unit (kattha) and NPR which were later converted to hectare and USD. The exchange rate was chosen as per the date of the field visit i.e. 25$^{th}$ March, 2022 which was 1NPR=0.0082 USD. The market value was collected from different government offices (Khadhya Sansthan), local shops and farmers themselves. The land price was determined as suggested by Malpot officials (Land revenue officials) (Rajapur, Bardiya). The descriptive statistics like mean standard error, standard deviation, minimum value, and maximum value, were then calculated.

Table 1: Proposed indicators in BIPAD

| Sector | Subgroup | Indicators | Description |
|---|---|---|---|
| Productive | Agriculture | Land | Area of crop field destroyed and damaged |
| | | | Economic loss |
| | | Productivity | Amount of production lost |
| | | | Economic value of production loss |
| | | Stored Grains | Amount of stored grains lost |
| | | | Economic value of stored grains |
| | | Livestock | Number of livestock dead |
| | | | Economic value of dead livestock |
| | | Farm machinery | Economic loss due to damaged/destroyed productive assets in the agricultural sector |

### 3.3.4 Framework for loss and damage

The gradual climate change leads to an extreme weather events or slow onset events. To prevent from extreme weather events certain adaptation measures are followed. After adapting adaptation measures some effects are avoided and some are unavoided and unavoided impacts leads to the loss and damage.

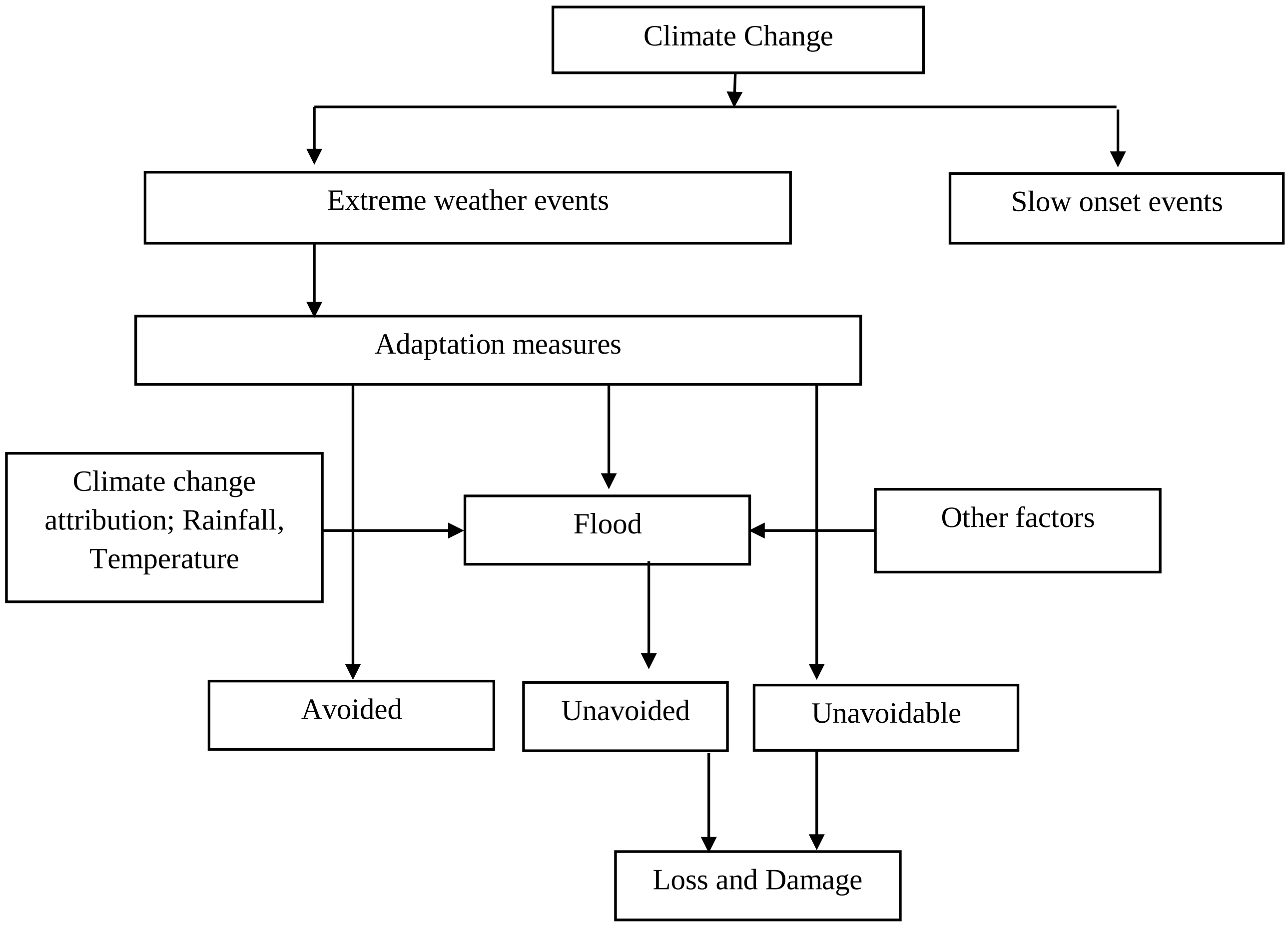



Figure 4: Framework for loss and damages

### 3.3.5 Assessment of Loss and Damage of agricultural land

i. Land Area

Loss and Damage (ha) = Total Land-(Land loss+ Land Damage)

Loss and Damage ($) = Lost land value + restoration cost

*(Note: Bigha and Kattha are local unit of land measurement)*

*1 Bigha = 20 Kattha*

*20 Kattha = 20 lakh*

*1Kattha = 1 lakh*

*1 Kattha= 0.0338 hectare*

*1lakh = 0.0082*100000 (1 NPR= $0.0082)*

*1 kattha = $820*

*0.0338= $820*

*ii.* Production

Loss and Damage (mt) = Previous year yield- This year's net yield

*(Note: Farmers were expected to yield a similar amount as in the previous year. So it was assumed that the previous year is the same as this year's expected yield. Here, the term 'this year' refers to the flooding year i.e.2021)*

Loss and Damage ($) = Economic value of expected yield – economic value of this year's yield.

*(Price determined by Government * total yield)*

*(Khadhya Sansthan (Nepal Government's Body) has determined the price of paddy which is determined every year.*

*1 Quintal= NPR 2752*

*1 Quintal = 0.1 mt (metric tonnes)*

*1 Quintal = 2752*0.0082*

*1 Quintal = $22.5664*

*10 Quintal = 1 mt*

*10*22.5664 = $225.664*

1 *mt* = $225.664 (Thus the price determined by Khadhya Sansthan for 1 *mt* is equal to $225.664)

iii. Stored Grains

Loss and Damage (*mt*) = Quantity of stored grains* pre-disaster value of destroyed stored grains

(Stored grains like rice, wheat, maize, mustard, and red lentils were considered. All the prices for these grains were either determined by Khadhya Sansthan or by local shops or farmers themselves).

iv. Livestock

Loss ($): Pre-disaster value of dead animals

v. Farm Machinery Damage/ Asset damage:

Repair cost of partially or fully destroyed assets

vi. Food sufficiency:

Loss (Month): Average sufficiency month pre-disaster – average sufficiency month post-disaster

Additional Impact on:

a. Income

Loss and Damage: Previous year's total sell – This year's total sell

*(It was assumed that farmers expected to sell a similar amount of paddy this year as in the previous year*)

Loss and Damage ($) = Previous year income – (This year's selling price* total sell)

*(This year's selling price was different. Farmers determined the price as per the quality of rice. Farmers sold prices ranging from $8.2 to $ 22.14 post the flood as the rice couldn't meet quality parameters as the paddy field was inundated for several days)*

b. Input (Inputs are considered as seeds that are used for sowing, fertilizers used, and labor wages)

Loss and Damage: Input used*Input prices

*(Amounts and costs of input were collected from the farmers.)*

### 3.3.6 Analysis of Coping Mechanism

The percentage of each coping mechanism was calculated from the data obtained from the household survey and then the value was presented in bar graph.

# CHAPTER 4

# RESULT AND DISCUSSION

The study demonstrates variation of trend in temperature, rainfall, and discharge at different stations.

Table 2: Details of Hydrological and Meteorological stations

| S.N. | Station Name | Latitude | Longitude | Elevation (m) | Parameters |
|---|---|---|---|---|---|
| 1 | Tikapur | 28°32' N | 81°6' E | 149 | Temperature |
| 2 | Rajapur | 28°26' N | 81°5' E | 133 | Precipitation |
| 3 | Chisapani | 28°38' N | 81°17' E | 201 | Discharge |

## 4.1. Variation in Temperature, Rainfall, and Discharge

### 4.1.1 Variation in Temperature:

For the analysis of variation in temperature, daily minimum and maximum temperature, data from the year 1992 to 2021 of Tikapur station were used. The result is presented below:

*i. Minimum Temperature:*

a. Winter Minimum Temperature Trend

The analysis showed that the trend of winter minimum temperature was decreasing at the rate of -0.0103 °C/ year. Also the trend of the days below the average minimum temperature in winter was decreasing at the rate of 0.1135 days/ year. The average winter minimum temperature is 8.19 °C and the minimum and maximum winter temperature recorded was 0 °C in 2013 and 34°C in 2006 respectively.

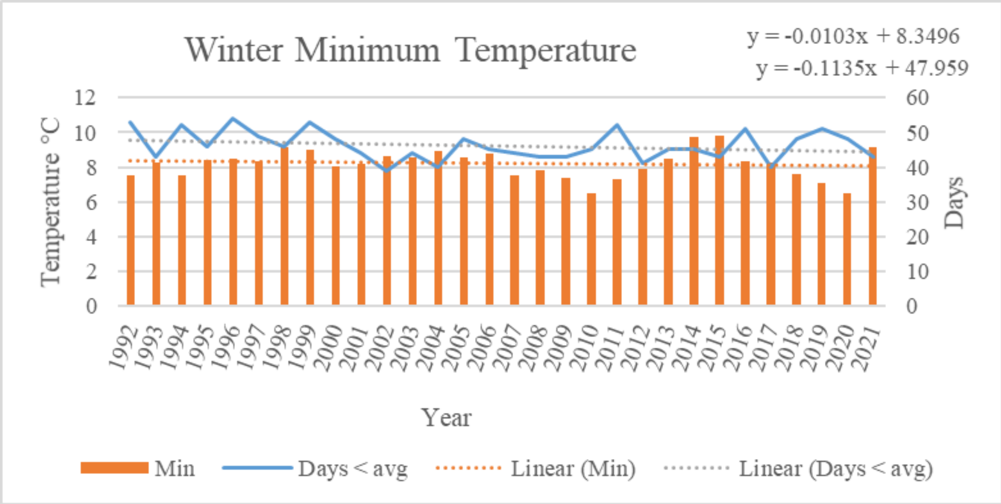



Figure 5: Winter Minimum Temperature Trend

Pre-Monsoon Minimum Temperature Trend

The analysis showed that the trend of pre- monsoon minimum temperature was increasing by 0.014 °C / year. Also the days below the average minimum temperature in pre-monsoon was increased by 0.004 days/ year. The average pre-monsoon temperature is 18.017 °C.

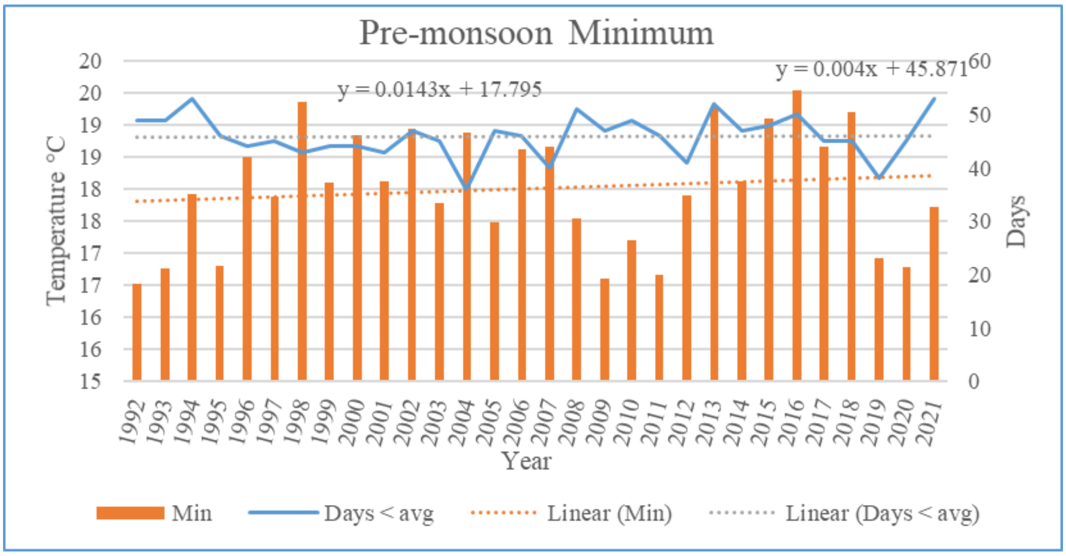



Figure 6: Pre-Monsoon Minimum Temperature Trend

b. Monsoon Minimum Temperature Trend

The trend of monsoon minimum temperature was found to decrease by -0.028 °C per year. The days below an average minimum temperature in monsoon were increased by 0.013 days per year and the average minimum monsoon temperature was found 25.07 °C. The minimum monsoon temperature recorded was 13.5 °C observed in the years 1992 and 2019.

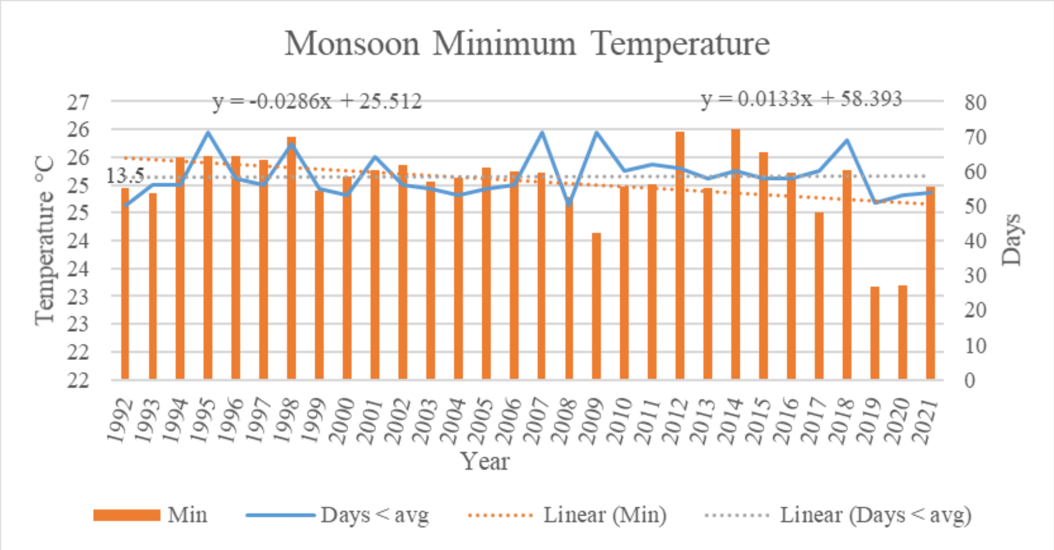



Figure 7: Monsoon Minimum Temperature Trend

c. Post-Monsoon Minimum Temperature Trend

The trend of post-monsoon minimum temperature was found to decrease by -0.0621 °C/year and the days below the average minimum temperature in post-monsoon was increasing by 0.0198 days/year. The average minimum post-monsoon temperature was found 15.72 °C. The minimum monsoon temperature recorded was 0 °C in the year 2021 for three consecutive days.

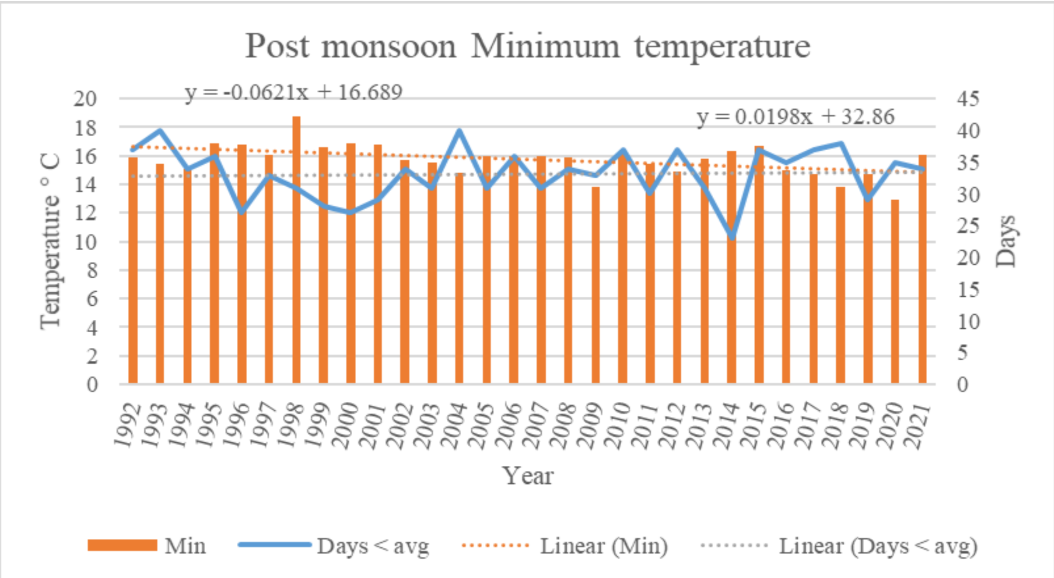



Figure 8: Post-Monsoon Minimum Temperature and Days Trend

*ii. Maximum Temperature:*

a. Winter Maximum Temperature Trend

The analysis showed that the maximum temperature in the winter season was increasing by 0.0171 °C/ year but the days above the average maximum temperature in this season were decreasing by -0.0685 days/year. The average maximum winter temperature was found at 22.605 °C, whereas the maximum monsoon temperature recorded was 34 °C in 2006.

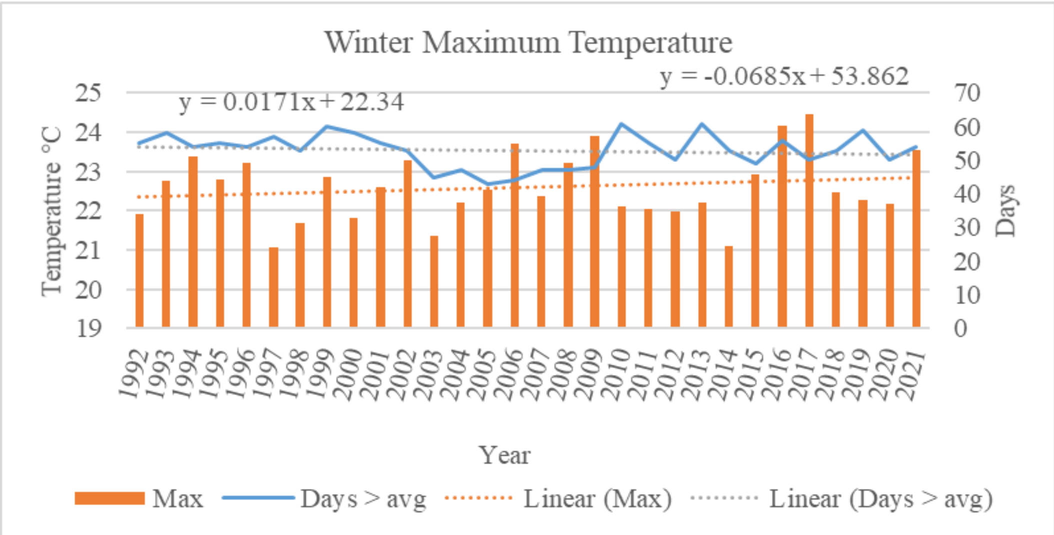



Figure 9: Winter Maximum Temperature Trend

b. Pre-monsoon Maximum Temperature Trend

The trend of both maximum temperature and days above the average maximum of pre-monsoon season was found to increase by 0.0335°C/ year and 0.053 days/ year respectively. The average maximum pre-monsoon temperature was found as 35.10 °C, whereas the maximum monsoon temperature was 44.4 °C in year 1994.

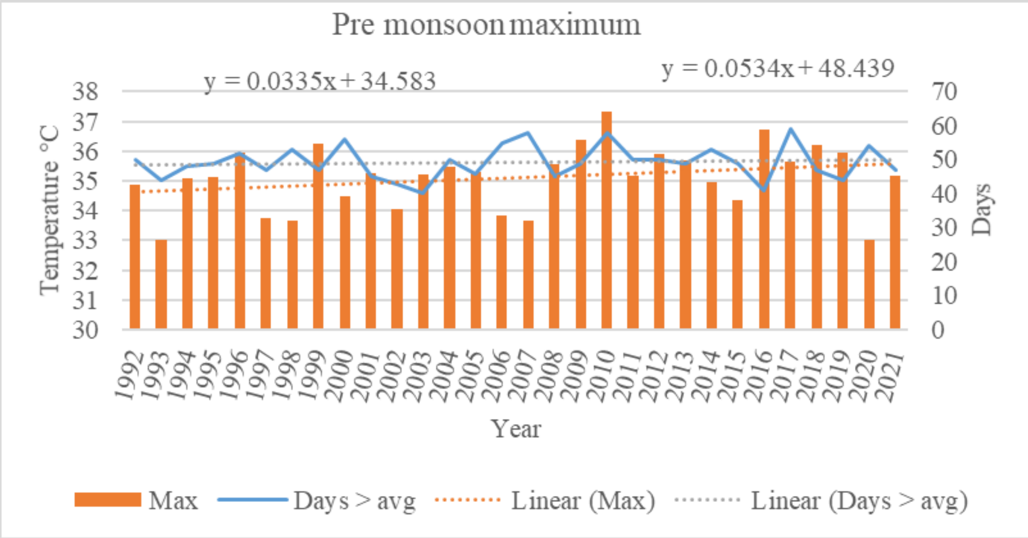


Figure 10: Pre-monsoon Maximum Temperature Trend

c. Monsoon Maximum Temperature Trend

The analysis showed that the monsoon maximum temperature was found to increase at the rate of 0.0467 °C / year. Also, the days above the average maximum temperature in the monsoon season were increased by 0.350 days per year. Similarly, the maximum average temperature in the monsoon season was 33.94 °C. The maximum temperature for this season was recorded in the years 1992 and 2012 with a temperature of 45°C.

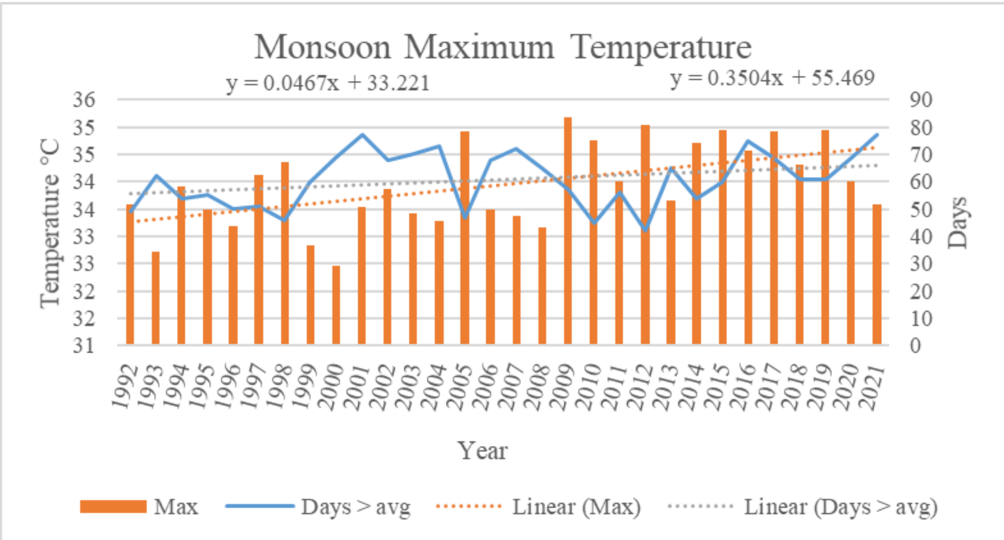


Figure 11: Monsoon Maximum Temperature Trend

d. Post-Monsoon Maximum Temperature Trend

The trend of the post-monsoon maximum temperature was found to increase by 0.045°C, whereas the days above the average maximum temperature in post-monsoon were found to decrease by -0.138 days per year. The maximum average temperature post-monsoon season was found 29.8°C. The maximum temperature for this season was recorded in the year 2019 i.e. 38°C.

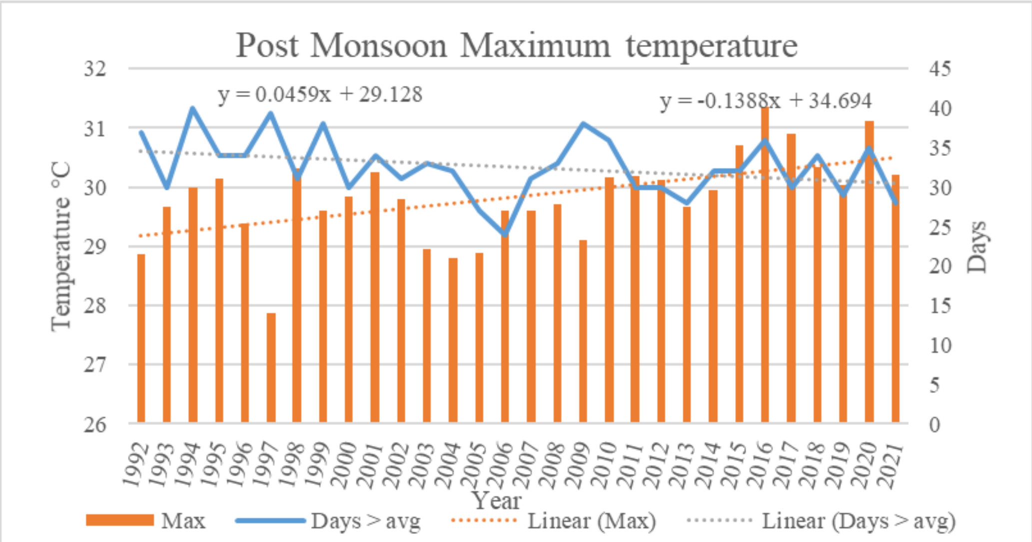



Figure 12: Post-Monsoon Maximum Temperature Trend

Temperature Trend above 40 °C

The trend shows that both the temperature and days above 40°C are gradually decreasing at the rate of -0.039°C and -0.004days per year. In 2010 and 2012 there were 40 days of temperatures exceeding 40 °C. In the year 2012, the maximum temperature had reached 45 °C. The minimum temperature for the first time dropped to 0.3 °C in the year 2012, 0°C in 2013. In the year 2021, post-monsoon minimum temperature was recorded **0** °C for three consecutive days.

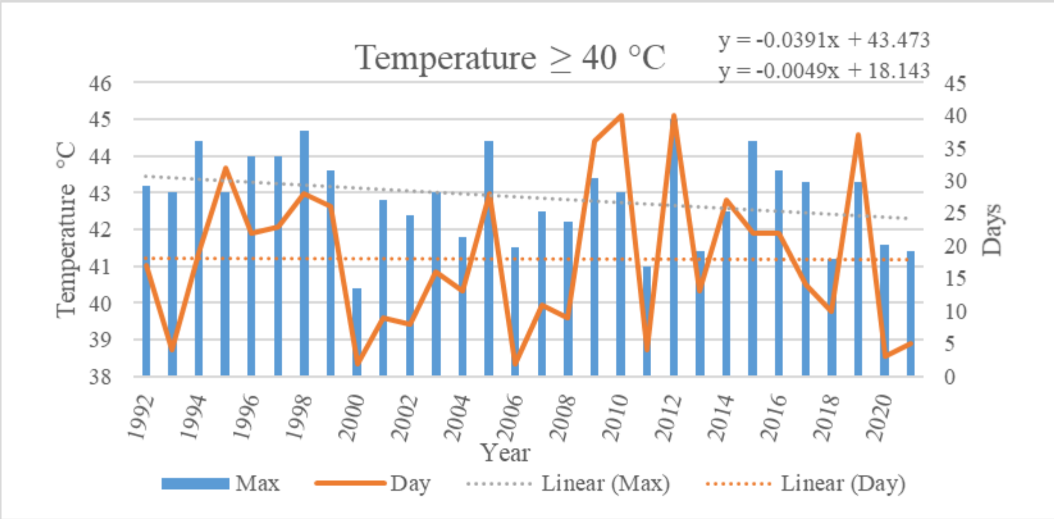



Figure 13: Temperature trend above 40 °C

## 4.1.2 Variation in Rainfall

### Total Annual Rainfall

The total annual rainfall trend shows that the rainfall trend is increasing at the rate of 8.806 mm per year. The highest value was observed in 2007 and the lowest value was observed in 2019.

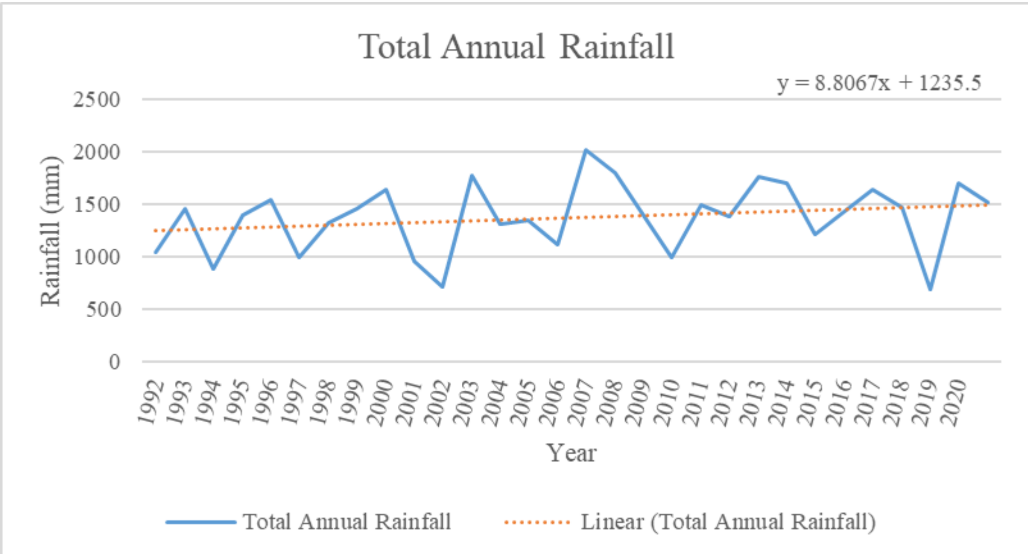



Figure 14: Total annual rainfall

The monthly Average Rainfall: trend showed that the highest precipitation was observed in August with a value of 414.17mm followed by July (393.85mm). The minimum precipitation was observed in the month of November i.e. 0.880mm.

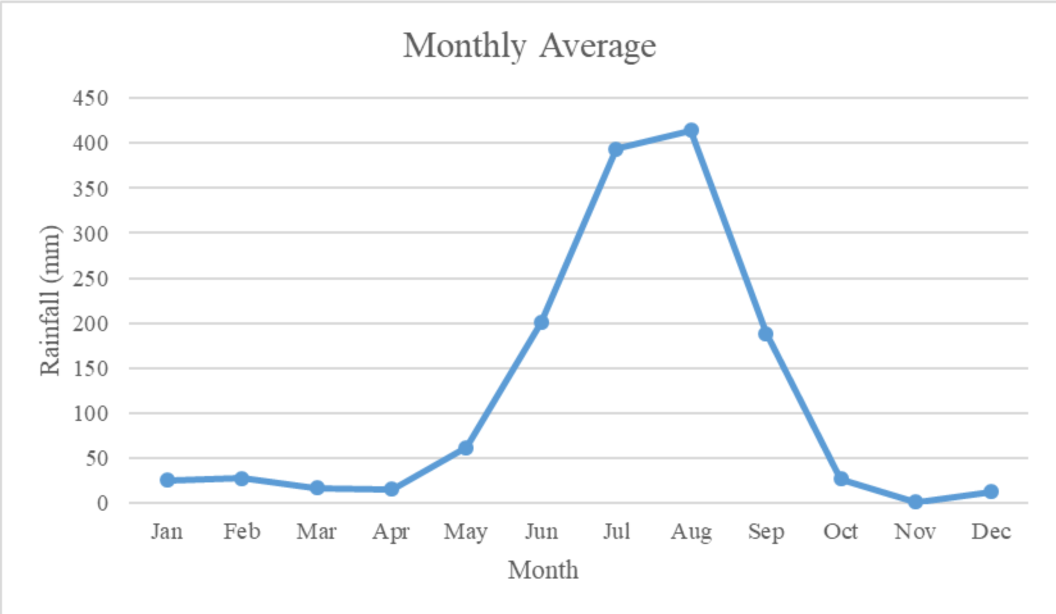



Figure 15: Monthly average rainfall

Table 3Total wet day precipitation, Days with heavy precipitation and Days with very heavy precipitation.

| Details | Winter | Year | Pre-Monsoon | Year | Monsoon | Year | Post-monsoon | Year |
|---|---|---|---|---|---|---|---|---|
| Total Rainfall (mm) | 1943.55 | | 2811.9 | | 34903.05 | | 823.8 | |
| Total wet day Precipitation (PCP ≥ 1 mm) | 228 | 1997 | 215.5 | 2011 | 1839.1 | 2007 | 220.1 | 1998 |
| Days with heavy Precipitation (PRCP ≥ 10 mm) | 52.5 | 1996 | 104.2 | 2011 | 228.8 | 2008 | 39.4 | 1997 |
| Days with very heavy precipitation (PRCP ≥ 20 mm) | 198.3 | 1997 | 143 | 2021 | 1688.8 | 2007 | 214.5 | 1998 |

i. Variation in Winter Rainfall

Total wet-day precipitation (total precipitation in wet days PCP ≥ 1 mm) in winter was 228mm. The days with heavy Precipitation (PRCP ≥ 10mm) were found to be decreasing, and the days with very heavy precipitation were found to be increasing (PRCP ≥ 20 mm).

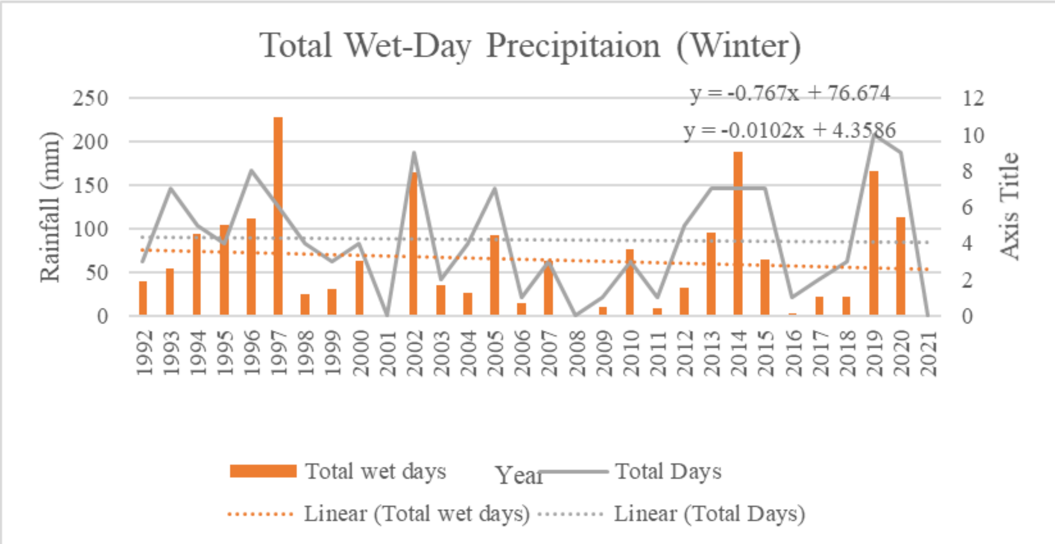



Figure 16: Variation in winter rainfall

ii. Variation in Pre-Monsoon Rainfall

The total wet-day precipitation and total rainfall days of pre-monsoon season i.e. PCP ≥ 1mm, were found to be increasing at the rate of 2.162mm per year and 0.073 days per year. The PRCP ≥ 10 and PRCP ≥ 20 were also found to be increasing at the rate of 0.331mm and 1.367 mm each year respectively. Also, the rainfall days were found to be increasing at the rate of 0.008 and 0.045 days each year. The highest rainfall 143mm was recorded in the year 2021.

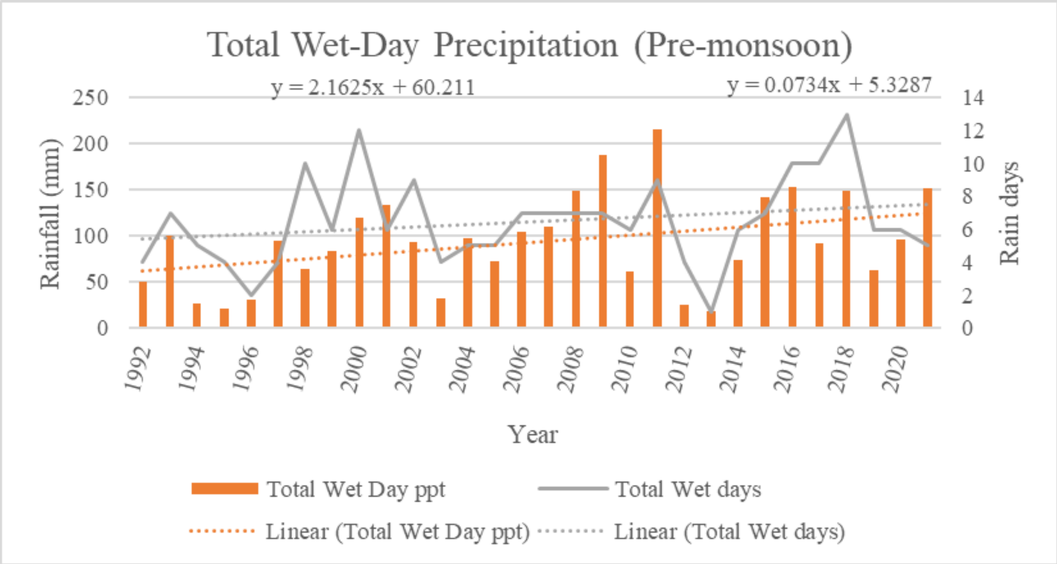



Figure 17: Variation in pre-monsoon rainfall

iii. Variation in Monsoon Rainfall:

The analysis of the pre-monsoon season shows that the total wet day precipitation (PRCP ≥ 1) is increasing at the rate of 8.878mm per year. Also, the PRCP ≥ 10 and PRCP ≥ 20 were found to be amplified at the rate of 0.352mm and 7.026 mm each year respectively. Total rain days for PRCP ≥ 1, PRCP ≥ 10, and PRCP ≥ 20 were also observed to be increasing at the rate of 0.298, 0.020, and 0.103 days respectively each year. In the year 2007, the highest rainfall of 1839.1mm was observed.

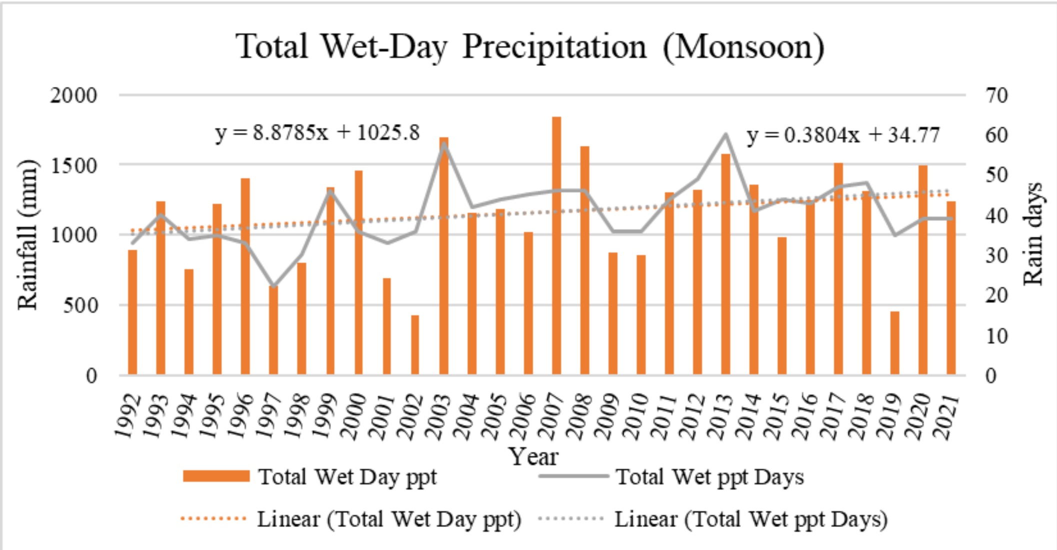



Figure 18: Variation in monsoon rainfall.

iv. Variation in Post-Monsoon Rainfall

The figure shows that the total wet-day precipitation of the post-monsoon season trend of Rajapur is slightly decreasing at the rate of -0.214 mm per year. Whereas, the rainy days were increasing at the rate of 0.024 days per year. However, the PRCP ≥ 10mm and days both were found to increase by 0.088mm and 0.002days respectively. The PRCP ≥ 20, both the total amount of rainfall and days were found to be decreasing by -0.356mm and -0.003 days each year. The highest post-monsoon rainfall received was 220 mm in the year 1998.

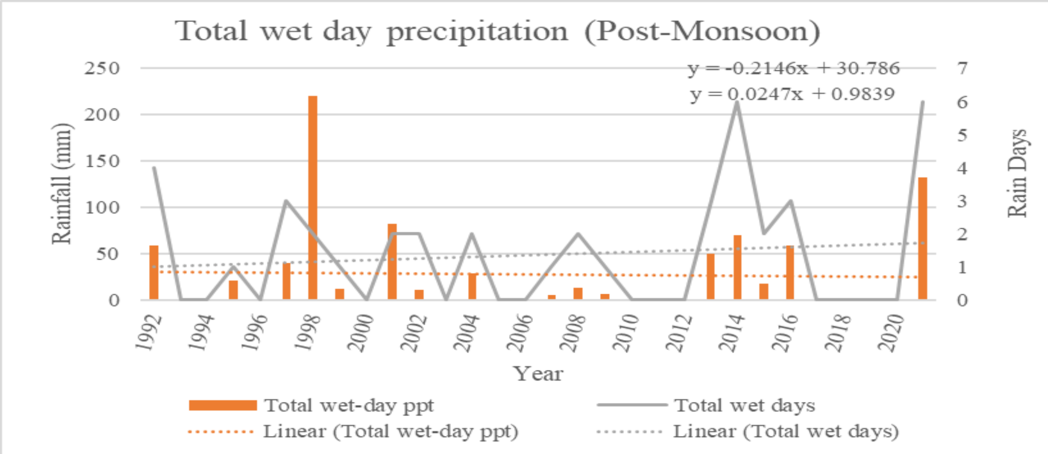



Figure 19: Variation in post-monsoon rainfall

### 4.1.3 Variation in Discharge of Karnali River

The annual discharge trend showed that the discharge of Karnali River is decreasing by -2.665($m^3$/s) per year.

Table 4: Seasonal Discharge (High, Low and, average)

| Details | Winter | Year | Pre-Monsoon | Year | Monsoon | Year | Post-Monsoon | Year |
|---|---|---|---|---|---|---|---|---|
| High Discharge ($m^3$/s) | 438 | 2020 | 750 | 1998 | 4085 | 2000 | 2008 | 2021 |
| Low Discharge ($m^3$/s) | 285 | 2012 | 337 | 2016 | 2203 | 2015 | 679 | 2015 |
| Average Discharge ($m^3$/s) | 372 | | 487 | | 2931 | | 997 | |

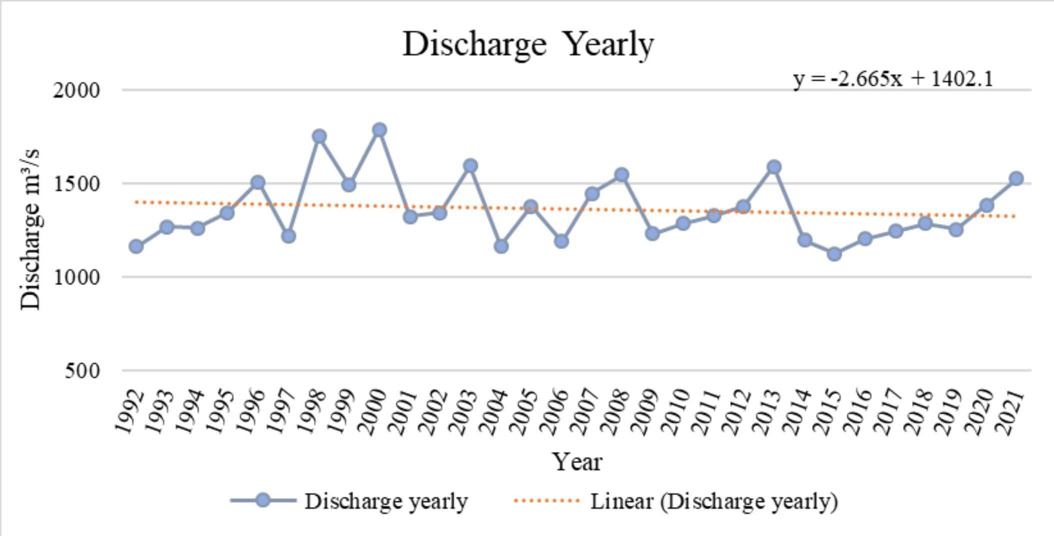



Figure 20: Annual Discharge

i. Variation in Monthly Discharge

The graph shows that the discharge in Karnali River starts increasing from the pre-monsoon season i.e. may and reach the peak in the month of August then the discharge slowly decreases.

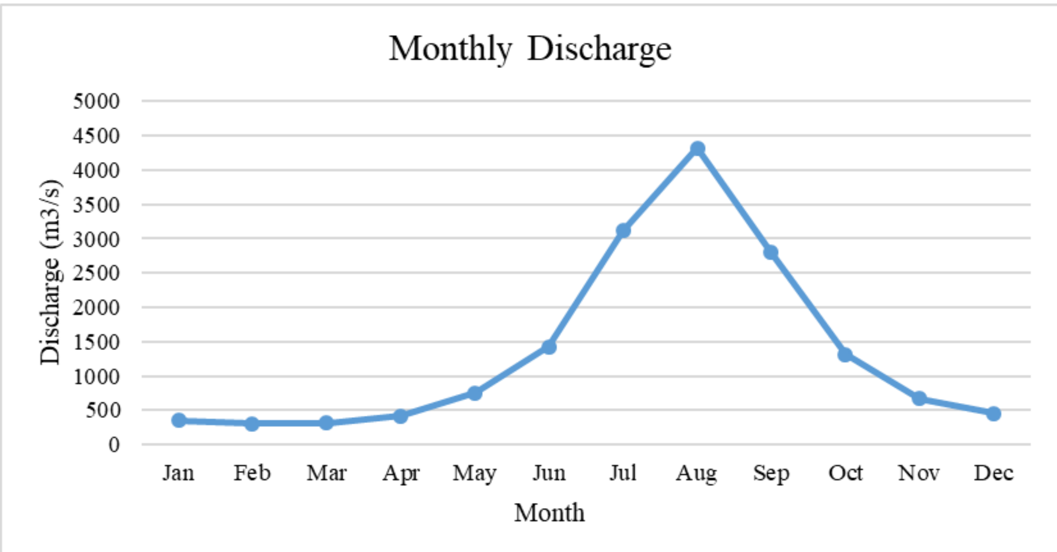



Figure 21: Variation in Monthly discharge

ii. Variation in Winter Discharge

The discharge of Karnali River shows a negative trend analyzed from the year 1992 to 2021. Average winter discharge was shown to decrease at the rate of 0.079 $m^3/s$. The highest winter discharge is in the year 2020 with a discharge value of 438 $m^3/s$ and the lowest discharge was recorded in the year 2012 with a value of 285 $m^3/s$.

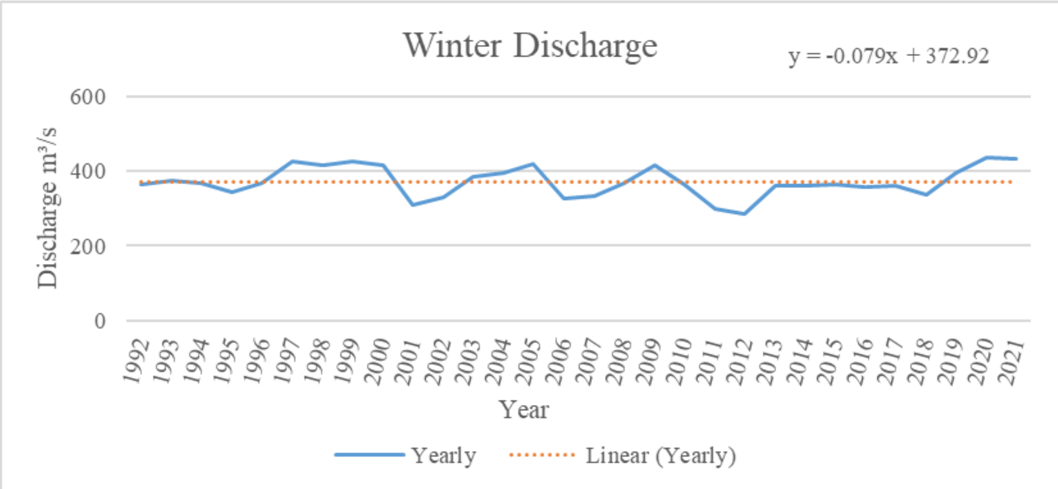



Figure 22: Variation in Winter Discharge

iii. Variation in Pre-Monsoon Discharge

Average pre-monsoon discharge is decreasing at the rate of -2.1789 $m^3/s$ per year. The highest pre- monsoon discharge was recorded in 1998 with a value of 750 $m^3/s$, whereas the lowest discharge was recorded in 2016 with a value of 337 $m^3/s$.

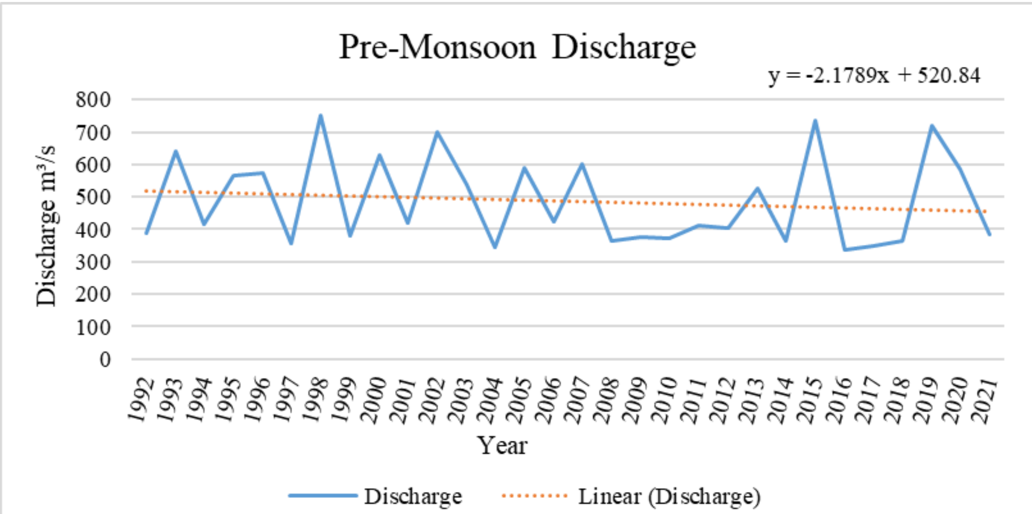



Figure 23: Variation in pre-monsoon discharge

iv. Variation in Monsoon Discharge

Average monsoon discharge is found to be decreasing at the rate of -8.27 $m^3/s$ every year. The highest monsoon discharge was recorded in 1998 i.e. 4085 $m^3/s$, whereas the lowest discharge was recorded in June 2015 i.e. 2203 $m^3/s$.

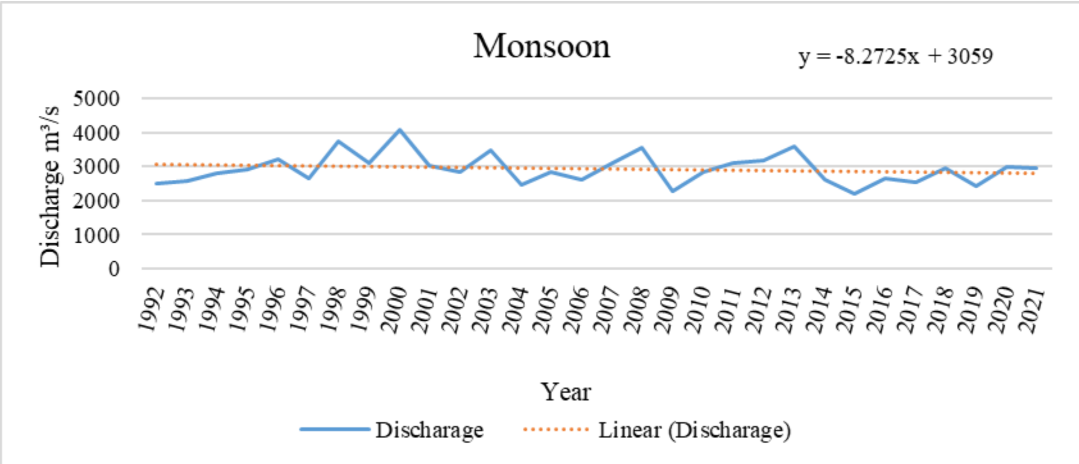


Figure 24: Variation in monsoon discharge

v. Variation in Post Monsoon Discharge

Average post-monsoon discharge is found to be increasing at the rate of 1.370 $m^3/s$ every year. The highest post-monsoon discharge was found in October 2021, whereas the lowest discharge was recorded in November 2011, with a value of 437 $m^3/s$. Average

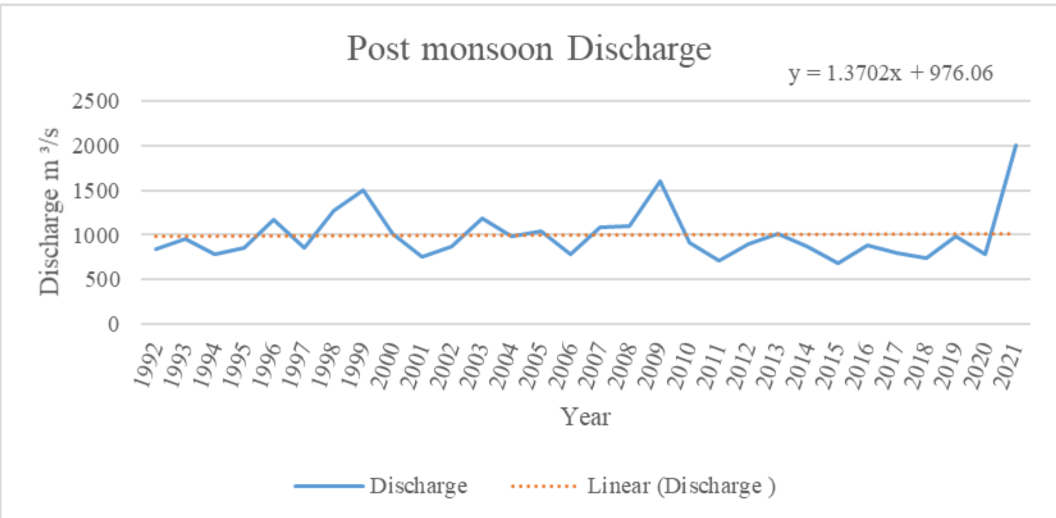
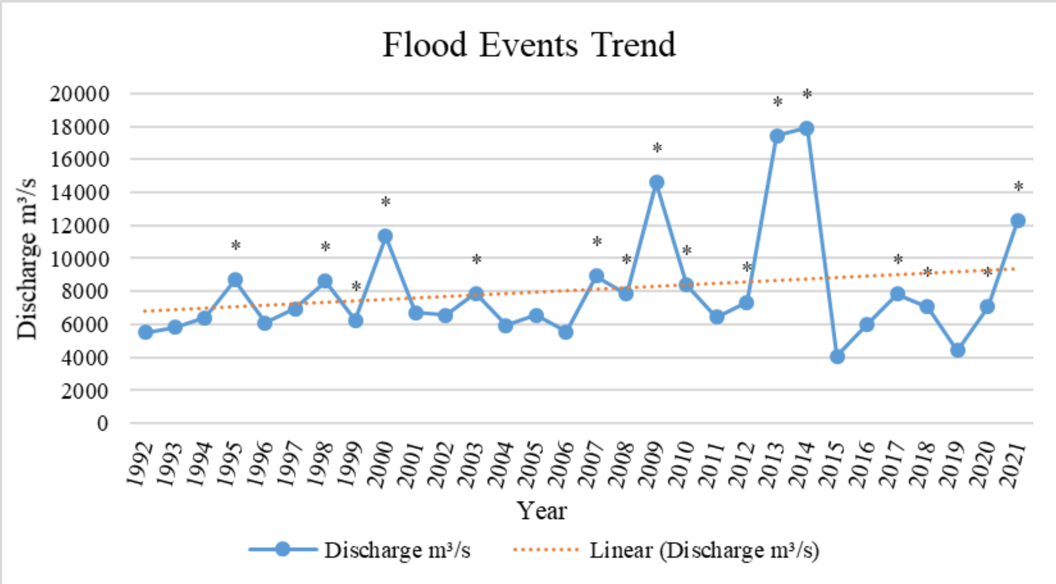


Figure 25: Variation in post-monsoon discharge

## 4.2 **Flood Event Trend**

The figure shows the trend of flood events in Rajapur, Bardiya. In the period from 1992 to 2021, sixteen major flood events were observed and the trend is increasing. However, minor flooding and inundation occur almost every year. The deadliest flood occurred in 2014 with a discharge rate of 17,900 $m^3/s$. Post-monsoon season floods occurred in 2009 and 2021, causing loss and damage in a variety of sectors, particularly paddy production.

Figure 26: Trend of flood events




(*denotes the flood events in respective years)

### 4.3 **Analysis of Loss and Damage in Agriculture**

The extent of loss and damage caused by an unseasonal flood that occurred from October 17 to October 21, 2021, is shown in the graphs and tables below. At first, the farmer types were categorized as large, medium, and small farmers, and then the loss and damage was calculated in terms of land, production, stored grains, livestock, farm machinery, and food sufficiency from the data obtained from the household survey. In addition, income loss, input loss, and support (compensation) from different organizations were also calculated.

#### 4.3.1 Loss and Damage in Agricultural Land

Out of 144.806 ha of land, a total of 20.445 ha of land was damaged which later was restored to agricultural land, whereas around 1.448 ha of land was lost to the flooding. Large farmers have total land of 64.763 ha, out of which 11.523 ha of land was damaged due to flood in 2021, which is 17.79% of their total land. The repair and restoration cost for the damaged land to turn back to normal arable land costs $1726. The L&D per farmer was found to be 0.354 ha.

Similarly, medium farmers had total land of 60.972 ha of land. The loss and damage due to the flood was found to be 7.131 ha worth around $26875.5, which is 7.13% of their total land. In the same way, small farmers had total land of 19.071 ha of land, and the L&D was estimated to be around 3.240 ha, the loss is $9860.5. Small farmers have lost 16.98 % of their total land to the flood.

Table 5: Loss and damage on agricultural land

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| Total land (ha) | 64.763 | 60.9717 | 19.0714 | 144.806 |
| L&D (ha) | 11.523 | 7.131 | 3.240 | 17.452 |
| L&D (%) | 17.793 | 11.695 | 16.988 | 12.052 |
| No. of farmers | 20 | 54 | 86 | 160 |
| Damage per farmers (ha) | 0.576 | 0.132 | 0.038 | |
| Total Loss and Damage ($) | 1726 | 26875.5 | 9860.5 | |
| L&D per farmers ($) | 86.3 | 497.694 | 114.657 | |

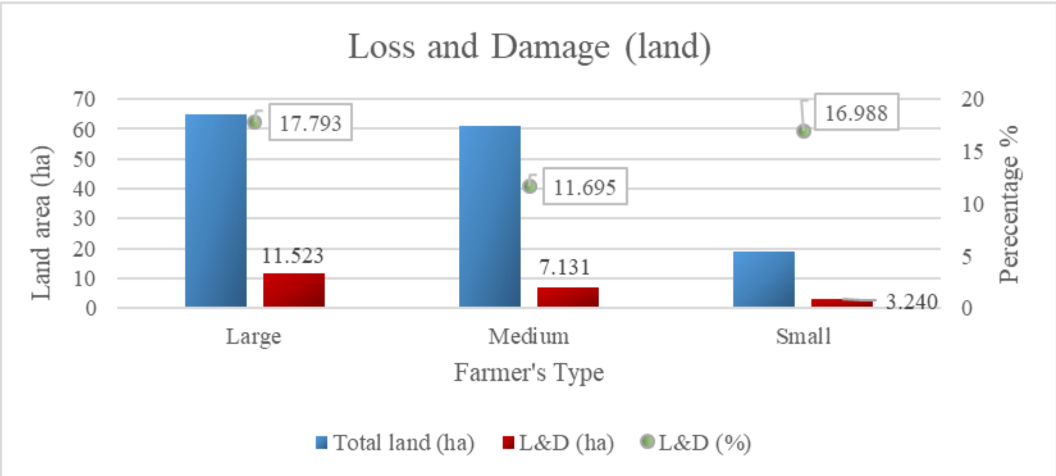



Figure 27: Loss and damage in agricultural land (ha)

### 4.3.2 Loss and Damage of Paddy Production

Large farmers lost production of 86 mt of paddy worth $19407.104. Medium farmers lost production of 79.2 mt of paddy worth $17872.589 and the small farmers lost production of $31.7 mt of paddy worth $7153.549. Large farmers lost 34.67% of paddy production in compare to previous years, medium farmers lost 41.27% and small farmers lost 53.39% of paddy production. Per farmer loss and damage for large farmers was 4.3 mt, 1.46 mt for medium farmers and 0.44 mt for small farmers. Similarly, an average economic loss bear by single large farmer was $970.35, medium farmer was $330.97 and, small farmer was found to be $100.10.

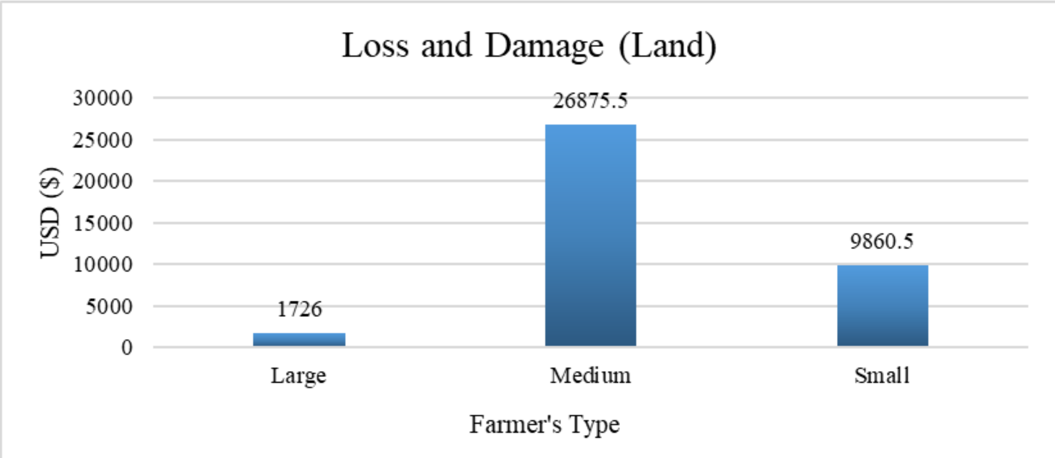



Figure 28: Loss and damage in agricultural land (in USD)

Table 6: Loss and damage in paddy production

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| Previous Year (mt) | 248 | 191.9 | 71.45 | 511.35 |
| This Year (mt) | 162 | 112.7 | 33.3 | 308 |
| Loss and Damage (mt) | 86 | 79.2 | 38.15 | 203.35 |
| L&D % | 34.677 | 41.271 | 53.394 | 39.767 |
| No. of farmers | 20 | 54 | 86 | 160 |
| Production damage per farmers (mt) | 4.3 | 1.467 | 0.444 | 6.210 |
| L&D ($) | 19407.104 | 17872.589 | 8609.082 | 45888.774 |
| L&D per farmer ($) | 970.355 | 330.973 | 100.105 | 286.804 |

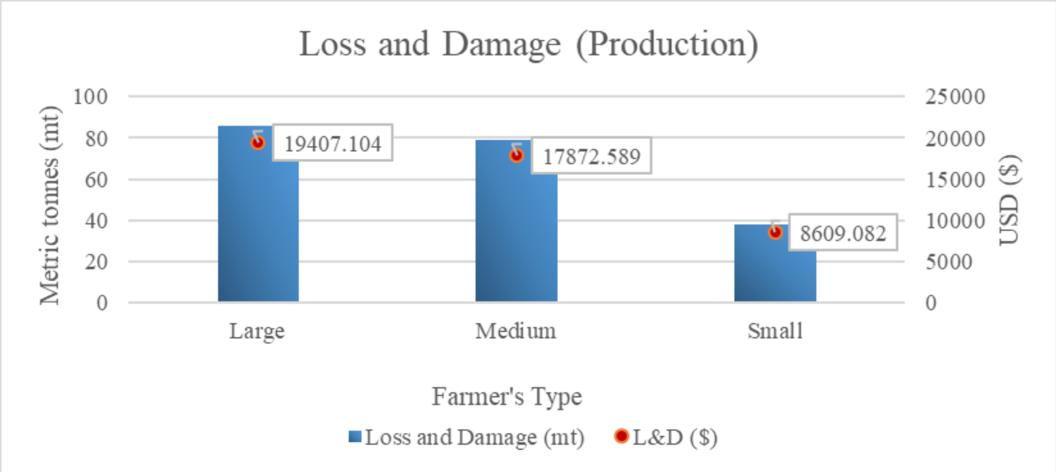



Figure 29: Loss and damage of paddy production

### 4.3.3 Loss and Damage of Stored Grains

The flood destroyed 32.565 mt of grain storage, including rice, wheat, maize, mustard, red lentils, etc., worth $9924.926. Large, small, and medium farmers were projected to have lost $3437.588, $3738.751, and $2748.588 as a result of flooding in grain storage. Where, the anticipated L&D per farmer was $171.879, $69.236, and $31.959, respectively.

Table 7: Loss and damage of stored grains

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| No. of farmers | 20 | 54 | 86 | 160 |
| L&D (mt) | 10.13 | 14.065 | 8.37 | 32.565 |
| L&D per farmers (mt) | 0.507 | 0.260 | 0.097 | |
| L&D ($) | 3437.588 | 3738.751 | 2748.588 | 9924.926 |
| L&D per farmer $ | 171.879 | 69.236 | 31.960 | |

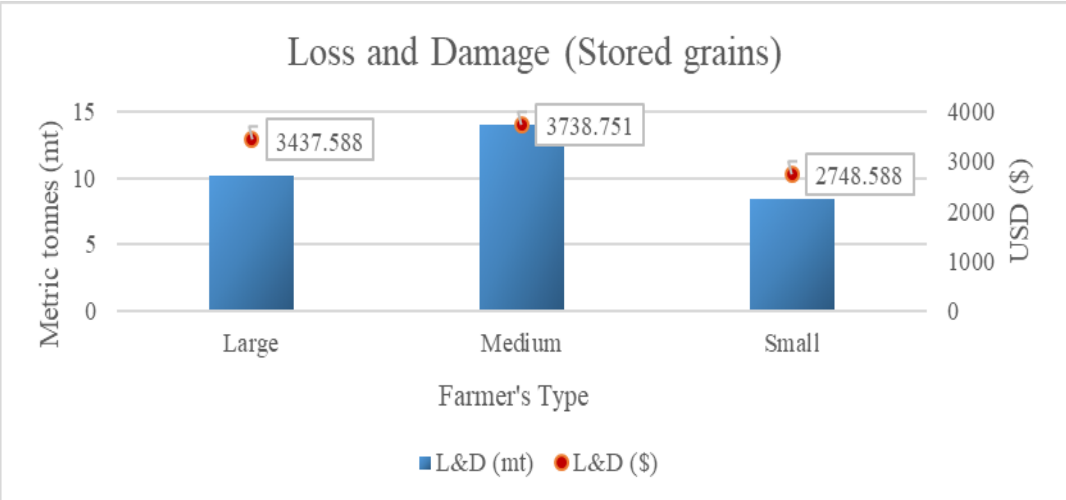



Figure 30: Loss and damage of stored grains

4.3.4 Loss of Livestock:

The estimate for the total livestock loss and damage was $9569. Due to the flood, large, medium, and small farmers suffered livestock losses of $7525, $1607, and $409.6 respectively. L&D was estimated to be $377.61, $29.763, and $4.763 per farmer.

Table 8: Loss of livestock

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| L&D ($) | 7552.2 | 1607.2 | 409.6 | 9569 |
| No. of farmers | 20 | 54 | 86 | 160 |
| L&D per farmers ($) | 377.61 | 29.763 | 4.763 | |

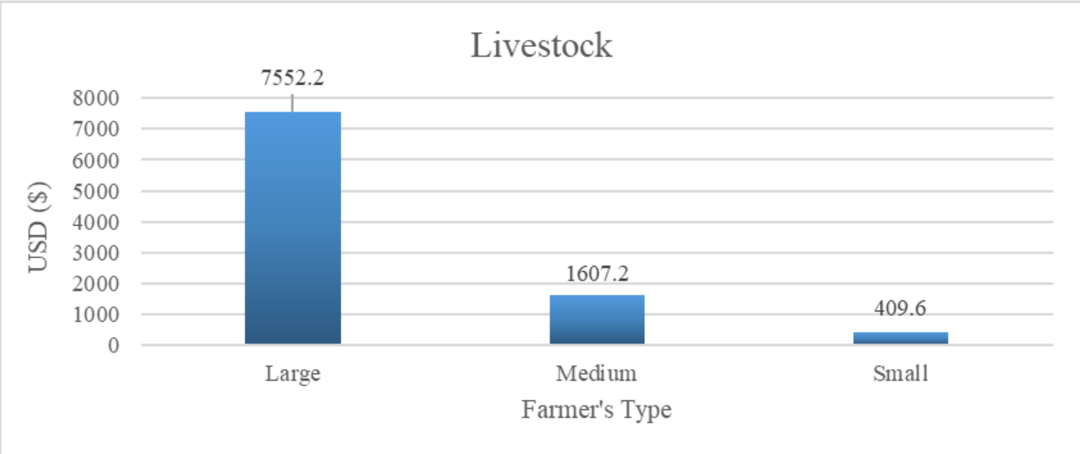



Figure 31: Loss of livestock

4.3.5 Damage to the Farm Machinery

An estimated cost to restore the farm machinery is $483.8. The farm equipment's restoration is anticipated to cost $483.8. Farm machinery includes motors, power tillers, and other devices. Large farmers paid around $270.6, medium farmers $131.2, and small farmers $82 in total for repairs. Per farmer's damage of large, medium and small farmers was estimated to be $13.53, $2.430 and $0.953 respectively.

Table 9: Farm machinery damage

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| Farm machinery damage | 270.6 | 131.2 | 82 | 483.8 |
| L&D per farmers | 13.53 | 2.430 | 0.953 | 16.913 |

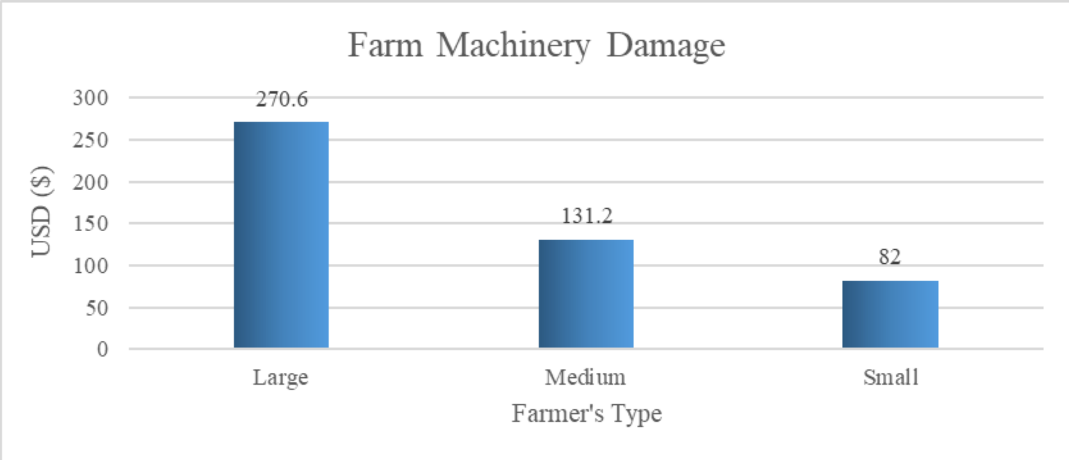


Figure 32: Damage to the farm machinery

### 4.3.6 Loss of Food Sufficiency

Table 10: Loss of Food Sufficiency

| Farmer's Type | Large | Medium | Small |
|---|---|---|---|
| PY average (Month) | 12 | 11.444 | 6.721 |
| TY average (Month) | 8.2 | 6.556 | 3.279 |
| Loss (Month) | 3.8 | 4.849 | 3.442 |

Flood has a significant impact on farmers' food security. On average, large farmers lost food for about 3.8 months, medium farmers lost 4.925 months and small farmers lost 3.110 months.

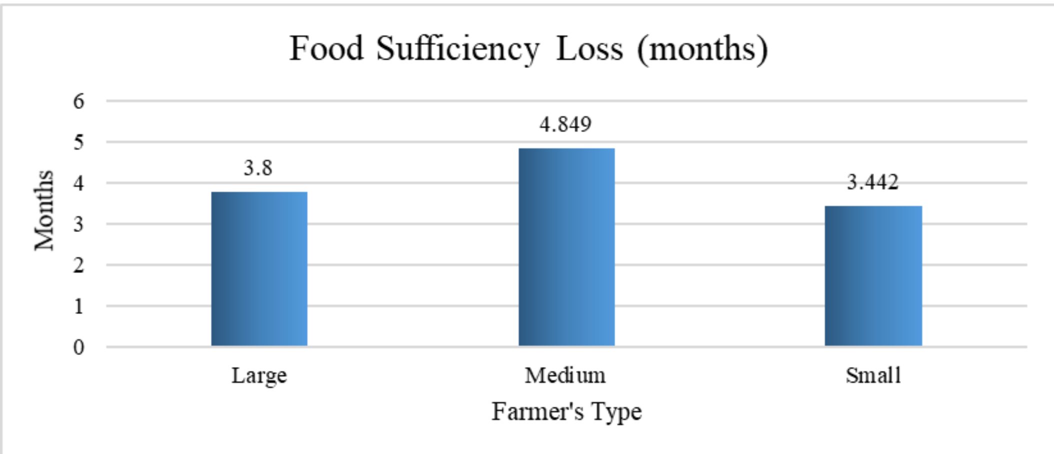


Figure 33: Loss of food sufficiency

### 4.3.7 Additional Input to Farming

Inputs are indirect losses due to flood as they are investments that farmers invest during the cultivation. Sowed seeds, fertilizers and labor wages are considered as input. A total of 9.036 mt of paddy seeds were used for sowing worth $4841.69, and 18.669 mt of fertilizers have been used worth $6591.455. For labor wages, farmers had invested around $19204.4.

Table 11: Input to paddy production (mt)

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| Sowed seed (mt) | 3.87 | 3.413 | 1.753 | 9.036 |
| Fertilizers (mt) | 8.4 | 6.84 | 3.429 | 18.669 |
| Total Input (mt) | 12.27 | 10.253 | 5.182 | 27.705 |
| No. of farmers | 20 | 54 | 86 | 160 |
| L&D per farmers (mt) | 0.614 | 0.190 | 0.060 | |

Table 12: Input to paddy production (in USD)

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| sowed seed | 2062.71 | 1819.129 | 959.851 | 4841.69 |
| Fertilizers (mt) | 2886.4 | 2467.872 | 1237.183 | 6591.455 |
| Wages | 10332 | 5428.4 | 3444 | 19204.4 |
| Total Input cost | 15281.11 | 9715.401 | 5641.034 | 30637.545 |
| No. of farmers | 20 | 54 | 86 | 160 |
| L&D per farmers | 764.056 | 179.915 | 65.593 | |

### 4.3.8 Income

Flood had impacted people’s livelihood and income. Large farmers lost 40.22% of their income in compare to previous years which was around $16195.164, medium farmers lost $11735.512, and small farmers lost $1687.462 of their income due to the production loss of paddy. The L&D per farmer was estimated at $809.758, $217.324, and $19.622 for large, medium, and small farmers. An estimated loss of large farmers in their income was around 53.960%, medium farmers lost the income around 88.74%, and small farmers lost the income around 91.752%.

Table 13: Sell details

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| Preivous year sell (mt) | 133 | 58.6 | 8.15 | 199.75 |
| This year expected sell (mt) | 133 | 58.6 | 8.15 | 199.75 |
| This year total sell (mt) | 79.5 | 10.7 | 0.8 | 91 |
| Loss and Damage (mt) | 53.5 | 47.9 | 7.35 | 108.75 |
| No. of farmers | 20 | 54 | 86 | 160 |
| L&D per farmers (mt) | 2.675 | 0.887 | 0.085 | |
| L&D (mt) % | 40.226 | 81.741 | 90.184 | |

Table 14: Income details

| Farmer's Type | Large | Medium | Small | Total |
|---|---|---|---|---|
| Previous year income $ | 29823.92 | 13140.464 | 1827.556 | 44791.94 |
| This year expected inocme $ | 30013.312 | 13223.910 | 1839.1616 | 45076.384 |
| This year total income $ | 13818.148 | 1488.398 | 151.7 | 15458.246 |
| Loss and Damage ($) | 16195.164 | 11735.512 | 1687.462 | 29618.138 |
| No. of farmers | 20 | 54 | 86 | 160 |
| L&D per farmer | 809.758 | 217.324 | 19.622 | |
| L&D ($) % | 53.960 | 88.745 | 91.752 | |

### 4.4 Support Materials received as relief materials

Immediately after the flood, the Rajapur municipality and the Nepal Red Cross Society, along with other organizations, distributed some relief materials worth $9209.68. Large farmers received support worth $832.79, medium farmers received support worth $3209.73, and small farmers received worth $5167.16. The compensation and support included rice, water, pulses, salt, oil, medicines, a bucket, soap, medicine, a tent, etc. However, the support was not provided as compensation for the loss and damage. Due to the delay in the compensation process farmers were unable to manage agricultural goods like seeds, fertilizers etc. till the day of the field visit. Farmers would experience relief from the loss and damage if the compensation process was sped up.

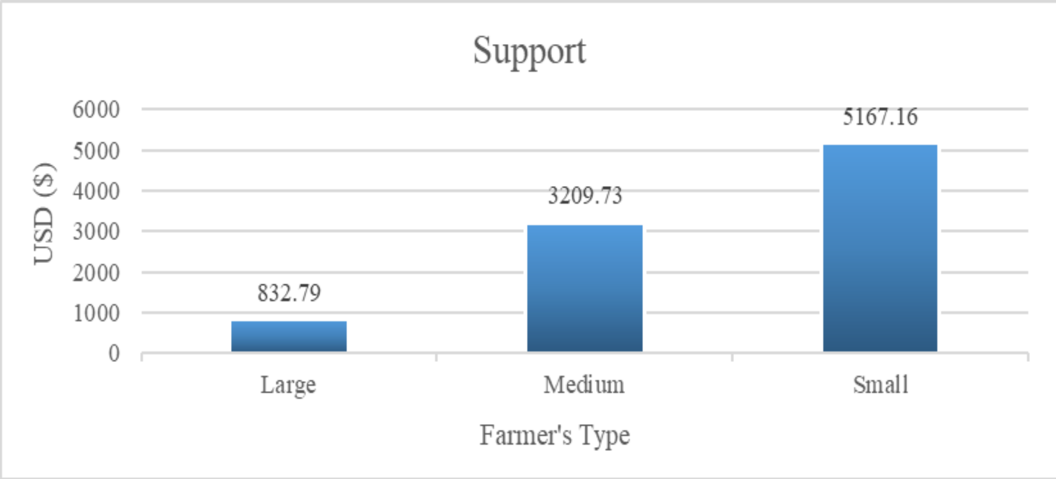


Figure 34: Support received

Descriptive Statistics

Table 15: Descriptive Statistics

| Indicators | Large | | | | Medium | | | | Small | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean± SE | SD | Min | Max | Mean± SE | SD | Min | Max | Mean± SE | SD | Min | Max |
| land (ha) | 0.576 ± 0.147 | 0.658 | 0 | 2.004 | 0.132± 0.029 | 0.215 | 0 | 1.00 2 | 0.037±0. 009 | 0.08 6 | 0 | 3.23 9 |
| USD | 86.309± 22.479 | 100.5 29 | 0 | 328 | 497.69± 170.042 | 1249. 551 | 0 | 578 1 | 114.657 ± 76.894 | 713. 09 | 0 | 5756 .4 |
| Production (mt) | 4.3 ± 0.658 | 2.944 | 1.5 | 12 | 1.466± 0.147 | 1.085 | 0 | 5 | 0.443± 0.041 | 0.38 5 | 0 | 1.5 |
| USD | 970.35± 148.56 | 664.4 04 | 338. 496 | 2707. 968 | 330.974 ± 33.321 | 244.8 59 | 0 | 112 8.32 | 100.106 ± 9.370 | 86.8 97 | 0 | 338. 496 |
| Food (month) | 3.8± 1.047 | 4.686 | 0 | 12 | 4.849± 0.539 | 3.929 | 0 | 12 | 3.686± 0.261 | 2.42 2 | 0 | 10 |
| Stored (mt) | 0.506± 89.191 | 1.102 | 0 | 4.3 | 0.260± 0.077 | 0.57 | 0 | 3.2 | 0.097± 0.024 | 0.22 7 | 0 | 1 |
| USD | 171.879 ± 89.191 | 398.8 77 | 0 | 1637. 13 | 69.236± 21.194 | 155.7 49 | 0 | 810. 438 8 | 31.960± 7.453 | 69.1 2 | 0 | 331. 116 |
| Machinery (USD) | 8.2± 6.379 | 28.53 | 0 | 123 | 2.429± 1.307 | 9.608 | 0 | 49.2 | 0.953± 0.582 | 5.39 8 | 0 | 41 |
| Livestock( USD) | 377.61± 289.135 | 1293. 053 | 0 | 5740 | 29.762± 17.626 | 129.5 29 | 0 | 820 | 4.762± 2.270 | 21.0 58 | 0 | 160 |

*(SE: Standard Error, SD: Standard Deviation, Min: Minimum, Max: Maximum)*

The descriptive statistics shows that, for the agricultural land it's the medium farmers who have lost more of their land to flooding. The mean±SE value of medium farmers was found to be 0.132± 0.029 and the large farmers found to be 0.576 ± 0.147. Though the large farmers have got more values but the economic loss was high of those medium farmers because the large farmers didn't lose their land to the flooding but was only damaged. Similarly, it's the large farmers who have lost most of their paddy production and small farmers lost least as small farmers hold less land in compare to others. The mean±SE value of large farmers was 4.3 ± 0.658 and small farmers was 0.443± 0.041. For the food sufficiency, the mean±SE value of medium farmers was found to be 4.849± 0.539 and the small farmers was found to be 3.686± 0.261. The highest mean±SE of large farmers for the farm machinery damage and livestock loss was 8.2± 6.379 and 377.61± 289.135 respectively. Similarly, the lowest mean±SE of small farmers for the farm machinery damage and livestock loss was 0.953± 0.582 and 4.762± 2.270 respectively. This is because the large farmers own large land and have facilities to the farm machineries, whereas, small farmers rely on traditional cart. Also, the small farmers had to go for labor wages thus, they used to keep less number of livestock so they had less livestock loss in comparison to large farmers who kept more number of livestock.

## 4.5 Coping Mechanisms

Farmers of Rajapur area have been following some coping mechanisms to deal with the loss and damage after flood. They began adapting to the situation differently in order to ensure food security and to support their livelihood.

Buying rice to support food security is one of the coping mechanisms that the farmers followed after the flood. The reduction in the production of paddy causes financial losses to the farmers and has an impact on food availability. Thus, many farmers in the community fulfill the food insufficiency by consuming wheat as an alternative. To deal with the situation, many farmers didn't sell paddy but instead saved it for their own use. Rajapur is well-known for its paddy and wheat production. Spring season rice has the highest productivity than that of main season paddy and the PMAMP project has emphasized the farmers towards the cultivation of spring season paddy. Cultivation of spring season paddy is one of the coping mechanisms that the farmers adapted to deal with the after-flood loss and damage.

Floods have a major impact on the income of agricultural-dependent farmers. Some members of the farmers have left education and went in search of work. Some went for labor work or employment in Rajapur, Bardiya, Nepalgunj, Kathmandu, Pokhara, Dhangadhi, Kalikot, Bajura, and other places. Many male members of the family went to work in India. Some farmers were already engaged in other work which they continued doing. Another way of dealing with loss and damage after the flood to support their lives and livelihood is by taking loans from different co-operatives, relatives, mother groups, or other groups. However, these strategies may temporarily help farmers in dealing with the loss and damage. But in the climate change scenario, the occurrence and severity of catastrophic floods as well as their impacts are likely to increase. Thus, new and policy-level strategies are needed.

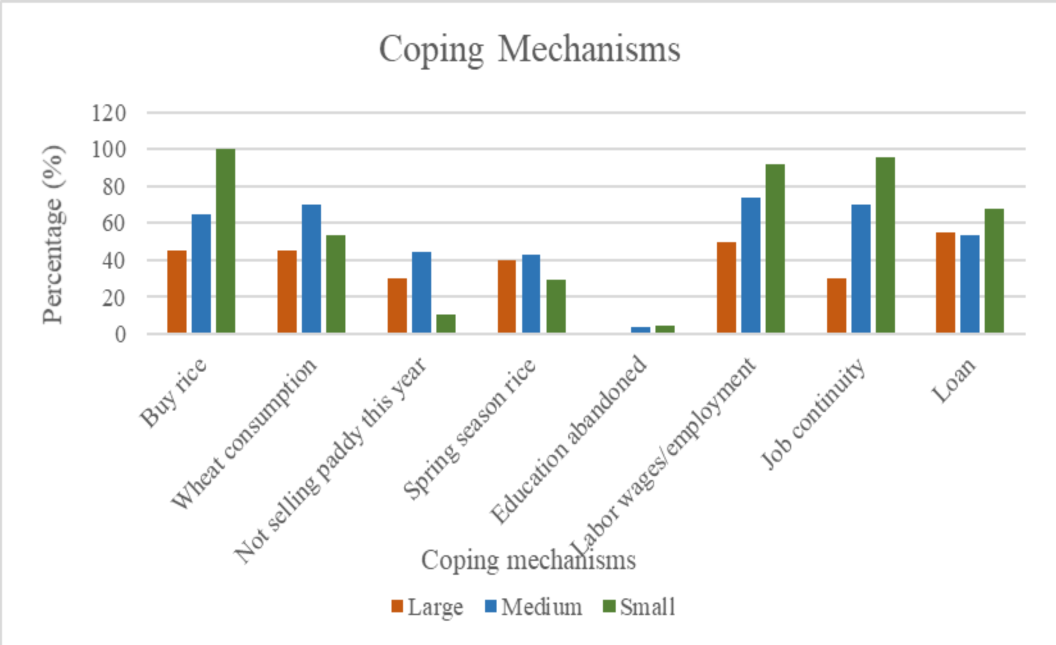



Figure 35: Coping mechanism

## 4.6 Discussion

### 4.6.7 Temperature, Rainfall and Discharge analysis

The variation in minimum temperature, maximum temperature, rainfall, and discharge was analyzed based on four different seasons with temperature ranging from 0 to 45 °C. The temperature ranges from 0 to 45 degrees Celsius. The result shows that the minimum temperature in winter and post-monsoon has reached 0 °C, which hadn't been previously recorded before the year 2012. The temperature trend shows a decline in below-average minimum temperature during the winter and post-monsoon season whereas the same trend was found to be increasing during pre-monsoon and monsoon seasons. Similarly, the maximum temperature trend illustrated about the temperature being above average for all seasons in an increasing trend. The finding shows consistency with few other studies in Nepal [76][77]. The precipitation trend of Rajapur showed that rainfall's frequency and intensity varied. The total annual rainfall trend shows that the rainfall trend is increasing. The total wet day precipitation in all seasons except in pre-monsoon season found to be increasing. Whereas the annual discharge shows the decreasing trend in Karnali Chisapani station and in most of the stations [78] [3]. This study shows that the discharge trend is decreasing in winter, pre-monsoon and monsoon season. Whereas, the discharge in post-monsoon season is increasing. The higher runoff period begins during the monsoon season and lasts until the post-monsoon period, when the temperature is comparatively higher. Similarly, after August, there is more discharge at Chisapani than precipitation in the KRB, which is likely due to the glacial discharge. Due to the increasing discharge trend in post-monsoon season, the unseasonal flooding events also have become more frequent. In the year 2021 itself, country experienced two major climatic disasters in different districts including Sindhupalchowk (Melamchi), Manang, Mustang, Gorkha etc. Due to the arrival of monsoon two weeks earlier and after the ending of monsoon season a country had to bear the loss and damage to the lives, settlements, agricultural, roads, bridges etc. [79].

Trend of Flood Events:

The trend of flood events in Rajapur Municipality over the past 30 years was analyzed using secondary literature, household surveys, and DHM data. The result showed that the flood occurred in the years 1995, 1998, 1999, 2000, 2003, 2007, 2008, 2009, 2012, 2013, 2014, 2017, 2020, and 2021. Other researchers have also found a similar flood trend of flood events. It was found that the frequency and severity of flood trend is increasing [68][46][80] [34]. Both theoretically and practically, it is significant that rainfall and flood discharge probability are correlated. From the study, most of the flooding evetns were occurred in the monsoon season, followed by post-monsoon season. Since rainfall trend was found to be increasing in monsoon season, the more flooding events were recorded in the monsoon season. However, post-monsoon precipitation trend is decreasing, but the flooding events are seen increasing. This may be due to the rise in tempreature in post-monsoon season contributed to glacial melting, which increases the discharge in rivers resulting in the floods [78]. The worst hit flood was in the year 2014 with a maximum discharge of 17900 $m^3/s$, causing the death of 12 people and a loss of physical assets worth $24.6 million (NPR 3bn) [46]. In terms of agricultural losses and damages, the flood period from 18 October 2021 to 20 October 2021, caused maximum loss and damage. A finding shows that around 1.4529 ha of land was eroded by flood worth $35741.34 and around 20.4408 was damaged which costs $2720.66 to restore to agricultural land. Due to the loss and damage of agricultural land around $38462 was cost in total. However, this is not the only time when a large swath of agricultural land was swept away. Based on the LDCRP, Rajapur Municipality in wards 1, 3, 4, and 7 has lost 462.2 ha of agricultural land to flooding till now.

### 4.6.8 Loss and damage

Rajapur is best known for paddy production and is categorized as a rice superzone by the PMAMP project. The lives and livelihood of the local people of Rajapur are highly dependent on agriculture. Paddy that was ready to be harvested was affected by the flood. From the FGD and HHS, it was found that some already harvested paddy was flooded, and some standing crops were inundated for several days which caused the germination on the field. Out of the total land, the flood had caused damaged to the 17.93% of land to the large farmers. For the restoration, per farmer damage was estimated to be $86.3. Medium and small farmers lost 11.695% and 16.988% of their agricultural land. Per farmer L&D was estimated to be $497.694 and $114.657 respectively. Even though, the large farmers damage was greater but it's the medium and small farmers who have lost their agricultural land to the flooding as their land is near to the river. In many cases, the poorest and vulnerable people live in high-risk area, and low-lying flood-prone zones, due to which they are hardest hit by any kind of disaster [81]. Flood has major impact on paddy production. Large farmers lost 34.67% of production in compare to previous years. The medium farmers lost 41.27% and small farmers lost 59.394% of total production in compare to previous years. Large farmers, per individual lost 4.3 mt of production worth $970.355. Per farmer L&D of medium and small farmers was 1.467 mt and 0.444 mt worth $330.973 and $100.105 respectively. Though it's the larger farmer who have lost most of their production but it's the small farmers who suffers the most. Larger farmers have other sources of income and enough stored grains to support food security. But with the production loss, medium and small farmers were challenged to ensure food security. The agricultural department of the Rajapur Municipality has surveyed the loss of paddy production. The estimated price was equivalent to $415094.25 and per farmer, L&D was estimated to be $120.49. The difference in the finding could be because of the consideration of damaged (low quality or germinated paddy) in this study, which couldn't be primarily used for consumption. Also, after the flood, due to the inundation for several days and high moisture retention in the field, mustard production also decreased as per farmers.

In terms of farm machinery damage, larger farmers with larger lands are better equipped with farm machinery. However, small farmers rely on traditional farming methods or rent farm machinery, which results in less damage to farm machinery in the case of small farmers. In case of livestock loss, small farmers were found to rear fewer livestock than large and medium farmers because they must go for labor wages. While large farmers were discovered to have animal farms, it was the large farmers who suffered the most in terms of livestock loss due to the flood.

Table 16: Loss and damage to different sectors

| | **Loss and Damage ($)** | | | | | |
|---|---|---|---|---|---|---|
| Farmer's Type | **Land** | **Production** | **Stored Grains** | **Livestock** | **Farm machinery** | **Total** |
| **Large** | 1726 | 19407.104 | 3437.588 | 7552.2 | 270.6 | 32393.491 |
| **Medium** | 26875.5 | 17872.589 | 3738.751 | 1607.2 | 131.2 | 50225.239 |
| **Small** | 9860.5 | 8609.082 | 2748.588 | 409.6 | 82 | 21709.769 |
| **Total** | 38462 | 45888.774 | 9924.926 | 9569 | 483.8 | **104328.500** |

Table 17: Loss of food availability (month)

| Farmer's Type | PY average (Month) | TY average (Month) | Loss (Month) |
|---|---|---|---|
| Large | 12 | 8.2 | 3.8 |
| Medium | 11.444 | 6.556 | 4.849 |
| Small | 6.721 | 3.279 | 3.442 |

Farmers had a total income of $44791.94 in the prior year after producing 511.35mt of paddy and selling 199.75mt of it. But due to 2021 unseasonal flooding, just 308 mt of paddy was produced because of flood, they sold 91 mt of paddy and earned a total of $15458.246 in total. After getting inundated for several days, the quality of paddy was degraded and hence couldn’t meet the required quality standard. Hence, the farmers were compelled to sell the paddy at lower price to private companies as the Khadya Sansthan couldn’t purchase because of quality issue. The decrease in paddy production has a direct impact on farmers' means of lives and livelihood. Due to production loss, there was also a reduction in food availability. Despite the fact that large farmers lost an average of 3.8 months to flooding compared to medium farmers who lost an average of 4.84 months and small farmers who lost an average of 3.44 months, large farmers still had access to enough food to ensure their food security.

Livestock worth $9569 were destroyed by flood and to repair the farm machinery repair cost was around $483.8. About 32.565mt of stored grains including rice, pulses, maize, and wheat were flooded away and damaged (which couldn't be primarily used for consumption) in the flood. Which caused the loss of around $9924.926.

#### 4.6.9 Adaptation Measures and Strategies

After the disaster, farmers of the affected regions change their employment strategies in response to such disasters [82]. Flood changes the land quality, production was reduced thus many farmers who hold less land were severely affected. In order to deal with the losses and damages they had to find alternative way of earning. Various coping mechanisms were followed like buying of rice, consumption of wheat as alternative to rice, cultivation of spring season rice, saved paddy by not selling as in previous years, taking loans, temporary migration for earning etc. From the result it shown that, small farmers are the one who has to change their livelihood and adaptation strategies in order to cope with the flood aftermath. Even in non-flooding year, small farmers are least benefited from the agricultural production. They struggle to get basic daily necessities, thus have a less resilience capacity [83]. The proportion of small farmers who abandon education in search of work, take out loans, and earn labor wages is higher than that of medium and small farmers. First, they have a small plot of land, and second, they have no other source of income. Thus, when a flood struck the community, it was common for male members of small and medium farmers to be forcibly moved to nearby cities. Also, They are not well equipped with farm machineries and hence sharecropping is also done to the more resourceful Tharu people [84].

Rajapur Municipality, Nepal Red Cross Society in collaboration with other I/NGOs had provided immediate aid worth $9209.68 to the farmers. The loss that incurred is quite bigger than the support received. Though, this relief aid was not provided as a compensation for the L&D to the paddy production. The government declared a compensation schemes for the flood affected farmers. Due to the delaying in the compensation process farmers were unable to manage agricultural goods like seeds, fertilizers etc. till the day of the field visit. Farmers would experience relief from the loss and damage if the compensation process was sped up.

Several efforts and adaptation practices have been made to cope with the loss and damage by the communities. The central government, provincial government, and local governments, along with other organizations, have been working in the field of adaptation and resilience and capacity building. Karnali Nadi Byabasthapan Aayojana (Karnali River Management Project) is building an embankment on the bank of Karnali and Geruwa Rivers of Rajapur. So far, 17 km of embankment have been built. It has provided safety to the communities however agricultural adaptation strategies are still inadequate. Also, the embankment cannot withstand big floods, resulting in the breakage of the dam. In 2020, a 500m long dam in Tihuni village was destroyed by the flood [7]. In 2021, water overflowed an embankment and caused massive agricultural destruction.

Early warning system (EWS) has been an effective adaptation measure to deal with the loss and damage. People of downstream receive a messages via mobile phone when the water level reaches to alert level i.e. 9m in Chisapani gauge station. Siren system has also helped communities to get alert and move to the safer places. Due to this system human casualties are rare. Elevated house (machan), elevated well, thati (traditional double storey house generally used for storing essentials) are traditional way of dealing with the floods. Community Disaster Management Committees (CDMCs), search and rescue committees, youth groups, and trained volunteers are formed and mobilized during the disaster [46] . Other adaptation strategies to deal with the loss and damage in agriculture are alternative farming like switching to vegetable farming or sugarcane farming, cultivation of hybrid seeds for more yield is highly practiced, but that has replaced the local seeds, cultivation of spring paddy etc. Plantation around agricultural land is rare, but some farmers have grown trees around their farmland. Sharecropping, improved drainage systems, etc. are other adaptation strategies.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

## 5.1 **Conclusion**

In recent years, the risk of extreme weather events has been increasing. The temperature and precipitation trends are also increasing. Flooding and inundation are the major problems in the Rajapur area. The flooding events have become more frequent and more severe, causing loss and damage to lives and properties.

The study was mainly focused on the economic loss and damage and specifically in agriculture. The assessment of economic loss and damage by climate-induced loss and damage is primarily based on the market value of goods. The accurate estimation of loss and damage to agriculture is challenging. A list of agricultural indicators was prepared namely land, production of paddy, stored grains, livestock, and farm machinery losses and damages caused by the flood. However, the study excludes the non-economic losses and damages. The focus was also given to food security and its impact on income and how the different farmers have been dealing with the loss and damage. After the adaptation measures, human casualties are barely recorded but the increasing flood risk poses a huge threat to the agricultural-dependent communities. Erosion of agricultural land and fertile soil, deposition of sediments, and overuse of chemical fertilizers have already causing declining in crop production in the area. The embankment has been a huge relief to the residents of Rajapur, but it is not strong enough to withstand a significant flood. Which results in the breakage of the dam causing massive destruction.

Though the loss and damage concept is relatively new in Nepal. But being one of the vulnerable countries to climate change, adequate consideration must be given to address and assess the climate-induced loss and damage in national and local policy.

## 5.2 **Recommendation**

- Since, this research couldn't oversight non-economic loss and damage. The impacts of non-economic L&D can be deeper than the economic one. Further research on non-economic L&D would help to identify the ignored impacts of climate change.
- Additional research in assessing loss and damage in other sectors, such as forestry, infrastructure, and roads, could provide a clearer picture of loss and damage that this study could not.
- For more reliable results, additional research can be conducted by comparing at least three hydrological and meteorological stations (upstream, Chisapani, and downstream).
- Sharecropping is commonly practiced in the Rajapur area. Sharecropping farmers are typically small or medium-sized farmers who make all their investments during cultivation and later share the product with the owner. But when the flood hit, again they are the ones who suffer most. Further investigation in this scope would help to understand the situation of these farmers clearly.
- Despite the scale of the effects of climate change, it's the local communities and farmers who suffer the most in the disaster-prone areas. So, while working in the field of L & D and making policies, the thoughts and ideas of scientific communities, experts, and locals need to be incorporated.
- The frequency of floods and their impacts have the potential to increase in the future. Thus, to prepare the farmers in flood-prone areas should be given adequate awareness programme and training for their upliftment. Aware and educate the farmers on the likelihood of such climatic events, training on flood resistant crops, crops with short maturity period, emphasize spring season rice as it has higher productivity, helping them in exploring irrigation facilities so that they don't have to rely only on rain-fed agriculture.
- Loss and damage is recently evolved topic and hence very less studies have been carried out in this field. Thus, more encourage should be given in incentive grants in research in the field climate induced loss and damage.
- Encourage farmers and locals to move towards nature based solution. Bio-engineering technique, plantation along the river bank and around the farmland might be some of the nature based methods for flood risk management.

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# APPENDICES

Appendix A: Loss and Damage Calculation for Agricultural Land for Larger Farmers

| S.N | Kattha | Hectare | Loss (ha) | Damage (ha) | L&D ha | L&D in USD |
|---|---|---|---|---|---|---|
| 1 | 140 | 4.676 | 0 | 1.336 | 1.336 | 180.40 |
| 2 | 61 | 2.037 | 0 | 0.668 | 0.668 | 82.00 |
| 3 | 62 | 2.071 | 0 | 0.668 | 0.668 | 123.00 |
| 4 | 80 | 2.672 | 0 | 0 | 0 | 0.00 |
| 5 | 80 | 2.672 | 0 | 1.002 | 1.002 | 123.00 |
| 6 | 61 | 2.037 | 0 | 0.334 | 0.334 | 82.00 |
| 7 | 80 | 2.672 | 0 | 0.501 | 0.501 | 61.58 |
| 8 | 70 | 2.338 | 0 | 0.668 | 0.668 | 82.00 |
| 9 | 61 | 2.037 | 0 | 0.334 | 0.334 | 82.00 |
| 10 | 400 | 13.360 | 0 | 2.004 | 2.004 | 328.00 |
| 11 | 61 | 2.037 | 0 | 0 | 0 | 0.00 |
| 12 | 108 | 3.607 | 0 | 0.668 | 0.668 | 123.00 |
| 13 | 80 | 2.672 | 0 | 0 | 0 | 0.00 |
| 14 | 65 | 2.171 | 0 | 0 | 0 | 0.00 |
| 15 | 61 | 2.037 | 0 | 0 | 0 | 0.00 |
| 16 | 85 | 2.839 | 0 | 0 | 0 | 0.00 |
| 17 | 78 | 2.605 | 0 | 2.004 | 2.004 | 328.00 |
| 18 | 145 | 4.843 | 0 | 1.336 | 1.336 | 131.20 |
| 19 | 61 | 2.037 | 0 | 0 | 0 | 0.00 |
| 20 | 100 | 3.340 | 0 | 0 | 0 | 0.00 |
| **Total** | **1939** | **64.763** | **0** | **11.523** | **11.523** | **1726.18** |

Appendix B: Loss and Damage Calculation for Agricultural Land for Medium Farmers

| S.N | Kattha | Hectare | Loss (ha) | Damage (ha) | L&D ha | L&D in USD |
|---|---|---|---|---|---|---|
| 1 | 45 | 1.503 | 0.167 | 0 | 0.167 | 28.7 |
| 2 | 29 | 0.969 | 0.501 | 0 | 0.501 | 16.4 |
| 3 | 40 | 1.336 | 0.167 | 0 | 0.167 | 41 |
| 4 | 25 | 0.835 | 0 | 0 | 0 | 0 |
| 5 | 20 | 0.668 | 0 | 0 | 0 | 0 |
| 6 | 43 | 1.436 | 0.334 | 0 | 0.334 | 41 |
| 7 | 22 | 0.735 | 0 | 0 | 0 | 0 |
| 8 | 22 | 0.735 | 0.4342 | 0 | 0.4342 | 41 |
| 9 | 32 | 1.069 | 0 | 0 | 0 | 0 |
| 10 | 45 | 1.503 | 0 | 0 | 0 | 0 |
| 11 | 40 | 1.336 | 0 | 0 | 0 | 0 |
| 12 | 50 | 1.670 | 0 | 0 | 0 | 0 |
| 13 | 35 | 1.169 | 0.167 | 0 | 0.167 | 28.7 |
| 14 | 42 | 1.403 | 0 | 0 | 0 | 0 |
| 15 | 35 | 1.169 | 0 | 0 | 0 | 0 |
| 16 | 29 | 0.969 | 0.167 | 0 | 0.167 | 16.4 |
| 17 | 40.5 | 1.353 | 0.334 | 0 | 0.334 | 20.5 |
| 18 | 50 | 1.670 | 0 | 0 | 0 | 0 |
| 19 | 34 | 1.136 | 0.501 | 0.0835 | 0.5845 | 2091 |
| 20 | 36 | 1.202 | 0.1002 | 0.1002 | 0.2004 | 2476.4 |
| 21 | 45 | 1.503 | 0.4676 | 0 | 0.4676 | 32.8 |
| 22 | 44 | 1.470 | 0 | 0 | 0 | 0 |
| 23 | 20 | 0.668 | 0 | 0 | 0 | 0 |
| 24 | 54 | 1.804 | 0 | 0.167 | 0.167 | 4100 |
| 25 | 40 | 1.336 | 0 | 0.0501 | 0.0501 | 1230 |
| 26 | 30 | 1.002 | 0.9352 | 0.0668 | 1.002 | 1681 |
| 27 | 57 | 1.904 | 0.1837 | 0.1336 | 0.3173 | 3308.7 |
| 28 | 20 | 0.668 | 0.0668 | 0.0668 | 0.1336 | 1656.4 |
| 29 | 48 | 1.603 | 0.2672 | 0.2338 | 0.501 | 5781 |
| 30 | 28 | 0.935 | 0.501 | 0.167 | 0.668 | 4165.6 |
| 31 | 30 | 1.002 | 0.0668 | 0 | 0.0668 | 20.5 |
| 32 | 50 | 1.670 | 0 | 0 | 0 | 0 |
| 33 | 50 | 1.670 | 0 | 0 | 0 | 0 |
| 34 | 40 | 1.336 | 0 | 0 | 0 | 0 |
| 35 | 20 | 0.668 | 0 | 0 | 0 | 0 |
| 36 | 34 | 1.136 | 0 | 0 | 0 | 0 |
| 37 | 21 | 0.701 | 0 | 0 | 0 | 0 |
| 38 | 20 | 0.668 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 39 | 36 | 1.202 | 0.167 | 0 | 0.167 | 20.5 |
| 40 | 40 | 1.336 | 0 | 0 | 0 | 0 |
| 41 | 40 | 1.336 | 0 | 0 | 0 | 0 |
| 42 | 21 | 0.701 | 0.0668 | 0 | 0.0668 | 12.3 |
| 43 | 40 | 1.336 | 0.1336 | 0 | 0.1336 | 24.6 |
| 44 | 28 | 0.935 | 0 | 0 | 0 | 0 |
| 45 | 28 | 0.935 | 0 | 0 | 0 | 0 |
| 46 | 27 | 0.902 | 0 | 0 | 0 | 0 |
| 47 | 20 | 0.668 | 0 | 0 | 0 | 0 |
| 48 | 22 | 0.735 | 0 | 0 | 0 | 0 |
| 49 | 20 | 0.668 | 0.334 | 0 | 0.334 | 41 |
| 50 | 40 | 1.336 | 0 | 0 | 0 | 0 |
| 51 | 27 | 0.902 | 0 | 0 | 0 | 0 |
| 52 | 23 | 0.768 | 0 | 0 | 0 | 0 |
| 53 | 22 | 0.735 | 0 | 0 | 0 | 0 |
| 54 | 26 | 0.868 | 0 | 0 | 0 | 0 |
| Total | **1825.5** | **60.9717** | **6.0621** | **1.0688** | **7.1309** | **26875.5** |

Appendix C: Loss and Damage Calculation for Agricultural Land for Small Farmers

| S.N. | Kattha | Hectare | Loss (ha) | Damage (ha) | L&D ha | L&D in USD |
|---|---|---|---|---|---|---|
| 1 | 4 | 0.1336 | 0 | 0 | 0 | 0 |
| 2 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 3 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 4 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 5 | 10 | 0.334 | 0 | 0.0668 | 0.0668 | 20.5 |
| 6 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 7 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 8 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 9 | 2 | 0.0668 | 0 | 0 | 0 | 0 |
| 10 | 4 | 0.1336 | 0 | 0 | 0 | 0 |
| 11 | 9 | 0.3006 | 0 | 0.0668 | 0.0668 | 8.2 |
| 12 | 2 | 0.0668 | 0 | 0.0668 | 0.0668 | 8.2 |
| 13 | 1 | 0.0334 | 0 | 0 | 0 | 0 |
| 14 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 15 | 3.5 | 0.1169 | 0 | 0 | 0 | 0 |
| 16 | 1 | 0.0334 | 0 | 0 | 0 | 0 |
| 17 | 9.5 | 0.3173 | 0 | 0 | 0 | 0 |
| 18 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 19 | 10 | 0.334 | 0 | 0.2338 | 0.2338 | 20.5 |
| 20 | 9 | 0.3006 | 0 | 0.3006 | 0.3006 | 24.6 |
| 21 | 0.5 | 0.0167 | 0 | 0 | 0 | 0 |
| 22 | 8 | 0.2672 | 0 | 0 | 0 | 0 |
| 23 | 6 | 0.2004 | 0 | 0.2004 | 0.2004 | 16.4 |
| 24 | 2 | 0.0668 | 0 | 0 | 0 | 0 |
| 25 | 5 | 0.167 | 0 | 0.167 | 0.167 | 28.7 |
| 26 | 7 | 0.2338 | 0 | 0 | 0 | 0 |
| 27 | 7 | 0.2338 | 0 | 0 | 0 | 0 |
| 28 | 10 | 0.334 | 0.1336 | 0.1002 | 0.2338 | 3321 |
| 29 | 9 | 0.3006 | 0.2338 | 0.0668 | 0.3006 | 5756.4 |
| 30 | 3 | 0.1002 | 0.0167 | 0.0501 | 0.0668 | 422.3 |
| 31 | 4 | 0.1336 | 0 | 0 | 0 | 0 |
| 32 | 7 | 0.2338 | 0 | 0 | 0 | 0 |
| 33 | 8.5 | 0.2839 | 0 | 0.0668 | 0.0668 | 16.4 |
| 34 | 1 | 0.0334 | 0 | 0 | 0 | 0 |
| 35 | 5 | 0.167 | 0 | 0.167 | 0.167 | 16.4 |
| 36 | 2 | 0.0668 | 0 | 0 | 0 | 0 |
| 37 | 2 | 0.0668 | 0 | 0 | 0 | 0 |
| 38 | 2 | 0.0668 | 0 | 0 | 0 | 0 |
| 39 | 9.5 | 0.3173 | 0 | 0 | 0 | 0 |
| 40 | 5 | 0.167 | 0 | 0 | 0 | 0 |
| 41 | 10 | 0.334 | 0 | 0.0668 | 0.0668 | 16.4 |
| 42 | 2 | 0.0668 | 0 | 0 | 0 | 0 |
| 43 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 44 | 6 | 0.2004 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 45 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 46 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 47 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 48 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 49 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 50 | 9.5 | 0.3173 | 0 | 0 | 0 | 0 |
| 51 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 52 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 53 | 5 | 0.167 | 0 | 0 | 0 | 0 |
| 54 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 55 | 10 | 0.334 | 0 | 0.0334 | 0.0334 | 8.2 |
| 56 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 57 | 5 | 0.167 | 0 | 0.0334 | 0.0334 | 8.2 |
| 58 | 5 | 0.167 | 0 | 0.0334 | 0.0334 | 8.2 |
| 59 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 60 | 3 | 0.1002 | 0 | 0.1002 | 0.1002 | 24.6 |
| 61 | 5 | 0.167 | 0 | 0.0334 | 0.0334 | 12.3 |
| 62 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 63 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 64 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 65 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 66 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 67 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 68 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 69 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 70 | 3 | 0.1002 | 0 | 0 | 0 | 0 |
| 71 | 6 | 0.2004 | 0 | 0 | 0 | 0 |
| 72 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 73 | 4 | 0.1336 | 0 | 0 | 0 | 0 |
| 74 | 4 | 0.1336 | 0 | 0 | 0 | 0 |
| 75 | 6 | 0.2004 | 0 | 0 | 0 | 0 |
| 76 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 77 | 6 | 0.2004 | 0 | 0 | 0 | 0 |
| 78 | 10 | 0.334 | 0 | 0.334 | 0.334 | 41 |
| 79 | 10 | 0.334 | 0 | 0.334 | 0.334 | 41 |
| 80 | 10 | 0.334 | 0 | 0.334 | 0.334 | 41 |
| 81 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 82 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 83 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 84 | 10 | 0.334 | 0 | 0 | 0 | 0 |
| 85 | 9 | 0.3006 | 0 | 0 | 0 | 0 |
| 86 | 8 | 0.2672 | 0 | 0 | 0 | 0 |
| Total | 571 | 19.0714 | 0.3841 | 2.8557 | 3.2398 | 9860.5 |

Appendix D: Loss and Damage Calculation for Paddy Production for Large Farmers

| | Previous year | 1mt=224.27 | | Expected | This year | This year | | | | 1mt=225.664 |
|---|---|---|---|---|---|---|---|---|---|---|
| | yield (mt) | PY value | expected yield | value | total yield | value | Loss | Damage | L&D | L&D |
| S.N | | in USD | (mt) | in USD | mt | in USD | mt | mt | mt | USD |
| 1 | 28 | 6279.56 | 28 | 6318.592 | 20 | 4513.28 | 8 | 0 | 8 | 1805.312 |
| 2 | 6 | 1345.62 | 6 | 1353.984 | 4 | 902.656 | 2 | 0 | 2 | 451.328 |
| 3 | 9 | 2018.43 | 9 | 2030.976 | 0 | 0 | 9 | 0 | 9 | 2030.976 |
| 4 | 14 | 3139.78 | 14 | 3159.296 | 9 | 2030.976 | 5 | 0 | 5 | 1128.32 |
| 5 | 12 | 2691.24 | 12 | 2707.968 | 8 | 1805.312 | 4 | 0 | 4 | 902.656 |
| 6 | 6 | 1345.62 | 6 | 1353.984 | 4 | 902.656 | 2 | 0 | 2 | 451.328 |
| 7 | 12 | 2691.24 | 12 | 2707.968 | 0 | 0 | 12 | 0 | 12 | 2707.968 |
| 8 | 10 | 2242.7 | 10 | 2256.64 | 8 | 1805.312 | 2 | 0 | 2 | 451.328 |
| 9 | 5 | 1121.35 | 5 | 1128.32 | 2.5 | 564.16 | 2.5 | 0 | 2.5 | 564.16 |
| 10 | 40 | 8970.8 | 40 | 9026.56 | 33 | 7446.912 | 7 | 0 | 7 | 1579.648 |
| 11 | 6 | 1345.62 | 6 | 1353.984 | 3 | 676.992 | 3 | 0 | 3 | 676.992 |
| 12 | 16 | 3588.32 | 16 | 3610.624 | 12 | 2707.968 | 4 | 0 | 4 | 902.656 |
| 13 | 12 | 2691.24 | 12 | 2707.968 | 9 | 2030.976 | 3 | 0 | 3 | 676.992 |
| 14 | 6 | 1345.62 | 6 | 1353.984 | 4 | 902.656 | 2 | 0 | 2 | 451.328 |
| 15 | 7 | 1569.89 | 7 | 1579.648 | 5 | 1128.32 | 2 | 0 | 2 | 451.328 |
| 16 | 6 | 1345.62 | 6 | 1353.984 | 4.5 | 1015.488 | 1.5 | 0 | 1.5 | 338.496 |
| 17 | 6 | 1345.62 | 6 | 1353.984 | 0 | 0 | 6 | 0 | 6 | 1353.984 |
| 18 | 28 | 6279.56 | 28 | 6318.592 | 21 | 4738.944 | 7 | 0 | 7 | 1579.648 |
| 19 | 12 | 2691.24 | 12 | 2707.968 | 10 | 2256.64 | 2 | 0 | 2 | 451.328 |
| 20 | 7 | 1569.89 | 7 | 1579.648 | 5 | 1128.32 | 2 | 0 | 2 | 451.328 |
| | 248 | 55618.96 | 248 | 55964.672 | 162 | 36557.57 | 86 | 0 | 86 | 19407.104 |

Appendix E: Loss and Damage Calculation for Paddy Production for Medium Farmers

| | Previous year | | | Expected | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | yield (mt) | PY value | Expected yield | value | Total yield | value | Loss | Damage | L&D | L&D |
| S.N | | in USD | (mt) | in USD | mt | in USD | mt | mt | mt | USD |
| 1 | 5 | 1121.35 | 5 | 1128.32 | 3.5 | 789.82 | 1 | 0.5 | 1.5 | 338.50 |
| 2 | 3.5 | 784.95 | 3.5 | 789.82 | 0 | 0.00 | 3.5 | 0 | 3.5 | 789.82 |
| 3 | 5 | 1121.35 | 5 | 1128.32 | 3.5 | 789.82 | 1 | 0.5 | 1.5 | 338.50 |
| 4 | 3 | 672.81 | 3 | 676.99 | 2 | 451.33 | 0.4 | 0.6 | 1 | 225.66 |
| 5 | 2.2 | 493.39 | 2.2 | 496.46 | 1.8 | 406.20 | 0.4 | 0 | 0.4 | 90.27 |
| 6 | 4 | 897.08 | 4 | 902.66 | 3 | 676.99 | 0.6 | 0.4 | 1 | 225.66 |
| 7 | 2 | 448.54 | 2 | 451.33 | 1.8 | 406.20 | 0.2 | 0 | 0.2 | 45.13 |
| 8 | 1.7 | 381.26 | 1.7 | 383.63 | 1.1 | 248.23 | 0.6 | 0 | 0.6 | 135.40 |
| 9 | 3 | 672.81 | 3 | 676.99 | 2.2 | 496.46 | 0.8 | 0 | 0.8 | 180.53 |
| 10 | 5.5 | 1233.49 | 5.5 | 1241.15 | 4 | 902.66 | 0.8 | 0.7 | 1.5 | 338.50 |
| 11 | 5 | 1121.35 | 5 | 1128.32 | 3.5 | 789.82 | 1 | 0.5 | 1.5 | 338.50 |
| 12 | 5 | 1121.35 | 5 | 1128.32 | 2.5 | 564.16 | 1.5 | 1 | 2.5 | 564.16 |
| 13 | 4 | 897.08 | 4 | 902.66 | 3 | 676.99 | 0.8 | 0.2 | 1 | 225.66 |
| 14 | 5.5 | 1233.49 | 5.5 | 1241.15 | 2.5 | 564.16 | 2.5 | 0.5 | 3 | 676.99 |
| 15 | 4.5 | 1009.22 | 4.5 | 1015.49 | 2.5 | 564.16 | 2 | 0 | 2 | 451.33 |
| 16 | 4 | 897.08 | 4 | 902.66 | 3 | 676.99 | 1 | 0 | 1 | 225.66 |
| 17 | 4 | 897.08 | 4 | 902.66 | 2.5 | 564.16 | 0.9 | 0.6 | 1.5 | 338.50 |
| 18 | 5 | 1121.35 | 5 | 1128.32 | 0 | 0.00 | 5 | 0 | 5 | 1128.32 |
| 19 | 3.5 | 784.95 | 3.5 | 789.82 | 1.5 | 338.50 | 1.5 | 0.5 | 2 | 451.33 |
| 20 | 4 | 897.08 | 4 | 902.66 | 2.5 | 564.16 | 1.5 | 0 | 1.5 | 338.50 |
| 21 | 3 | 672.81 | 3 | 676.99 | 1.5 | 338.50 | 1 | 0.5 | 1.5 | 338.50 |
| 22 | 5 | 1121.35 | 5 | 1128.32 | 3.5 | 789.82 | 1 | 0.5 | 1.5 | 338.50 |
| 23 | 1.2 | 269.12 | 1.2 | 270.80 | 0.8 | 180.53 | 0.4 | 0 | 0.4 | 90.27 |
| 24 | 7 | 1569.89 | 7 | 1579.65 | 4.5 | 1015.49 | 1.6 | 0.9 | 2.5 | 564.16 |
| 25 | 3 | 672.81 | 3 | 676.99 | 2 | 451.33 | 1 | 0 | 1 | 225.66 |
| 26 | 4.5 | 1009.22 | 4.5 | 1015.49 | 2.4 | 541.59 | 1.5 | 0.6 | 2.1 | 473.89 |
| 27 | 4.5 | 1009.22 | 4.5 | 1015.49 | 2.5 | 564.16 | 1.5 | 0.5 | 2 | 451.33 |
| 28 | 3 | 672.81 | 3 | 676.99 | 1.8 | 406.20 | 1 | 0.2 | 1.2 | 270.80 |
| 29 | 4 | 897.08 | 4 | 902.66 | 0 | 0.00 | 4 | 0 | 4 | 902.66 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 4.5 | 1009.22 | 4.5 | 1015.49 | 0 | 0.00 | 4.5 | 0 | 4.5 | 1015.49 |
| 31 | 4 | 897.08 | 4 | 902.66 | 1.5 | 338.50 | 2 | 0.5 | 2.5 | 564.16 |
| 32 | 6 | 1345.62 | 6 | 1353.98 | 4 | 902.66 | 1.5 | 0.5 | 2 | 451.33 |
| 33 | 6 | 1345.62 | 6 | 1353.98 | 4 | 902.66 | 2 | 0 | 2 | 451.33 |
| 34 | 4 | 897.08 | 4 | 902.66 | 3.8 | 857.52 | 0.2 | 0 | 0.2 | 45.13 |
| 35 | 1.6 | 358.83 | 1.6 | 361.06 | 1.6 | 361.06 | 0 | 0 | 0 | 0.00 |
| 36 | 3 | 672.81 | 3 | 676.99 | 2 | 451.33 | 0.5 | 0.5 | 1 | 225.66 |
| 37 | 3 | 672.81 | 3 | 676.99 | 2 | 451.33 | 0.5 | 0.5 | 1 | 225.66 |
| 38 | 3.5 | 784.95 | 3.5 | 789.82 | 2.3 | 519.03 | 0.8 | 0.4 | 1.2 | 270.80 |
| 39 | 5 | 1121.35 | 5 | 1128.32 | 3 | 676.99 | 1.5 | 0.5 | 2 | 451.33 |
| 40 | 5 | 1121.35 | 5 | 1128.32 | 3 | 676.99 | 1.5 | 0.5 | 2 | 451.33 |
| 41 | 4 | 897.08 | 4 | 902.66 | 3 | 676.99 | 0.8 | 0.2 | 1 | 225.66 |
| 42 | 2.5 | 560.68 | 2.5 | 564.16 | 1.5 | 338.50 | 0.5 | 0.5 | 1 | 225.66 |
| 43 | 5 | 1121.35 | 5 | 1128.32 | 4 | 902.66 | 0.6 | 0.4 | 1 | 225.66 |
| 44 | 1.5 | 336.41 | 1.5 | 338.50 | 1.2 | 270.80 | 0.3 | 0 | 0.3 | 67.70 |
| 45 | 1.5 | 336.41 | 1.5 | 338.50 | 1 | 225.66 | 0.5 | 0 | 0.5 | 112.83 |
| 46 | 1 | 224.27 | 1 | 225.66 | 0.8 | 180.53 | 0.2 | 0 | 0.2 | 45.13 |
| 47 | 1.2 | 269.12 | 1.2 | 270.80 | 0.9 | 203.10 | 0.3 | 0 | 0.3 | 67.70 |
| 48 | 1 | 224.27 | 1 | 225.66 | 0.6 | 135.40 | 0.4 | 0 | 0.4 | 90.27 |
| 49 | 2.5 | 560.68 | 2.5 | 564.16 | 0 | 0.00 | 2.5 | 0 | 2.5 | 564.16 |
| 50 | 4 | 897.08 | 4 | 902.66 | 3.5 | 789.82 | 0.5 | 0 | 0.5 | 112.83 |
| 51 | 3.5 | 784.95 | 3.5 | 789.82 | 1.5 | 338.50 | 1.5 | 0.5 | 2 | 451.33 |
| 52 | 1 | 224.27 | 1 | 225.66 | 0.8 | 180.53 | 0.2 | 0 | 0.2 | 45.13 |
| 53 | 1.5 | 336.41 | 1.5 | 338.50 | 0.7 | 157.96 | 0.8 | 0 | 0.8 | 180.53 |
| 54 | 1.5 | 336.41 | 1.5 | 338.50 | 0.6 | 135.40 | 0.9 | 0 | 0.9 | 203.10 |
| | 191.9 | 43037.41 | 191.9 | 43304.92 | 112.7 | 25432.33 | 65 | 14.2 | 79.2 | 17872.59 |

Appendix F: Loss and Damage Calculation for Paddy Production for Small Farmers

| | Previous year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | yield (mt) | PY value | Expected yield | Expected value | Total yield | This year Value | Loss | Damage | L&D | L&D |
| S. N | | **in USD** | **(mt)** | **in USD** | **mt** | **in USD** | mt | mt | mt | **USD** |
| 1 | 0.6 | 134.82 | 0.6 | 135.40 | 0.4 | 90.27 | 0.2 | 0 | 0.2 | 45.13 |
| 2 | 1.2 | 269.64 | 1.2 | 270.80 | 1 | 225.66 | 0.2 | 0 | 0.2 | 45.13 |
| 3 | 1.2 | 269.64 | 1.2 | 270.80 | 0.5 | 112.83 | 0.5 | 0.2 | 0.7 | 157.96 |
| 4 | 1.4 | 314.58 | 1.4 | 315.93 | 0 | 0.00 | 1.4 | 0 | 1.4 | 315.93 |
| 5 | 1.5 | 337.05 | 1.5 | 338.50 | 1.2 | 270.80 | 0.3 | 0 | 0.3 | 67.70 |
| 6 | 1.2 | 269.64 | 1.2 | 270.80 | 0.5 | 112.83 | 0.5 | 0.2 | 0.7 | 157.96 |
| 7 | 1.2 | 269.64 | 1.2 | 270.80 | 0.5 | 112.83 | 0.7 | 0 | 0.7 | 157.96 |
| 8 | 1.3 | 292.11 | 1.3 | 293.36 | 0.5 | 112.83 | 0.5 | 0.3 | 0.8 | 180.53 |
| 9 | 0.4 | 89.88 | 0.4 | 90.27 | 0.2 | 45.13 | 0.2 | 0 | 0.2 | 45.13 |
| 10 | 0.5 | 112.35 | 0.5 | 112.83 | 0 | 0.00 | 0.5 | 0 | 0.5 | 112.83 |
| 11 | 1.2 | 269.64 | 1.2 | 270.80 | 0 | 0.00 | 1.2 | 0 | 1.2 | 270.80 |
| 12 | 0.3 | 67.41 | 0.3 | 67.70 | 0.1 | 22.57 | 0.2 | 0 | 0.2 | 45.13 |
| 13 | 0.2 | 44.94 | 0.2 | 45.13 | 0.1 | 22.57 | 0.1 | 0 | 0.1 | 22.57 |
| 14 | 1.2 | 269.64 | 1.2 | 270.80 | 0.7 | 157.96 | 0.5 | 0 | 0.5 | 112.83 |
| 15 | 0.7 | 157.29 | 0.7 | 157.96 | 0.4 | 90.27 | 0.3 | 0 | 0.3 | 67.70 |
| 16 | 0.3 | 67.41 | 0.3 | 67.70 | 0 | 0.00 | 0.3 | 0 | 0.3 | 67.70 |
| 17 | 1 | 224.7 | 1 | 225.66 | 1 | 225.66 | 0 | 0 | 0 | 0.00 |
| 18 | 1.4 | 314.58 | 1.4 | 315.93 | 0 | 0.00 | 1.4 | 0 | 1.4 | 315.93 |
| 19 | 1.4 | 314.58 | 1.4 | 315.93 | 1 | 225.66 | 0.3 | 0.1 | 0.4 | 90.27 |
| 20 | 1.2 | 269.64 | 1.2 | 270.80 | 0 | 0.00 | 1.2 | 0 | 1.2 | 270.80 |
| 21 | 0.2 | 44.94 | 0.2 | 45.13 | 0.2 | 45.13 | 0 | 0 | 0 | 0.00 |
| 22 | 1.2 | 269.64 | 1.2 | 270.80 | 0 | 0.00 | 1.2 | 0 | 1.2 | 270.80 |
| 23 | 1 | 224.7 | 1 | 225.66 | 0 | 0.00 | 1 | 0 | 1 | 225.66 |
| 24 | 0.5 | 112.35 | 0.5 | 112.83 | 0.4 | 90.27 | 0.1 | 0 | 0.1 | 22.57 |
| 25 | 1 | 224.7 | 1 | 225.66 | 0 | 0.00 | 1 | 0 | 1 | 225.66 |
| 26 | 0.9 | 202.23 | 0.9 | 203.10 | 0.5 | 112.83 | 0.3 | 0.1 | 0.4 | 90.27 |
| 27 | 0.7 | 157.29 | 0.7 | 157.96 | 0.4 | 90.27 | 0.3 | 0 | 0.3 | 67.70 |
| 28 | 1.5 | 337.05 | 1.5 | 338.50 | 0.3 | 67.70 | 1.2 | 0 | 1.2 | 270.80 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 0.8 | 179.76 | 0.8 | 180.53 | 0 | 0.00 | 0.8 | 0 | 0.8 | 180.53 |
| 30 | 0.3 | 67.41 | 0.3 | 67.70 | 0.1 | 22.57 | 0.2 | 0 | 0.2 | 45.13 |
| 31 | 0.5 | 112.35 | 0.5 | 112.83 | 0 | 0.00 | 0.5 | 0 | 0.5 | 112.83 |
| 32 | 0.7 | 157.29 | 0.7 | 157.96 | 0.3 | 67.70 | 0.4 | 0 | 0.4 | 90.27 |
| 33 | 0.6 | 134.82 | 0.6 | 135.40 | 0.3 | 67.70 | 0.3 | 0 | 0.3 | 67.70 |
| 34 | 0.1 | 22.47 | 0.1 | 22.57 | 0 | 0.00 | 0.1 | 0 | 0.1 | 22.57 |
| 35 | 0.7 | 157.29 | 0.7 | 157.96 | 0 | 0.00 | 0.7 | 0 | 0.7 | 157.96 |
| 36 | 0.6 | 134.82 | 0.6 | 135.40 | 0 | 0.00 | 0.6 | 0 | 0.6 | 135.40 |
| 37 | 0.25 | 56.175 | 0.25 | 56.42 | 0 | 0.00 | 0.25 | 0 | 0.25 | 56.42 |
| 38 | 0.1 | 22.47 | 0.1 | 22.57 | 0.1 | 22.57 | 0 | 0 | 0 | 0.00 |
| 39 | 1.5 | 337.05 | 1.5 | 338.50 | 1.2 | 270.80 | 0.3 | 0 | 0.3 | 67.70 |
| 40 | 0.5 | 112.35 | 0.5 | 112.83 | 0.4 | 90.27 | 0.1 | 0 | 0.1 | 22.57 |
| 41 | 1.2 | 269.64 | 1.2 | 270.80 | 0.8 | 180.53 | 0.4 | 0 | 0.4 | 90.27 |
| 42 | 0.3 | 67.41 | 0.3 | 67.70 | 0.2 | 45.13 | 0.1 | 0 | 0.1 | 22.57 |
| 43 | 1.5 | 337.05 | 1.5 | 338.50 | 0.7 | 157.96 | 0.8 | 0 | 0.8 | 180.53 |
| 44 | 0.3 | 67.41 | 0.3 | 67.70 | 0 | 0.00 | 0.3 | 0 | 0.3 | 67.70 |
| 45 | 1.5 | 337.05 | 1.5 | 338.50 | 1.3 | 293.36 | 0.2 | 0 | 0.2 | 45.13 |
| 46 | 1.5 | 337.05 | 1.5 | 338.50 | 1.3 | 293.36 | 0.2 | 0 | 0.2 | 45.13 |
| 47 | 1.2 | 269.64 | 1.2 | 270.80 | 1.2 | 270.80 | 0 | 0 | 0 | 0.00 |
| 48 | 0.5 | 112.35 | 0.5 | 112.83 | 0.3 | 67.70 | 0.2 | 0 | 0.2 | 45.13 |
| 49 | 0.5 | 112.35 | 0.5 | 112.83 | 0.1 | 22.57 | 0.4 | 0 | 0.4 | 90.27 |
| 50 | 1.4 | 314.58 | 1.4 | 315.93 | 0.7 | 157.96 | 0.7 | 0 | 0.7 | 157.96 |
| 51 | 1 | 224.7 | 1 | 225.66 | 0.6 | 135.40 | 0.4 | 0 | 0.4 | 90.27 |
| 52 | 1.4 | 314.58 | 1.4 | 315.93 | 1 | 225.66 | 0.4 | 0 | 0.4 | 90.27 |
| 53 | 0.5 | 112.35 | 0.5 | 112.83 | 0.2 | 45.13 | 0.3 | 0 | 0.3 | 67.70 |
| 54 | 1.5 | 337.05 | 1.5 | 338.50 | 1.2 | 270.80 | 0.3 | 0 | 0.3 | 67.70 |
| 55 | 1 | 224.7 | 1 | 225.66 | 0.6 | 135.40 | 0.4 | 0 | 0.4 | 90.27 |
| 56 | 0.3 | 67.41 | 0.3 | 67.70 | 0 | 0.00 | 0.3 | 0 | 0.3 | 67.70 |
| 57 | 0.4 | 89.88 | 0.4 | 90.27 | 0 | 0.00 | 0.4 | 0 | 0.4 | 90.27 |
| 58 | 0.4 | 89.88 | 0.4 | 90.27 | 0.3 | 67.70 | 0.1 | 0 | 0.1 | 22.57 |
| 59 | 0.5 | 112.35 | 0.5 | 112.83 | 0.3 | 67.70 | 0.2 | 0 | 0.2 | 45.13 |
| 60 | 0.5 | 112.35 | 0.5 | 112.83 | 0 | 0.00 | 0.5 | 0 | 0.5 | 112.83 |
| 61 | 0.7 | 157.29 | 0.7 | 157.96 | 0.3 | 67.70 | 0.4 | 0 | 0.4 | 90.27 |
| 62 | 1.3 | 292.11 | 1.3 | 293.36 | 0 | 0.00 | 1.3 | 0 | 1.3 | 293.36 |
| 63 | 0.4 | 89.88 | 0.4 | 90.27 | 0.15 | 33.85 | 0.25 | 0 | 0.25 | 56.42 |
| 64 | 0.4 | 89.88 | 0.4 | 90.27 | 0.15 | 33.85 | 0.25 | 0 | 0.25 | 56.42 |
| 65 | 0.4 | 89.88 | 0.4 | 90.27 | 0.2 | 45.13 | 0.2 | 0 | 0.2 | 45.13 |
| 66 | 1.5 | 337.05 | 1.5 | 338.50 | 0.7 | 157.96 | 0.8 | 0 | 0.8 | 180.53 |
| 67 | 1.3 | 292.11 | 1.3 | 293.36 | 0.6 | 135.40 | 0.7 | 0 | 0.7 | 157.9 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 6 |
| 68 | 0.7 | 157.29 | 0.7 | 157.96 | 0.5 | 112.83 | 0.2 | 0 | 0.2 | 45.13 |
| 69 | 0.3 | 67.41 | 0.3 | 67.70 | 0.2 | 45.13 | 0.1 | 0 | 0.1 | 22.57 |
| 70 | 0.4 | 89.88 | 0.4 | 90.27 | 0.3 | 67.70 | 0.1 | 0 | 0.1 | 22.57 |
| 71 | 0.8 | 179.76 | 0.8 | 180.53 | 0.4 | 90.27 | 0.4 | 0 | 0.4 | 90.27 |
| 72 | 0.7 | 157.29 | 0.7 | 157.96 | 0.5 | 112.83 | 0.2 | 0 | 0.2 | 45.13 |
| 73 | 0.5 | 112.35 | 0.5 | 112.83 | 0.5 | 112.83 | 0 | 0 | 0 | 0.00 |
| 74 | 0.5 | 112.35 | 0.5 | 112.83 | 0.4 | 90.27 | 0.1 | 0 | 0.1 | 22.57 |
| 75 | 0.5 | 112.35 | 0.5 | 112.83 | 0.5 | 112.83 | 0 | 0 | 0 | 0.00 |
| 76 | 0.7 | 157.29 | 0.7 | 157.96 | 0.5 | 112.83 | 0.2 | 0 | 0.2 | 45.13 |
| 77 | 0.6 | 134.82 | 0.6 | 135.40 | 0.2 | 45.13 | 0.4 | 0 | 0.4 | 90.27 |
| 78 | 0.9 | 202.23 | 0.9 | 203.10 | 0 | 0.00 | 0.9 | 0 | 0.9 | 203.10 |
| 79 | 1.5 | 337.05 | 1.5 | 338.50 | 0 | 0.00 | 1.5 | 0 | 1.5 | 338.50 |
| 80 | 1.5 | 337.05 | 1.5 | 338.50 | 0 | 0.00 | 1.5 | 0 | 1.5 | 338.50 |
| 81 | 1.2 | 269.64 | 1.2 | 270.80 | 0.8 | 180.53 | 0.4 | 0 | 0.4 | 90.27 |
| 82 | 1.2 | 269.64 | 1.2 | 270.80 | 1 | 225.66 | 0.2 | 0 | 0.2 | 45.13 |
| 83 | 1.5 | 337.05 | 1.5 | 338.50 | 1.5 | 338.50 | 0 | 0 | 0 | 0.00 |
| 84 | 0.5 | 112.35 | 0.5 | 112.83 | 0.2 | 45.13 | 0.3 | 0 | 0.3 | 67.70 |
| 85 | 0.5 | 112.35 | 0.5 | 112.83 | 0.3 | 67.70 | 0.2 | 0 | 0.2 | 45.13 |
| 86 | 0.5 | 112.35 | 0.5 | 112.83 | 0.3 | 67.70 | 0.2 | 0 | 0.2 | 45.13 |
| | 71.45 | 16054.815 | 71.45 | 71.45 | 33.3 | 33.3 | 37.25 | 0.9 | 38.15 | 8609.08 |

Appendix G: Market Value of Stored Grains

| Rice | Wheat | Maize | Mustard | Red Lentils |
|---|---|---|---|---|
| 1 Q = NPR 2752 | 1 Q= NPR 3111 | 1 Q= NPR 3500 | 1 Q = NPR 12000 | 1 Q = NPR 12000 |
| 1 Q = 2752*0.0082 | 1 Q = 3111*0.0082 | 1 Q= 3500*0.0082 | 1 Q = 12000* 0.0082 | 1 Q = 12000* 0.0082 |
| 1 Q = $22.5664 | 1 Q = $25.510 | 1Q = $ 28.7 | 1 Q = $98.4 | 1 Q = $98.4 |
| 10 Q = 1 MT | 10 Q = 1 MT | 10 Q = 1 MT | 10 Q = 1 MT | 10 Q = 1 MT |
| 10*22.5564 = 1 MT | 10*25.510 = 1 MT | 10*28.7 = 1 MT | 10*98.4 = 1 MT | 10*98.4 = 1 MT |
| 1 MT = 225.664 | 1 MT = 255.10 | 1 MT = $287 | 1 MT = $984 | 1 MT = $984 |

## Some Photographs

Farmer showing high flood level

Farmer showing the quality of rice

Agricultural land damaged by the


Erosion of agricultural land due to flood

Household survey

FGD with the members of KMJS

FGD with ward members and stakeholders

FGD with the farmers

KII with administrative officer of Rajapur Municipality