Gendered vulnerability in Irrigated Agriculture in the Context of Climate Change: A case study of Labdu Dikure Shera Irrigation system in Nuwakot District

By

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A thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science (M.Sc.) in Interdisciplinary Water Resources Management awarded by Pokhara University

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Abstract

Climate change has been a proven fact with increase in temperature and rainfall variability. The impacts of climate change are not homogeneous within a society, it varies from person to person, i.e. it has differentiated social impacts based on gender, age, disability, ethnicity, geographical location, as these parameters determines the coping capacity and capability. As women and men play significantly different roles the impact of climate change on various gender social groups varies. For instance, in patriarchal social structure of Nepal, men are involved in decision making and women mostly do the labor work including care services for household. The differential role men and women play in day to day life determines different level of access to resources and decision making power that is crucial to cope with climatic stressors. Understanding differentiated impact and adaption strategies are important to tackle climate change problem. This study analyses gendered impacts and responses to climatic stressor in irrigated agriculture scenario in rural communes in Nuwakot District a part of Province No. 3, one of the seventy-five districts of Nepal. This research assesses the impact of climate change in agriculture and livelihoods of people in *Labdu Dikure Shera Irrigation System*. The study is carried out inspired by participatory research methods and qualitative research tools. Data collection tools, such as face to face formal and informal interviews, focus group discussion, case studies and field observation. Checklist in form of open ended questionnaire are used n later part of the study to quantify some of the qualitative parameters on gendered understanding on climate change.

This study found both men and women perceive climate change as a serious threat to agriculture operations. Respondents perceived temperature is increasing, Also, reported mean annual rainfall is increasing, where pre-monsoon, monsoon, post-monsoon is increasing respectively while winter rain is decreasing. There is shift is monsoon. Decreasing winter rain has serious impact on farming as well as water availability in the system. This problem has been further multiplied with poor governance on water distribution, because of which branch number 8, 9 and 10 tail end branches out of 10 total branches never received water including in rainy season. Change in cropping season is unaltered in head end as irrigation water fulfills water stress created by rainfall variability. Though, head end farmers reported that the time to grow rice has not changed, there is remarkable difference on time of harvesting. They assume it is because of increase in temperature. However tail enders who relies on rainfall had shifted the time of cultivation of paddy during monsoon. In addition, decreased productivity may be because of flash rainfall during pollination, flowering. Climatic hazards like water logging, flooding along the river side are caused due to intense rainfall during May/ June affecting summer crops, as well as threatening occurrence of flood in command area as the irrigation canal acted as drainage canal collecting water from upstream of watershed. Also, increased temperature with less or no rainfall in February-April caused dry spell problem affecting summer crops and available drinking water sources. Increase occurrence of diseases and pest including in millet is reported as surprises by the respondents.

These climatic stressors have different effect on women and men situated in different stretches of irrigation system. The differential gender effect is determined by the availability of water supply in the system, demographic changes such as male absenteeism, exposure to use of chemicals to cope with occurrence of disease and pest; and gender norms, values and knowledge. Intensive use of pesticide is observed,

where women's engagement is increasing due to increased male migration from the study area. With lack of enough knowledge on risk of intensive use of chemicals, women farmers are found to be using the chemical in interval closer than the recommended. Drying of drinking water source has increased women's drudgery by increasing time of collecting drinking water. Climate change is affecting human beings differently, influencing their priorities and adaptation strategies for coping with the challenges. In addition to stress caused on farming due to climatic stressor, the socioeconomic stressors such as government policy of manure supply and other accessories, alternate work opportunities, and increase cost of farming have caused farmers to divert from farming to non-farming activities. People with lesser hope in farming have changed their livelihoods like going abroad for earning. Thus, along with climate change impacts on farming, food distribution policy and changed livelihood sources has affected the farming side by side.

Disclaimer

I hereby declare that this study entitled **"Gendered vulnerability in Irrigated Agriculture in the Context of Climate Change: A case study of *Labdu Dikure Shera* Irrigation system in Nuwakot District"** is based on my original research work. The views expressed in this work are those of the creators and do not necessarily represent those of HI-AWARE study in Gandaki Basin funded by UK Government's Department for International Development, the International Development Research Centre, Canada or its Board of Governors, and are not necessarily attributable to their organizations. Related works on the topic, by other researchers, have been duly acknowledged. I owe all the liabilities relating to accuracy and authenticity of the data or any other information included hereunder.

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Date:

Recommendation

This is to certify that this thesis entitled, **"Gendered vulnerability in Irrigated Agriculture in the Context of Climate Change: A case study of *Labdu Dikure Shera* Irrigation system in Nuwakot District",** prepared and submitted by Prajjwl Bhandari in partial fulfillment of the requirements of the degree of **Master of Science (M.Sc.)** in **Interdisciplinary Water Resources Management** awarded by Pokhara University, has been completed under my supervision. I recommend the same for acceptance by Pokhara University.

Signature:

Name of the supervisor: Dr. Pranita Bhushan Udas

Organization: International Centre for Integrated Mountain Development

Designation: Gender, Water and Adaptation Specialist Livelihoods

Date signed:

Certificate

This thesis entitled, **"Gendered vulnerability in Irrigated Agriculture in the Context of Climate Change: A case study of *Labdu Dikure Shera* Irrigation system in Nuwakot District"** prepared and submitted by Prajjwl Bhandari has been examined by us and is accepted for the award of the degree of Master of Science (M.Sc.) in Interdisciplinary Water Resources Management by Pokhara University.

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ABBREVIATIONS

ADB	:	Asian Development Bank
DFID	:	Department for International Development
DoI	:	Department of Irrigation
FMIS	:	Farmer Managed Irrigation System
GDP	:	Gross Domestic Production
GoN	:	Government of Nepal
GRB	:	Gandaki River Basin
ICIMOD	:	International Centre for Integrated Mountain Development
IM	:	Irrigation Management
IPCC	:	Intergovernmental Panel on Climate Change
ISF	:	Irrigation Service Fees
JTA	:	Junior Technical Assistant
SLA	:	Sustainable Livelihood Approach
SLF	:	Sustainable Livelihood Frameworks
UNDP	:	United Nations Development Programme
VDC	:	Village Development Committee
WB	:	The World Bank
WEDO		Women's Environment and Development Organization
WUAs	:	Water Users Associations

CHAPTER 1

INTRODUCTION

1.1 Background

Climate change is a phenomenon due to emissions of Green House Gases (GHGs) from fuel combustion, deforestation, urbanization and industrialization (Upreti, 1999) resulting variations in, temperature and precipitation, in which increasing temperature trend and rainfall variability is becoming obvious. It is a real threat to the lives in the world as it largely affects water resources, agriculture, coastal regions, freshwater habitats, vegetation and forests, melting of snow covers and increase occurrence of geological hazards such as landslide, desertification and floods, and has long-term effects on food security as well as in human health. The impact of global warming is more in mountainous countries like Nepal, and hence is vulnerable to natural disasters, particularly floods and landslides. Much of the population is reliant on rain fed agriculture that is vulnerable to localized drought and variation on precipitation in form of rain, snow and hail, their timing and intensity. Even in irrigated farming, the impact is climate change is becoming obvious with reduced water availability at the source. With increased intensity of summer monsoon rain events, the risk of flash flooding, erosion and landslides has increased. With warmer winters, particularly at higher altitudes, less precipitation will fall as snow, further accelerating glacial retreat but also reducing soil moisture and accelerating erosion and therefore impacts on winter crops. However, due to Nepal's diverse topography and range of ecological zones, the overall impact of climate change on agriculture and ecosystems is likely to be high depending on location, making it difficult to detect patterns and plan national responses.

The climate related disasters and impacts often intensify existing inequalities, vulnerabilities, economic poverty and unequal power relations (IPCC, 2007). Differently positioned women and men perceive and experience climate change in diverse ways because of their distinct socially constructed roles, responsibilities, status and identities, which result in varied coping strategies and responses (FAO, 2003; Biodiversity, 2009). Often, women are more vulnerable to climate change than men. This is because they make up the majority of the world‘s economically poor, do most of the agricultural work , which is mostly affected by climatic variability, women bear unequal responsibility for household food security, carry a disproportionate burden for managing water and fuel for everyday survival, and rely on threatened natural resources for their livelihoods (UN, 2009). The increase male absenteeism for work outside has further increased women’s work burden.

1.2 Statement of the Problem

Climate change affects human beings differently, influencing their priorities and adaptation strategies for coping with the challenges. For instance, the impact of climate change in drying of water source, used for drinking water, which is primary responsibility of women in Nepali society, can increase women work burden. The impact of Climate change are not homogeneous within a society, it varies from place

to place, i.e. it has differentiated social impacts based on gender, age, disability, ethnicity, geographical location and focused on many other factors (Mitchell & Tanner, 2008).

The challenge of climate change could impede people's livelihood opportunities based on irrigated agriculture, particularly of those living in the rural areas, affecting their lives and productions greatly. This study focuses on the impact of climate change on women and men's in irrigated agriculture, as well as the ways they are currently responding to these changes in rural communes in the Nuwakot District of Bagmati Zone. Thrust reason to focus on impact of climate change in irrigated farming is driven by the fact that earlier studies on climate change highlight the problem in rain fed farming. Availability of irrigation is considered as adaptation strategy to overcome climate change impact on farming based on rainfall. However, the impact of climate change cannot be derived only from precipitation. Several other climatic parameters such as wind, mist, fog and frost can equally affect farming. Meanwhile, the irrigation system itself might get affected by available water creating competition and conflict.

1.3 Research Question

How are the vulnerabilities posed by climatic stressors are gendered in irrigated agriculture and what are the farmers belonging to different gender and social group coping and adaptive strategies?

The operational research questions have been framed to address specific theme of inquiry as follows:

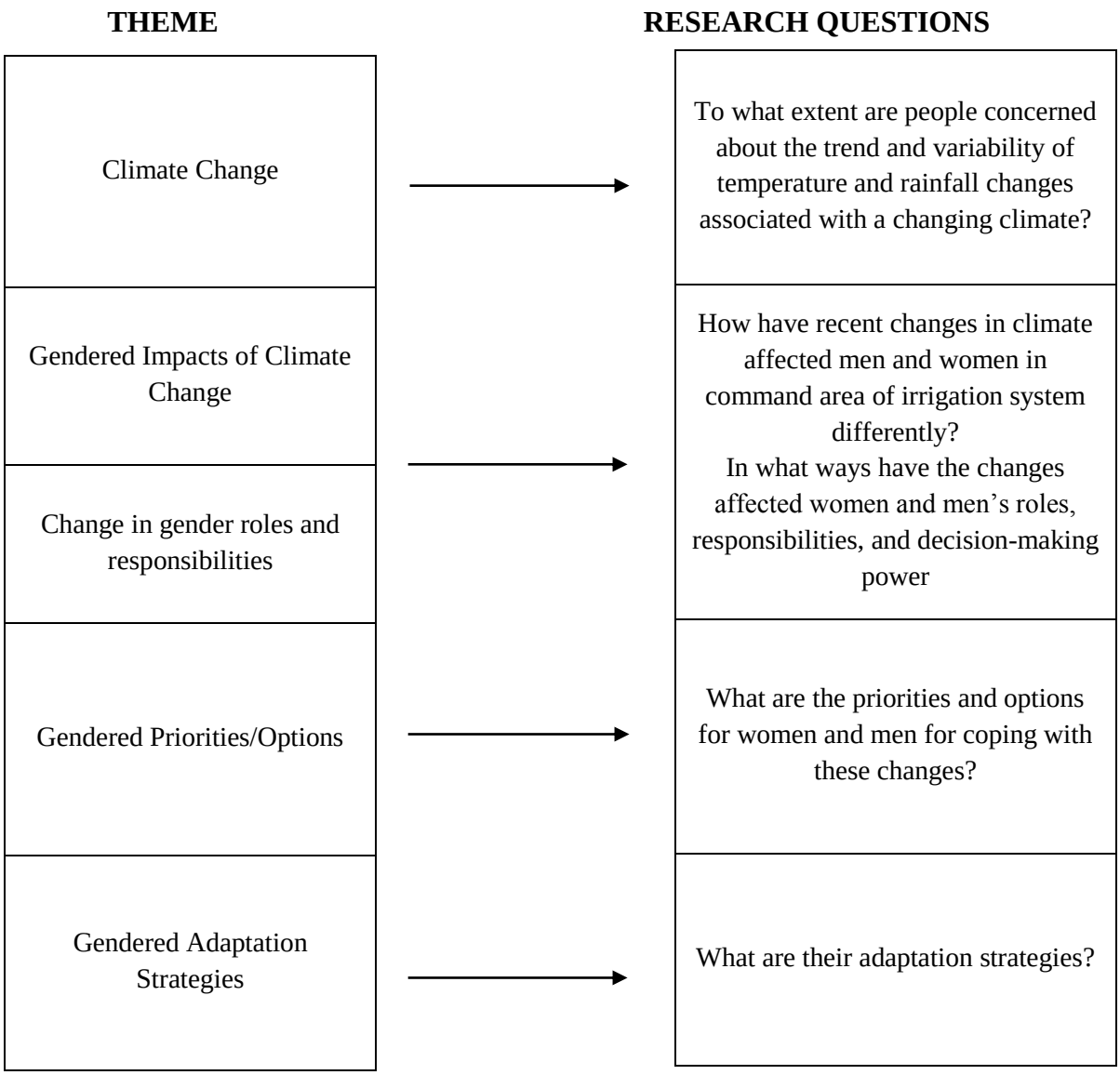


Figure 1.1 Typology of research questions

1.4 Research Objectives

The overall objective of the study was to assess the gendered impacts of – and responses to – climate change by focusing in irrigated agriculture scenario in rural communes in the Nuwakot district of Bagmati Zone, Nepal. For this the operational objectives are:

- To identify key indicators to assess the impact of climate change in agriculture
- To document ccropping pattern and crop calendar of the system.
- To assess the impact of climate change on livelihoods of the farmers
- To contribute to the climate change knowledge on gender vulnerability in irrigated agriculture.

1.5 Significance of Study

As weather patterns become increasingly unpredictable and extreme events such as floods and drought become more common, the poorest communities, especially those dependent on natural resources, are finding their livelihoods most threatened. Women living in poverty are most vulnerable to the impact of climate change and disasters due to inequitable power relations and to unequal access to natural resources such as land and water and to development resources such as credit, trainings, information, and agricultural inputs. Dealing with climate change impacts on water resources requires pro-active partnerships, to contribute not only to more efficient use of water, but to also harness pro-poor and gender equitable agricultural growth. This thesis presents major issues and constraints relating to the water, climate change, and gender nexus in Nuwakot District of *Labdu Dikure Shera* Irrigation System, and explores opportunities for promoting gender engagement in agricultural water management, in the context of climate change.

The title of the present study, "Gendered Vulnerability in Irrigated Agriculture in the Context of Climate Change: A case study of *Labdu Dikure Shera* Irrigation System in Nuwakot District", was selected to help clearly understand some key perspectives related to gendered impacts of climate change on men and women's production and lives, as well as the ways they respond to the changes. Climate change is hitting the area hard, and women and men here are being forced to adapt. In these communes, what aspects of their lives are affected by adverse climatic phenomena, as well as by changes in the production and output of agriculture? What are their priorities and options for coping with the impacts of climate change on irrigated agriculture, and how are women's adaptation strategies different as compared with men? These are just a few of the questions this study tried to address in greater details. Answers to these questions are important so as to provide input to gender sensitive efforts to minimize and mitigate the climate change problem.

1.6 Scope and Limitation of Study

This study was carried out with its prescribed objectives to access

- Gendered perception on climate change
- Effect of climatic variability in farming and day to day livelihoods of women and men living in command area of irrigation system
- Documentation of local adaptation measures and mitigation measures taken by different gender social groups

The study focused on understanding gender vulnerability in changing 'climate context in irrigated agriculture', which has not been researched enough. This study aims to understand women's roles and constraints in irrigation and agricultural development and management in the context of changing climate, to analyze their priority needs and understand about women's major challenges in water resource management and climate change adaptation so that relevant agencies and groups working on gender issues can take appropriate action. The methodology of the study inspired by anthropological research tools allowed researchers to continuously engaged

community about half a month in peak period of farming, which broadens the scope of work to capture impact of climatic stressor at the time of rainfall. The study also explores women's roles in Interdisciplinary Water Resources Management (IWRM), with focus on water for farming as well as for other livelihood opportunities such as water for drinking and livestock and climate change adaptation to generate realistic recommendations for eliminating barriers to women's greater engagement in sustainable water resource management, and climate change resilience. The findings of the study also contribute to gender mainstreaming efforts in climate change programs to improve women's livelihoods and minimize climate change vulnerability.

Still some of the limitations of this study are:

- The study has been carried out as part of partial fulfillment of master degree. In process of learning, limitation may lie in analysis and interpretation.
- The result of this research carried out in *Labdu Dikure Shera* Irrigation system, only limited to this site. Generalizing the findings is limited
- Though perception studies have its own strength of valuing people's experiences, however, it may be guided by individual experience and perceived impact which may not be applicable in all cases (Impacts of Climate Change, Hazard Mapping).
- The study being carried out in peak time of farming made it difficult to arrange time for interviews, and though provided to opportunity observed farmers engagement.

The study on climate change impact on agriculture is a long term study and would require plenty of resources, time and scientific instruments and methods. This study was constrained in a variety of ways including the limitation of the funds, timing for the studies and adequate prior research training.

Not all crucial aspects of climate change impacts could be captured even within the agriculture. Some factual data could not be obtained especially on phenology of the plants of food and agriculture importance. Data on livestock, birds and fisheries were not included in the study. Also, impacts studies were not carried out on fruits .Without a detail and disaggregated data sets conclusions drawn from this study have limitation on generalization.

CHAPTER-2

LITERATURE REVIEW

This chapter deals with review of studies related with gender and irrigation. This chapter is divided into two sections. The first section describes the in-depth review of related studies and the second section provides conceptual framework of the studies.

2.1 Climate Change

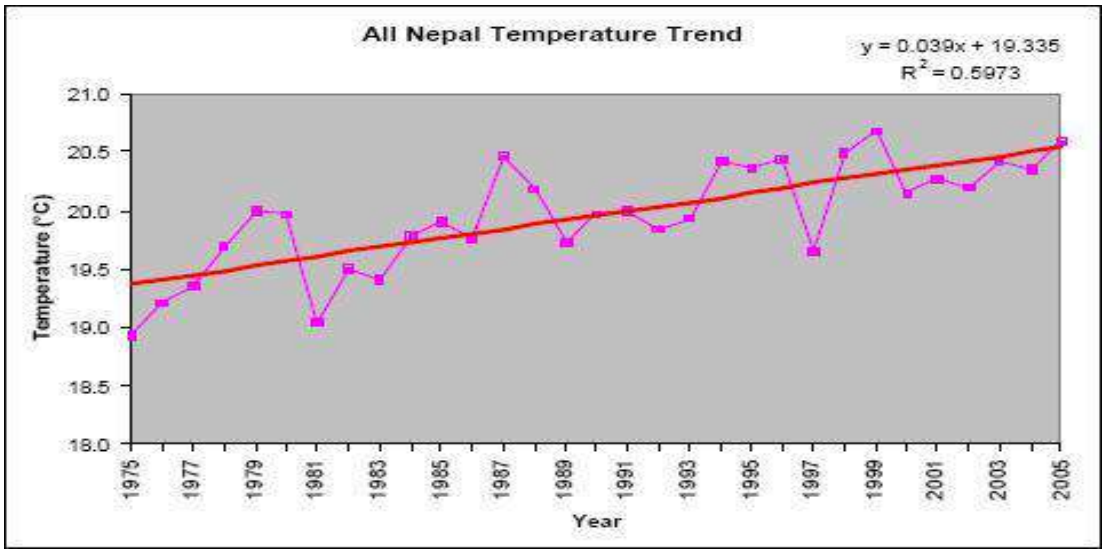
Climate change is a burning issue in the world. Different scholars and organizations have defined climate change differently "climate change is any long-term change in the statistics of weather over periods of the time that range from decades to millions of years"(IPCC, 2007). It can express itself as a change in the mean weather conditions, or in distribution of weather. Climate change may occur in specific region, or across the whole earth.

The term ‘climate change’ is often used interchangeably with the term ‘global warming’ but according to the National Academy of Sciences the phrase 'climate change' is growing in preferred use to 'global warming' because it helps to convey meaning of other terms related to climate change in addition to rising temperatures. Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period, decade or longer. (Sapkota, 2008).

Nepal is already a country vulnerable to natural disasters, particularly floods and landslides. Much of the population is dependent on rain fed agriculture that is vulnerable to localized drought and more variable precipitation in terms of form (rain, snow and hail), timing and intensity. With increased intensity of summer, monsoon rain events the risk of flash flooding, erosion and landslides increment. With warmer winters, particularly at higher altitudes, less precipitation will fall as snow, further accelerating glacial retreat but also reducing soil moisture and accelerating erosion and therefore impacts winter crops. However, due to Nepal‘s diverse topography and range of ecological zones, the overall impact of climate change on agriculture and ecosystems is likely to be highly variable depending on location, making it difficult to detect patterns and plan national responses (Uprety, 1999)

2.2 Climate Change and Nepal

Nepal's contribution for causing climate change is negligibly small: today Nepali citizens comprise less than 0.4% of the world population and are responsible for only about 0.025% of annual greenhouse emissions. Nepal's vulnerability to damage from climate change, however, is large. Temperature is likely to increase more in high mountain areas than elsewhere. Glaciers and snowfields will reduce and may even disappear, reducing Nepal's dry season river water source. This will impact irrigation and drinking water supply and as well as in hydroelectricity. Global climate change will also likely shift monsoon rainfall patterns in ways that threatens Nepal's current agricultural practices, as well as threaten infrastructure. Changing temperature and moisture pattern will threaten biodiversity, especially in mountain areas where migration of species is physically restricted (GON, 2003).



(Source: DHM, 2006)

Figure 2.1 Trend of Temperature in Nepal

According to the study carried out by Department of Hydrology and Metrology Nepal (DHM), there is increasing phenomenon of melting of glacier and Glacier Lake may cause outburst and increases flooding. According to the report, temperature is increasing by 0.12^0C in Himalaya, 0.03^0C in Hill and 0.06^0C in Terai annually (Sapkota, 2008). Above Figure shows the increasing trend of temperature in Nepal. (DHM, 2006). ICIMOD reports the temperature increase in mountain country like Nepal is more than the global average.

Climate change is contemporary issue for Nepal. The following impact will be seen from climate change (Sedhai, 2008):

- Increase in temperature causes the spread of tropical insect - mosquitoes, flies and other diseases in upper part that causes epidemics.
- The pasture land of Himalayas covers with bushes that lead to scarcity of pasture land and negative impacts on livestock rearing.

- Scarcity of water, poverty, decrease in agricultural productivity, effects negatively on sustainable tourism development.

2.3 Glimpse of Irrigation Management in Nepal

Farmer managed irrigation systems in Nepal have contributed significantly for overall food security in the country for years. The studies carried out in Godakhar-Nuwakot, Bhutlung, Jhapa and Laugain-Kapilvastu by Malla et.al, (2002) revealed that FMIS in Nepal is one of the successful systems which was due to the initiation and frequent effort of farmers leading to sustainability which is run and patterned by the existing social norms, values and conformation. These factors are either called the social capital or the softer sides of the projects by some scholars like (Pradhan, 2010). The studies, more focusing, analyzed critically both the positive and negative consequences of the intervention in the irrigation system. Despite the positive consequences, it probes into the reality that the intervention moreover has increased dependency to external assistance and use of technology beyond the capacity of the local farmers. As a recommendation, the studies suggest to more prioritize the participation of farmers, increment of Water User's Association (WUA) from the beginning in decision-making process, importance and need of training for strengthening the capacity of farmers.

Pradhan, (2010) stresses on the social capital as the prominent issue in the irrigation management that has probability for the long term sustenance of the systems so he has also recalled FMIS of Nepal as heritage of Nepal. Water adequacy, equity and timeliness are three major kinds of objectives which require high social capital to be effective. Equity is the main concerned objective of Farmer's Management whereas adequacy is predominant in government that results in the lack of sense of ownership which does not possess the fair share distribution of the resources among the farmers. In other words, everyone should feel the same degree of loss and gain in the system is presumed among the farmers to sustain the organization.

Ostrom (1992) emphasizes on the institutional arrangement of the system to be sustained for long-term enhancing the farmer's participation. The social capital is the rules in use rather than the organization's formal legislation bodies that are crucial in the organization. Here, the institutions shape the patterns of human interaction and the results that individuals achieve. Institutional design must be well crafted so as to reduce the opportunistic activities like free-riding, rent-seeking, corruption that leads mismanagement in the system which might not be sustainable in other words.

Consequently, coordination activities like monitoring and sanctioning have to be increased for the project's transparency. She stated that the shared belief systems of a particular region, caste, religion, or ethnic group along with climate geology, soil conditions, terrain and physical works of irrigation must be in consideration. So the organization must be based on both bottom up and top down as well because only the outsider may not understand the existing system of specific area. The proposed design principle that characterizes long-enduring, self-organized irrigation is clearly defined boundaries which are related with the rules identifying who the users are. Thus, the people who contribute in operation and maintenance of the system are involved in the management. The institutions are required for the scarce resource for sustainability.

Proportional equivalence between benefits and costs is related with the rules for allocating the amount of water on the basis of their contribution in irrigation system either in kind or cash. Collective choice arrangement concerned with the rules of making decision by the group or the individuals are affected by operational rules. Monitoring is associated with norms what, where, when, how the resource is to be managed. There are graduated sanctions for those who violate the rules of the system. The degree of penalty is based on the crime they have committed. There must be specific conflict resolution mechanism to resolve the problem in the irrigation management because the upper farmers want to utilize the excessive amount of water which may lead the lower end with no water. For illustration, the construction of the infrastructure will be handled by state. Nested enterprises is dealt with the multiple layers of users groups if there are more user groups as in *Chattis Mauja* and *Sora Mauja* (Uprety,2005). The afore-mentioned terms and conditions lead to the sustainability and transparency of the system or organization.

2.4 Gender in irrigated agricultural scenario

Gender is not just about women, but the arrangement of roles, responsibilities and relations between women and men of different social groups, ages, educational and marital statuses and other parameters that differentiate women and men. Both perceptions of risks and actual vulnerabilities are shaped by these roles, responsibilities and relations, and hence may vary across place, time and social position/location.

While one's sex does not change, gender roles are learned and changed over time. They vary from culture to culture, and often from one social group to another within the same culture according to class, ethnicity, and race. Factors like education, access to technology, economics, sudden crises, and war and famine cause gender roles to change. Gender is considered as social construct because it is socially determined and supported by societal structures (Bennet, 1983).Gender is socio-economic variable to analyze roles, responsibilities, constraints and opportunity of people that considers both men and women (Zwarteveen, 1993).

According to Mishra (1995) in her paper, "Indigenous Perspective on Health Care and Water Management" presents the hierarchy existed in the knowledge system. She has stressed on the hierarchy of knowledge system prevailed in the men and women in which women's knowledge often is considered inferior to that of men because of the inequality in gender relations, and tendency to associate women with private domain (doing only household tasks) and men with public outside affairs (productive, economic access). It is obvious that division of labor with regards to this is very important. This hierarchy in knowledge system always tends to the superior one holding more power as compared to inferior one (females). Since women are associated with inferior knowledge and norms of considering their knowledge as non-knowledge may be the hindrance of female's participation in the different arenas actively. Uprety (1999) shared that the participation of females in irrigation/WUA has been the problem as they were just included in WUA so as to complete quorum. It was identified that there was lack of participation and some elite users (as leaders) holding the projects for political connection.

Likewise, Chhetri (1999) too argued that the people's participation including women's have been the more rhetoric in which the case of *Riyale* can be analyzed for instance to investigate the real situation of female. As mentioned by different studies, it is clear that the women's involvement is overlooked and even if they are, too involved in irrigation activities that symbolizes their roles and responsibilities. In addition, the level of women participation especially in formal water management forum is limited by persisting gender norms and values that hinders effective expression and argument in public forum due to gender hierarchy in society. Even the water distribution rules that is for night irrigation has detrimental effect in households where irrigation is women's responsibility, for instance in female headed household (Udas, 2014).

It is widely recognized that climate change does not affect people equally. The related disasters and impacts often intensify existing inequalities, vulnerabilities, economic poverty and unequal power relations (IPCC, 2007). Differently positioned women and men perceive and experience climate change in diverse ways because of their distinct socially constructed roles, responsibilities, status and identities, which result in varied coping strategies and responses (FAO, 2009; Lambrou 2010). Often, women are more vulnerable to climate change than men. This is because they make up the majority of the world's economically poor, do most of the agricultural work, bear unequal responsibility for household food security, carry a disproportionate burden for managing water and fuel for everyday survival, and rely on threatened natural resources for their livelihoods (UN, 2009). Moreover, they have unequal access, control and ownership to these natural resources, and are often excluded from important decision and policy-making forums and institutions that govern them. At the same time, women are active agents of adaptation in rapidly changing contexts who negotiate strategies, contest and resist relations, discourses and policies that disadvantage them. Zwarteveen and Neupane (1996) stated that irrigation related studies, policies, interventions often based on the implicit assumption that irrigators, farmers and water users are predominantly male and they function individually. Irrigation and farming are consequently analyzed as reflecting behavior and the users are thought to consist of men only, which are untrue for most parts of the world which is either faulty understanding that leads to ineffectiveness to policy and intervention. In such a way, the women are delicate and they hesitate to speak in front of others which are due to socio-cultural factors (Zwarteveen, and Neupane, 1996).

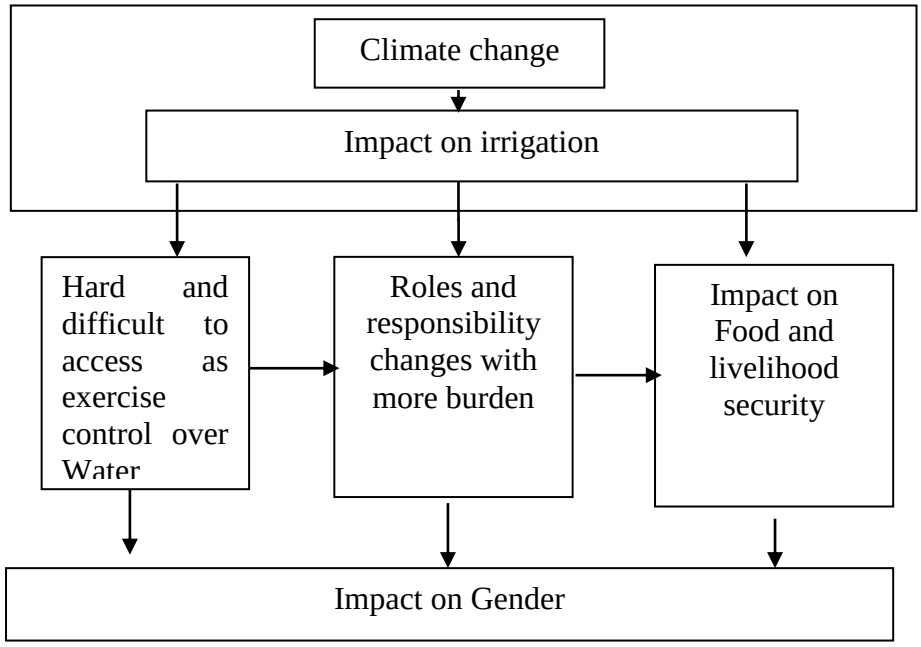


Figure 2.2 Impact of CC on Irrigation that interlink impact on gender

Zwarteveen and Dick (1998) mentioned the minimal participation of females in South Asia due to the formal and informal membership criteria and they make a critical analysis that the problem lies because of not having differences in asset or power in natural resource management but of cultural differences (in perception and norms) and differences in interests in a resource can be detrimental. They even argued that the great concern has to be lain down on the existing traditional stereotyped and there must be accountability who within the community takes the task, and who controls the usage of water in irrigation system, who makes the decisions and who enjoys benefits.

Uprety (1999) writes that gender integration in participation has been the crucial factor as they are water bearers, have specialized knowledge of conservation, purification, and treatment of water. He often focused that government has to pay attention towards women for encouraging them to participate in WUA by giving priority in their training and other development activities. In such a way Uprety (1999) shares that the participation of females in irrigation/WUA has been problem as they were just included in WUA so as to complete quorum. It was identified that there was lack of participation for strengthening their political connections.

Udas (2002) has argued the different factors hindering the participation of females in WUA which has emphasized to understand the heterogeneity of women. Equally the existing societal norms hinder the participation and norms of understanding women as uneducated, having lack of knowledge in official matters, and poor in accounting due to the involvement of women in indoor activities which are internalized by the women themselves result into having no self-esteem in themselves. As a consequence, internalization of such norms makes feel the women low among others lacking self-confident. She even stress on the local level governance to national level governance which is characterized by the male dominance really affects the process of information sharing to the women. Thus, neither women have access to ward level to national level politics nor are they disseminated with the information that requires proper channel to disseminate information especially to the women.

Upadhaya (2004) inscribes that women are found to be extensively contributing in vegetable farming under drip irrigation system. The total mean hours used for irrigation in vegetable production is higher in comparisons to other activities. The findings of the study reveal that the women spend 328 hours per annum for vegetable farming while men spent only 44 hours. Hence, based on the study findings, it has recommended the adoption and innovation of new technology so as to reduce the work load of women. Traditional technology were more time consuming and strenuous in comparison of drip irrigation. She even stresses that irrigation developers should focus on the need of gender sensitive technology along with socio-economic and cultural scenarios of the region where diffusion of the technology takes place.

As such Shrestha (2007) in her studies mentions that female constitutes more than 50% of the total population. However, their involvement low as compared in every

aspects of development. An active and equal involvement of women is imperative for a balanced development of any nation. It is important to increase the number of women professionals in the engineering field. The reasons of low involvement of women in this profession are mainly deprivation of education to girl students at scholars. In the higher education, the number of female participation is decreasing. As a result, female participation in engineering education is greatly affected.

Udas (2010) stresses that the leadership is about the capacity of leaders to listen and observe, to use their expertise as starting point to encourage dialogue between all levels of decision-making to establish processes and transparency in decision making to articulate their own value and visions clearly but not impose them. Hence, she argues that the person should have leadership quality either that is male or female.

Table 2.1 Climate change direct and indirect impacts on agriculture

Direct climate change impacts upon smallholder livelihoods	Biological processes affecting crops and animals at the levels of individual organisms or fields	Direct impacts of changes in temperature, carbon dioxide and precipitation on yields of specific food and cash crops and productivity and health of livestock.
	Environmental and physical processes affecting production at a landscape, watershed or community level	Agriculture will be affected by direct impacts at the level of communities, landscapes, and watersheds (some overlaps with studies on extreme events). E.g. decreased flow of River Nile affecting irrigation systems for many smallholders, also experiencing increasing water scarcity, impacts on soil processes from complex global warming impacts and associated hydrological changes (accelerated decomposition of organic matter, depression of nitrogen-fixing activity). Soil fertility and water holding properties may be affected.
	Impacts of climate change on human health	The above impacts on agriculture are combined with impacts on human health and the ability to provide labor for agriculture, such as increased malaria risk.
	Impacts of climate change on non-agricultural livelihoods	Impacts on important secondary non-farm livelihood strategies for many rural people in developing countries.
Indirect impacts climate change	Distant, off-site impacts of climate change on a particular smallholder	Impacts of climate change in other distant areas may create changes which affect a smallholder system.
	Impacts of climate change adaptation and mitigation policies, programs and funds	The secondary impacts of climate change occur as governments, civil society, the private sector etc. gear up to respond to climate change and institute new policies, programs, and funds- all of which may impact up on smallholders (positively or negatively).

Source (Morton, 2007 and 2010)

2.5 Gender and Climate Change

Gender relations and social discrimination cut across all facets of human endeavor – but the precise nature of the process varies. Similarly, climate change will affect all human societies in all their activities, albeit in different ways and to different degrees. It is, therefore, necessary to look in more detail at some of the many, varied ways in which gender and climate change issues intersect. This section begins with a précis of some of the common threads that can be observed in the gender and climate change literature to date, and then sets out how climate change impacts will be gendered. The lack of recognition of gender relations in climate policy-making and the efforts to rectify this situation are then discussed. The particular gender issues arising in disaster and long-term, slow onset climatic changes are explored, followed by a synthesis of current debates on gender and mitigation.

Climate change affects people of different genders, ethnicities, caste, and geographical regions differently. Rising temperatures, unpredictable precipitation patterns, and an increase in extreme weather events will have a disproportionate impact on women who depend on subsistence farming for their livelihoods. In a traditionally patriarchal society such as Nepal, there is a restrictive opportunity structure and livelihood options are limited. Upholding their gendered roles, women maintain responsibility for domestic functions such as housekeeping, child rearing, cooking and fetching water and firewood. Access to education, economic independence and fair remuneration practices are typically enjoyed more by men than women.

The stresses to agriculture and foods and nutrition security that have accompanied changing weather patterns in recent years have necessitated that men and women adopt different methods of coping. Many men and boys are migrating seasonally in search of off and on-farm work. Migration is typically scheduled around agricultural patterns, with men departing after planting season and returning in time for the harvest. In Terai, men are able to remain closer to home, as there is an abundance of agricultural work in neighboring India and other parts of Nepal. Conversely, men residing in the hills are obligated to migrate for longer periods of time because of the greater distance they need to travel in search of work.

While men are absent, women and children manage the household, taking on both domestic and productive roles. These include maintaining the home, tending to livestock and crops, and occasionally taking on work outside the home as laborers, domestic workers, or porters. Not only are their workloads increasing as a result of male migration, but water scarcity and deforestation related to climate variability are obligating women to walk longer distances to fetch water, fuel, and fodder.

Several recurring contentions appear in the gender and climate change literature:

- Women are disproportionately affected by climate change compared to men, yet the gender-differentiated nature impacts have only belatedly been recognized. The reason for the gender-differentiated impact is the widespread existence of entrenched and deep gender inequalities. These inequalities mean that women have differing roles, resources, rights and time with which to cope with climate change compared to men.

- The gender division of labour means that women and men may be responsible for different tasks, and women's roles in household reproduction (e.g. collecting fuel and water) means that they are relatively more reliant on climate-sensitive livelihoods.
- The failure to tackle poverty and inequality undermine climate adaptation efforts, because of the underlying social determinants of poverty and limitations on adaptive capacity.
- There is a lack of representation of women and gender issues in climate change policy and decision-making across the scales, from the local to the international level.
- Women and other marginalized groups have relevant knowledge and skills for adaptation, which is being ignored; each marginalized group (women, children, older people, etc.) has unique vulnerabilities to climate change.

2.6 Gender inequality in the context of climate change

Women's and men's differential access to social and physical goods or resources is one of the key dimensions of gender inequality. Women's social positioning in many situations means that the roles they are expected to take on are often supportive and reproductive, centered around the home and local community rather than the public sphere. This does not mean that women do not play crucial roles in agricultural production or other activities crucial to sustainable livelihoods and national economies. But the roles they play are generally less visible and attract less public recognition than the work men engage in. Typically, women – particularly those in poor, rural locations – are expected to assume primary responsibility for their families' subsistence. Yet because they often do not earn a wage, women are frequently excluded from decisions about spending or about their children's education. The expectation that girls will help their mothers with household tasks and with caring for younger siblings means that they are more likely to be excluded from opportunities to gain an education than boys, although these gaps are gradually closing. Women earning a wage typically earn less than men, leaving them more vulnerable to changes in their working environment caused by external phenomena, including climate change. This section considers some of the ways in which these inequalities are exacerbated by climate change, and explores how gender inequality prevents the effective mitigation of these impacts (Genanet, 2007).

Table 2.2 Gender inequalities and climate change

Gender Inequalities	**Gender & Climate Change**
Resource rights are gendered Women & female headed households tend to have less well defined or secure land/natural resource rights than men and male headed households	Women & female headed households tend to have fewer resources with which to adapt to climate change challenges.
Responsibilities and identities are gendered	
Women & men are ascribed different responsibilities within the household & community. The gender division of labor means that women tend to have much higher workloads than men, because of their responsibilities in domestic production & reproduction and often have lesser control of household income due to more limited power in household & community decision-making.	Women have more domestic reproductive responsibilities e.g. collecting firewood and water – resources likely to be affected by climate change. Women's higher work burden means they may have less time & energy to adapt to a changing climate and fewer resources to diversify their activities. Men may also migrate more than women, potentially increasing the work burden of women who remain behind.
Knowledge systems are gendered	
Whilst some knowledge & skills are shared at a local community level, the gender division of labor also means some differences in the knowledge and skills held by women and men (or different social groups). Also differential access to education, modern media and information is common along gender lines.	Specific social groups may also have specific occupational skills and knowledge sets (E.g. in seed selection) or traditional weather forecasting. Lesser access to information & media can constrain women's capacity to adapt; but with appropriate support they can take the lead and build upon their own knowledge and capacities.
Power relations and participation are gendered	
Power relations are shaped by gender norms and vice versa.	Women's participation in climate change decision-making is inadequate at all levels. Despite gains in some countries regarding gender awareness or equality, more needs to be done to take up opportunities in new climate policy

(Source: Nelson 2010)

2.7 Conceptual and Analytical Framework

2.7.1 Definitions and Concepts: Vulnerability, Adaptation, and Livelihoods

Vulnerability, according to Webster's Online Dictionary (2012), is being prone to or susceptible "to physical or emotional injury or attack". The definition of "vulnerability" has been refined by Blaikie, Cannon and others (Vulnerability Network, 2012). In their explanation, they state that "by vulnerability we mean the characteristics of a person or group of people in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard". They also argued that vulnerability occurs at the tangent between two opposing forces: the processes that generate vulnerability that can be observed and the physical exposure to hazards (e.g., storms, floods, etc.). This, however, involves a combination of factors that

“determine the degree to which someone’s life and livelihood is put at risk by a discrete and identifiable event in nature or in society”

The vulnerability concept is relative and dynamic. This term is now a central concept in a variety of research contexts including, for example, disaster management, climate impacts and adaptation. From a climate change perspective, according to the IPCC (2001):

"Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity".

From the above definition, the term “vulnerability” may therefore refer to the vulnerable system itself, the impact to this system, or the mechanism causing these impacts. Vulnerability may also arise from individual or group challenges; and is differentiated between and within groups given that the factors that affect individual or group might be more (or less) vulnerable because of their capacities and resources, coping mechanisms, supports, and size and complexity of the group. Complementing the above definition of IPCC, an individual or group’s vulnerability to climate change can be defined as the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the adverse effects of risk, shock or stress (IFRC, 2012). The degree to which a person, household, social group, business, organization, locality or a sector is unable to cope with, resist or recover from adverse effects of shocks and stresses, including climate variability and climate extremes that are enhanced by climate change.

More importantly, vulnerability may differ across groups within communities or individuals within a household, as well as over time. As an example, at household level, the ability to adapt to climate change depends on control over land, money, credit, and tools; low dependency ratios; good health and personal mobility; households entitlements and food security; secure housing in safe locations; and freedom from violence (Bridge, 2008).

O’Brien (2007) shows that the consequences of climate change are closely related to the context in which individuals or groups experience the changes. By context, O’Brien means the multiple, interacting processes and factors that create or contribute to climate change vulnerability. Adaptation, therefore, is necessary, though there are different definitions of adaptation. According to Burton et al., (1998) adaptation is referred to as all those responses to climate change that may be used to reduce vulnerability, whilst Rennie and Singh’s (1996) definition of adaptation is that adaptive strategies are ways in which local individuals, households and communities have changed their mix of productive activities, and modified their community rules and institutions in response to vulnerabilities in order to meet their livelihood needs (Schipper, 2007).

Another definition from the IPCC describes adaptation as adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of

opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability (IPCC, 2001). A livelihood comprises the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and for the future, while not undermining the natural resource base.

"Sustainable livelihoods" came to prominence as a development concept in the early 1990s (Eldis, 2012). In sharing and learning lessons about the sustainable livelihoods approaches, Ashley and Carney (1999) defined sustainable livelihoods as "a way of thinking about the objectives, scope, and priorities for development". Also, according to them, livelihoods approaches are conceptual frameworks that promote people-centered, responsive, and multi-level approaches to development. By empowering the poor to build on their own opportunities, supporting their access to assets, and developing an enabling policy and institutional environment, livelihoods approaches contribute to development and poverty reduction interventions (Eldis, 2012).

Climate change would have wide-ranging, serious effects on the environment, and on socio-economic and related sectors. Because of the speed at which climate changes are happening, it is urgent that the vulnerability of affected populations be reduced and their capacity to adapt increased, ensuring that their livelihoods are insulated or improved. The present work would aim toward gaining an in-depth and detailed understanding of the impacts of climate change phenomenon on people's livelihoods in Nuwakot District of *Labdu Dikure* Irrigation System. Since the purpose of this study is to address questions on livelihoods approaches in climate change vulnerability and gender roles for livelihoods are distinct, this research based its analysis on livelihoods in climate change adaptation. The climate change livelihood impacts are gendered and adaptive capacity is thus differentiated along gender lines. For those reasons, this study is part of a process of sharing, learning and analyzing men and women's adaptation responses. This study uses the vulnerability and "Sustainable Livelihoods Framework" – meaning a set of principles, backed up with a set of analytical tools, to analyze links between gender and climate change. The combination of these two factors is employed to highlight the fact that gender adds a specific dimension to vulnerability analysis. The analytical framework guiding this study draws upon sustainable livelihoods approaches, which would serve as a way to improve our understanding on how assets, vulnerabilities, and livelihood strategies differ between men and women in the area selected for the study.

2.7.2 Gender and Climate Change Analytical Framework

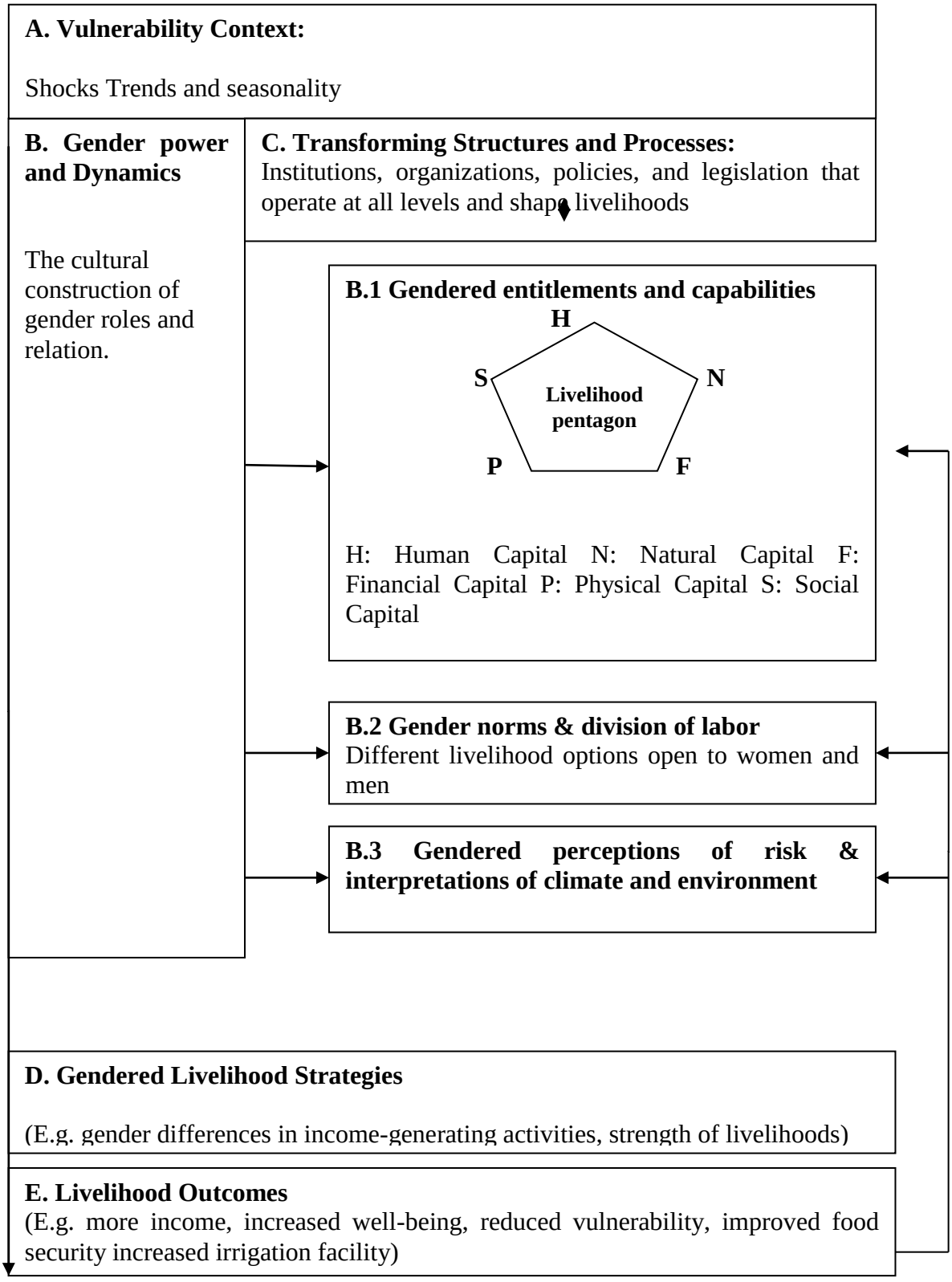
The concept "gender" refers to the 'socially constructed 'roles, behaviors, aptitudes, and relative power associated with being female or male in a given society at a particular point in time (Esplen, 2009). In analysis of climate change, the gender approach is necessary to understand not only how the identities of women and men determine different vulnerabilities and capacities to cope with climate change impacts, but also how to tackle both the causes and consequences of climate change. It is recognized that people who are already the most vulnerable and marginalized, experience the greatest impacts (IPCC, 2007). At the same time, they have the least capacity or opportunity to prepare for the impacts of a changing climate (Bridge,

2008). As women constitute the largest percentage of the world's poorest people, they are the ones who would experience the greatest impact of these changes they are least responsible for. There is little existing research that explores the linkages between climate change and gender. More recent research is the integration of the gender-sensitive perspective in climate change (Bridge, 2008).

Since this study focuses on answering different questions about men and women's livelihoods in climate change adaptation, the Sustainable Livelihoods Approach (SLA), including both the Sustainable Livelihoods Framework (SLF) and gender theory, is used. SLA has been influential within the field of international development in expanding our understanding of the vulnerability context, the policies and institutions which affect actions of individuals and households, and the diverse livelihoods strategies undertaken by women for their households. The SLF is a tool to improve our understanding of livelihoods, particularly the livelihoods of the poor and women who are among the most vulnerable to climate change effects, and when used with participatory research methodologies, it becomes useful to analyze complex rural and urban realities (Oxfam, 2009).

The gender analytical framework is used to analyze what and how gender relations would be shaped or changed in the process of adaptation. SLA framework was developed by Department for International Development (DFID) of the United Kingdom, UNDP, and NGOs (e.g., CARE, Oxfam, etc.), and is considered as an important tool to improve the understanding of livelihoods, especially livelihoods of the poor and women who make up a large proportion of the poor.

Figure describes the SLF, which presents the main factors that affect women and men's livelihoods and typical relationships between these factors. This framework shows that livelihoods are shaped by a multitude of different factors and forces, which include "vulnerability context", "gender and power dynamics", "transforming structures and process", "livelihood strategies", and "livelihood outcomes", that are all constantly shifting, but are ultimately centered on gender and climate change. Gender-centered analysis begins with simultaneous investigation of men and women's assets, their objectives (i.e. the Livelihood Outcomes which they are seeking), and the Livelihood Strategies which they adopt to achieve these objectives.



(Sources: DFID, 1999 and Oxfam, 2009)

Figure 2.3 Conceptual Framework

The Vulnerability Context (part A) frames the external environment in which people exist. Women and men's livelihoods and their wider availability of livelihood assets

are fundamentally affected by critical trends as well as by shocks and seasonality, over which they have limited or no control.

Table 2.3 Trends shocks and seasonality

Trends	Shocks	Seasonality
• Population trends • Resource trends (including conflict) • National and international economic trends • Trends in governance (including politics), • Technological trends	• Natural shocks • Economic shocks • Human health shocks • Crop and livestock health shocks • Conflict	• Of price • Of Production • Of health • Of employment opportunities

(Source: DFID, 1999)

The factors that make up the vulnerability context are important because they have a direct impact on people's asset status and the livelihood options. Different components of the vulnerability context affect different people in different ways. To give an example, natural shocks may have a more adverse effect on agricultural activity than on urban employment, will affect women engaged in farming more due to their assets base and lab our work. Similarly changes in international commodity prices will affect those who grow process or export such commodities but have little direct effect on those who produce for, or trade in the local market.

The relative vulnerability or resilience of men and women to comparable shocks and stresses is determined under the Gender and Power Dynamics (part B). These power dynamics and cultural values shape gender roles and the division of labor, differences in resource rights and livelihood options open to women and men, and their varying capabilities (Oxfam, 2009). The ways in which women and men perceive risks and interpret their climate and environment are also influenced by these dynamics and values.

The livelihood framework identifies five core asset categories or types of capital upon which livelihoods are built, including human capital (H), social capital (S), natural capital (N), physical capital (P), and financial capital (F).

Table 2.4 The Livelihood Pentagon Assets

Human capital (H)	Social Capital (S)	Natural Capital (N)	Physical Capital (P)	Financial Capital (F)
It refers to the labor available to household combined by its education, skills, knowledge and health. Human capital varies at the household level according to household size, skill levels, leadership potential, health status etc.	It referred as 'reciprocity within communities and between households based on trust deriving from social ties'. Birth, age gender, or caste, which differs within a household, most often determine access and amount of social asset.	Natural asset simply denote the natural resource stocks from which resource flows and services Such as land, water, forests, air quality, erosion protection and biological resources. These capitals are very important to those who derive all or part of their livelihoods from such recourse- based activities like farming, fishing, gathering forest products.	It can be regarded as manmade asset. Those are infrastructures and producer goods (equipment's) needed to support livelihoods. Irrigation canals, roads, tools, machines, communication are physical assets.	It refers to stocks of money to which the household has access. Cash in hand, saving, liquid asset such as livestock and access to credit in the form of loan are the fundamental financial capital for rural household including pensions and other transfers from the state and remittances.

(Source: DFID, 1999; Moser, 1998)

The Transforming Structures and Processes (part C) within the SLF are the institutions, organizations, policies, and legislation that operate at all levels and shape livelihoods. The influence of the Transforming Structures and Processes extends throughout the framework and maintains a two-way 'influence and access' with men and women's entitlements and capabilities and a direct feedback to the vulnerability context.

The Gendered Livelihood Strategies (part D) denote the range and combination of activities and choices that men and women make and undertake in order to achieve their livelihood goals (DFID, 1999). Gendered livelihood strategies are greatly varied across sectors, between gender, within households, and over time.

The Livelihood Outcomes (part E) are the achievements or outputs of the Gendered Livelihood Strategies. The richness of potential livelihood goals maximizes the efficacy of the outcomes that are pursued.

2.8 Gender and Climate Change Analytical Framework as a Research Method for Study

The above mentioned Vulnerability, gender and livelihood framework provided the holistic understanding to analysis of genders norms values, assets and recourses because of which climate change have different impact on women and men which guides this study. At its core, it emphasizes specifically on the gender roles, responsibilities, and decision-making power which shape the livelihood strategies available to women and men in the study area.

In order to understand gender-sensitive adaptation strategies, this study focuses more on gender differences in the impacts of climate change as well as on gendered roles and capacities in coping with these phenomena. Women face particular constraints in their capacity to adapt to existing and predicted impacts of climate change. In fact, gender-related patterns of vulnerability mean that the impacts of climate change are different on women compared to men. As such, gender-sensitive priorities and processes have been mainstreamed at all stages of this study around climate change impact and adaptation strategies. Equally important for distillation and analysis of existing mechanisms is for climate change adaptation designed to promote women's participation in disaster risk reduction to be gender-sensitive in the study area. Particular attention is given to documenting the different participation patterns of women and men to inform targeted adaptation strategies which poor women and men need for their security.

CHAPTER-3

RESEARCH METHODOLOGY

This chapter is particularly concerned with the information about the socio-economic and demographic background of the study area .This includes study site description, location, and climate condition of the study area site in historical perspective, social infrastructure of the study area and methodology used for data collection.

3.1 Physical Setting

Labdu Dikure Sherya irrigation system lies in the Nuwakot District located in Bagmati Zone, Central Development Region of Nepal between longitudes 85°02' to 85°29'E and latitudes 28°05' to 27°45'N. The district boundaries are marked by Rasuwa District in the North, Sindhupalchowk District in the east, Kathmandu and Dhading towards south and Dhading towards west. It occupies 1,121 sq. km area which is 0.76% of total area of Nepal. Most part of Nuwakot District lies on Mid-mountain region (83%) followed by High-mountain region (15%) and High Himalaya (2%). Elevation of the district ranges from 512m to 4876m.

Administratively, the district comprises one Municipality and sixty-one Village Development Committees (VDCs), and three electoral constituencies. Bidur is the district headquarter of Nuwakot. Trishuli River, Tadi Khola, Likhu Khola and Kolpu Khola are Major River and streams of the district and all the catchment water finally drain to Trishuli River.

Labdu Dikure Shera Irrigation lies about 10 km away from Bidur. Construction of the scheme was undertaken in 2040 BS with Thadi khola as the source of water. Prior to assistance by DoI, irrigation was rain fed and depends on monsoons through several temporary canals.

3.2 Methodological Framework

This study aims at describing and understanding certain mechanisms, to be precise -an adaptation strategy which is based on qualitative research method. For qualitative quantification is done to see the pattern of response through questionnaire method. The study has adopted a type of hybrid approach of both qualitative and quantitative method. It involved extensive review of secondary sources of information supplemented with some informal interviews and interactions and participants' observations. The methodological framework adopted in the course of the study is illustrated in figure.

3.2.1Research Methodology

Research Process

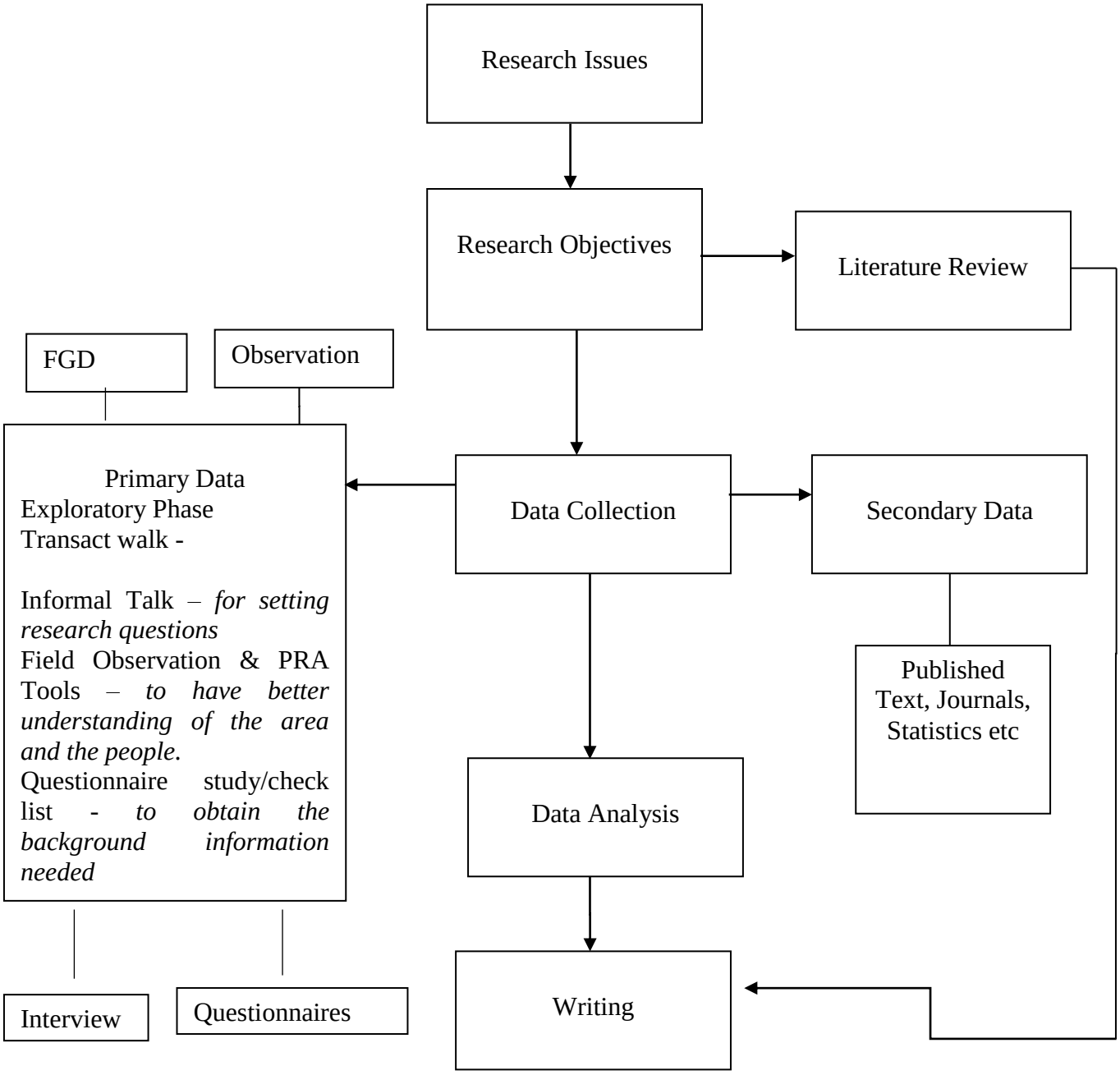


Figure 3.1 Research framework

The major steps adopted to conduct the study are presented in figure. Several books, journals, articles and research reports were studied from the start of the thesis. These sources were major basis for the identification of the problem and setting of objectives. Apart from the table based study, exploratory visits were also helpful in setting of objectives. The second step includes site selection. As the field study has

been conducted as part of Gandaki Basin study of HI AWARE in irrigated scenario, the site selection is guided by case of hill irrigation system in the basin. Being one of the medium and old irrigation systems of Nepal under hill irrigation promotion program of the government, covering 7200 *ropanies* of land was also one of the reasons behind selecting this area for conducting research.

The next step in research was data collection; mainly primary data collection. Secondary data were collected from sources like office visits, internet surfing and literature reviews. Official visits were taken in this part of research whereas internet surfing and review of literatures were conducted throughout the period of research. Primary data collection was the major component in this stage, which was conducted in two phases:

- Exploratory Phase
- Case study

And finally data were processed and analyzed to get final result. And the last step was writing up of the thesis.

3.2.2 Nature, Sources and Techniques of Data Collection

I collected data for a period of 14 days (4^{th} to 18^{th} July) 2016 in the command area and remaining days of July-August at different levels; from users of irrigation system, members of WUA's , members of local governments bodies and outsiders view apart from users of system.

At the level of users, combination of different research methods was applied to collect data at community, farm, and household levels: participatory rural appraisal (Hazard mapping, Resources mapping, Respondent ranking of hazards). Qualitative and quantitative data collection methods were used together. Focus group discussions (FDG) and in-depth interviews were conducted in addition, to produce a detailed understanding of local ways of life.

For an ethnographic study of ways of life in the selected area I resided for 14 days in the villages consecutively. It was at the house of the Ex president of the water users' association. This location was selected to get information on local WUA leaders, and to identify active members involved in the WUA. The house was located at the village centre, next to the main road, and provided an opportunity for me to understand daily life in the village. As a paying guest the researcher stayed there which is crucial to understand intra-household dimensions. By studying street life I tried to understand people's mobility. Continuous stay in the study site provided rich information to analyze and interpret the situation.

Secondary Sources

The secondary data which includes the demographic information needed was collected from different sources. These sources were published or unpublished articles, journals, field reports and research studies undertaken by individuals and

institutions in the past. Kathmandu Metropolitan office, Central Bureau of Statistics (CBS), Ward office, Department of Irrigation and local Non-governmental Organizations were also source of supplement information**.**

Primary Data Collection

I. Exploratory Phase

After the site selection, there was an exploratory visit in the area with the supervisor. This helped to explore different facts about the area like available resources, use of resources, how people earn their livelihood, different type of occupation they have adopted, different group and castes of people in the area. The exploratory phase was very helpful in the stratification of the population for in-depth study. Methods adopted in this phase include informal talks, field observation, resource mapping and questionnaire study which are explained below:

- **Transect walk:** was done (transect) across the community/project area together with the local people to explore the Irrigation system by observing, asking, listening, looking and producing a transect diagram. The transect walk was conducted during the initial phase of the fieldwork. The information collected during the walk is used to draw a system layout of the irrigation, area under coverage and households being served. Along with it a needs assessment was conducted to determine the difference between the current situation and the desired situation (head end and tail end users' water distribution).

- **Informal Interviews and Interactions:** During the visits to the study area, informal interactions were conducted with people of the area about general climate change issues and impact on irrigation. This talk was helpful to find out their concerns to water related problems in the irrigation system as well as day to day activities. Interaction was directed to the local resident of the area, President of *Labdhu Dikure Sherya* Irrigation System, officers from Department of Irrigation (DoI) Office (Nuwakot) and others. This facilitated in finalising the research questions.

- **Field Observation:** Field observation was carried out first to get in-depth understanding about the technical layout of the system, as an irrigation system is a technological-societal artefact. It is followed by understanding social dynamics and demographic composition that often determines the flow of water in the system. This involved physical observation of the study area and interaction with the key stakeholders. This also helped to get closer to the people and feel the real problem of the area.

- **Resource Mapping**: Resource mapping is a method for collecting and plotting information on the occurrence, distribution, access and use of resources within the economic and cultural domain of a specific community. In this research also resource mapping technique was used to locate the resource of the area.

- **Questionnaire Study**: After resource mapping, different impacts of climate change were observed in the study area which were affecting differently to different people. Based on this, questionnaire was carefully designed targeting the objectives of the research and several other questions were also included to supplement the study and enhance the quality of result (Questionnaire is attached in appendix.)

		
a. Informal Interactions	b. Questionnaire Study	c. Resource Mapping

Photo 3.1 Exploratory Visits

II. Case Study

Case study method is adopted:

- To explore new areas and issues where little theory is available or measurement is unclear, for instance gender impact and adaptation strategy
- To describe a process or the effects of climate change event
- To explain a complex phenomenon, actions, strategies or behaviors prevailing from differential power relation
- To explain interactions among the actors

This research was an exploratory research with an objective of exploring the adaptation strategies of the people in response to climate change impact. So case study analysis is the technique adopted because it helped to achieve the new insight into the problems and stresses that are caused due to it and how the people are responding to it.

For this, some cases were selected by using purposive sampling method. This involved the deliberate selection of the particular units to collect additional and detailed socio-economic information.The basis for this selection climatic stressors specific problem along income, education, gender, caste, class and location specific issues. Such as, male and female member from same household has been taken as two cases; member from same caste but different income level has been taken as different cases so that comparison can be made.

Both structured and open ended questions were used in the interview. Based on the respondent's answers, subsequent new questions were also asked.

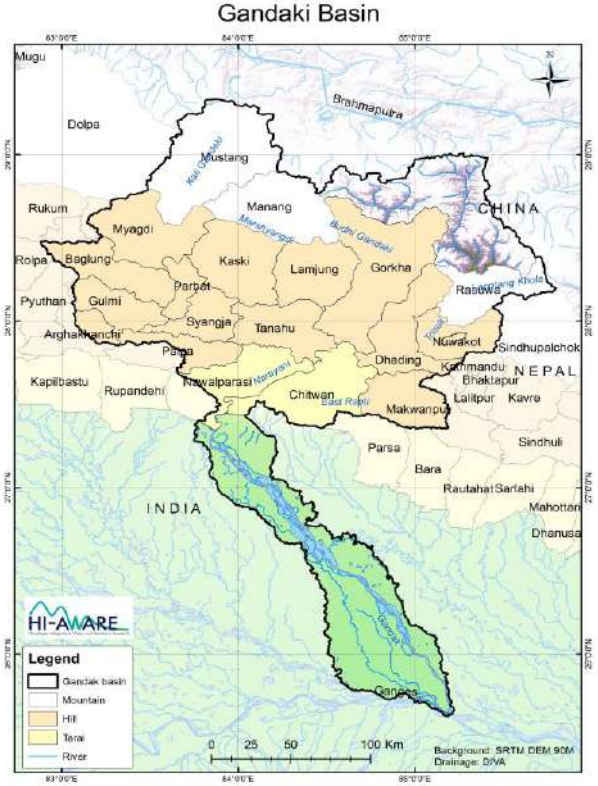
Analysis

This is an exploratory study that aims to link climate change parameters like (more hotter and colder day, wind speed, irregular rainfall, dew, smog, fog, flood, hailstorms) in health education, income level, ethnicity and gender and that ultimately impacts the livelihood of people living in the area, so it adopts both qualitative and quantitative methods in analysis. The data obtained from questionnaire study are presented in diagrams and charts by using MS office excel. For this purpose, the responses were ranked if needed and analyzed accordingly. The second phase of analysis includes analysis of cases in which the outcomes of the household study and stories were linked with reflective analysis linking to gender and climate change theories and literatures.

3.3 Study Area

Labdu Dikure Shera Irrigation system located in Khanigau of Nuwakot District which is implemented by the government of Nepal in 2040 BS year, belonging to the category of medium irrigation system is studied. This system lies in Gandaki river basin and receives water from Thadi River that is a tributary of Trisuli River. Trisuli River flows down and joins with Thadi River to Narayani.

The Gandaki River Basin (GRB), Nepal spreads from 27°21'45" to $28^0$36'36" degree north longitude to $83^0$08'00"- $84^0$53'00" degree east latitude (DDC, 2002). It covers the areas in the Mountain zone (Mustang, Manang, Gorkha, Rasuwa Districts), Hill zone (Myagdi, Kaski, Tanahun, Lamjung, Syangja, Parbat, Dhading, Nuwakot, Makawanpur, Baglung, Gulmi, Palpa), and the valley Terai zone (Nawalparasi, Chitwan, Kapilvastu). The average temperature of this area ranges from -9^0Celsius in Mustang to 42.5^0Celsius in Chitwan. Average annual rainfall is 26.58 mm in mustang to 2500 mm in Chitwan.



(Source: Hi -AWARE, 2017)

Figure 3.2 Map of Nepal showing Gandaki Basin and Nuwakot district

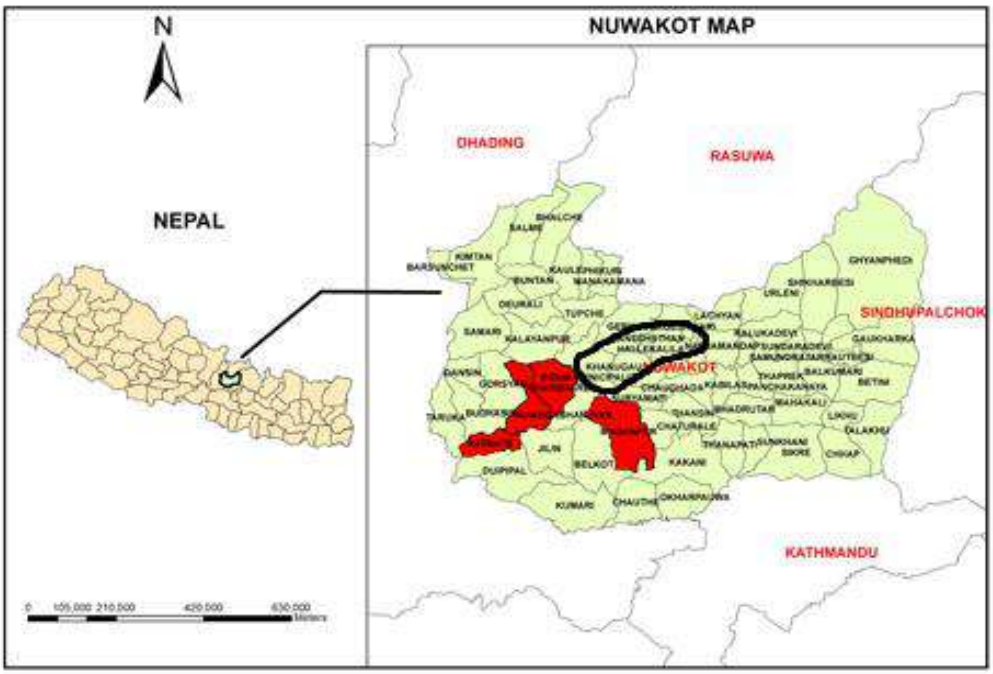
The catchment area of river Gandaki is trapezoidal in shape up to Triveni. Out of its total catchments area of 45.731 sq. km, 5.687 sq. km is in Tibet (China), 30.882 sq.km in Nepal, 1874 sq. km in Uttar Pradesh (India) and 7.288 sq. km in Bihar (India). It runs a course of 380 km in Tibet & Nepal and about 250 km in India.

3.3.1 A glimpse of Nuwakot District

As discussed earlier, Nuwakot District is located in Bagmati Zone, Central Development Region of Nepal between longitudes 85°02' to 85°29'E and latitudes 28°05' to 27°45'N. Elevation of the district ranges from 512 m to 4876 m. The district has historic significance. The rise of Shah Dynasty in Nepal became significant after the then King Prithvi Narayan Shah conquered the district. Nuwakot Dabar, one of the then largest Darbar signify the rise of Shah Power in the country. The district has mobilized national budget in past to build some of the major development projects like Trisuli hydropower, medium irrigation system like Labdu as well as one of the first lift irrigation system.

Bidur is the district headquarter of Nuwakot. Trisuli River, TadiKhola, LikhuKhola and Kolpu Khola are major rivers and streams and all the catchment water finally drain to Trishuli River. According to the Census 2011 (CBS) the total population of Nuwakot was 277,471 with an annual population growth - 0.39% and having 52.14 % population of female. The trend of men migrating out of the district is visible in Nuwakot too. Though varieties of Caste and Ethnic groups reside in Nuwakot, the Tamang (42.84 %), Brahmin (18.94 %), Chhetri (12.60 %) and Newar (7.44 %) are the dominant groups. Similarly, Rai, Kami, Magar, Damai, Sarki and Gurung do also

have remarkable presence within the district. Out of the total land of Nuwakot, 40.68 % is occupied by agricultural land or grass land and 36.06% is forest area. Likewise, 19.77 % of land is shrub, 2.02 % of total land is barren and 1.14% Snow covered (GoN, 2013).



(Source: ICIMOD, 2017)

Figure 3.3 Map of Nuwakot district showing irrigation system

3.3.2 Labdu Dikure Sherya Irrigation System

Labdu Dikure Sherya Irrigation lies in the central development region of Nuwakot district, about 10 km away from Bidur Municipality. Construction of the scheme was undertaken in 2040 BS (1983AD) with Thadi khola as the source of water. Prior to assistance by DOI, farming was rain fed and some parts were irrigated depended on monsoon through several temporary small canals.

The command area of the system extends to two VDCs that is Ganesthan and Khanigau which include 7200 ropanies of land 366.29 ha. Since the area under the irrigation command is large, water distribution is on rotation basis making water available for each 10 branches is equally on time basis. However the water availability in all the branches are not equal (figure below). The households which are direct beneficiaries of this irrigation system in the two VDCs area about1100 HHS

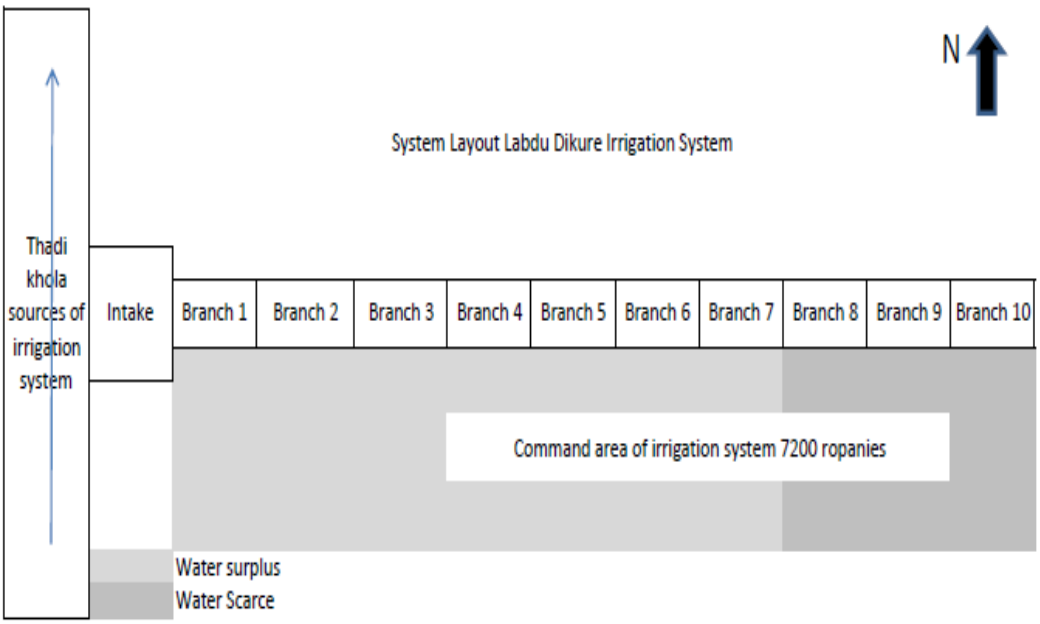


Figure 3.4 Irrigation System layout

CHAPTER-4

RESULTS AND DISCUSSION

This chapter is provides results on socio-economic and demographic background of the study area with respect to climatic and socioeconomic changes .This includes informant perception on climate change, social values norms, role and responsibility, their priority options and the gendered impact on livelihoods due to climate change and their adaptation strategies

4.1 Background of the Respondents

People in this area were from different background in terms of caste, class, place of origin and duration of stay. This was known from the exploratory part of the research which included the use of different methods like informal talks, field observations and questionnaire study. This sections of the chapter discuss about study site in historical perspective, social infrastructure, and occupational structure, cropping pattern and findings.

4.1.2 Population Distribution and Composition

The study area comprises of 1100 households with the total population of 5740. The household and population distribution in terms of sex is depicted in Table1 (as per the informant secretary and ex-president of WUA. Out of the total population of 5740, male population number 2900 and female 2840 in which 63 household are female headed whereas rest households are male headed.

Table 4.1 Population distribution in terms of household and gender

Branch No.	**Location**	**No. of households**	**Total Population**	**Male**	**Female**
1	Labdu	200	1100	600	500
2	CharSaiPhatLabbduTar	100	575	280	295
3	Tuniboleyhhat, Labaley	100	575	295	280
4	Chautra di bazar,Pipeliphat	100	575	275	300
5	Ram Mandir	200	1200	700	500
6	Barabisey,Ghatetar	150	880	480	400
7	Barafedi	100	450	250	200
8	Kasturitar	50	125	75	50
9	Mathiloshera	50	130	70	60
10	Talloshera	50	130	80	50

(Source: Field study, 2016)

Table 4.2 Households Distribution on the basis of Caste

Branch No	Location	HOUSE HOLDS ACCORDING TO CASTE IN BRANCH						
		Brahmin	Chhetri	Newar	Rai	Tamang	Dhami	Sarki
1	Labbdu	6	8	6	180			
2	Char SaiPhatLabbduTar	12	8		80			
3	TuniboleyGhat, Labaley	40	20	30	10			
4	Chautra di bazar,pipeliPhat	30	20	21	13	11	3	2
5	Ram Mandir	80	40	40	25	15		
6	Bara bisey, ghatetar	60	36	20	15	15	4	
7	Barafedi	25	30	14	10	15	6	
8	Kasturi tar	15	8	12	5	5	5	
9	Mathiloshera	15	25	10				
10	Talloshera	25	20	5				

(Source: Field study, 2016)

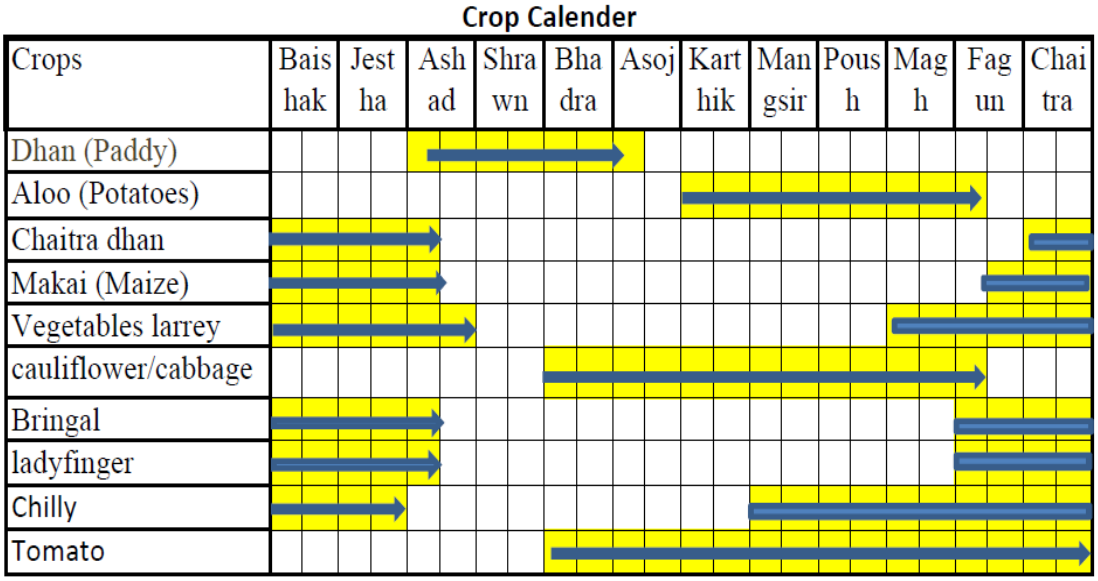
VDC is comprised of different caste and ethnic group. This village is a caste stratified society as other villages of Nepal which consists of Matwali and Untouchables. The village area is highly dominant by consisting of Brahmin, Chhetri and Rai community.

4.1.3 Cropping Pattern

The major cropping pattern followed in the system are rice cultivation during Ashad - Asoj, potato cultivation throughout Kartik - Magh, Chaitedhan rice cultivation in Falgun -Jestha. In the past days, before irrigation system the production was of a subsistence type which was seldom enough for annual household consumption. After the availability of water for irrigation cropping intensity has been increased. Farmers started to grow 3 bali (three times a year compared to two times before). After harvesting, potatoes are planted. Currently, the potato plantation is a commercial crop. Likewise different kinds of vegetables are grown for the commercial purpose. The branch no 1, 2,3,4,5 of study area is highly characterized by commercial vegetable which are sold to the market of Bidur and Trishuli, even to Kathmandu due to availability of irrigation water. Especially Brahmins and Chhetris and Rai carry out such tasks in which the males are predominantly involved in controlling cash income that has been generated from selling the vegetables.

The various crops cultivated in the study area along with their harvesting period are shown in table 4.3.The various crops cultivated are paddy, maize, vegetables such as potatoes, cabbage, brinjal, lady fingers, chilies and tomatoes.

Table 4.3 Crop calendar



(Source: Field Study, 2016)

Note: The arrow indicates the time period of the crops from sowing to harvesting.

Varieties of crops both local and improved are being practiced. Varieties of vegetables have also been practicing since 2009/10 (066/67B.S.). Table 4.4 shows the food crops and vegetables being practiced in the area.

Table 4.4 List of Food Crops Grown

Common Name	Local Name	Varieties
Rice	Dhan	Hybrid varieties ,Taichung, Manakamana,local
Wheat	Ghau	Annapurna-3, R-R 21
Maize	Makai	KhumalPahelo, Manakamana-1(seto)
Millet	Kodo	Dalle, Pangdur

(Source: field study)

The wheat and millet production is almost nil and few have been practiced for their household needs but large scale production has been stopped since 10 to 12 years before as per the informants. Locals have started cultivating vegetables because of their market values.

Table 4.5 List of Vegetables Practiced Over the Area

Common Name	Local Name	Varieties
Cabbage	Banda Kobi	Green coronet/kordio
Cauliflower	Phulkobi	Snow mistic, Kathmandu Local
Radish	Mula	Minu early,40days,Tokonasi
Onion	Pyaj	N53, Local
Larry vegetables	Gheusimi, Bodi, Lauka, Cucumber, Farsi	Bhaktapur Local, Local
Tomato	Tamatar	Local, Srijana, Surukchha

Coriander	Dhaniya	KathmanduLocal
Chilly	Khursani	Local
Lady's Finger	Ramtoria	Hybrid
Bringal	Bhanta	Hybrid
Bean	Simi	Hybrid

(Source: field study, 2016)

4.1.4 *Parma* System

Parma system is the reciprocal exchange of labor within the village between neighbors or relatives. In context of study area, the *Parma* system has been shadowing due to out-migration of males and females or being busy with their own works. Similarly, the migration of females either marrying or for higher studies has diminished the *Parma* system in the study area and male for alternative jobs or in gulf countries. Instead the paid labour is commonly practice. The males and females are hired by paying daily wages. The daily wages of male is NRs 700 per day compared to female NRs 350 per day.

4.1.5 Road Infrastructures

The research area lies in the VDC. There are regular and direct transportation available to people over there. Due to the road, market opportunity is open to the farmers. Hence farming has been commercialized in the command area. Also the intensity of youth going to study out of the village has increased.

4.1.6 School

Nowadays, both the girls and boys have access to school compare to previous days. The level of discrimination was found to be minimized while sending girls and boys to school. Basic education is provided to both girls and boys even though boys are prominently emphasized to educate them. The school is standardized as the English Medium School which is different than other government schools. Still when it comes to investment, there are cases that expensive school are for boys than girls. Also for higher education, boys get priority compare to girls with exceptional cases where the social cultural gender differences are minimal due to caste factor. For example, among Rai the gender differences are less compare to Brahmin Chhetris.

4.1.7 Health Post

There is a health post situated in *Labdhu* which provide basic health services. But in context of serious and severe cases, patients are taken to the hospitals of Bidur, Battar and Kathmandu.

4.1.8 Bank and Cooperatives

The people are getting the services of bank and co-operatives. Many co-operatives are being run in the study area to facilitate the loans for the farmers. Besides, giving loans, these co-operatives also provide manure for the farmers; the members of the co-operatives are given the first priority.

4.1.9 Agricultural Tasks and Activities Analysis

"Gender norms in Nepal categorize farming as the men's domain" (Ghimire, 2005). As such, although women involve prominently in the agricultural tasks, they are less identified and valued even though the women performs at par with men. From the table below, we find that weeding, transplanting cereals crops, threshing grain, are the tasks all done by females. Likewise, sowing grain, hauling manure, smashing clods, going to mills, growing vegetables, almost fall within the domain of the females. As shown in the table, except ploughing which is the taboo to the women and making ridges, going to markets almost all the other agricultural tasks have been performed by females in the research area.

Hence, for carrying out agricultural tasks, the women and men have to hire labor either for ploughing the field which is taboo for them or for transplanting which is only their task. In the research area, Parma system is still prevalent (in wage labor form) but not as much as it used to be in the past since due to migration of men and being busy with off farm activity, the works of women have been doubled.

If the outside labor or *Parma* is required for transplanting, all tend to be women labors. Out of the respondents, for the category of sowing grain, respondents replied that it is always done by the females. Weeding is the task which is more strenuous and time consuming work that lies in the head of women. It is considered one of the most monotonous works so especially girl children along with the aged people are engaged in it. Nowhere, in the research area, this is found to be done by the men neither in its history nor the same norms in the course of transforming in the present as well. For illustration,

> *"When the researcher asked a question regarding this then a lady said, this question doesn't need to be asked. It's natural that this (weeding) task is solely performed by the females only. Such type of boring work is not handled by the men."*

It clarifies that most of the agricultural activities are performed by the women in spite of, ploughing and making ridges are considered to be totally masculine works. Ploughing the field by the females is a taboo (the only work which is not considered to be performed by the females in absence of males). In the study area, those who don't have ox, use *Parma* from their neighbors or tractor. But those who don't practice *Parma* system hire the labor on daily wage basis along with plough man. In this area, plough men are called as *Lattey*, From the studies, it is found among 20 of them had replied that ploughing and making ridges were the works only done by males because *Lattey* are also males. It is considered as hard tasks that require physical labor which is really difficult for women to handle as it is perceived that women are physically weak than men from long time ago. The table 4.6 shows the various activities involved in agriculture, and distinguished between activities done by male or female farmers.

Table 4.6 Analysis of Activities

Different activities done by men and women

Activities	Always by men	Usually by men	Done by either	Usually by women	Always by women

Agricultural Tasks					
Ploughing					
Making ridges					
Irrigating khet					
Irrigating bari					
Sowing grains					
Weeding					
Transplanting					
Threshing grain					
Harvesting rice					
Hauling manure					
Growing vegetables					
Raising chickens					
Going to mills					
Going to markets					
Daily H.H Tasks					
Hauling water					
Cooking food					
Cleaning cookware					
Washing clothes					
Feeding animals					
Milking animals					
Collecting drinking water					
Caring for children					
Off-Farm Activities					
Building houses					
Thatching houses					
Erecting fences					
Cutting firewood					

(Source: Field work, 2016)

June/July and February/March are the months considered as peak agricultural seasons in the study area. Women and men engage in agricultural activities from dawn to the evening as the community is highly dependent in the agriculture for economic pursuits. The men prepare the field for rice plantation by wetting the *Khets*, ploughing the *Khets* and making ridges. Unlike the studies in the previous day, it's been found that irrigating Khet has been, nowadays, the work domain for women as well since 10 respondents replied that it is done by either sex. This is also due to increase men migration as well as men engagement in off farm activities. The trend of irrigating field earlier used to be men's job. Similar trend of gradually women getting involved in most of the farm work is observed due to men engagement in outside activities.

4.1.10 Daily Household Tasks

Nepal is highly influenced by Hindu ideology which is characterized by patriarchal norms and values, so is reflected in the study site too. Thus, women and girl children are prominent ones to handle the tasks which are related to indoor activities like cooking food, cleaning wares, washing clothes, fetching water, caring for children, sweeping courtyard and feeding the animals. In contrast, for milking cow both of them do the work in collaboration those who have leisure depending on the situation. Most of females start to handle their domestic affairs getting up at dawn before any one gets up, they start to mop the floor with red clay. To illustrate, morning visits to the site I noticed, the female lead of the house usually mop the floor with red clay. At the same time, while asking one of the ladies where the main male member at the time when she was mopping, she replied that he has gone to fulfill his daily routine job; it meant he is having his tea somewhere in the tea stall and reading the newspaper.

In the research area, the females use water from the canal for feeding animals, sweeping, etc. except for drinking purpose and washing utensils and clothes. Before the availability of irrigation water in canal, the females used to walk long for fetching water. Now it has reduced their time in such activities and instead utilizes the same time in managing at their home. For drinking purpose, they usually go far to fetch water. Caring of children is the sole responsibility of females but in the rural areas, most of the families are joint; adjoining grandmother and grandfather so they take care of them in absence of females.

Females have sole decision power in terms of cooking food or a female in the house decides what to cook, how much to cook, however her decisions are guided by pleasing the men head. Over the time, she had understood the preference of man-head of the family and it is planned as per the preference of men. In the study area, daughter-in-law of the house takes food lately after feeding all members. She can't have it before anyone in the house especially in the joint family. Similarly, after having meal, females wash dishes and clean the kitchen. Many daughters-in-laws are wife of migrant men.

As such, females carry out the daily domestic chores in which children go to the schools and job holders go to their destinations and as usual the females keep on continuing the same domestic affairs and other agricultural tasks or in the field. This way, women are often not in touch with outside happening directly, for instance information on new technologies and policy/programs are channelized to her through men members. Similarly Off-farm activities as categorized in the table like erecting, thatching roof, building houses, cutting firewood in the jungles are works performed by males as they require physical labor, and one has to engage in building houses. For carrying out such activities, one has to deal with other hired labor that is also male. Once in the morning, while making a visit and interviewing one of the males of a house, he was thatching roof along with other labors whilst his wife was threshing grain.

4.1.11 Summary

From the above mentioned contexts, came to the conclusion that the study area is dominated by the Brahmin, Chhetri, Rai and Tamang castes. The tasks like ploughing are sole task that is primarily carried out by males only. Ploughing the field is taboo for women which needs more physical labor. The other main tasks like making ridges also fall under the sole domain of males. In contrast, nowadays, the nature of agricultural tasks has been changing due to

migration of males towards gulf countries or India for unskilled wage labor, specially on irrigating farm and other agricultural activities.

For migrant women like Mrs. Rai, both the indoor and outdoor activities are in the head of females. Hence, this has led to increased workload of females in the study area. In the past days, females had to engage only in domestic chores but without any flux and change in the existing system (female's traditional tasks like washing the dishes, bringing water from the tap).In other words, the indoor activities as daily household tasks are considered the females tasks. There are cases that there is increasing trend of women owning land, that can be related to recent government policy on fee waiver while registering in women's name. Even though the female's access to land and agriculture has increased, it was found that the males have control over the resources. Simultaneously, the glimpse of change can be seen in the work domain of females.

The findings of this study corroborate some of the findings of Ghimire (2005) as; even though women play substantive role in the agricultural activities, their work is less identified and valued. Due to migration of males, the agricultural works have been primarily handled by the females in absence of males which has overburdened the work. Unlike men, the young female, too, are attracted towards urban areas for their higher studies after accomplishing their secondary level studies for some progressive families.

4.2 Gender in irrigation management in context of climate change

This Section explores the results regarding the roles performed by the males and females of the study viz. it reveals the participation of males and females in different processes like water acquisition, allocation, distribution, operation and maintenance, resource mobilization, conflict resolution in terms of their actual labor contribution and their decision making

4.2.1 Irrigation Management

This section deals with the background of irrigation system; overall management of the irrigation system like planning and decision making, local resources used and mobilization, water acquisition, water allocation and distribution, conflict resolution.

4.2.2 Background of Irrigation System

In *Labdu Dikure*, prior to the development of irrigation scheme, irrigation service was neither reliable nor accessible to most of the farmers. The command area was under rain fed farming prior to the development of the scheme. The farmers were growing rice, wheat maize during monsoon and winter. The farmers were making continued request for the development of an irrigation canal with Thadi khola as the source of water supply. On pressing the demand of local farmers and leaders, finally, Mr. Khadka, a local leader initiated the project in early 2033 BS and was in use from 2035 BS as per the informant. The farmers contributed 10% of total cost as equivalent cost in terms of labor contribution during construction period.
With initiation of the project, the *Labdu dikure shera* irrigation was highlighted as one of the largest irrigation schemes in hill area as per the command area by irrigation department and its production was also highlighted after the scheme. The farmers were able to sell the goods to the market and cropping pattern has also been changed from two crops a year to three in a year.

4.2.3 Planning and Decision Making

Water User's Association (WUA) in the study area comprises of 11 members in which 2 are represented by female candidates. The WUA in the system was formed and registered in early 2040 BS as per the informant. In the *Labdu Dikure Shera Jalupabhokta Sanstha*, there have been 8 presidents till date after the establishment of the system. Mr. Khadka was the first elected president of the system followed by Mr. Rai, Mr. Dhakal, Mr. Shrestha, Mr. Rai, Mr. Dhakal, Mr. Lamichane, and Mr. Dhakal. Currently again Mr. Lamichane has been nominated and Mr. Dhamala has been the join secretary of the system.

The Executive committee of the WUA consists of 11 functionaries where two positions are reserved for female farmers. The functionaries in the Executive committee are elected by the general assembly of the users for a 2 years term. There are 10 branch canals in the system. Each branch canal has a branch committee that consists of 7 functionaries who are responsible for the distribution of water among the users within the branch and one from each committee go to central committee panel.

4.2.4 Resource Mobilization

Initially, a member of household who is beneficiary of the irrigation system has to be mobilized as a labor for emergency repair and maintenance need in the system wherein each household was required to send one able man to work for the required duration at the time of annual de-silting of the canal. It created the problem that a person having 5 ropanies and 1 ropani was obligated to participate anyone on the basis of household which was not equity based. Considering this reality and problem into account the new rule was set up. Later on, the rule was changed which was based on the equity. Nowadays, the fees are collected on the basis of the size of the irrigated landholding. The rule is that: one has to pay NRs 100 per ropani to the WUA which is collected in the fund of users group and is used for the operation and maintenance of the system in the upcoming days.

Likewise, it is learnt from the past experience that each household required to send one able man to work for the required duration. At that time, one person used to be sent from each house either they have 1 Ropani or more than this or less than this too. Similarly, in the past, the users were involved as sending a candidate regarding irrigation. It was observed and experienced; some people being lazy, some not sending any one due to sickness, sometimes there was problem because of lack of active members at home which meant some of the households didn't have younger candidates in the family or had only old people who couldn't carry out the task. Such situations created the problem which obliged to set up the new system for collecting the fees on the basis of landholding formulated for the sustainable management. Hereafter, the existing trend is based on the equity sharing of the cash so that it would be collected to the WUA which can be used to hire the wage labor for the maintenance and operation of the system.

De-silting repair and maintenance of the canal is now done by the hired labor and the hired labor are themselves; the farmers having small land holding size and sometimes outsiders. The remaining cash is used to pay water guards and for construction if needed in the system. WUA has to maintain the record of income and expenses and to present them out in annual general assembly carried every year.

4.2.5 Water Acquisition

Water acquisition is the process of acquiring water from the sources. The source of this irrigation is Thadi Khola, which is perennial source of water and originates from *Surya Kunda* of Rasuwa District that flows in Nuwakot District. Water is available for all types of crops round the year but there is variation in the quantity of water on the basis of seasons. For water acquisition, various activities as design, construction, operation and maintenance are carried out. The length of the canal is 14 km. It is permanent in its type which was made in the collaboration of local people and DoI. Not all branch and sub branches are equally maintained and during the transact walk, is found to be eroding specially in tail end. There are altogether 10 branches.

4.2.6 Water Allocation and Water Distribution

Water allocation means assigning rights to user and determining who shall have access to how much of water. In *Ladchu Dikure Shera* irrigation, water in the study area is distributed on the basis of the land area in the branch canals. The norm of distributing water is based on the turn system for which the branch canals have been divided into several sub-canals to irrigate each and every plot of land. From the main canal, one water guard is assigned who is either called *Herala* or *Pani Paley i.e. water guard*. He is paid NRs 4000 in cash monthly depending on the nature of work. That *Herala* or *Pani Paley* is assigned to take responsibility to distribute the water from the main canal in which there are coordinators in each branches to disseminate the information regarding water acquisition, resource mobilization, water distribution, and system maintenance and conflict resolution. So at night too, there is provision of providing him lights to walk and observe at midnight if something happens. There is no female *Herala* for distributing water from the main canal since it is conceived as more challenging job. The turn of night irrigation could be troublesome for women farmer.

4.2.7 Operation and System Maintenance

Maintenance means repairing and cleaning of the system to make water acquisition and distribution smoothly and efficiently. In the study area, maintenance works start before growing rice that is on the month *Ashad*, as it is observed the system needs to be further cleaned by cutting unnecessary weeds, shrubs and digging out stones, gravel etc. It is obvious that the maintenance in the system of the study area is inefficient. During the maintenance within the branch system/whole system, labor and material resources are mobilized on the basis of the farmer owns. Sand, small stones, pebbles are used as local resources. There is change in one person one house policy for labour contribution to Rs. 100 per Ropani contribution which is based on equity perspective on land ownership that has equal benefit to small and marginal farmers.

4.2.8 Water Guard

Pani Paley or *Herala* who works as employee in a system, has been appointed by the WUA. He is responsible for the monitoring of canal operation and allocating water in different parts of the system. He is also responsible for the minor repair and maintenance on day-to-day

basic. During monsoon season, the work load of *Pani Paley* increases, so keeping in mind they hire additional Paley temporarily for the seasons to help him out. The *pani paley* is paid NRs 4,000 per month.

4.2.9 Conflict Resolution

Those farmers who are from downstream face problem by not getting much of the water as per their needs The above mentioned statement reveals that sometimes the problem occurs in the study area due to lack of water to the farmers residing at the bottom of the canal. The WUA constitution does mention that WUA committee is responsible to resolve water conflict. However in practice, active engagement of WUA members on resolving the water conflict is not observed. The tail end farmers hardly receive water. Farmers residing at the bottom of the stream are deprived of getting the adequate water and sometimes due to the overflow of the water there is loss of crops as the top soil are eroded by the overflow of water. When the water is scarce water stealing takes place. Water guard is authorized to detect and identify person stealing water.

4.3 The Climate Change Impact on Gender and their Responses in the study area

Based on the collected data from the field Study , this chapter provides tabulation and analysis to reveal the findings on how are the vulnerabilities posed by climatic stressors are gendered in irrigated agriculture and what are the farmers belonging to different gender and social group coping and adaptive strategies. The climate change impacts on gender and adaptation strategies are also presented in this chapter based on the gendered entitlements and capabilities described in the analytical framework which included social, natural, physical, financial and human capitals. Apart from these, this chapter also provides useful information that reflects the different status of men and women's lives and activities which are considered to have impacts on their perception and understanding of climate change and other stresses and adaptation choices. Discussion about the main findings is shown in the conclusion section of this chapter.

4.3.1 Home Owner and Livelihood Activities of Respondent

All 50 respondents' households owned their own land, and the owners of the house and land were generally men, except for few cases where the women had inherited such property from their husbands after they passed away. In few cases, even when women were the main income generators, they were disregarded as property owners. Rather the son is seen as the hire. Women were also the keepers of the household budget, but could only decide independently on small expenses, such as purchasing food items or certain tools, and they could not access this budget as much as they might need.

"My husband gives me the money he earns for buying food and small tools needed for family. I just know what he gives, and I do not argue or ask for more. He does not know anything about the current finance status of the family if I do not tell him. The amount he gives is not enough for the family living expenses, so I have to cut down on the household expenses as much as possible, or borrow from my relatives or neighbors. I never purchase valuable

furniture or equipment for the family. I follow his decision on this" (extracted from interview source field study).

In this process, women often compromise their wish. Altruistic behavior of women is devoted to family welfare first. On the contrary, according to male respondents, when men wanted to spend money on something, they would simply tell their wives to pay for.

"I do not have much money in my pocket, as I gave it to my wife already. When I think we should buy an electrical device or new equipment and furniture for our house, I ask her for the money. If I really need to buy something and it is likely that we do not have enough money, I would discuss with my wife to find a solution such as selling something in the house or borrowing from somewhere else".

In other verses, women keep the family budget, but they could not control it. They suggest that men should be the main income generators, and the male respondents shared their view. However, the fact is that men were the main income generators in some cases, and women in other cases. Household size and composition were important factors for the respondent' family because it was considered that their livelihood activities and incomes were contributed to by the number of people in the household. The bigger the respondent's household size, earning family members, the higher their income could be, and the young women could work more and the old less, compared to small families. Also in such settings, the elderly mothers get more opportunities to help her spouse or daughter-in-law with domestic tasks.

"I stay at home an old lady said, but 'my husband, my son, and his wife work'. I am mainly responsible for looking after my nephew and preparing lunch for the whole family. My daughter-in-law is in-charge of the dinner after work. She also cleans the house and conducts other domestic activities in the evening".

The narratives shows that women who work outside do need to take care of kitchen and domestic work for the family after office hours, whereas that that is not the case for men who work outside.

Agriculture operations are the main livelihood activities of all respondents which contribute to their sources of income. The landownership differs from families ranging 2 to 17 ropanies. Conversely, all respondents also mentioned that, while the agriculture operations were considered largely "men's work", women were also engaged in this production activity in order to help men to concentrate on other on-farm activities or off-farm employment.

Women play a key role in most agriculture production activities, while the husband and children help only to refurbish the field's surface. Maintenance of the storehouse is also necessary, and some respondents said that they had to do this kind of job every year in the case of a wooden or tent storehouse, and between two to three times for a concrete storehouse. Women had to hire labors to help them with this job if their husband and children are not available. All female informants stated that they tried to keep the investment in the production sector as low as possible, because they might face losses at the end of the production season. In process, women end of contributing labour work.

Regarding the irrigation operation, men are the main workers, and they get lots of support from their wives. Besides, being involved in the agriculture production and helping men in

operations, all women plant vegetables or raise poultry in their home gardens. Women say that these activities provide more food for their family and they can also sell the products at the market to earn some extra money. Some women try to find jobs in the vicinity of home, as a cleaner or cook or as *ropai* (cultivators) from adjacent village too for example, but men appear to have more mobility than women.

The information presented in this sub-section referred to the relationships between men and women with respect to their activities, finances, decision-making power etc. As explained, irrigation operation is the main livelihood activity which contributes to the household incomes of respondents. The entire production process is managed and operated by men, then women also involve in operations even when this production activity is considered largely as "men's work". Women's domestic and subsistence production tasks remain, but they are disregarded almost entirely as property owners, except inheritance instances. Roles in decision-making in the family's budget management are also gendered, with women having less of a say in decision-making, responsibilities and experience. This sub-section also indicates that when men have more decision-making power at home, households tend to spend more on men's preferred goods. With increase engagement of women in economic activities either for farm or off-farm activities, their work burden seems more, however men's engagement in domestic work appear still static and limited.

4.4 Economic, Climate Change Stresses, and Disasters

The trends affecting local economy, seasonal fluctuations in price, production and natural shocks (exposure to climate stresses and hazards) are vulnerability factors that men and women in the study area clearly could not control directly. These factors have a direct impact on men and women's assets and the options available to them in pursuing optimal livelihood strategies.

It is an acknowledged fact that the commune targeted in this study is situated in one of the oldest irrigation system of Nepal. The secretary of the system indicated that people's lives here have been changed significantly recently in terms of their access to key resources and relations that enabled them to increase their production, food security and income. All respondents in the interviews and group discussions agreed that the local economy appeared to diversify recently, with their incomes now coming from different sources rather than just from the irrigation as in the past. Therefore, diversification of income sources is a local common strategy to avoid risk, and as a consequence, additional ways of generating income are needed such as migration to the cities to engage in manual labor jobs as electrician and rising of poultry in the area; and even to abroad. Even a case of diversifying profession guided by caste and religion is observed (Box below)

A local man belonging to Brahmin caste used to earn his living through religion based activities such as doing pooja for community member. With the promotion of Ladbu Dikure Irrigation System by the government, compare to Pandit work, his earning from farming became more few years ago. He focused on purchasing land and intensifying farming. However with the increase incidences of uncertainties of farming due to climatic as well as socioeconomic stressors, he has started to pay attention to his earlier family job of offering ritual services. At the same time with increase of migration and uncertainties in the societies, the demand for religious counseling is more and the people offering such services are few in the village.

However it is possible for him to diversify the livelihood strategy due to his caste and possibility to do the religious job. The same for low caste man will different.

Diversification of income is a practical strategy employed by study households in order to reduce risk of external shocks since different sources of income are likely to be affected differently by external shocks. Income diversification appear to be key for risk management and help vulnerable respondent households to meet and smooth their family's consumption, social and labor needs, and improve incomes. The seasonal fluctuations in price and production are other critical trends over which people in the communes have limited or no control. Farming is a traditional occupation in these communes which used to provide a high and steady source of income. However the result of farming is in challenge as climatic stressors affect farming the most.

The respondents also noted that the cost of cereals and vegetables also fluctuates according to the selling time, and is lower than usual during the harvesting season. The harvest time price drop of vegetable product often happens partly because when all producers are waiting to sell at harvest time, they are fully exposed to price risk, basically bearing whatever the market happens to be offering at the time. If they cannot handle the volatility and switch out of production after the market crash, waiting until the price is up again before switching back in, then they are more likely to lose money and potential income. Hereafter, they are probable to be better off with low profit, or even suffer some loss, so that they can maintain their household during the market crash to retain this traditional job, or otherwise to secure a stable or sufficient income for the households some other way. And due to unavailability of cold store in the area, they have no others option rather than to sell.

Notably, as reported among all study respondents and calculated by the researcher, income from vegetables is three times higher than that of normal cereals production, but it requires more investment and includes more risks. It is indicated by the respondents that the price of cereal products is rather stable in the local market, but the productivity of this sector also varies according to the hybrid used, various techniques, and weather conditions.

The respondents believe that many households involved in the irrigation operations in *Labdu Dikure Shera* have losses for three consecutive years, especially was lower during the flood season in 2008 when all of their irrigated lands were swept away and destroyed.

There have been significant changes in weather pattern of *Labdu dikure shera* area of the system especially since 2005/2006 as per the informant. The weather now doesn't appear to follow the normal pattern as before, making forecasting more difficult. The temperature is now higher during summer and hot period longer than before (35 degree was observed during site visit which was to be around 30-32 degree before.) So is the case of winter; the whole area has recorded the cold period.

The rainy flood seasons normally comes from *Ashad* to *Bhadra* has been also delayed and hit harder and often destroy infrastructures (irrigation canal, intake, transportation, irrigated land). Flood is a natural phenomenon which happens annually in the area but it has recently become more intense and complex with the crest of flood being higher and stronger as per the informant. Each year flood in Thadi Khola has destroyed the irrigated land in some extent. The impact of climatic parameters on the livelihoods of the people is shown in tabular form.

In addition to flooding , abnormal rainy days, extreme hot days, extreme cold, fog, dew, high wind speed have significantly affected the lives and productivity in the area. Farmers are saying that this is the new sensation where high wind speeds, irregular pattern of rain, high temperature have affected them hardly, causing increase occurrence of disease and pest.

Table 4.7 Respondents' ranking of problems caused by climate change

1 Highest	Shortage of drinking water
2	Dew fog (Tusaro, Husoo), cold wave
3	High wind speed
4	Flood
5	Hailstorms
6	Land slides
7	Precipitation (rainfall)
8 Lowest	Extreme hot weathers

Other climate stresses and hazards observed by respondents and the researcher are tabulated below with the time frame of occurrence. All respondents reported there is lack of stable sources of fresh water, and they consider this as a serious environmental issue in commune and have drastic effect on their health as well as they are in danger zone in collecting fresh water for themselves as all the sources had been dried up or either polluted. Table shows how participants in group discussions ranked the level of seriousness of the problems caused by climate change phenomenon observed in these communes. The problem of drinking water has direct relation to increase vulnerability of women as it is their task to collect water every day.

There is gender role differentiation during the different phases of the disasters. Before any disasters, women are responsible for food preparations, water storage, packing belongings, while men take care of the home maintenance and production activities. The men also cut down some overgrown tree branches and participate in the resident's disaster reduction groups. During the disasters, men has tendency to take care of the public works while women care for the domestic arena, including care of the children and elderly. After the disasters, both men and women are involved in preparing or rebuilding the houses and recovering from the damages, though men tend to perform the tasks that require most physical strength. In commune, if men are far away from home, women are responsible for almost everything thus, their workloads increase significantly, and consequently they may have to ask for help from their relatives or neighbors in an extreme weather situation. Generally, both men and women suffer from the increased workloads before, during and after any disaster events. (Case of earth quake as per respondent what they did after the impact).

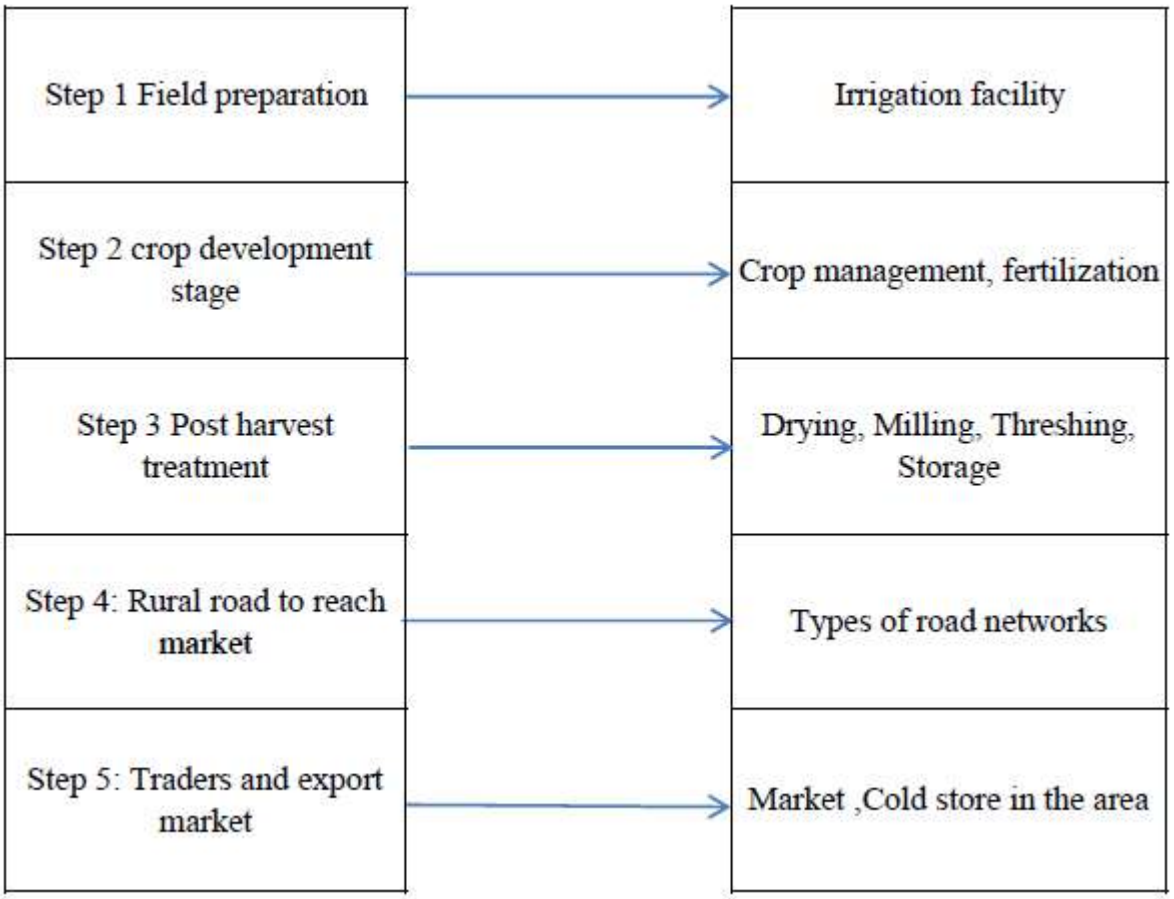
Table 4.8 Climatic Hazard Observed at the Study Area

Year BS //AD	**Disaster**	**Immediate Local Impact**	**Remarks**
2053 //1997	Flood *Thadi khola*	Most of the irrigated land has been damaged and high loss in crops.	Still land is unfeasible for cultivation.
2058//2002	Hail stone(*Asina*)	Loss of crops such as wheat, maize, mustard.	Food production deficiency
2058/57//2002/2001	High flooding	Intake damaged	
59,60,61,62...65// 2003.....2009	Flood	Irrigated land destroyed each year no major adaptation is adopted	Sal bisney to khukeway Gablion wall used to prevent
2071//2015	Hail stone	Loss of Maize, chilly, rice and irrigated land	
71....73//2014/2015/16	Flooding	Land cutting, damage of irrigated land.	Impact of flood is high on *Ashad* and *Shrawan*.
2070//2014	Flood Khareykhola	Damaged canal, delay in cropping time.	Reconstructed.
2069/70//2013/14	Landslides due to high flood and rain. (Chedi khola)	Canal blocked.	
2061 and so on /2005.....2016	Fog and dew(tusaro/husso)	Potato farming highly damaged.	
2072//2016	High wind speed	Damaged of Taichung rice	

(Source: Field Study, 2016)

So seeing the above trends, the livelihood of the farmers has been directly hit by climate change knowingly or unknowingly which can be furthers illustrated by the figure below:

At this point, five different stages can be seen and in each stage the impact of climate change can be seen.



(Source: Field Study, 2016)

Figure 4.1 Climate change impact on Elements of agricultural value chain

Step 1 - Field Preparation: Without the irrigation canal, it is not possible. Or to depend on the rain as stated earlier can delay the cultivation time because of the irregularities in rainfall pattern and maintenance of canal. So is the impact of flood and landslides in the canal in 2070 BS, which swept away the land and destroyed. So it has directly obstructed livelihood pentagon which will be further described.

Step 2 - Crop Development: First and the foremost, the irrigation water is a must and management of water is needed. Due to changing trend in the climate such as high wind speed, dew, fog and many more shows the wilting effect on vegetables leading to maximum use of pesticides. Few new types of plants also have been observed in the irrigated land making more difficult for the farmers.

Step 3 - Post Harvest Treatment: Rainfall at the time of drying, storage problem due to delay in drying, late wind after flowering is the major effects that have been observed.

Step 4 - Rural Road to Reach Market: Farmers have to export the goods to the market but the access to the market may also block sometimes due to landslides. In that case, they do not have the proper cold storage to keep their goods. Blockades in the country is also the factor and adding to that, it delays the arrival of the seeds and fertilizers and insects can ultimately destroy the crops, if the pests could not be applied at appropriate time.

Step 5 - Traders and Export Market: As stated earlier, farmers are hit by the various climatic factors. In addition to that, they cannot sell the products at appropriate rate by the reason of government not fixing the rate and due to lack of storage; they need to sell the product at loss sometimes.

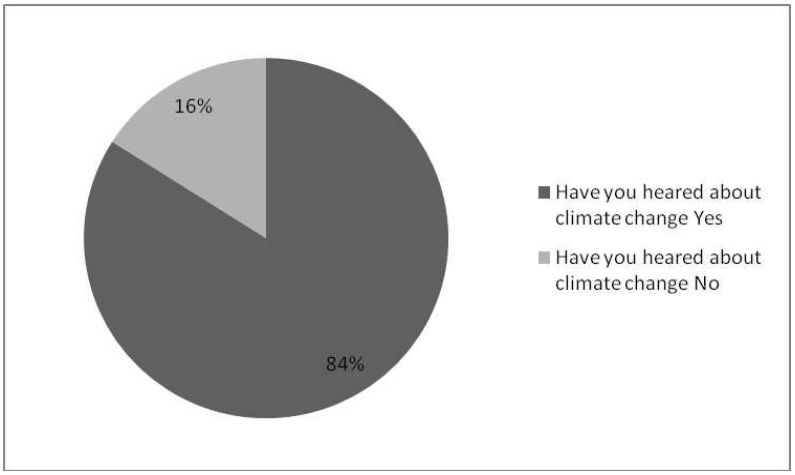
From the information presented in this sub-section, we have learned about the vulnerability factors in terms of economic and climate change and other stresses that are affecting men and women in the study area. These factors have a direct impact on both men and women's assets and the options available to them in pursuing optimal livelihood strategies, and it is clear that they could not control them directly. Women are more likely than men to suffer from these factors as they are often more vulnerable to disasters than men due to differences of socially constructed roles and responsibilities. Further information and analysis will be presented in the following sections.

4.5 Gender Perception on climate change

Impacts of climate change can be affected by gender patterns, culture, and other social relations. The IPCC (2011) has indicated that these impacts would be differently distributed among different sexes, ages, occupations, and lifestyles. It is also argued that the impacts of climate change can become one of the major threats to the social relations and the future of human society. This section focuses on gender-differentiated participation in household decision-making, community activities, and local political and management structures.

From the information provided by the respondents, this sub-section presents the discussion on the different types of roles and responsibilities of men and women in the decision making and process of consultation at the household and community levels, as well as stressing the importance of participation of both genders in the household-decision making, community activities, and local political and management structures. It is important to analyze participation of both men and women in all decision-making processes and management structures in order to promote and fulfill the right to equality for all persons, as well as to ensure the increased representation of women in decision-making, particularly, during the disaster events and in the process of formation of adaptation strategies and initiatives to climate change.

Of 50 interviewees, 84 % (42 people) have previously heard the term "climate change", or "mainly through television or the commune's public radio and loudspeakers, though not many could explain what climate change was. Actually, some people do not understand what climate change is, indicating the effect of changing climate is not drastic and obvious to many In day to day interaction with communities, the climate change impact is more perceived by community as effect on increase temperature, increase disaster like flood. Weather is more obvious at day to life than the climate. People do respond to trend, but not obviously expressing confidence that they know about climate change. The climate change phenomenon was understood mostly as the altered weather conditions that people in the area were experiencing.

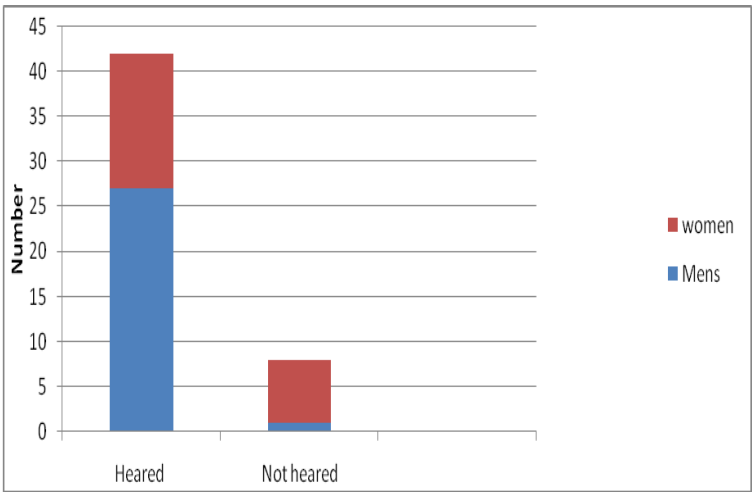


(Source: Field study, 2016)

Figure 4.2 Respondent's perception about climate change

The 16 percent who expressed not being aware about climate change when interacted further indicated that it is due difference in understanding between perceived climate change by scientific world and general farmers. When they say they do not know about climate change, the climate scientist should not consider their ignorance as being not aware. Since the impact of climate change is in gradual stretch over a longer period of time, realization about climate change for layman is different than the scientists who keep record of years of data in number and fill the difference. Still the response from people on change on weather pattern reported indicates that they are aware about changing weather patterns.

It appeared that more men knew about climate change than women. Among those who had heard about climate change, all respondents said that it was men who usually watched television and conveyed the information to their wives and were also engaged in various outdoor activities so they convey them the message.



(Source: Field Study, 2016)

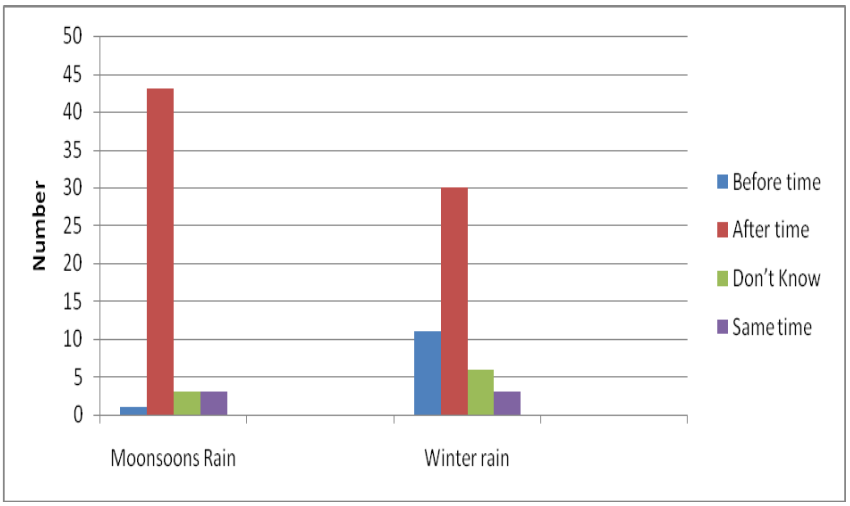
Figure 4.3 Gender perception about climate change

Men tend to get more opportunities to equip themselves with a stronger skills base and deeper knowledge of climate change than women. Also, there are many more men than women in the saving group for disasters, a group established by the commune to help the families to

cope with natural disasters and strengthen the community-based disaster preparedness by giving the people the opportunity to prepare and build up reserves. The focus groups discussions also shows that men have more understanding and knowledge related to climate change than women and men also look more confident in presenting their own ideas.

The awareness of climate change issues seems to affect the intra-household decision-making process established to manage climate change impacts, as well as for other household issues. All respondents stated that they usually discuss with their partner whenever household decisions are made, but that final decisions on the important issues or large expenses in the household, such as buying a motorbike or furniture, are ultimately decided by men. Women are often responsible for small and daily living expenses, for example, purchasing food items, clothes for family members, or working tools.

All of the respondents have perceived changes in the micro-climate of the locality. Study reveals, out of 50 respondents, 43experienced the occurrence of monsoon rain after the usual time, 1 before the usual time whereas 3 respondents experienced no change. Similarly, 30 experienced occurrence of winter rain after the usual time and 11 experienced no change. The occurrence of rainfall is not consistent over the area. There was occurrence of shift in rainfall pattern. Alteration in monsoon rain was observed by more respondents in comparison to the winter rain.



(Source: Field Study, 2016)

Figure 4.4 Change in rainfall pattern in monsoon and winter as perceived by respondents

In the same way, decrease in length of winter was also experienced by the respondents. Also, they experienced increase in occurrences of drought whereas all respondents experienced increase in length of drought period. Drought and its length have significant effect on water sources. Eighty percent (40 respondents) found decrease in water sources in recent years. Rainfall pattern has become erratic. 38 observed increase in frequency of heavy rainfall in short periods. Life in the study area have become difficult in recent years due to shift in rainfall pattern, decreased amount of rainfall, increased length and frequency of droughts associated with decreased water sources (in case of drinking water '*muhan sukdai gayo'*).

4.6 Changes in Farming System

96 percent of the people have experienced changes in farming system. Many cultivars of different crops have disappeared due to their low productivity in recent years, especially of wheat which has been replaced by potato farming. New cultivars are being introduced to increase production and local cultivars are becoming extinct (hybrid quality).

Twelve percent of the respondents experienced decrease and 36% experienced increase in rice production. Farmers have not experienced any significant changes in maize and millet production. Twelve percent experienced increase in maize production while 8% experienced decrease. During informal interaction, farmer mentioned surprises on occurrence of aphid even in millet, which was never a case before.

Cultivars which were common few years back now have become extinct or rare. Ninety-four percent of the respondents observed disappearance of existing cultivars of cereals and same percentage observed introduction of new cultivars. This is the most important adaptation strategy of the local people to fight low productivity. They have started growing high yielding and more adaptive cultivars to adapt in the changing climate. Thirty eight respondents experienced change in planting time in cereals crops. Rice was previously planted in first week of *Ashad*, nowadays; it is planted up to last week of *Ashad*. According to them, it is a result of delayed monsoon and maintenance in the canal works. Respondents haven't experienced change in planting time of maize, millet and vegetables. Some of the farmers found early ripening in maize. Respondents experienced no any major changes in flowering time of major cereals. Some of the respondents witnessed heavy wind at flowering time destroying the crops which was not seen before, it has now changed from *Jestha* to *Bhadra*. Farmers have encountered appearance of new weed species. *Ilame jhar* (Ageratum species) having dull leaf, *Parpare jhar*, *Tike jhar* etc. are becoming dominant in the crop fields and that is hard to remove and difficult to sustain with it as it destroys the complete area.

4.7 Pesticides Concern

4.7.1 Pesticides Use in the area

In the study site, farmers use pesticides mostly on standing crops in the field. Majority of farmers use chemical fertilizer in their fields besides chemical pesticides. In the study area, farmers use pesticides mainly on potato, tomato, rice, cauliflower, brinjal , chilly, beans and a lot more for controlling various insect and diseases. In the areas, potato, tomato and rice are the important crops followed by different vegetable crops in terms of pesticide use.

The farmers buy pesticides from the retailers like agro-vet shop, local agro-shop, and farmers' cooperatives in consultation of JTA or local agro vet shopkeepers. So the pesticides are locally available.

Almost all the respondents reported that the use of pesticides and chemical fertilizer in the crops has increased the crop production. They complain that without the use of the pesticides, the crops in this area cannot be grown well and the disease namely "*Daduwa*" is prevalent in the area affecting productivity. In potato occurrence of fog increase the incidence of blight.

This compelled them to use the pesticides. Equally, all of them said that along with increase in the crop production, the amount of pesticides and investment on pesticides has also increased the cost of production.

4.7.2 Use of Protective Measures and Practices

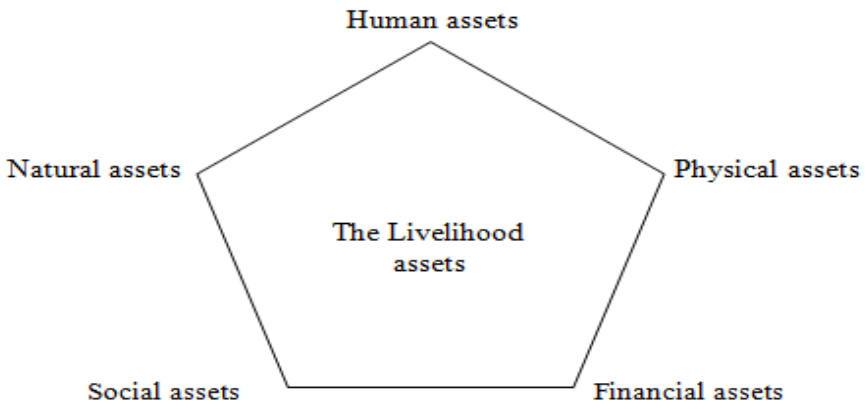
The adoption of safety measures during and after pesticide application is very important factor for preventing against harmful impacts of pesticide. The various safety options could be use like gloves, masks, long sleeved cloth, glass, long boots etc. The present study shows that none of the farmers uses safety measures although they wash their hands after application. People are conscious about hand washing but the procedure of the hand washing is not satisfactory. Most of them use the soap and water for hand washing, but few use simple water for it. This may clean up the pesticides traces in the hands but cannot clean up completely.

Majority of the respondents have not taken any training regarding the pesticide handling and modern agriculture. The hand compression (usually 9-litre capacity) and the knapsack sprayer (16-litre capacity) are very commonly used. In the absence of a sprayer, locally made brooms are used. Similarly, in the absence of a duster, pesticide dust is spread over plants and soil surface by hand. The river water and well is used for mixing of pest.

More over farmers were found to apply pesticide in close intervals than recommended does. There is increase rate of women farmers being involved in pesticide application due to male absence. The way chemicals have been handled are in hazardous situation can be illustrated with an incidence of death of a farmer towards tail end. During FGD members reported an incidence of death of a farmer due to mishandling of chemicals.

4.8 Climate Change impact on livelihood

Moving from how people perceive the general impact on their livelihood because of various climate change stresses and change in farming system to a focus on men and women's assets, the following sub-sections summarize the five main categories of gendered livelihood assets in the study area affected by climate change. Following are the gender and climate change analytical framework, which include natural capital, human capital, physical capital, social capital, and financial capital.



(Source: Ellis, 2000; DFID, 1999)

Figure 4.5 The livelihood asset pentagon

Natural Asset

The land and house owners are generally men. Women only inherit from the husband after his death. This gendered pattern of land ownership remains as before. The climatic changes have had a significant impact on both men and women's access to and control over land. The land used for agriculture has decreased in few households as result of flooding or cut off.

Many households in the study area found that access to fresh water resources have become worse for the reason that most of the wells in their commune have no more fresh water or are dried up and have to travel 30 to 40 minutes to get water for their households but the source from where they use to carry water is also observed to be polluted or in danger condition as it seems to be hit by flood sooner or later.

Women are responsible for collecting water for household use as this is considered as a domestic job. However, this task has become more difficult and stressful during the hot dry season and natural disasters (e.g., floods, long period of hot weather, rainy time and at night).

Physical Asset

Losses and damages caused by disasters are significant. With regard to agriculture, natural disaster events cause the water logging in the irrigated land or sweep away the field. Major impact has been observed in canal passage and breakdown of intake by the flood.
All respondents believe that they have already applied some adaptation strategies to protect their production and income from the climate change and other stresses. To minimize impacts on their production, the first thing people did was to maintain and upgrade the canal (WUAs) i.e. earth lined replaced concrete in fewer places. Both women and men conducted the reinforcement activities before-hand to help withstand disaster events, as well as rebuilt after the event. The frequency of these activities varied and was based on the severity of damage as well as the regularity of disasters. Maintenance appears as a long term adjusted habit, though these maintenance practices might also be regarded as adaptation strategies but are quite low in case of irrigated land if cut off either due to less income source of family or depended on external party to look after them has been observed in the field.

Regarding public infrastructure, some main roads are already built of concrete, but people say that since many roads are simply dirt in the past, they gets very muddy after the rain. Nevertheless, these concrete roads are still rough and easily flooded. More female respondents complained about the current state of infrastructure than did male respondents, specially on availability of drinking water system.

Human Asset

The female respondents said that they are more worried about the natural disasters than men, in terms of health and safety. As they directly take care of other family members and do all the housework, the threats to their physical safety increase immediately aftermath of a disaster. They become weaker during the disaster events and between-crop periods, as they tend to eat less than their husband and children, letting them eat first and eat more. They also face the outbreaks of water-borne diseases such as cholera, intestinal worms, and typhoid, particularly following the exceptionally wet periods which result in contaminated water in the source.

There are also some common sicknesses among men and women including headache, irritability, and back pain. Both male and female informants complain that they have to work for long hours under the hot, direct sunshine, especially in harvesting and sowing period, and they think this is linked to their illnesses. Correspondingly, application of pest and pesticides without the full body harness affect has also been observed specially in women groups aged in between 25 to 40 in branch no. 4 as per the informant.

All interviewees indicate that they try their best to ensure their children finish the high school, but ultimately it is up to the child's learning ability and the family's financial capacity, and it is a topic worthy of further study whether they study or not.

Some respondents explain that, as their educations are interrupted in the past, they like to see their children get a better education and have the same opportunities to go to school as others of the same age. Many respondents agree with the fact that they really wanted their children to go to high school for further education and training

Social Asset

Respondent take part in at least one social organization in their commune. Nevertheless, men participate in more activities with more frequency than women, especially in the training courses. Men's increased engagement in such groups implies the stronger local network of social and community organizations. These community-based organizations can be considered as a core pillar of the commune's capacities to adapt to changing conditions in its natural and physical environment, including the changing climate. In the rural areas, these organizations in particular, have an important traditional role in the local governance and management. The increased presence and participation of men and women in these organizations can strengthen the roles of these organizations contributed to the adaptive capacity to climate change at the community and household levels.

As per the interaction with the secretary of WUA, there are two female representation and their views are consider in the process although the women education level is primary but their understanding regarding the system and agriculture is strong.

Although the WUA have been actively involved, the social conflict is also seen especially regarding the water distribution between the tail end and head end farmers. Within the head end members also it signifies that the awareness training and knowledge lack between the family users as stated earlier.

For E.g.,*Shubha Bihani Mahila Krishi Sar-SarkariSanstha* Ltd. has given local traditional training to the local female members as per the staff of the company. She added making of

dolls, bangles, etc. help them as an earning source different from agriculture at free periods and also it motivates them during stressful period in life.

Alike, other *Sarkari Sansthas* were also observed and saving was also good as per the informant and members of such companies in the village. Eventhen community engagement on awareness about safety of chemical application and uses is yet limited.

Financial Asset

The difficulties in production caused by climate change and income loss forced many people to migrate to the city to make extra-income for the family or to look after the local traditional jobs. Also, men have more opportunities to migrate far from home than women do, as women have to care for their traditional responsibilities (e.g., cooking, washing, child care, etc.). Women also migrate to find work, but only in the local vicinity. While men are paid NRs 700 per day, women are paid merely half. Yet, it is agreed that everyone work for same hours in the field although the work they do differ.

There are some potentially negative implications from the changes in the household structure caused by migration from these communes, for example, few elderly people are left at home and their children are far away from them and in few cases they have-not visited them for more than a year or so or visited during festival time only. In such situation vulnerabilities of elderly are high.

Almost all households interviewed have borrowed money to invest or re-invest in the production. They also tend to borrow money to pay for their children's education and re-construction of their houses. Some households benefited from the government's special policies for the poor or for women, so they are able to borrow money from the bank in low interest rates. Some respondents are afraid that they might not be able to repay the loans, so they try to borrow as little as possible. In general, the large loans are often provided to the men, who are the household owners.

4.9 Findings

From the presentation of relevant gender-dimensions of the climate change responses and strategies in the commune of study, the following are important points.

First, people in the study area are facing more and more difficulties, struggling to deal with the effects of climate change. The increase in both the frequency and increased magnitude of impacts of extreme weather in this area are of particular concern. The climate phenomenon happening in this region include extended times for severe winds, storms and floods, shortages of fresh water, extremely hot weather, and cold wave. Climate change is not gender neutral, and men and women in this area have not previously faced crises on this scale. In order to recover from one climatic shock after another, as well as to rebuild assets and cope with the persistent stresses posed by changing conditions, men and women's workloads have increased substantially, even though their workloads are not equal to begin with. These factors make relations between men and women more and more stressed, resulting in negative effects on their own mental and physical health. In particular, women are strongly affected, both physically and psychologically, because they are often forced to become the

sole caretaker for family members without much decision making power and possibility to mobilize family resources.

For instance, farmers perceive increased fog in winter has increased occurrence of potato blight. With increase blight diseases, the use of pesticide has been intensively increased. Due to men migration women are found to be involved intensively on application of pesticide. As most of the women are uneducated, they don't know application of pesticide should be limited. It has made women more vulnerable. Several others problems has also been seen in the study area such as itching back bones, skins problem. In addition uterus problem in case of women especially in branch 3,4and 5 as per informant and health post in charge Dikure. "

Second, the coping strategies are determined by gender social category. Both men and women try to take action to protect them and their family against the inevitable impacts of climate change but generally have to look for alternative sources of income due to the loss of income and reduction in crop yields. Generally, women ensure both the food and water security it can be said that women, especially poor women, have a limited range of coping strategies. They lack access and control over land as well as mobility since most of their activities revolve around the home. In addition, their participation and possibility to influence through participation in social activities are limited due to gender social hierarchy. Ability to cope with climatic stressor is found to be link to gender, class and caste that define asset base. For example in a case of one of the respondent whose irrigated land has been completely destroyed due to flood in 2053 and still waterlogged to cope up better due to his caste, which for people belonging to low caste will be difference. Since he was a Brahmin he used a pundit works as alternative and due to his alternative works he owns 8 ropanies of land in others side and irrigate it and earns but this may not be the case in marginalized caste groups.

Third, the current adaptation strategies to climate change for men and women in the study area can be considered good only as long as other adaptation options that have long-term implications are available for them. The changes in working and harvesting times, and migration trends can be adaptation options for both men and women to reduce the losses and damages caused by climate change in the short-term. Table below summaries the commonly adopted adaptation strategy and constraints for families and gender social groups depending on asset base.

Table 4.9 Impacts of climate change, community adaptation strategies and constrains

Impacts	**Local Adaptation measures**	**Constraints**
Landslides	Stones wall, afforestation	Lack of fund and manpower
Flood	Gabions wall, afforestation	Lack of fund and manpower, Lack of knowledge and resources
Health, human disease	Health Post	Lack of health facility center, post
Appearances of mosquito and harmful insets	Mosquito nets, mats	

Crop disease and vegetables	High use of pesticides and chemical	Lack of Knowledge, Expensive Market shortage in availability of chemical and fertilizers
Dew, Fogs, Rain temperature	Plastics shed used in vegetable framings in few cases	Lack of resource, fund, lack of knowledge
Drinking water source	None	Lack of fund, in affected area and in danger of being washout again

To sum up, Nepal is highly vulnerable to impacts of climate change due to topographic adversity, climatic complexity, agriculture based economy and poverty. There is noticeable change in rainfall pattern. Total annual rainfall is decreasing and the pattern is becoming unpredictable. This is associated with natural calamities such as landslides, floods. Trend of temperature shows an increment in maximum temperature and a decreasing trend in minimum temperature. Increase in mosquito and diseases of warm regions in the study areas support the evidence of increase in temperature. Analysis indicates decreasing productivity of major cereal crops in recent years. Study indicates that primary impacts of climate change are seen in agriculture. Disappearance of local cultivars of crops, shift in planting time of rice, increased frequency of plant and animal diseases, appearance of new weed species, appearance of human diseases of warm regions, increased frequency of landslides, forest fires and loss of natural biodiversity provide evidence of the changing scenario of the study sites. Maximum use of pests and pesticides as a result impact on human health has also been observed in the study area, with indication that women's vulnerability has increased.

The changing scenario has forced local people to find measures to secure their livelihoods. Local knowledge, resources and innovations are important for community based adaptation strategies. They have started adapting in these conditions with efforts as much as possible. Few examples of adaptation strategies are found in the study areas such as adoption of new, high yielding cultivars, cultivation of cash crops instead of cereals, construction of stone walls to prevent landslides.

In addition to what farmers have been doing, other services like climate forecasting system, crop insurance program and strengthening agriculture research. For this sufficient number of meteorological stations, awareness program in community level, inclusion of climate change related issues in planning and designing of developmental activities would be helpful.

During the field a study farmer suggested way forward to solve the problem arising from climatic stressors and is illustrated in table below.

Table 4.10 Suggestions from informants to improve the situation

Suggestions	**Use**	**Other**
Water and other input supply at fixed time	Work from community	Awareness Trainings

Regular supply Monitoring Water leakage control Cleaning and maintenance at time Cold store	Source conservation Equitable use Storing and preservation	

Since farmers are not fully satisfied with the management of water users' organization, most of the suggestions are directed on improvement of water management. However users who are also responsible for large amount of water waste in head end, were not found interested in changing their water use practices instead they were in search of alternative source of water like river diversion. In addition, people complain about changing social relation with increasing individualism as an issues than collective effort in water sharing and management. Such changes do have negative impact on livelihoods of marginal families specially women.

Chapter - 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This Study has centered on the impact of climate change on men and women engaged in agriculture operations, the gendered responses, and the effects on men and women's roles, responsibilities and decision-making power in the selected study area. This final chapter provides the conclusion to the study, including some recommendations based on the study findings, which might provide a good point of departure for further research.

This study shows that even in irrigated scenario climate change is causing unusual, unpredictable and extreme weather events in case such as L*abdu Dikure Shera* Irrigation system where this study was conducted. Although this level of exposure to climate change affects everyone in these communes, its impacts are differently distributed between genders. The results show that effects of climate change are unavoidable regarding the agricultural production of communes, as well as imposing different impacts on women and men in terms of assets, gender roles, and adaptation responses. The differential impact of climate change on different gender groups prevails with different level of livelihood assets one possess, including social, physical, financial, human and social capital. There are sharp differences between men and women of different social groups on access and opportunities to build these five assets and capitals that could be utilized to cope with climatic stressor.

Agriculture is the main livelihood activities that contribute to people's sources of income. Women play a key role in most production activities, while men are the main workers of the operations. While managing and operating the entire production process, women are also involved in operations even though this production activity is considered largely "men's work". This study has shown that these types of productions are dramatically affected by the weather changes in terms of productivity and yield. The climate stresses are considered as risk factors in these production activities as well as negatively affecting men and women's health and safety. The impacts of disasters on these production types are direct and differentiated between men and women. Women generally face a higher level of vulnerability than men because of the unequal workload distribution, and their limited intra-household decision-making and economic power, since they generally have less assets and powers. The inequitable workload distribution often restricts women's access to formal education and career development opportunities, while other contextual factors such as household food allocation and domestic quarrels that impact women's vulnerability might directly affect their physical and mental health. Another barrier involves the limited opportunities for women to speak out about their lives and the challenges they face in their everyday life and production, because they have less of a say in decision-making, responsibilities and experience options.

Women in the study area suffer more than from the climatic and socio-economic stressors due to differences of socially constructed roles and responsibilities, largely based on tradition, social norms, gender division of roles and resources. These factors have a direct impact on women's assets, their access to economic resources, and the options available to them in pursuing optimal livelihood strategies.. Because their livelihood opportunities are limited, they and their families are significantly affected. They face greater challenges compared to

men, but they are often left behind to try to find solutions after the disastrous events that the changing climate might cause.

It is also clear from the study that both women and men are struggling to deal with the increasing frequency and impacts of extreme weather and climate events, and their coping and adaptation strategies vary. Women and men are part of the same households, thus although they are somewhat distinctly affected by climate change, their adaptation strategies within the household must also be considered jointly. People in general have few options for coping with climate change. They try to take action to protect themselves and their families against the inevitable impacts of climate change, but they also look for other adaptation strategies. Their coping strategies vary depending on the financial capacity of the households, their awareness and knowledge in coping with disasters, technique issues, and supports from the community and government. It can be said that women, especially poor women, have a limited range of coping strategies as they lack access and control over land as well as mobility since most of their activities revolve around the home. Men appear to more opportunity to migrate to the cities to engage in manual labor jobs and far from home than women do. In destination men may face different vulnerabilities; they do escape from the vulnerabilities caused in study area back in home. In addition, men with his own earning, there is a possibility that he could have higher possibility to invest to minimize his vulnerabilities in destination, however women who have remain behind depended on farming have more fluctuation either to raise cash income from farming due to external and internal climatic and socioeconomic stressors to cope with stressors.

Discussions in the study have revealed that though men and women in the area have experienced the changes in the climate, the vast majority of them do not have many ideas about the causes or suitable adaptation strategies. Their lack of livelihood opportunities and knowledge on the causes and impacts of climate change, contribute to their limited adaptation actions. In other words, people in this vulnerable region need better access to livelihood opportunities and information related to climate change. With the impacts of climate change, the livelihood activities of men and women in the area now suffer significant losses, but their adaptation strategies and capacities to increase resilience, as well as their options for coping with these changes in different contexts are still limited and often easily exhausted.

5.2 Recommendations

Gender equity in irrigation management, in which the existing socio-cultural factors have the prime cause to hinder the participation of women in decision making whereas all of men staying outside make difference in their attitude and behavior. Men have control over the resources, henceforward; the irrigation comes to the part of the men even though women's contribution is crucial. Since more women are involved in irrigating farm land, the gender equitable governance in irrigation management could lead to address water scarce and water related disaster in the area.

Men and women's access to education and training related to climate change, possible consequences, and need for good governance, safety measures in use of chemicals should be improved in order to ensure that men and women of all ages can acquire the information,

knowledge, capacities, and skills needed to participate fully under equal conditions in climate change adaptation strategies and actions in the area of study.

Gender-based climate change awareness training should be targeted at all members of local households, with a special focus on women and girls of different social strata since these gender social groups are tend to be overlooked but face particular vulnerability.

Local authorities and civil society organizations should involve themselves more in the process of developing adaptation strategies and addressing climate change impacts in the area. In addition, it is extremely important to encourage the participation of women in all management structures and processes in order to promote their rights as well as to ensure increased representation of women at decision-making levels.

The researcher believes based on the study that there is room for more research on the availability of other relevant adaptation options for men and women in this area, particularly related to the long term view, and especially with regard to the drinking water scarcity and uses of pesticides in agriculture and inter mix cropping. For example rain water harvesting for drinking purpose, revival of spring watershed in hilly areas and promotion of integrated pest management.

Other studies could offer recommendations on the viability of diversification income opportunity for both men and women in this region of the country, validating that there are different sources of income that people might consider which could serve to top-up their income and increase their adaptive capacity to extreme weather events. Since market is an opportunity for the study area due to access to road, promotion of processing of agri-product like potato and other resources could multiply the return of the produce.

Some of these recommendations could be implemented immediately while the others may need more preparation and are more realistic in the medium-to-long-term depending on, among other factors, the willingness and capabilities of the local government authorities and availability of resources.

More in-depth study on this line of inquiry could result more reliable analysis and recommendations.

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APPENDIX-I-Questionnaires

Interview question: local households

Section A: Background Information

S.NO	QUESTION	RESPONSE
1	Name	
2	Age	
3	Gender	M F
4	Marital status	Single Married Divorced Separated Widow
5	Education	Primary Secondary Graduate None Other
6	House hold Size	
7	House hold Composition	Under 5 yrs: M... F..... 5 to 18 yrs: M... F..... Over 18 yrs: M... F.....

Section B: Socio-economic

S.NO	QUESTION	RESPONSE
1	What is your current occupational?	Agriculture Business /Service Household work Foreign jobs
2	How much agriculture lands do you have	
3	What type of irrigation system are you adopting in your land? Are You keeping livestock? Yes/no, if yes, how many?	Rain-fed Seasonal irrigation Irrigated throughout
4	Which type of livestock management system is adopted by you?	Stall feeding Open grazing Seasonal grazing
5	Has irrigated agriculture affected your work schedule in any way?	
6	Do you compete for water with domestic animals especially in the dry season?	
7	What other income generating activities are you involved in?	
8	What have you been able to achieve or acquire since you started working on the irrigated plot	buying of assets

Section c: Perspective on climate change

S.NO	QUESTION	RESPONSE
1	Do you know about climate change	Yes

		No Only heard of
2	Where did you get your knowledge on climate change?	Reliable source Media Community meetings Awareness's program me
3	Have you realized any change in rainfall pattern?	Yes No
4	Have you realized any change in other climate? (Storm, Fog formation, Dew formation, Acid rain, Hailstorm)	Yes No
5	Have you noticed any changes on plant due to climate change? (E.g., early ripening of Mango	Yes No
6	Is climate warming over the last 10 years?	Yes No No idea
7	Is there any increase in dry period?	Yes No No idea

8	Are climatic hazards increasing	Yes No No idea
9	If yes, what are they?	Floods Thunderstorms Hailstorms Flash rain Drought Landslides Others
10	Have you realized any change in temperature?	Extreme hot in summer Less cold in winter If yes, from when
11	Have you faced any kind of Weather Related Disaster (WRD) since 10 years	Floods Thunderstorms Hailstorms Flash rain Drought Landslides Others
12	What changes have you seen on your farm or around your community that area result of climate change	Flooding or water-related changes Soil erosion or land degradation Destruction of crops or buildings Unpredictably of season Other Specify

Section D: Climate change and its impact on Gender role and responsibility

S.NO	QUESTION	RESPONSE
1	Does climate change have any consequences on your lives or households?	Yes No No idea
2	What are the major risks/ shocks you had due to climate change?	Heavy rain and Flood Crop failure

		Disease Drought
3	Had there been any natural disaster in the past 10 years?	Yes No No idea
4	What happened to your work (field and home)during last disaster?	Crop destroyed Animal washed out Houses destroyed Water flooded inside the house Works are disturbed and stopped
5	Are there social inequalities prevalent in the community?	yes no in some extent
6	What are the roles o man and woman in agriculture activity of the family?	
7	Do Man and Woman have decision making power or control over inputs and outputs in agriculture Equally?	
8	In your family who fetches drinking water?	Women /daughter Men /son
9	Do you think that economic status of women is low in your community?	yes no in some extent
10	Do you think that the climate change leads to migration?	yes no
11	If you are a farmer or a wage Labor ,which season do you go to field work	May/June(rice) June/July/August(millets, rice) Nov/Dec/Jan(mustard) All season but not everyday
12	How many hours do you work in a day in a field?	Less than 6hours 6 to 7hours 7 to 8hours 8 to 9 hours 9 to 10hours
13	Are you experiencing summer season hotter than before?	
14	If yes do you still work in the field for the same long hours of time in the extreme temperature?	Yes No Most of the time
15	If you have a land do you give work to wage labor	yes no
16	To whom do you prefer to give work to	Men Women Both
17	If male why/	More physical strength More work is done Gets less tired Heavy lifting work is done
18	If female why	Works more finely and carefully Less daily wages More focuses and determined
19	Is there wage difference in men and women?	Yes No I don‘t know
20	What do you think about wage differences?	Its age old tradition It‘s a discrimination

		Paid according to work they do. Its ok with me
21	Do you involve in any community groups	No yes
22	Are climate change and its effects in agriculture are discussed in the meeting?	Yes No
23	Are women empowerment and gender discrimination are discussed in the meeting?	yes No
24	If both what are the main discussion about and how does it help a women in your community?	Mentally strong Will power boosted Uplifts poor women It increases awareness
25	According to you what is the best way to make women aware of the climate change and its effects on them?	

Section E: Gender Analysis

1. What activities are done by women, men, boys and girls; and what activities are done together?
2. Does this mean you can now be given more leeway to participate in decision-making in the household?
3. How much do you make on average in a month?

Section F: Checklist for Focus Group Discussions (FGD)

A. social-economic impact and land accessibility for women farmers

What do you think the position of women is now that they are participating in irrigated agriculture (earning an income)?

B. Household food security issues

Has the project improved the food situation in your households?

C. Gender and social relations

Have you experienced any changes in your roles, responsibilities and duties as result of your participation in the irrigation scheme?

D. Benefits of project

What have been the benefits of this project?

E. Alternatives to agricultural activities

Do you have any alternatives from your current agricultural activities?

F. Recommendation
What are your recommendations with regard the implementation of this irrigation scheme?

Section G: Checklist for Key Informants

What was the situation of the household food security before the irrigation scheme?
What has been the impact of the people's participation in the irrigation scheme, especially women?
What are the coping strategies in times of crisis?
What difficulties are the people facing in tail head and mid race of the irrigation scheme?
Whether the changing weather patterns have affected the water source?
Would you say your participation in the scheme has empowered you as a community?
Do you have anything else you would like to day or comment on?

APPENDIX-II-PHOTOGRAPHS

FGD, Informal Talks and Resources Mapping

Adaptation Strategy in Study Area

Impact of CC on Study Area

Drawbacks OF WUA

Difference of water flowing in the main canal Branch10 and Branch 1 and Difference of water distribution in Branch 5 and Branch 9

Study Area