

CHAPTER-I

INTRODUCTION

1.1 Background

The emerging discourse on climate change has now begun as one of the most emerging issue for scientists, academicians, professionals, donors, and governments/non-governmental agencies. The climate change effects have already been observed and scientific findings indicating that precautionary and prompt actions are necessary to address its impending threats Intergovernmental Panel on Climate Change (IPCC 2001). Climate change is also increasingly being foreseen as a crisis of global proportions and climate change is no longer a theory or meteorological model that interests only a specific scientific professional, but it is taken as one of the social, cultural and humanitarian issues. It is crucial to understand the dominant factors shaping climate change are societal in nature from social science perspective.

The unparalleled impacts of climate change extended to effects on ecosystem, health, food production, water resources, agriculture and livelihood (IPCC 2001). With developing countries on the frontline, climate change puts an extra burden on the existing social and economic challenges that they already face (UNFCCC 2007). Nepal is already experiencing the adverse impacts of climate change from unusual weather behaviour and decline in crop production to severe water-induced diseases (SAGUN 2009). This is considered that it affects or will affect agriculture, energy, human health, the economy and the physical infrastructure. The planet is being already experiencing its impact on biodiversity, freshwater resources and local livelihood (WWF 2006). In the high Himalaya, as compared to other ecological zones, the global warming has seriously impacted of their lives and livelihoods of the local communities (UNFCCC 1992).

The increased global temperature since the 20s century is mainly because of anthropogenic activities. For instances, Greenhouse Gas (GHG) emissions from burning fossil fuel and destruction of forests are some of main examples of many others (IPCC 2007). The effects of climate change in mountains are claimed to be

more intense and detectable since climatic conditions vary more sharply with elevation than with latitude e.g. mean temperatures decline about 1° Celsius per 160m of elevation, compared to 1° Celsius per 150km by latitude (ICIMOD 2007). Between 1977 and 1994, Nepal's average temperature rose at a rate of 0.03°-0.06° Celsius per annum (Dc/an.), with a higher rate in the mountains than in lowlands (Shrestha et al 1999).

At the global scale, there is considerable variation among countries with regard to their capacity to adapt climate change. In general, countries with well-developed social institutions supported by higher levels of capital and stores of human knowledge are considered to have greater adaptive capacity (Smith and Lenhart 1996). Adaptation option-including traditional coping strategies-often are available in developing countries and countries in transition: In practice, however, those countries capacity to effect timely response actions may be beyond their infrastructure and economic means (IPCC 1997).

Government of Nepal (GoN) has expressed commitment through international conventions and treaties to develop strategies to minimize the impacts of climate change on environment. GoN has set priority to study and information dissemination on climate change and its impact including its adaptation measures. However, the field actions of climate change impact adaptation measures have not been adequately address including their academic research in this regard (MoPE 2004). But, somehow, practicing of adaptation measures in order to minimise the impact of climate change have been widely used traditionally by local people in the entire Nepal Himalaya and elsewhere in the World. Unfortunately, lack of database on climate change impact and its adaptation mechanism in local context hinders to develop adaptation and mitigation strategy in the context of climate changing scenarios.

While mitigation efforts to reduce greenhouse gas emissions is the traditional deliberate international policy approach to address the threats of climate change, adaptation has become a key focus and is currently playing as a major theme or discussion in the multilateral climate change processes (IIED 2007). Adaptation is one of the most available responses addressing the threats of climate change, as it is a process that involves moderating strategies to cope with uncertain climatic events.

Effective adaptation therefore entails the coordination of actors at all levels-from the international community, national governments to communities and local networks (UNFCCC 2007). Local communities play a vital role in the adaptation process as the characterization of climate change impacts at the local level could present solutions and measures that can possibly be adopted at meeting the challenges in the future (IIED 2007).

Nepal's economy is basically agriculture-based and highly dependent on agriculture for their everyday needs. Local farmers of the study area are primarily depended on a climate-sensitive rain-fed agriculture system and vulnerable to climate change. Agriculture is likely to be affected positively and negatively and negative effects are likely to be feared to be larger than the positive effects. Data on climate change impacts and its adaptation by local knowledge is indeed deemed necessary. This research therefore aims to examine predicted impact of climate change on agriculture systems and their capacity to increase the resiliency of rural communities in Bhorle VDC of south-eastern part of Rasuwa district of central Himalaya Nepal.

1.2 Statement of the Research Problem

Climate change has been already experiencing throughout the country with varying degree of impacts. It is experiencing increase in dry periods, intense rainfall, floods, landslides, forest fires, glacial retreats and Glacier Lake Outburst Flood (GLOF) threats (Shrestha, 2007). Agriculture is affected most when drought adversely impacts rain-fed agriculture, largely in developing countries where the majority of farmers practice subsistence agriculture (Presiser 2005).

Nepal is more vulnerable to the effects of climate change due to its high dependence of climate-sensitive sectors such as glaciers, agriculture and forestry, and its low financial adaptive capacity (Karki, 2007). Moreover, Nepal is largely dependent on climate-sensitive sectors, such as rain-fed agriculture and agricultural productivity is declining with increasing problem of food security. In recent years, the signs of such changes are being observed and may become more prominent over next couple of decades. Many rural communities are struggling through different adaptation measures as an attempt to reduce the risk of climate change vulnerability.

Although a coping strategy is essential for reducing carbon molecules on air and soil, it is not sufficient to save us and our world from climate change related woes. Nepal is poor in infrastructure and lack resources to immediately and effectively practice any adaptive measures in the short term. Thus it will be prudent to increase people ability to adapt to change and warning people about certain events in advance and preparing them to deal with vulnerability and uncertainty. Even though, academically speaking, adequate published and unpublished literatures are available on climate change, its impacts and adaptation mechanism (Chaudahry 2009), however, it lacks database on local perspectives in climate change and adaptive knowledge from social science perspective, particularly from the sociological perspective in Nepal. Thus, this study has concentrated to find out the answer on how the changing climatic condition impacted in particular agriculture systems which is a major way of living in site. Furthermore, communities may design specific coping and adaptive strategies in the face of climate. Hence, based on these assumptions, this study aims to address any severe climatic impacts that directly affects their local livelihood, if yes how and why. Thus, this study has tried to answer the following research questions;

- 1.How do people experience the climate change?
- 2.How does climate change impact upon the socio-economic life of local people?
- 3.How does local people response and cope to the climate change?

1.3 Objectives of the Study

The general objective of this study is to explain the adaptive strategies of rural communities in the context of climate change.

The specific objectives are:

1. To assess the impact of climate change on socio-economic life of rural communities, and
2. To describe coping mechanism of local communities to the changing climatic conditions

1.4 Rationale of the Study

Climate change has become local phenomenon just as it is global. Recent years adaptation come to fore of the international climate change debate among academicians, professional and policymakers. In Nepal, several studies are being

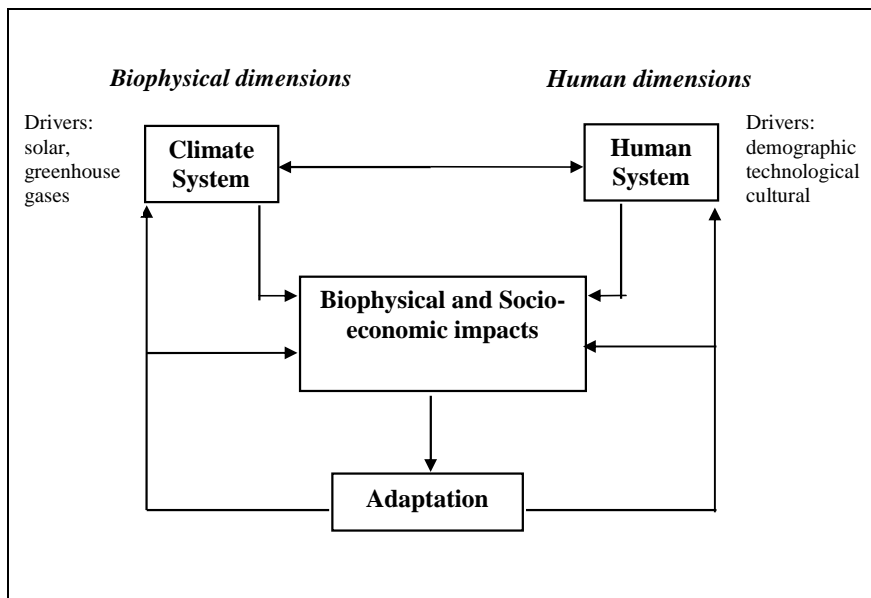
carried out to understand the climate change, its extent and impact on the biophysical and social aspects. Although the issues have drawn the attention of centre-base knowledge elite groups, a large section of rural area people have inadequate knowledge about the causes and consequences of climate change because the information is scattered and produced mostly in scientific language obscured by jargon and sophisticated mathematical models (Chapagain et al 2009). There are insufficient studies in Nepal on impacts of climate change from the social science perspective

However, local people have observed changes in temperature, rainfall pattern and increase in extreme climatic events has incurred loss of agricultural productivity, infrastructure and human life. Such extreme climatic events disrupt people's adaptive capacity and undermine their resilience. Undoubtedly, different adaptation mechanisms have been adopted to cope with climate change impacts locally and elsewhere in the world. However, the existing adapting mechanisms of the communities have not been in the form of well documented. Hence, local level study is necessary to document the ex-situ-based knowledge on climate changes, their impacts and adaptive strategies.

1.5 A Conceptual Framework for Climate Change Impact and Adaptation

The conceptual framework of climate change represents the key elements that shape the terms like impacts and adaptation. This understanding can be conveniently summarised in the conceptual diagram shown in figure 1.

Figure1. A Conceptual Framework for Climate Change Impact and Adaptation



Source: Warrick, 2000

It is the interplay of both natural and human systems that result in biophysical and socio-economic impacts. Biophysical impacts are such as climatic extremes (drought), physiological impact on crops, change in land, soil water and livelihood and Socio-economic impacts particularly on agriculture. The sensitivity of the changes in climate depends on its resilience.

It is now widely appreciated that the changes and variations in climate system cannot be viewed in isolation from those of the human systems. The human dimensions of change, including drivers such as population growth and distribution, technological and economic development trends, and social and cultural alterations, play a critical role in determining the degree of exposure of various sectors to climate change, variability and extremes. Thus, in conducting assessments of future effects, scenarios of future demographic change and socio-economic development need to be consistently woven alongside scenarios of climate change.

It is the dynamic, evolving nature of the overall system that presents opportunities for adaptation (responses that lessen adverse impacts or enhance beneficial effects) and cope (responses that prevent the climate changes) as feed-backs over time adaptation

can occur naturally (e.g. diversification of income). The existing socio-economic system, knowledge system and the perception of the individual determines the nature magnitude intensity and severity of the effect caused by these impacts and also mediates the community for proper response to these impacts through various coping and adaptive strategies. There are still large challenges that remain in identifying the full range of adaptation options and in evaluating their effectiveness.

1.6 Organization of the Study

This study consists of eight chapters. Chapter one provides the introductions, aims and objectives. The second chapter deals with the review of literature and provides ideas about the previous researcher and studies being done in relation to the topic of this thesis. The third chapter summarizes the methods and approaches followed for the research. The fourth chapter outlines the information about the study area. The fifth chapter includes discussion on sample study of household and population. Chapter six includes experiences on climate change and its impacts on local people. Chapter seven deal with coping and adaptive strategies which is followed by local people. Finally this study has been concluded in chapter eight. These major chapters are followed by references, appendices, acronyms and annexes related to the study.

CHAPTER-II

LITERATURE REVIEW

This chapter reviews the literature on climate change impacts and adaptation, which provides a synthesis of its broader understanding and common responses. Section one discusses global and national scenario of climate change, its impact and effects was noted which help to understand the issue of climate change for the research purpose; second section briefly looks into the theoretical review on the impact and adaptation is crucial to understand the research ideas and important to formulate the particular way conceptual idea according to the needs of this study.

2.1.1 Global Context of Climate Change

Climate change refers to a significant change in precipitation, temperature and other climatic parameters observed over time in a specific area which significantly affects the biophysical and socio-economic circumstances (IPCC 2005). Furthermore it defined “any change in the climate, whether due to its natural variability or as a result of human activity”. United Nations Framework Convention on Climate Change (UNFCCC 1992) defines it as “a changes of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere”.

Climate change is typically discussed in global terms, yet its effects vary quite dramatically among different regions of the earth. Climate change is a globally distributed challenge and its consequences are widespread and alarming. The leading global authority on global climate change, IPCC on climate change in its third assessment report in 2001, projected that there will be a 1.4 to 5.8°C (2.5 to 10.4°F) increase in globally averaged surface temperature between 1990 and 2100.

The future impacts of climate change will lead wide-ranging impacts across different sectors and regions. The broad range of impacts of climate change (IPCC 2007), include effects on agriculture, fisheries, desertification, biodiversity, water resources, heat and cold related mortality, coastal zones and floods. The number of days with extreme heat in summer is increasing and winters are becoming warm and dry with less snow (Chaudhary and Aryal, 2009). Changes are also observed in the nature,

intensity and frequency of precipitation. Scientists have observed odd patterns of rainfall throughout the world, but the results are mixed and distribution is uneven. More rain in terms of amount and intensity is experienced in higher altitude regions during the summer (Shrestha et al. 2000).

Global warming has remarkable effects on the phenology of plants and the breeding behaviour of animals that are highly sensitive to photoperiod and heat. Several studies have already confirmed the change in breeding habits (e.g. courtship calling, birthing, mating, birth singing) in animals and insects, and in the blooming and flowering time of plants from a few days to as early as month before historical precedents (Groom et al. 2007 cited in Chaudhary and Aryal 2009).

Climate change is not only affecting the climate and ecosystem, but it is also impacting human well beings. Agriculture is affected most when drought adversely impacts rain-fed agriculture, largely in developing countries where majority of farmers practice subsistence agriculture. As one-sixth of the global population relies on glaciers and seasonal snow packs for their water supply, the people living in mountains will face more severe water shortage problem. In addition, people will bear a huge economic loss due to reduced crop yield and damaged roads, bridges and other property. This may cause more food insecurity and hunger throughout the world (Goswami et al. 2006).

2.1.2 Climate Change in the Context of Nepal

Nepal's contribution to the global annual GHG emission is only 0.025% (MoPE, 2004). But over the last twenty-five years, the temperature in Nepal has been increasing at the rate of 0.06° Celsius per year (GoN 2008). In the mountains it increased by 0.6° Celsius than in lowlands (Shrestha et al. 1999). It shows that Nepal is warming significantly higher rate compared to the global average 0.74° Celsius, recorded in the twentieth century (IPCC 2007). Precipitation is also becoming unpredictable and more erratic than ever, with more droughts and shorter periods of heavy rainfall (Shrestha et al. 2000). Observations show that high rainfall regions and seasons are recording increases in precipitation and becoming wetter, whereas low

rainfall regions and seasons are recording decreases in precipitation and becoming drier (HMGN 2004).

Climate change impacts every aspect of nature and people, and is predicated to continue now and in future. The major impact of climate change in Nepal is on agriculture, glaciers, water resources, biodiversity, and natural resources. Several studies have been carried out on glaciers in Nepal compared to other aspects and studies show that Nepal's glaciers are retreating rather than the world average (Dyrgerove and Meier 2005). GLOF in 1985; from Dig Cho Glacial Lake, which washed away Namache Hydropower Plant, several hectares of cultivated land, bridges and houses, and caused human and livestock deaths (WWF 2005). Similarly, frequent floods and landslides washed away 100 of hectares cultivated land and outbreaks of diseases.

Poor countries, including Nepal, are disproportionately vulnerable to disaster and hence to the effects of climate change for a number of reasons. First, the ability to adapt to and cope with weather hazards depends on economic resources, infrastructure, technology and social safety (IPCC 2001). Many are already under the pressure of population growth, rapid urbanization and resource depletion, making them further vulnerable to challenges resulting from climate change (IPCC 2001). The reason for uneven consequences is that individuals, households, communities or regions have different opportunities and capacity to respond to change and thus differential vulnerability (Regmi et al 2009).

In Nepal, several studies are being carried out to understand the climate changes, its extent and impact on the biophysical and social aspects (LI-BIRD 2008). But most of the studies primarily focused on the biophysical aspect of the climate change like glacial melting, river runoff, vegetation change, trend in temperature fluctuation, rainfalls wind patterns and floods. Environmental experts are busy modelling scenarios and long-term impact of climate change on various sectors, for example on the economy. In this endeavour of expanding and deepening our knowledge of climate change, and exploring local people's observations, feelings, perceptions and adaptive capacity of the issue (Chapagain et al. 2009).

Poor, marginalized and disadvantaged people in rural areas of Nepal, whose livelihoods primarily depend on natural resources and climate-sensitive sectors such as agriculture, forestry, and fisheries, are more vulnerable to climate change (Regmi et al. 2009). Agriculture the mainstay of rural food and economy that accounts for about 96% of the total water use in the country – suffers a lot from erratic weather patterns such as heat stress, longer dry seasons and uncertain rainfall since 64% of the cultivated area fully depends on monsoon rainfall (CBS, 2006). Declined yield due to unfavourable weather and climate change will lead to vulnerability in the form of food insecurity, hunger and shorter life expectations (Chaudhary and Aryal 2009), and the rural poor will again be the hardest hit.

In both developing and developed countries, the impact of climate change can be much greater for indigenous communities who rely most directly on their immediate environment for subsistence and livelihood often living in the more remote and economically fragile zone (Regmi and Adhikari 2007). A few emergency management items such as construction of emergency shelters and provision of housing for disaster-affected families have been proposed in the tenth plan but given the enormity of climate change, policies that help slow-down the climate change and those that aid to adapt are also required (Alam and Regmi 2005).

The impacts of climate change is likely to have the greatest impact in the 49 least developing countries (LDCs) because of overwhelming dependence of their economic on climatic sensitive resources, as well as because of their low adaptive capacity (Haq and Khan 2006). The impacts associated with climate change have threatened and increased the vulnerability of both, natural (forest, land and water) and human system (health, economy and culture) equally, which ultimately brings the various destruction of the natural and social life (Regmi and Adhikari 2007). Climate change is one of the most complex challenges that humankind has to face in the next decades. As the change process seems to be irreversible, it became urgent to develop sound adaptation processes to the current and future shifts in the climate system. In particular, it is likely that the biggest impacts of changes will be on agricultural and food systems over the next few decades (Brown and Funk, 2008).

2.1.3 Impact on Agriculture of Climate Change

Over two-third of Nepal's population depends on agriculture for their livelihood and follow traditional cultivation practices. Now the old rhythms are upset by unpredictable rains or prolonged droughts (WFP 2009). In the past four decades, the agricultural productivity of major grains in Nepal has gone from being the highest in South Asia to the lowest. Since 1960, the number of global weather related disasters have increased four fold, real economic losses seven fold, and insured losses. A part of this rise in disaster losses can be attributed to rapid weather changes. Developing countries are the most vulnerable to natural disasters that have serious economic impacts. The projected changes in climatic conditions of Nepal will adversely affect agriculture production. Climate change is expected to lead increasing dryness in drought-prone areas and to wetter condition in wet areas (WFP 2009).

Agriculture and livestock system are the vital livelihood source of the communities which primarily depend upon the natural resource for subsistence. So any change in the climatic condition directly or indirectly affects the livelihood assets of the communities. Reduce in the crop yield, change in the cropping variety, change in cropping and harvesting time, poor health of livestock, decreasing grazing land and reduce in the productivity of the livestock are the major effect seen in the agriculture and livestock system. The impact of climate change has already become severe, with more impact likely to come. The adaptation to any climate change programme should keep the future projection in mind. If they likely future impact not taken into account, any investment in coping strategies will be a waste of resources, as they are likely to be destroyed by bigger disasters in the future (Gurung and Bhandari 2008). Nepal has generally not received sufficient attention or funding from international communities on adaptation to climate change (Regmi and Adhikari 2007). Farmers in Nepal have used indigenous knowledge and innovations to adapt to climate change for generations (Regmi et al 2009).

Agriculture is likely to get affected positively or negatively. Negative effects are feared to be larger than the positive effects. Climate change can have both direct and indirect negative impact on the natural resources such as agriculture and forest for their livelihood are likely to be most affected by the climate change. In this regards to

the agriculture, the general consensus is that changes in temperature and precipitation will result in changes in land and water regimes that will subsequently affect agricultural productivity (World Bank 2003). There is an increasing concern about the impact of climate change on agriculture in developing countries with the changing in global climate (IPCC 1996) and some attempts have been made to estimate this impacts. The impact of climate change on agricultural sector is therefore a matter of concern, particularly in the low income countries where a majority of people are living in rural areas. The impact of climate change on agriculture show a prediction of reduction in agriculture yields particularly in tropical regions (Thapa and Joshi 2010). Large adverse impacts on agricultural productivity, especially among small holders who depend on farm productivity for livelihood and subsistence opportunities can lead to a rise in poverty levels (World Bank 2003).

2.1.4 Socio-Anthropological Perspective on Climate Change

As the human causes and consequences of climate change have become increasingly apparent, social scientists engaged to understanding of the role of humans in global climate change. Due to multi-dimensional impact on human and natural system, it is no longer only environmental and atmospheric problem rather it has become an important social and humanitarian issue (Crate and Nutall 2009). The late of 1960s and the 1970s (the environmental decade) that a significant number of sociologists began studying the impacts of natural process of humans and its reverse- the social practices that organize our development and use of the product and technologies that impact ecological and human communities. Certainly many people in the early part of the twentieth century were interested in a wide range of environmental issues- from the conservation of vast expanses of wilderness to the improvement of urban spaces (Taylor 1997).

Environmental sociologists of the late twentieth and early twenty-first contribute to the development of a theoretical perspective known as ecological modernization, they have reached outside sociology's boundaries to borrow and adapt theoretical models from population ecology, geography, and demography, among others (Nagel et al. 2008). Environmental sociologists have recently turned their attention to global climate change and have learned that contributes to understanding the causes of global climate change, for example, which populations are most vulnerable and resilient to

the impacts of climate change, and what is the role of competition among states in the global system to accelerating the drivers of global climate change (Nagel et al. 2008).

Sociologists have applied theories from ecology to study the complex relationship between human and their natural environment. The human ecology perspective underscores the socio-spatial dynamics of climate change and varied interactions human have with their physical environments across spatial and temporal scales. Sociologists have applied this “place-based approach” to research on migration, resource competition, and disaster relief. This perspective provides evidence that while climate change is a global threat, its effects are experienced locally and can better be understood when sociologists include data from humans' biophysical environments (Nagel et al. 2008). As the 2007 IPCC report notes, there is an unequal distribution of impacts and vulnerabilities to climate change associated with social class and age in both developed and developing countries and also noted the potential for conflict arising from the unequal economic, social, and health consequences of climate change.

The debate on climate change formally entered within anthropology after the Rio conference of 1992 which formally recognized climate change as becoming one of the major challenges faced by the natural and human system in the new millennium. By the late 1990s, there was a talk of climate anthropology as a field (Batterbarry 2008). Even within these studies, some of them study about climate change through local people's experience observation about the ongoing change in their surrounding environment-local perception (Crate 2008, Nutall 2009), while others emphasized on the social construction of impact and coping and adaptive strategies followed by the community in response to such change, and stressed on the importance of empirical studies for the better understanding of the phenomenon through humanistic perspectives (Staruss and Orlove 2003, Roncoli et al. 2009).

From the early evolutionists through Steward, Rappaport, Vayda, Wolf, Mccay and others, environmental anthropology, cultural and political ecology have provided the conceptual tools to examine the complex interplay of culture, society, power and environment (Lahsen 2007). The disturbances in human-environment interaction directly affect the human behaviour and their society. The issue of climate change

directly hits the existing human-environment interaction and is a subject matter of the sociology. Then after sociologists were involved in the diverse aspect of climate change research such as the local perception on climate change, climate change knowledge, interaction between the local climatic model and scientific forecast, impact of climate change on the livelihood and culture, coping and adaptive strategy to climate change, community base adaptation and public advocacy oriented issue like fairness, equity and human rights on climate change.

2.1.5 Concept of Adaptation to Climate Change

The IPCC Third Assessment refers to climate change as the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts' (2001:881).

Adaptation is necessary because of the impending threats of climate change to unique ecosystems and biodiversity, as well as its aggregate impact on Gross Domestic Production (GDP) or local economy (Ravindranath and Sathyahe 2003). The IPCC fourth assessment report makes clear that "adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emission" (IPCC 2007:18). As such, it supports adaptation as a complimentary response strategy to mitigation. The Bali Action Plan from the UN Climate Change conference in Bali 2007 (UNFCCC 2007) clearly emphasized the importance of enhanced action on adaptation. In addition, adaptation to climate change is considered especially relevant for developing countries, where societies are already struggling to meet the challenges posed by existing climate variability (Yamen et al. 2005; Adger et al. 2003), and are therefore expected to be the most adversely affected by climate change (McCarthy et al. 2001). Therefore, adapting to the changes has consequently emerged as a solution to address the impacts of climate change.

Adaptation takes place in different types and forms. It can be anticipatory or proactive, which takes place before the impacts of climate change are observed; autonomous or spontaneous, which is widely applied and occurs as a reactive response to climatic stimuli without the directed intervention of a public agency; and

planned, which is a result of a deliberate policy decision, based on climate change studies and predictions (Smit and Pilifosova 2003).

Adaptation to climate change is an important aspect of protecting the poor from its adverse impact and the challenge there is on how to keep local communities and households involved in the climate change discussions, without losing the focus on their existing needs and vulnerabilities. Local communities play a vital role in the adaptation process as the characterization of climate change impacts at the local level could present solutions and measures that can possibly be adopted at meeting the challenges in the future (IIED 2007). While mitigation efforts to reduce greenhouse gas emissions is the traditional deliberate international policy approach to address the threats of climate change, adaptation has become a key focus and is currently playing as a major theme of discussion in the multilateral climate change processes (UNFCCC 2007). Adaptation is one of the most available responses addressing the threats of climate change, as it is a process that involves moderating strategies to cope with uncertain climatic events. Effective adaptation therefore entails the coordination of actors at all levels- from the international community, national governments to communities and local networks (UNFCCC 2009).

Societies worldwide have had a long record of adapting for centuries however, with human-induced climate change, necessary adaptation options are needed urgently especially for developing countries due to their existing vulnerabilities (IPCC 2001, UNFCCC 2007). Developing countries, as emphasized in recent research publications and studies, are expected to suffer the worst impacts of climate change in relation to loss of lives, livelihoods and increasing damage to their living standards. The incremental limitations of developing countries in terms of adaptive capacity are associated with human, institutional and financial constraints to anticipate and respond to the direct and indirect effects of climate change (Gacusana 2008).

Adaptive capacity is context-specific and varies from country to country, among social groups and individuals, and over time, but is ultimately connected to social and economic development (Smit and Wandel 2006). The capacity is adapted influenced by a society's productive base, which includes natural and man-made capital assets, social networks and entitlements, human capital and institution, governance, national

income, health and technology, including multiple climate and non-climate stress as well as development policies (IPCC 2007). The IPCC further notes that adaptive capacity is not evenly distributed across and within societies, as is the case for many developing countries. Adaptive capacity is a function of several factors, such as level of income, knowledge and skills, technology, access to information, equity in resource distribution and access to opportunities (IPCC 2001).

Adaptation strategies of local people are also an integral element of the development because they enable the management not only environment variability, but also perturbations in social, economic and political variables (Pelling 2003). As a result, numerous disciplines undertake to examine social, biological and cultural adaptation processes from a variety of perspectives, including anthropology, archaeology, biology, ecology, geography, political, psychology, and global environmental change science (Janseen et al. 2006). Ironically, many disciplines representing the conceptual roots of adaptation are seldom referred to in the climate change discourse.

Adaptation has major role in combating unprecedented effect of climate change. The early works on the adaptation basically targeted to identify potential impact of future change using different scientific climate models. But these models fail to furnish information on regional and local impacts that really forms a basis for catalyzing immediate and practical action in the context level. Natural and human system in different region may respond differently according to the geography, social structure and economy of the region. We can expect this at the regional, national, community and even at the individual level. Therefore, large and centralized adaptation measure may not expose the local realities and hence, might not be able to contribute on vulnerability reduction which is the urgent need impact (Adger et al. 2006). Adaptive capacity is the potential or ability of a system, region or community to adapt to the effects or impacts of climate change. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development (Smit et al. 2000). The determinants of adaptive capacity relate to the economic, social, institutional and technological conditions that facilitate or constrain the development of adaptive measures (Kelly and Adger 2000).

Local people respond the unfavourable environmental condition by modifying the available strategies available for them. Migration as one of the important adaptive strategies followed in response to environmental difficulties through out the human history Smith (2009). In addition to this, various scholars have conducted research on the local coping adaptive strategies which are traditionally developed by the local communities in response to the uncertainties and adaptation to climate change (Vedwan 2006, Ishaya and Abaje 2008) from various parts of the world.

In South Asia, the majority of the communities being dependant on the natural and cultivated resources, the traditional knowledge resource base with respect to coping strategies is enriched with a number of indigenously developed methods/technologies to counter the uncertainties of climate change. For example, the Van Panchayat of Uttarkhanda (India), large cardamom based agro-forestry in Eastern Himalayas, Warabandi in Pakistan and the ploughing of sloping lands following a bottom up fashion in a sword- like pattern in Nepal, the cultivation of tubers, cereals, legumes and fruits in side the coconut field in Sri Lanka are some indigenous coping strategies to the climatic threat (Silori, 2008).

Nepal has more stakes to adaptation and the implications of the climate changes to the fragile mountain ecosystem, fresh water, and extreme weather events, agriculture, human health others could be a serious problem for Nepal in the future. Few glacial lake out-burst events are already seen in Nepal and others such as Chho-Rolpa have been prevented from out-bursting recently. The downstream economic and societal implication of the floods induced by such glacial lake outburst would be huge, and their likelihood will increase with climate change. At the same time Nepal lacks human resources, economic resources, scientific resources and institutional resources to cope with the negative implication of climate change, making it more vulnerable (Shadul et al, 2003).

CHAPTER-III

RESEARCH METHODOLOGY

The study primarily focused on local people's experiences of impacts and coping strategies adopted by the communities to climate change in the Bhorle VDC of Rasuwa district. This section deals with the rationale of selecting study site, research design, nature of the data sources, sampling procedure and sample size, data collection tools techniques, data analysis and limitation of the study.

3.1 Rationale of the Site Selection

Rasuwa district is one of the climatic prone zone areas of Nepal (Local people, Per. Comm.) Mountain region's communities are more susceptible to climate change and vulnerability. Livelihood of mountain communities are highly influenced by climate change induced risks. Local communities are facing many problems such as change in agricultural practice, appearance of new pests and diseases, decreasing water resource. Climate change is a global phenomenon but its impact is always at local level. Hence local level study is important. In this context, I have selected Bhorle VDC of Rasuwa for this study purpose. In addition, local communities are primarily depended on the agriculture and livestock for the subsistence livelihoods. And majority of the people are indigenous, dalits, underprivileged and deprived communities. Few research has been conducted yet on the impact and adaptive measures followed by the communities to the ongoing climatic change.

3.2 Nature and Sources of Data

This study consisted of both qualitative and quantitative nature of data. To fulfil the objectives of the study both primary and secondary data were used.

3.2.1 Primary Data

In order to carry out the study a standard checklist was designed (Annex I). The primary data were collected through household survey, interviews of key informants, interviews, focused group discussion with user group members, including direct field observation. This helped the researcher comprehend a holistic picture of the Bhorle Ward no 1 and 4. During the course of the interview with the local people, I had primarily taken the reference of some climatic indicator like temperature, disaster, drought, landslide, hailstorms and windstorms, which were happening during their lifetime providing important generalization about the changing situation of climatic

regime. On the other hand, I focused how to local people response on the impact of the ongoing change to the social wellbeing, which was also another goal of this study. Finally, after knowing the impact focused my attention on how local people respond to such change through various coping and adaptive strategies.

Observation is a major technique of data collection in sociology. I also carefully observed the impact of climatic extremes such as the landslides. In addition to those I have also observed the present coping and adaptive strategies such as plantation of species like broom grass, bamboo, natural regeneration of uttis, charatio and wire meshed gabion wall to stabilize the landslides.

3.2.2 Secondary Data

The secondary data was obtained from the published and unpublished materials, journals, books, articles, newspapers and magazines, brochure, websites, thesis report and government publications. Some have accessed through internet while other have been collected from the relevant libraries. The socio-demographic information regarding study sites were collected from Central Bureau of Statistics (CBS) records.

3.3 Sampling Procedure and Sample Size

In this study, the two wards of Bhorle VDC were randomly selected i.e ward 1 and 4. The selected respondents were from all the section of society including well off or ultra poor family as well as gender was considered during sampling process. The systematic random sampling was applied, that minimised the selection biasness. And snow balling technique was also used to crosscheck the obtained information through key informants. Data were also collected opportunistically as and when possible. Especially at teashops, agriculture field and special occasion (such as *Barta banda*) were taken as opportunities to interview. This research focuses on how local people see the changes in climate through different climate parameters and climate related risk and disaster near their vicinity. I have paid attention on how local people cope with such unprecedented change through various adaptive strategies.

3.4 Data Collection Tools and Technique

This study has performed using both sorts of information sources: primary and secondary. The study has given priority to primary data and data collected from the field; namely, household survey, focus group discussion, key informants interview and observation. While secondary information was obtained through review of relevant literatures and interaction with VDC, DDC, I/NGO and other organization.

3.4.1 Sample Household Survey

Household survey was carried out to collect primary information. The purpose of conducting household survey was to acquire information about age and sex composition, primary occupations, educational status, livestock holding, different aspects of weather and climate, risk and hazards, agricultural production, and adaptation measures in response to those changes. All together, 60 households were surveyed. Primarily, head of the household was preferred, but in their absence other senior member of the family and gender was also considered. The purpose of the interview was explained before and if the respondent was willing to participate, then interview was preceded. Each interview lasted around 45-60 minutes and took in the form of conversation, structured around a written questionnaire consisting of both fix-response and open-ended questions. By using household survey method the researcher collected data of household socio-economic features.

3.4.2 Key Informant's Interview

Key informant interviews were conducted during the field work in order to comprehend the impact of climate change and how to adaptation to changing condition. Snowball sampling technique was basically used to obtain general information and to understand the relationship of social processes, communal adaptation and information exchange about climate change. This sampling is appropriate for determining the actor who becomes the source of deep knowledge/information on subject matter if situation is dependent on other social factors. In case of selecting key informants of specific or unique characters for example (CFUG members and local conservation organization, NGOs, teachers and governmental official of VDC older farmer etc) in which an informant was first visited and next one was selected based on reference from the first. They were interviewed about change in rainfall and temperature pattern and changes in resource

availability, external support. The checklists for this purpose were open-ended (annex-I). Time interval for each interviewed ranged from 45 minutes to 60 minutes.

3.4.3 Focus Group Discussion

The qualitative information was collected in the form of discussions. All together, two focus group discussions (FGD) were conducted with different age group and sex. Both discussions were carried out with directly affected group of farmers due to climatic related risk and disasters. These discussions helped to obtain agreed views of people on past natural disasters events, observed environment changes in recent years, past and present condition of climate, changes in agricultural productivity, changes in their economic condition, adaptation measures adopted by local communities at each of the visited settlements. A group of eight to ten people was formed consisting of small and medium farmers as well as VDC members. In the process, a topic of discussion was introduced and one by one seeking response from the participants. Each discussion lasted for one to 2 hours.

3.4.4 Field Observation

The field observation was performed to observe and gather information on social and physical features for getting insights view of the consequences of disasters. Mainly, I observed the impact of climatic hazards such as landslide, effect of drought on potatoes plant and disease on mustard plants. In addition, I have also carefully existing coping and adaptive alternatives of the communities for instances, they have planted broom grass, uttis as well as gabion wall for minimize of landslides on impact of climate change. The direct field observation was used especially to know how household coping and adaptation strategies as well as factors contributing to the vulnerability of household. Photograph was taken which was publicised in page number 75 to 77.

3.5 Method of Data Analysis and Presentation

The collected data was first organized the data into different topics, coding it in the Microsoft Excel according to topic. Initially, the collected data were organized into different topics and coded according to topic. Qualitative data were analyzed in

descriptive way and findings were presented in simple tables, charts and figures. Graphical representation of the data was done in Microsoft Excel.

3.6 Scope and Limitation of the Study

The study had some limitations due to the timeframe of the study, and the limited resources. The study was carried out in only 2 wards of VDC and therefore a complete generalization of its findings on the entire wards of the VDC may not be possible.

1. It is an individual study, therefore it does not cover whole aspect of climate change, but it can be references for the further study.
2. The research has been conducted through sociological perspective so the methodology and generalization may not fit on the other approach.
3. The study was focused on gathering the impacts and adaptive mechanism to climate change. So the validation of these experiences with the scientific data was a major limitation.
4. Detail physical vulnerability and impact assessment on the basis of the elaborated biophysical, environmental and climatologically analysis and modelling was out of scope of this study.

CHAPTER-IV

THE PHYSICAL SETTING

In this chapter I mentioned the basic features of the study area, location, demographic feature, social organization feature etc. It begins with the general information of Rasuwa district which is followed by the information about Bhorle VDC and intensive study site within the VDC.

4.1 Rasuwa District

Rasuwa is one of the remote mountain district of central region that lies in 27°55' to 28°25' North Latitude and 85°00' to 85°50' East Longitude to the north of Kathmandu. The district covers an area of 1512 square kilometres. The district demonstrates the elevation from 614 meter to 7227 meters above mean sea levels. The district experience distinct summer and winter seasons. From mid-April to mid-June, it is warm but often cloudy with occasional showers. Summer monsoon lasts until the end of September. The maximum temperature occurs generally in August and reached the minimum in December or January. The mean minimum temperature is 4°C in winter and means maximum temperature is 24°C in summer. Monsoon generally starts in the second week of June and retreats in the fourth week of September. The two months (July and August) contributes 691.7mm of the total rainfall. The study area received negligence or lowest in the winter season (CBS 2007).

Langtang National Park (LNP) was established under His Majesty's Government in 1976 to protect its natural beauty, exemplary biodiversity, and rich cultural heritage. Some of the most attractive place of the areas includes the Langtang valley, the holy lake at Gosainkunda and Mt. Langtagn Lirung 7,324m. LNP is well managed protected area where deforestation and habitat loss still remain significant; thus it was expected to provide good indicators of climatic impacts. Agricultural land covers the third largest land use i.e. 6.3 per cent. Tamang constitute the major ethnic group in district. Tourism is one the principal sources of income to the inhabitants.

4.2 Bhorle VDC

Bhorle Village Development Committee (VDC) is lies in 11 km south-eastern from the district headquarters of Rasuwa district. Its altitudinal variation ranges from 700 to 2100m from sea level (CBS 2007) (Annex II). Agriculture is dominant occupation of the local economy. The total area of agriculture land of VDC is 30,437 ha. However, out of this, the total cultivated area of land is 8,940 ha. Only 11.3% cultivated land being the irrigated out of total cultivated land (NARC 2006). Rice, maize, millet, mustard and potato were the major crops in the area. Bhorle VDC is landslide prone

VDCs in Rasuwa district. The landslide had damaged the agriculture land, natural spring, infrastructure including private houses, drinking water system and road transport. Landslides had discharged the sediments in the lower part of the VDC destroying the agriculture land. In 2003, the Polchet Pahiro blocked the Trishuli River and caused hug damage to the paddy filed in the down streams.

4.2.1 Demographic Features of the Study Area

The total households of the VDC is 1078 and population is 5965 (male 2983 and female 2982) (CBS 2001). The targeted survey households were total households residing in the VDC, however, because of large number of households in the VDC the intensive study was focused in ward number 1 and 4. With this, out of total 270 household of ward number 1 and 4, only 22% households were selected for this study purpose. Because of Tamang being the dominated ethnic group, the highest percentage respondents were Tamang and rest were Ghale, Brahamin, so-called Dalits, and others. There is slightly male dominated to female and the average family size of sampled household is 4.1 of the study area, whereas the average family size of the Rasuwa district is 5.1, which is comparatively higher than study area. As rain-fed farming systems dominate food production. The majority of the communities are dependent on the natural resources and monsoon climate for livelihoods. Crop farming is mainstay of the people. In also provided additional sources of income generation. In addition, wage labour, off-employment, trekking and selling surplus of Amriso (*broom grass*) complimentary sources of income. Rice, maize, potato, millet and wheat are major cereal crops produced in the area. A high school is located in southern corner of the village and a health post nearby. Bhorle VDC is linked with track road. Daily bus service is available to Kathmandu making easy access to the people for marketing and other purposes. But, road in monsoon and rainy season remain damaged so, transportation is irregular temporally. During the monsoon season, every year the roadblock was common and the life of communities were disrupted due to lack of food grains and basic requirements, which used to come from the cities. Some farmers who used to small scale trading like the selling of agriculture and forest products were also affected due to the blockade in their movement.

4.2.2 Forestry and Biodiversity

The vegetation type of surrounding study area falls under subtropical to lower-temperate forest types. The presence of broad leaved to pine forest where dominated vegetations are Chilaune (*Schima wallichii*) and chirpine (*Pinus ruxburghii*). There are total 27 Buffer Zone Community Forest User Groups (BZCFUG) distributed in Bhorle VDC. There are three BZCFUG in alone ward 4: i) Ringung BZCFUG, ii) Chulanipakha BZCFUG, and iii) Lamachet BZCFUG. The formation of community forestry started from after 1994 and most of the forest are plantation forest.

Majority of the population in the study site depend on forest products for their livelihood. Communities used forest for fulfilling their basic requirement of firewood, fodder and timber. Communities had limited forest resources in order to meet all their demand of forest products. This situation had increased pressure on Buffer Zone and core area. This also led to the increased deforestation and loss of local species. After the initiations of Langtang National Park on establishment of Buffer Zone Community Forest, the massive plantation activities were carried out in both the buffer zone and national park and in private and public lands. This had somehow contributed in biodiversity conservation. The discussion with communities revealed that there was irregularity in flowering of different species. People indicated that the Rhododendron, Juniper and Lokta appearing in the higher altitudes than their normal distribution range. Fruiting calendar of Kaphal (*Mulberry*), Aishelu (*Wild berry*) has changed and fruiting happened almost one month earlier.

4.2.3 Water Resources

Impact of climate change on water resources has directly affected the agriculture. In the study site, the majority of farmers primarily depend on monsoon rainfall for cultivation of major crops like maize and paddy. Since the rainfall deviated from past pattern, the available water resources and irrigation facilities are negatively affected. The impact of climate change on water resource was manifested in the form of availability of quality and quantity of water in the study site. There was prominent change in seasonality and amount of water flow in the stream. According to local people, natural springs, wells and water sources had dried significantly over the past

10-8 years. The drought and landslide had badly affected the water supply system used for drinking water, irrigation and other purposes. Drying of waters sources in the study area was not only causing problem for drinking water and irrigation as they have to walk a longer distance to collect water but it has significant impact on operation of water mills. Drying of springs had fact caused major problems to paddy cultivation that depend on rain-fed systems. Communities also mentioned that the water level in the river during the dry season has drastically decreased.

CHAPTER-V

DISCUSSION ON SAMPLE HOUSEHOLD AND POPULATION

This chapter deals with socio-economic feature such as household size, land holding, livestock holding, and food deficiency as well as population in the sample household's by age and sex group, educational attainment, occupation and income by sources of housed members etc. Brief description of this feature can be helpful to understand the socio-economic status of the household.

5.1 Household Size

Household (HH) size refers to a total number of members pertaining to a household. Family (HH) size varied in the study area from as low as 2 persons to as high as 17 members. The average household size was 6.9 in the study area. However, household size of surveyed population was found remarkably larger than national average household size of the country, i.e, 5.4. The large family size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural tasks. Household with a larger pool of labour should be more likely to adopt agricultural technology and use it more intensively because they have fewer labour shortages at peak times. Here it is expected that household with large family size to be likely to adapt to climate change. The table 1 presents the distribution of household size.

Table 1 Percentage Distribution of Household by Size

Household Size	No. of Households	Percent
1 to 2	2	3.3
3 to 4	13	21.7
5 to 6	20	33.3
7 to 8	10	16.7
9 +	15	25.0
Total	60	100
Average size	6.9	

Source: Field Survey, 2010

5.2 Households Caste and Ethnicity

In the study area, local communities were found heterogeneous in terms of caste and ethnic composition. The different caste of people with different backgrounds and profession with their own culture, and their traditions are resident in this place.

Table 2 Composition of the Caste and Ethnic by Sex

Caste	Sex of HH Members		Total
	Female	Male	
Tamang	125	126	251
Gurung	56	50	106
Brahamin	23	28	51

Dalits	4	6	10
Total	208	210	418

Source: Field Survey, 2010

The table 2 displays the composition of caste and ethnic groups in the study area. Tamang constitute the major ethnic group followed by Gurung, Brahmin and Dalits. Climate change is affecting everybody, regardless of caste, ethnicity, and level of income. Different groups have limited access to resources and due to factors like, access of land, low education, awareness and knowledge, and inadequate financial opportunities that enhance their capacity to cope and adopt to climate change.

5.3 Land Holding Size

The size of land holding is considered the principal asset and prosperity of the household in the rural areas. Smallholders and marginal farms predominant Nepalese agriculture with the average holding size of 0.8 ha. And farms are getting smaller-average size of holding declined by 28 percent between 1961 and 2001 (CBS, 2004). In terms of distribution on agricultural lands, the story is true in study area. As rain-fed farming system dominate food production and generating livelihoods in rural areas. Different climate induced disasters such as landslide and drought events are gradually deteriorating land fertility and productive land are left barren. Even some farmers have become landless and had weakened their economic condition as they are highly dependent on agriculture. Of the total agricultural holding, the majority of 55% respondents of all have less than 0.25 ha (5 ropani) of land, while those without land constitute 20 percent of all holdings.

Furthermore, agricultural land holding size is associated with greater wealth and it is believed to increase adaptation to climate change. Shortage of land has been associated with high population pressure. High population pressures force farmers to intensively farm over a small plot of land make them unable to adapt to climate change but also to sustain their livelihood during harsh climatic extremes such as landslide and droughts. The amount of land access and used for agriculture by a household however is still generally seen as determinant of the food sufficiency for a

household. A general concept is that more the amount of land accessed, more is the production and so the food sufficiency for them is supposedly higher.

Table 3 Distribution of Agricultural Land in Study Area

Land holding (ropani)	Khet (rain-fed)	Bari (upland)	Kharbari
Landless	20.0	5.0	61.7
<5	55.0	58.3	36.7
5-10	15.0	28.3	1.6
10-15	8.3	6.7	-
15>	1.7	1.7	-
Total	100	100	100

Source: Field Survey, 2010

The table 3 indicates that those people who were landless or access of land less than 0.25 ha in particular were more vulnerable and adversely affected by climate change. These factors have made them more difficult for these people to cope with the agricultural consequences of climate change.

5.4 Food Deficiency Level

Climate change has adverse impact on food security (production) and particularly poor are more vulnerable to due to low coping capacity. The arable land degradation is reducing due to landslides and drought; as a result crop production is adversely affected. The productivity decline has strong correlation with the food security (significant at zero level). This implies that the smaller the land holding size the more the food deficiency. And the poor households who had small land holding are facing problem with food sufficiency. In the study area, the majority of the 80 percent households were food- sufficient only for less than 6 months.

Table 4: Percentage of Respondent's Opinion about the Status of Food Deficiency Level

Months	No of respondents	Percent
< 6 months	48	80.0
6-9 months	11	18.3

9-12 months	1	1.7
Total	60	100

Source: Field Survey, 2010

The table 4 indicates that food sufficiency was also a problem among households. In particular, small land holding households were facing more difficulties to meet food-sufficient from their land production. The frequent occurrence of landslides and prolong droughts had adversely affected the traditional agricultural practices and decreased substantially in crop production and a negative impact on food security. Thus, it implies that either well-off or poor households were facing problem to sustain their livelihood and more difficulties to cope with agricultural consequences of climate change.

5.5 Sources of Livelihood

Information on household income provides support for the analysis of living standard of a household and indicates the earning capacity and purchasing power as well. Household income, for the purpose of the survey was comprised of individual salary/wage income of all usual members of the households and income of household that can be measured at household level only, such as income from agricultural or non-agricultural activities of a household where more than one member of the household might be engaged, transfer incomes and remittances, and miscellaneous incomes such as transfers in kind.

The rural households primarily depend on agriculture for their livelihood, and this dependence tends to rise the poorer the household is. For the poorest of these households, two-third or more of income is earned on average through agriculture. Such an agricultural dependence suggested that the income effects of a decline in agricultural productivity could be significant. Household is dependent on agriculture for their income, with the agriculture sector is most affected by climate change.

Livelihood in Bhorle is largely agriculture subsistence oriented. Hence household level agriculture i.e. small scale crop cultivation to produce mainly paddy, maize, wheat and potato etc. remains the biggest support to household economy. Altogether, 51.2 percent of the population were found to be employed or engaged in kind of work.

While, another 48.8 percent of the individuals reported to be either children or student. According to the results of the survey, the share of agriculture and livestock constituted highest among households' income and followed by remittance.

Table 5 Households Member Income by Source

Sources	Sex of respondent's		Total
	Male	Female	
Agriculture & Livestock	90	67	157
Salary, Wages & Allowance	17	5	22
Business/Service Enterprise Related	1	1	2
Remittance	19	6	25
Miscellaneous	1	7	8
Total	128	86	214

Source: Field Survey, 2010

The table 5 indicates that agriculture is main source of income among households in the study site. Communities are now exploring other options and opportunities like livelihood diversification to sustain their livelihood. Due to impact of landslides and droughts as a result of disrupted income sources, loosing of lands, properties, animals and even family members, people are migrating to new places searching better options. It encourages diversification of income sources, and in the dry season or in particularly bad years many rural households seek additional income in non-agricultural wage labour or foreign employment. These sources of income were important, and enhance their capacity to cope and adapt to climate change.

5.5.1 Livestock Management

Livestock provides draft power and manure to agriculture, income, nutritional and other by-products. This is also evidenced by presence of livestock in 53 households sampled out of 60. The population of animal species such as cows, buffaloes, goats and ox/bullock were kept by local communities. And average number of livestock accounted 4.08 animals.

The respondents of study site also argued that the entire livestock farming system has undergone change during the past 20-15 years. They have pointed various natural causes like change in climatic parameters, climatic extreme event that directly affects the availability of fodder, water, forest and grazing land disease to animal. In addition to this, various economic and socio-cultural causes like changing meaning of livestock rearing, changing land use practices, availability of manpower and alternative source of income, education and technology for the change in the livestock system since past 20-15 years.

Table 6 Percentage of the Respondent's Having Livestock per Household

Livestock Type	Number	Percent
Cow	31	12.6
Buffalo	82	33.5
Goats	124	50.6
Ox	8	3.3
Total	245	100
% of Hhs having livestock		88.33
Average number of livestock/Hhs		4.08

Source: Field Survey, 2010

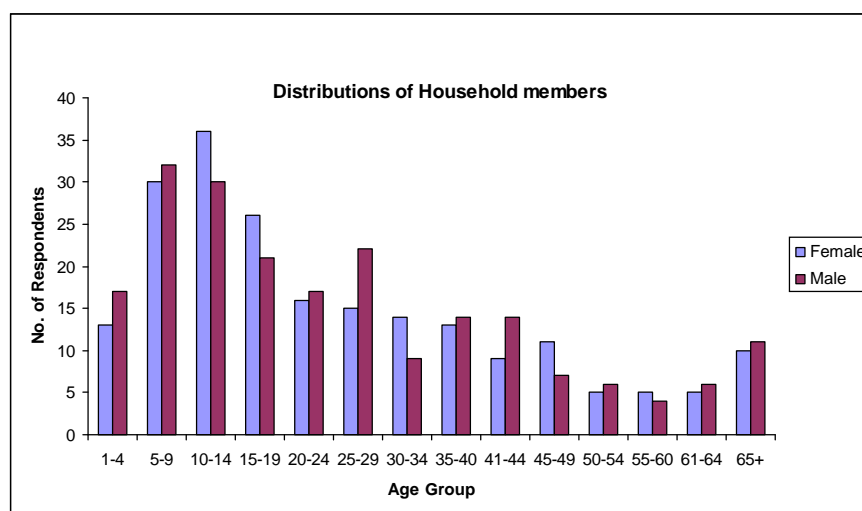
The table 6 indicates population of livestock was decreasing especially buffalo and cows due to decrease in grazing land, loss of local grass species, lack of feed availability and reduction in the size of some fodder trees. Local people also revealed that climatic stresses such as forest fire, prolong drought and landslide factors were causing the decline in livestock population. Livestock farming used to be the major income source of communities. And older respondents connect it as a consequence of the ongoing increase in the temperature and long drought which were experiencing in a last few years. In particular, income source from goat farming contributed some amount in the income of communities.

5.6 Age and Sex Group

The age-sex distribution of household population is shown in tells us about study area population growth rate and dependency ratio. The 60 households interviewed were

composed of 418 persons; 210 were men, representing 51 percent of the population, and 208 were women, representing 49 percent. The age structure of the population indicates that a larger proportion of population falls into the younger age groups for each sex. The proportion of dependents (under the age of 15 or 65 and above) is highest in study area.

Figure. 2 Distributions of Household Members by Sex and Broad Age Groups



Source: Field Survey, 2010

As indicated in figure 2 that greater the number of dependents in a household less is the chances of generating income which would ultimately not secure the livelihood of the household. Due to climate risk and disasters, these dependent groups will adversely impact their education, their emotional well being, and access to water, and they face severe constraints order to cope.

5.7 Literacy Rate and Educational Attainment

A good level of education will increase available livelihood options and enhance adaptive capacity. Education includes knowledge, skills, competencies and attributes embodied in people that facilitate creation of personal, social and economic well-being; as well as motivation, behaviour, physical and emotional attributes and mental health (OECD 2001). Higher level of education is believed to be associated with access to information on improved technologies and productivity consequences. Evidence from various sources indicates that there is a positive relationship between

the education level of the household head and adoption of improved technologies and adaptation to climate change (Maddison 2006). It affects every aspect of life, including demographic and behaviour. Although nearly all children start primary education, only half of them complete it and completion rates are lower among the poor family. However, they also mentioned that trend of sending children to school and an enrolment is increasing in recent years. However, during the monsoon, children could not go to school due to the blockade and devastation of landslide. Adult literacy ratio is a comparatively low and also low in comparison on to the national average. Of the total population aged six years and above having educational attainment, about 47 percent of the household members were either illiterate or could read and write the Nepali alphabet. The literacy rate gap between male and female widen within illiterate and literate members. But the literacy gap between both sexes narrowed down as the level of educational attainment increased in different age group years. Overall, the proportion of population in the age group of 5 to 9 and 10 to 14 appears to be encouraging. As far as the gender ratio of education level is concerned, female were found to be lagging far behind that of male as elsewhere in the country.

Table 7 Literacy Rate of Household by Age Group and Sex

Age group	Illiterate		Literate		Primary		Secondary		SLC		Intermediate & above		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
1-4	17	14	-	-	-	-	-	-	-	-	-	-	31
5-9	3	2	-	-	29	27	-	-	-	-	-	-	61
10-14	-	-	-	-	20	22	10	13	-	1	-	-	66
15-19	2	3	1	2	4	2	4	10	8	8	2	1	47
20-24	4	2	3	3	4	3	2	-	1	1	3	7	33
25-29	1	4	5	6	4	1	1	-	1	-	10	4	37
30-34	-	4	2	7	2	3	1	-	2	-	2	-	23
35-39	2	7	4	4	2	1	2	-	1	1	3	-	27
40-44	3	5	9	4	-	-	-	-	2	-	-	-	23
45-49	1	9	6	2	-	-	-	-	-	-	-	-	18
50-54	4	4	2	1	-	-	-	-	-	-	-	-	11
55-59	4	5	-	-	-	-	-	-	-	-	-	-	9

60-64	4	4	2	1	-	-	-	-	-	-	-	-	11
65+	7	10	4	-	-	-	-	-	-	-	-	-	21
Total	52	73	38	30	65	59	20	23	15	11	20	12	418

Source: Field Survey, 2010

As indicated in Table 7 education level was found comparatively low in the study area. However, there was significant difference between in education and income of communities. The poor people of communities have less education and income than the rich do. Rich households have more income than the poor do. This implies that education and income determining factors for adapting to climate change.

5.8 Occupation by Sex and Age Group

Occupation refers to all the activities of earning by people for their livelihood and daily requirement fulfilment. Shifting in the traditional occupation by the new occupation is emerging due to the impact of climate change. Similarly, there were some young people involved in wage-earner occupation from where they manage the basic cash that is needed in their family forcefully. Now, foreign employment and trekking have become the new and emerging occupation among local young people. Foreign employment is the second largest occupation after agriculture.

Age Group	Agriculture		Service/ Teaching		Business		Wage-earner Trekking		Student		Foreign Employment		No Work		Total
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	
5-9	-	-	-	-	-	-	-	-	27	29	-	-	2	3	61
10-14	-	-	-	-	-	-	-	1	36	29	-	-	-	-	66
15-19	4	5	-	-	1	-	-	-	17	13	4	2	-	-	46
20-24	7	8	3	1		1	-	-	5	2	1	6	-	-	34
25-29	10	4	-	4	1	3	-	-	4	5		6	-	-	37
30-34	13	4	-	1	-	1	-	-	-	1	1	2	-	-	23
35-39	13	6	-	5	-	1	-	-	-	-	-	2	-	-	27
40-44	8	11	1	-	-	1	-	1	-	-	-	1	-	-	23

45-49	10	7	-	-	-	-	1	-	-	-	-	-	-	-	18
50-54	5	6	-	-	-	-	-	-	-	-	-	-	-	-	11
55-59	5	4	-	-	-	-	-	-	-	-	-	-	-	-	9
60-64	5	3	-	-	-	-	-	3	-	-	-	-	-	-	11
65+	10	9	-	-	-	1	-	1	-	-	-	-	-	-	21
Total	90	67	4	11	2	8	1	6	89	79	6	19	2	3	387

Table 8 The Total Number of Households Occupation by Sex and Age Group

Source: Field Survey, 2010

As indicated in table 8 employment patterns have also changed due to climate hazards. Decline in productivity in the study site caused many local communities to shift their occupation to trekking, foreign employment and other services. In addition, trend of migrated to gulf countries among women in search of jobs and employment was increasing in recent years. Thus it had somehow helped some of the household to improve their resilience livelihood terms but was very low and insufficient to minimize the impacts and adjust to climate change.

CHAPTER VI

EXPERIENCES ON CLIMATE CHANGE AND ITS IMPACTS

This chapter describes that how the changing climate affects agriculture practices system of the communities along with local people's observation and experience. The perception of the communities to change on the amount of temperature or rainfall was gathered and how major climatic risk and hazards have impacted on livelihoods of communities.

6.1 Perception on Climate Change in Temperature and Rainfall

Communities perceive change in their surroundings through what they have experience and observe while inhabiting on the particular place during the entire course of the time. Perception is necessary prerequisite for adaptation (Maddison, 2006). A local community of the study site was aware of the fact that temperature is

increasing and the level of precipitation was declining. And their life has been negatively impacted by these changes and have made their life difficult compared to the past. Particularly, older people of study site had experienced dramatic increased temperature and irregular rainfall pattern over the past 20-15 years. Similarly, focus group discussion and key informant interviews, also revealed that communities experienced water stress and increased temperatures, and place is becoming warmer in comparison to the recent years. They perceived that the number of hot days had increased and number of cold days had decreased. Furthermore, they also reported the nights in the winter season had less chilled than before. Similarly, they also felt that summer days are also becoming hotter in the area. Local communities related the case of increase in temperatures with appearances of mosquitoes for the last 6-5 years.

Like, changes in the temperature, communities experienced changes on the amount of rainfall decreased. During the interviewing with respondents, there was an interesting case occurred among older and younger. The majority of older people noticed short duration of the rainfall and high intensity of rainfall pattern in recent years but younger people observed high intensity of rainfall.. During the focus group discussion and key informants surveys participants told in the past years erratic monsoon and changes in rainfall intensity and patterns had increased and decreased in rainfall number of days. In addition, earlier rainy days used to be stayed longer period of time and were less intense compared to recent years. Similarly, they also revealed that there were no rainfalls at times needed for crops which decline in crops yield. They also felt that rainfall frequency has decreased in the winter significantly. Farmers linked this situation to change in rainfall pattern and intensity with magnitude and impact of disasters such as landslides and drought in the study area.

Table 9 Perception of Respondents on Climatic Parameters

Perception	Temperature	Rainfall
Increase	54(90.0%)	1(1.7%)
Decrease	2(3.3%)	59(98.3%)
Stayed the same	4(6.7%)	-
Total	100	100

Source: Field Survey, 2010

As shown in table 9 it is clear that almost all (more than 90%) revealed that local temperature had increased and (more than 98%) indicated that rainfall had decreased in compared to 20-15 years. The relationship between climatic variables such as temperature and rainfall on adaptation requires a time serious data of how communities have behaved over time in response to changing climatic conditions. As this type of data in not available for this study. Thus, it is hypothesized that communities adapt to increasing temperatures, as more adds more pressure on the already water scarce agriculture.

Table 10 Climate Change Variability and Local People Observation

Climate Variability	Local People Observation
Rise in temperature	Early flowering (rhododendron) Early ripe of fruits (pear, peach) Invasion of Mosquito Drying/ decrease water amount in water spring

Source: Field Survey, 2010

The table 10 clearly indicates that impacts of unpredictable weather pattern are already visible in study site. These impacts threaten communities' livelihoods, agriculture production, biodiversity conservation and health. The local level indicators of temperature rise included the changes in plant phonology, occurrence of new diseases and outbreak of pest and diseases. Similarly, the indicators for changes in rainfall pattern included the observation of decrease in snow cover, increase of drought and changes in monsoon (late and early ending). Similarly, communities noticed that mosquitoes were not found until 2005, are severely being invaded by them for the recent years. People are highly vulnerable to changes in temperature and rainfall impact, but they have the lowest capacity to deal with them.

6.2 Impact of Climate Risk and Hazards

The changes in climatic variability in rainfall and temperature had increased the frequency and impact of climate risk and hazards. Local communities linked the excessive soil loss and landslides with prolonged drought and erratic rainfall. The natural disaster and erratic rainfall caused significant damage to the socio-economic

and environmental assets of the community. The global and national data clearly indicates an increase in frequency of natural disaster for last few decades. Socioeconomic and environmental losses caused by these natural disasters are increasing. Various analyses revealed that weather/climate (hydro-metrological) induced disasters are the major contributors to the present increasing trend of natural disasters (Regmi and Adhakari 2007).

Local communities expressed their grave concern to climate risks and hazards. And, communities linked impact of disasters such as landslides and drought in the study area; this was mainly because of unevenly heavily rainfall in the area. Moreover, communities also indicated that the increase in frequent incidence of landslide, drought, loss/reduction of natural springs, hailstones and forest fire had already posed huge consequences in communities sensitive resources such as infrastructure designs, agriculture and water supply. Hence, these negative trends are likely to continue in the future and will make communities more vulnerable to climate risks and hazards.

Table 11 Respondent Perception on Trend of Climate Risks and Hazards in Study Area

Impacts	Landslides	Drought	Drying springs	Hailstones	Forest fire
Significant	55(93.3%)	45(75%)	33(55%)	32(53.3%)	21(35%)
Medium	5(6.7%)	14(23.3%)	26(43.3%)	26(43.3%)	37(61.7%)
Low	-	-	-	2(3.3%)	2(3.3%)
No	-	1(1.7%)	1(1.7%)	-	-
Total	100	100	100	100	100

Source: Field Survey, 2010

The table 11 shows that climate risks and hazards were increasing at study site. According to local communities, the magnitude of impacts and frequency of the occurrence have increased. And communities linked increased risks and hazards with decreased opportunities and employment level at rural level. Similarly, communities considered landslides and droughts as the major problem. Such climate risks and hazards had negative impacts on their livelihoods. The frequent landslides were devastating to agriculture and infrastructure. Every year, communities lost valuable

assets and land to landslides. Similarly, drought has multiple effects because it affects not only water resources, but also agriculture, and subsequently food security. Others hazards, such as hailstones and fire, also resulted in the loss of community assets. The impact of climatic stresses is high and capacity to deal with it was relatively low.

Case 1. Ghatte River Landslides:

The landslide is situated in the hill slope sharing geographic boundary of ward 1 and 4 of Bhorle VDC. Ghatte in Nepali means water mill and this ghatte river had more than 15 water mills located in steep terrain to facilitate rapid water flow to function the mill. However, there were only few of them currently operating due to destruction of the mills by frequently occurring landslides. At preset, the maximum horizontal outcrop distance of Ghatte River Landslides is approximately 200 m and vertical outcrop distance from top to bottom is 2 Km. Communities have observed the massive landslides in 1964 which destroyed some 26 households and affected family were resettled in Sindhure Ghari village. In 1976, after continuous downpour of rain, debris sided in Ghatte River, ravaged several water mills and took life of one person. The landmasses were gradually eroded/ taken away due to landslides reoccurrence after certain time interval. In 1984, landslides began to crumble again and landmasses shifted further downward. Every year communities had to live in fear and strange condition due to the massive devastation of the landslides. The conservation of forest and plantation in vulnerable areas started only after the establishment of community forest program in 1996/97.

Thus, this implies that communities were vulnerable to climate change.

As indicated in case 1, the climatic risks and hazards particularly landslide has major implication in the livelihood of communities residing in Bhorle VDC. It had washed away huge amount of productive agricultural land, destroyed crops and contributes in loss of agriculture crops. The losses of land and crops were very devastating and frustrating for communities and thus having negative implication in the food sufficiency status as well. Moreover, communities were facing difficulty in adapting to agricultural changes and increase more problems like land degradation. Therefore to adapt adverse impact of climate change farmers had abandoned their farmland and migrated to elsewhere.

Case 2. Experiences of Bhorle People to Climate Change

Ratna Bahadur Ghale, 66 years old man, is a local resident of Bhorle-I VDC, Rasuwa. Before the landslide he was practicing agriculture and enough to feed family members easily. But, unfortunately that night landslide had washed his huge amount of irrigated land. However, in order to combat that situation, he started trekking job to meet his family daily needs. He is in this profession from 25 years. During course of this time, he has reached almost all the trekking routes of Nepal and has observed several evidence of climate change. He had experienced of temperatures rise in villages and in trekking routes. And he has noticed the early flowering of Rhododendron in recent years. Similarly, taste of Kaphal (Mulberry) fruits is not as taste as it used to be before 10 years ago. He has observed delay arrival of moon and long period of drought and absence of winter rain. According to him, he has also observed some goman (cobra) snakes in the village in couple of years ago. Due to frequent landslide huge amount of arable land has become barren desert. He has also noticed some snowy caps area the tourist route of Langtang has changed into rock without ice.

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As indicated in case 2, the trend of climatic risks and disasters is increasing significantly in recent years. The frequent occurrence of landslide in Ghatte River had washed away huge amount of arable land and converted into barren land. Similarly, continuous landslide has gradually eroded agriculture land making some farmers completely landless. In addition, landslides had destroyed the infrastructure and development activities as well in the study area. According to respondent, particularly landslides had made him more panic and helpless. In order to overcome with this situation, he diversified his occupation and work as a porter to meet his family daily needs. Thus, this somehow had helped to sustain his livelihood.

6.3 Climate Change Impacts

6.3.1 Agriculture

Agriculture is highly sensitive to climate variability and weather extremes. Minor climatic variations can have a major impact on agricultural production even in a

single growing season, so long-term agricultural productivity and food security will certainly be affected.

The majority of the population in study site primarily depends on agriculture for their subsistence livelihood. Despite its high contribution to the overall source of livelihood, agriculture sector is challenged by multitudes of factors of which climate related disasters like landslides and droughts, which often cause adverse impacts on the economic wellbeing of local people. High, low and intensive rainfall, prolonged drought, changed in timing of rainfall, frequent erratic weather events have affected the agricultural production, making it more difficult for poor farmers to continue with traditional cultivation practices. In addition, Rasuwa is landslide prone district and land degradation and soil fertility loss was a major problem. The study site is also facing problem of hailstone and fire as well. The over dependence on agriculture and negative consequences of climate change were considered as major factors to the vulnerability of agriculture dependent communities of Bhorle VDC.

Table 12 Communities Observation of the Impacts on Agricultural Systems

Impacts	Community Observation
Invasive species	Invaded by Banmara (<i>Ageratina adenophora</i>), Lude sag (<i>Amaranthus spinosus</i>), Bethu sag (<i>partheninum hysterophorus</i>)
Vegetables and Fruits	Started slowly replacing by vegetables like cauliflower, cabbage, onion, garlic papaya etc
Pest and diseases	Increasing diseases in Maize (<i>Pale yellow</i>), Potato (<i>Dadelo</i>) and Mustard (<i>Lie</i>)
Change in cropping patterns due to extreme climatic events	Change in cropping season (paddy and rice plantation) and shift to vegetable farming
Loss and reduction of local species	Landraces rice (<i>Rato Dhan, Marsi, Bhangri, Kalokhathe</i>), Bhatmas (<i>Soyabean</i>), Bodi (<i>beans</i>) Gahat (<i>Horsegram</i>).

Source: Field Survey, 2010

The presented information on table 12 clearly indicates that local communities have already experienced their surroundings, they have never seen in their lives. Rising temperature and irregular rainfall pattern are creating favourable environments for invasive species to emerge in study site such as Banmara (*Ageratina adenophora*), Lude sag (*Amaranthus spinosus*), Bethu sag (*partheninum hystrophorus*). And communities perceived that invasive species is spreading fast and observed that production of crops had declined to some extent. Similarly, several new pests had also appeared and attacking on mustard (*lie*) and maize (*pale yellow*) plants. In addition, people no longer grow key landraces of rice and crops like (*Rato Dhan, Marsi, Bhangri, Kalokhathe*), Bhatmas (*Soyabean*), Bodi (*beans*) Gahat (*Horsegram*).

In recent years communities have started to focus on vegetables production instead of cereal crops, and some vegetables and fruits like cabbage, cauliflower and onion were produced and now performing well and which were not grown previously.

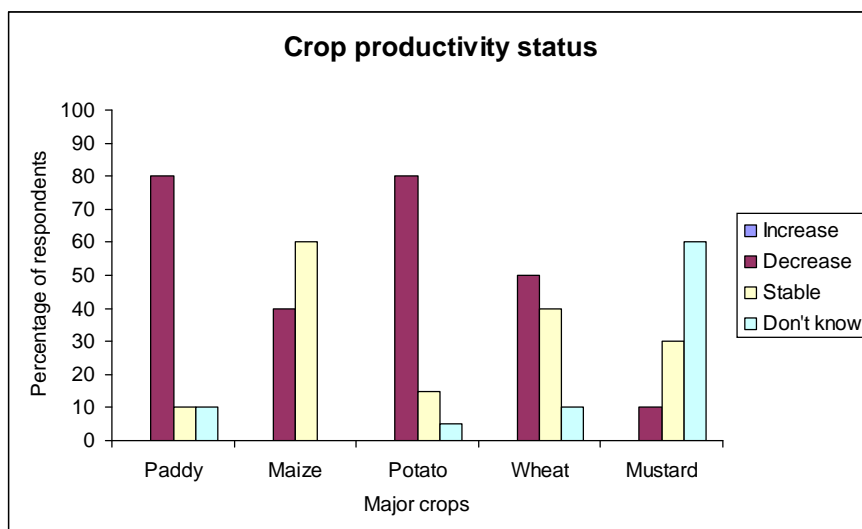
6.3.1.1 Changes in Crop Production

In the study site, the extreme severe weather events including droughts and landslides have dramatically affected crop production over the past 20-15 years, and leaving farmers unable to properly feed, and pushing them deeper into food insecurity and hunger. Similarly, local communities had experienced a substantial in cereal crop production due to the combined effect of water scarcity. In Bhorle VDC, paddy is the major food and the downfall paddy production was attributed to drought coupled with untimely rainfall. Community people also revealed that at the initial stages of paddy plantation, there was no rainfall. However, it rained a lot in the harvesting season affecting the production of paddy. Production of wheat was also estimated to see decline in production. The main reasons of such decline in the production crops was attributed to the lack of winter rainfall, reduction in cultivate land area.

Furthermore, inadequate rainfall at required time or heavy rainfall when not desired compounded with the incidence of new pests and diseases to the potatoes (*dadelo*) and mustard plants (*lie*), the seedlings of millet, maize were found to be pale yellow are the main facing problem by the communities and productivity of these crops has been severely decreased. Although, in recent years some farmers have started to use

chemical fertilizer and pesticide but the production of crops are decreasing. In the winter it is hard to harvest mustard seeds without using pesticides because of the aphids (*lie*) which were not prevalent before 12-10 years. In addition, local communities linked increase outbreak of pests and diseases were the rising temperature and inadequate rainfall.

Figure. 3 Percentages of Respondents on Cop Productivity Status



Source: Field Survey, 2010

The figure 3 clearly shows productivity of major cereal crops are decreasing. Increased weather unpredictability and intensity of climate hazards had disrupted rain fed agricultural system in site. This has contributed to decline in production of agricultural crops and has pose challenges for people and severe consequences, particularly for poor.

6.3.1.2 Changes in Crop Harvesting Time

The unprecedented rainfall pattern has severely affected and caused shift in agricultural calendar. The change in temperature and rainfall pattern was aggravation the situation by putting additional risk in the livelihood of communities. According to local communities, they were compelled to change the planting and harvesting time of many regular crops especially maize, rice and millet. The planting time of maize was

shifted in order to cope with prolonged drought. In the past people usually used to sow maize in second week of February and took almost 7 month for harvesting. But now it often cultivated maize on the third week of March and it does not take seven months these days to harvest. In general, they have undergone considerable change in the time of plantation which they are planting maize later than 15-10 years ago, but the harvest time of crop is similar or even earlier. And they have also changed in the species crops especially maize (small seed of maize) which causes early ripening within 5 months.

In addition, communities also revealed that the planting of paddy was pushed back by one month due to the delay in the monsoon for about fifteen days and rotational cropping systems were consequently affected. Climate change has also impacted the traditional harvesting techniques as well. They linked it due to the change in the sowing/cultivating and harvesting time or the change in cropping varieties. Because of unfavourable conditions during crop harvesting, communities were not able stored yield (seed) for next season. Therefore, to cope with such severe effect, they were dependent on other seeds that are available in market. This shows their concern about the uncertainty in traditional agricultural practices and making them more vulnerable.

Table 13 Percentages of Respondent's Perception on Changes in Crop Planting and Harvesting Time

Perception	No of respondents	Percent
Yes	52	86.7
No	8	13.3
Total	60	100

Source: Field Survey, 2010

The table 13 displays the changes in planting and harvesting time of major crops and local communities facing many problems. Due to scarcity of water, hectares of farmland were left fallow and production of standing crops declined. Changes in planting and harvesting crops time had thus posing threat to the livelihood of the community people by increasing the risks of food insecurity and hunger.

6.3.1.3 Changes in Cropping Pattern

According to local people, cropping pattern has changed considerable in the past 15-10 years. The changes were especially in the choices and varieties of agricultural productivity. Paddy, maize and millet were the major crops, where mustard and wheat common crops in the study area. But, now farmers have started to change in the variety and choices of crops and vegetables gradually. Similarly, people have shifted from paddy cultivation in irrigated lands to maize and finger millet due to delay in monsoon and lack of water. But, because of inadequate irrigation facilities people were started to grow maize instead of paddy in the field. They have also started to cultivate the whole potato bulb instead of cutting it into two lobes/pieces in order to prevent from rotting due to drought. The focuses of the communities were more on vegetable farming instead of cultivating cereal crops. Some crops, which were previously not grown in the study area, were now performing very well such as cabbage, cauliflower, guava and papaya. In addition, communities were also practicing mix cropping pattern such as (maize and soybean/beans/sweet peas) these days. But, many of the local landraces of rice, millet, and maize were already lost or being to loss and to replacement by new varieties. The local community's people revealed that causes of such changes in the cropping pattern were mainly climatic extremes such as long drought and heavy rainfall and availability of new varieties of seeds.

6.4 Socio-economic life

Nepal is particularly vulnerable to the impact of the climate change, socio-economic impact which tackling climate change has in poor countries by diverting resources which could otherwise be used for poverty reduction and supporting development (DFID 2009). Agriculture is a key economic sector in this area that could be significantly affected by changes in water resources related to climate change, due to the importance of agriculture in these changes may have widespread socio-economic consequences.

The natural disaster caused significant damage to the socio-economic and environmental assets of the community. Nearly half of the interviewed respondents have mentioned that the loss of the agriculture land and crops are the major impact.

Other repercussions include economic and social loss in terms of properties, human social-cultural life and animals. Climatic induced disasters are gradually mounting up in the study area. Hence, livelihood of local people is negatively impacted. According to local people, dwindling agricultural production such as paddy, maize, millet and potato has weakened their economic condition and face tremendous problems in their lives due to reduce food production. Small farmers and landless labours especially suffer, compared to with large farmers. Drought also stresses the supply of drinking water and irrigation. Decrease in agricultural production has weakened their economic conditions and compelled many people to migrate outside from the Bhorle VDC.

Landslides have caused migration in some cases to nearby settlements and other districts. Moreover, disasters such as floods and landslides are annually affecting the rural infrastructures such as roads, buildings and other monuments. Most people depended on subsistence agriculture that does not contribute significantly to household requirements needed to feed household members. Local people were engaged in various on-farm and off-farm activities. Earning derived from the sale was reported to be utilized on food, medicine, clothes and children's education. Due to the severe impact on agriculture, some of the community people have shifted their occupation from agriculture to the trekking, wage labour and some households even migrated to India and gulf countries for employment. Communities were now exploring other options and opportunities like livelihood diversification to sustain their livelihood.

Gender differences were noticed in the workload, with women working more than men. Compared to the men, women of the study area had limited access to resources like education, knowledge and skills, land, credit facilities and social networks. These livelihood resources would in fact help in building the adaptive capacity of women and poor households. Due to limited resources, women are often the worst hit and least able to recover from the effects of disasters. These in fact accelerate gender inequalities that already exist and deeply rooted in rural Nepali societies. Women in the area primarily involved in planting, sowing, processing and harvesting, whereas men were involved in social services and marketing, and migrated to India and Gulf countries in search for jobs and employment. Children from poor families and older people were found engaged in heavy household and farm work as well as wage

labour. Since women, children and older people often faced disasters, they were more vulnerable.

Focus group discussion and key informant interview with communities have revealed that women will probably suffer more from climate change because of their role in collecting water and fuel wood and the fact these resources are becoming more and scarcer. Thus, local communities are finding difficulty in adapting to agricultural change since the burden on agriculture system is going to increase more problem like land degradation, decline in production and outbreak of pest and diseases.

CHAPTER-VII

ADAPTION STRATEGIES TO MINIMIZE THE IMPACTS OF CLIMATE CHANGE

This chapter describes the existing coping and adaptation strategies followed at community level which help to increase the adaptive capacity and resilience in response to risks and hazards related to climate. Moreover, various barriers that limit the efficiency and well functioning of coping and adaptive strategies is also discussed in the latter part of this chapter.

7.1 Coping Strategies at Local Level

The coping and adaptive strategies individual or communities increase their adaptive capacity and resilience to the ongoing change. Local people not only face the hardness of change in their livelihood but also develop specific adaptive and coping strategies for their viable livelihood. From this perspective, adaptation is already necessary as people's lives and livelihood face an increasing burden of extreme shocks and stresses. Communities have been using traditional methods of adaptation for generation's event specific based on local knowledge and innovations.

7.1.1 Diversification of Livelihood Source

Diversification of available opportunities for livelihood income source has important role to cope with changing climate. Once the impact of climate change narrows down the scope of traditional livelihood people seeks alternatives. They give first priority to make the existing livelihood source more resilient. The second priority is to seek alternatives livelihood like income generation from the available resource and opportunities (Gurung and Bhandari 2009). From the field study, the impact of climate change was severe on livelihoods of communities in the study area. Many diversifications strategies that communities practice earn minimal incomes, rarely strengthen the livelihood. The major coping and adaptation strategies followed by people at study site are described below.

7.1.1.1 Agriculture and Livestock

Agriculture and livestock are the main source of income for the majority of the communities of the study site. People of community are already experiencing the changing climate. Agriculture and livestock practices are foremost hit by severe impact of climate change. And potentially reduces productivity of agriculture and

livestock systems. In order to cope with such economic loss which is consequences by climate change, local communities have diversified their agriculture systems. It is a serious concern to the local farmers. Local farmers have changed the planting and harvesting time of maize and paddy. Farmers have also changed in the species of crops especially maize and rice (*small seed of maize*) and rice (*genetically modified variety*). They are choosing these varieties which causes early ripening and good yield. Selling of surplus Amriso (Broom grass) is one of the important sources of income

Moreover, communities more focus on vegetable farming instead of cultivating cereal crops. Some crops, which were previously not grown in the study area, were now performing very well such as cabbage, cauliflower, and onions. Farmers also have grown lapsi fruits which help them to generate some additional income but, they could not continue due to lack of access markets.

In addition, due to extreme drought, there is a direct impact on livestock population. Drought has affected the livestock by water sources. As a result, communities were more focus on goat-rearing instead of other livestock animals due to good value in the market. Hence, goat farming contributed significant amount in the income of the communities.

Case 3. Diversifying Agriculture

Chakra Bahadur Ghale 65 of Bhorle-4 has a bitter experience of landslides as well. In 2053 B.S due to landslide he also lost huge amount of agriculture land and forced to look for other alternative sources of livelihood. With the support of some organizations, he planted broom grass, bamboo natural regeneration uttis (Alnus nepalensis) to stabilize the landslides. He perceived that although vegetative barriers were not capable of holding massive landmasses due to heavy landslides but this initiative has benefited him and other communities to generate some economic benefits. This year he has earned estimated Rs 18000 by selling broom grass. He found it very effective means of earning cash income instead of millet production.

The Case 3 clearly indicates that diversification of agriculture can provide additional income and improve their livelihood. Plantation of Amriso (*Broom grass*) is not good for erosion control but receive additional income. In addition, Broom grass can be supplied to goats and other livestock. Hence, it helps in increasing the adaptive capacities and resilience of the people.

7.1.1.2 Off-farm Employment

Communities were found to be engaged in various off-farm activities. Due to the severe impact on agriculture, the frequent migrations of men for seasonal labour, trekking and trading to nearby local towns and cities labour and some households even migrated to India and gulf countries for employment. The goods and cash generated through these employments help the local communities from post-disaster recovery and preparedness to the natural disasters and calamities which are caused due to adverse climate change. Therefore, it helps them increasing the adaptive capacity and resilience of the people. Many respondents seeking seasonal employment outside their communities especially trekking in Langtang route and some worked as wage labourers within community.

7.1.3 Social and Institutional Strategies

Social and institutional strategies were preparation for coping with risks and hazards in the study area of group cohesion and communal efforts. The village was relatively strong CFUGs and other groups formed by organizations like Langtang National Park Buffer Zone (LNPBZ) which focus on environment and biodiversity. In addition, local level Laligurans Eco Club (youth associated group) and local community peoples were formed and which were very active and knowledgeable about the issues of climate change. In the study area, local people have also adapting the water storage system and plantation for minimize of landslide gradually. The communities prioritized the management of water as well as plantation minimize of landslide on impact of climate change for both addressing landslides and drought issues. Impact of climate change on water resource and landslide is a social problems as well as social issue. The existing network of farmers and users group was to increase communal action towards addressing the issue of climate change. There was involvement of multi stakeholders in the system. They have participated in the decision making process and articulate their interests. Every member of these social groupings was encouraged by the local leadership to articulate their opinions/voice share their problems on impact of climate change.

Water resource is valuable and common property of the study area. Much of the impact was caused either due to intensity of rainfall or lack of rainfall. They constructed water tank for storing water with mutually beneficial collective action. Water management was made through pipeline system. Now many households had access of drinking water through this system. But improper handling of pipe water has increased the problem such as leakage of water worsening the situation. While, constructing the motor road most of water pipeline was damaged and local communities were helpless in order to maintain and water storage issues. They faced this problem because of their economic condition and inability to buy high tech materials. In order to mitigate this problem they started to manage spring source of water and storage with modern structure.

Communities identified landslides as the major problem, and disrupted the social system and agriculture-dependent livelihood in study site. The frequent landslides had

damaged infrastructure, development activities, large areas of cultivated land and in some cases farmer managed irrigation systems. Therefore, in order to address the problem of landslides; communities started plantation of bamboos and broom grass in chiraito (*Swertia chiraita*), broom grass, bamboo and Uttis. Similarly, wire meshed stone gabion was placed in various places. Despite the plantations in landslide affected areas to stabilize the landslides which had somehow effectively help to checked soil erosion. However, it demands short and long-term continuous adaptation planning for targeting vulnerable communities and building their resilience.

7.1.4 Social Networks

Social networks are the glue between many of the elements of adaptation hence itself is an important adaptive strategy for any kind of disaster and calamities. It is visualized as a web of connections that link diverse individuals and institutions, either directly or via other actors. The actors are interdependent, and through their relationship they create opportunities for resource and information exchange, and form the social, economic and political structure that defines how they as individuals or groups may act (Ensor and Berger 2009). It is an important form of social capital that built on trust and reciprocity, such that positive behaviour is expected and replicated by the members of the network, while destructive behaviour can lead to the breakdown of the relationships. This form of social capital can therefore be weak and fragile, and often situated in institutions that have formal rules of behaviour (Ibid: 21) but has great significance to adaptive capacity and resilience. The social network defines the access to and distribution of material as well as non-material resource. The social networks and institutional supports play a crucial role for increasing the adaptive capacity and resilience of the community in the face of change. The social networks may be vertical (between communities and government) or horizontal (between individual to individual and individual and communities to communities).

In Bhorle people take supports from neighbours and relatives whenever they need. The social structure in this community is based on the belief in helping each other during the need as in the case of most of village of Nepal. The sense of social binding and mutual assistance is strong in this community. According to the respondents the neighbours and villagers are the first to provide moral support and financial assistance

irrespective their caste, class and ethnicity. During disasters and hard time society and neighbours forget any rivalry and conflict, if any exist, and come forward to help needy ones. There are many incidents in Bhorle to prove it. The members of the community talk together and share their problems and knowledge to the other members. Most of the activities like, seed selection, plantation, harvesting, and selection of alternative source of income were made according to the local weather and climatic prediction and the past experience. They share labour power with neighbour during cropping and harvesting time. This type of social network and co-operation plays crucial role for their adaptive capacity and resilience to the negative impact of the ongoing change. In addition to this another factor that strengthens the adaptive capacity and resilience to the disasters and calamities to people of Bhorle is the support form relatives. The moral and financial supports from the relatives plays crucial role for maintaining the livelihood. Although the support provided them was not enough and sufficient to recover all the lost and pains but it gave great encouragement to start new way.

The existence of primary governmental bodies responsible for providing basic civil services and relief and rescue during disaster is important aspect. The well functioning of this institution can enhance the adaptive capacity of the local community. The health post, village development committee and veterinary office are the available governmental organization working in the study area and provide minimum government support during disasters. The efficiency and services of these government organizations were found higher in Bhorle. Besides these government organizations some non governmental organization like Red Cross Society and WWF Nepal and local community provide necessary support to the community.

7.2 Barriers to Adaptation Measures

Although, local communities have adopted various adaptive strategies in direct response to minimizing the risk and hazard and impacts of climate change but some constraints were recorded in the study site that hinders the adaptive capacity and resilience. At the study site, there were some local coping and adaptation strategies adopted in response to observed risks and hazards related to climate change. Most of the adaptive strategies were found to be event specific based on local knowledge and innovations, because most of the respondents were not aware about actual impacts of climate changes. Hence, for this study, I have recorded the following major constraints to adaptation.

7.2.1 Lack of Information and Financial Opportunities

In study area, lack of information on weather incidences, available modern technologies, available of adaptation options, adoption of climate-resilient agricultural practices was perceived hindrances towards adapting to climate change. In addition, information on climate represents access to the information required to make decision on adaptation to climate change. In addition, lack of money hinders farmers from getting the necessary inputs such as fertilize, improved crop varieties and irrigation facilities, which assist to adapt to climate change.

7.2.2 Infrastructure and Development

The insufficient infrastructure and facilities is regarded as one of the crucial means to adopt in climate change. In case of study area, limited infrastructure such as roads, engineering structure to control landslide seems relatively more, even this is not sufficient for proper adaptation. In terms of addressing the problem of landslide and drought, communities have received support from various international and national organizations to stabilize the landslides. Wire meshed stone gabion was laid in different places but the intensity of landslides have made the protection less effective and are found to be dismantled. Likewise, some plantation activities were carried out in various places. The species like broom grass, bamboo and natural regeneration of Uttis (*Alnus nepalensis*) seems to be effective as majority of communities perceived that vegetative barriers were not capable of holding the huge landmasses moved due to heavy landslides. Similarly, communities were using shading, mulching and watering techniques to protect the seed bed from drought. These interventions were very limited and less effective due to the severity of drought.

7.2.3 Shortage of Labour

It is one of the noticeable constraints faced by the communities in the study area. Often migration of young people primarily to urban areas within the country or outside the country, either temporally and permanently for employment, education and labour were causing shortage of labours for agriculture practices. Moreover, in recent years, trend of women migrated to Gulf countries for in search of job and employment had increased significantly, which causes shortages of labour in various on-farm and off-farm activities.

CHAPTER-VIII

SUMMARY AND CONCLUSION

This study was carried out at Bhorle VDC of Rasuwa district in order to examine the impact of climate change on agriculture and investigate the current adaptation strategies employed by local people, which will ultimately increase their adaptive capacity and resilience in changing scenarios. The primary information was collected through using household survey, key informant interview and focus group discussion in the respective VDC. A total of 60 households were chosen by systematic sampling for the interview process. The quantitative information derived from the household survey was analyzed using combination of analytical packages Microsoft Excel.

This study clearly indicates that climate change is evident in the study area. Local communities are already experiencing unusual rainfall and temperature patterns in 15-10 years, which are corroborated by number of indicators such as frequent occurrence of landslides, long drought, increased temperature, intensity and duration of rainfall uncertain, outbreak of pests and diseases etc. This has caused significant impact on livelihood assets, particularly on agriculture production and likely to be in future.

The communities did not hear the term 'climate change', but they were aware of the phenomena. They have noticed significant change in climatic variability such as rising temperature and irregular rainfall throughout their life experiences over the years. Communities identified landslide and drought as the major problem and have major implications in the livelihood. Particularly, the impacts were high in agriculture sector where more than 90% of communities depend on subsistence-based farming. Moreover, there was also food deficiency issue and the majority of people average food sufficiency is less than 6 months. More importantly one of household has become landless due to the effects of landslides. In addition, drought is also contributing to the loss of local crop species and declining productivity. Communities are also noticing appearance of mosquitoes in the last 6-5 years.

Climatic stresses have made agriculture sector more vulnerable and fragile. Impacts were observed contributing to declining productivity, changes in planting and harvesting time, crop variety, cropping pattern were the major change in the agricultural practices. Similarly, some communities replaced rice with maize and millet because that was the best alternative in hand. The main reason for such

replacement was not for the value of the maize produce, but to prevent their farmlands from lying fallow.

To cope with climate change impacts, various coping and adaptation strategies adopted by communities in response to risks and hazards. Most of the coping activities were found to be event specific-based on local knowledge and innovations, because most of the respondents were not aware of actual impacts of climate changes. To overcome landslide problem, Chiraito (*Swertia chiraita*), broom grass, and bamboo were planted in 2007/08 with the support of Danish support project, District Integrated Soil Conservation Office and WWF Nepal. To minimize the impacts from landslides, the community members had also promoted grass species in plantation like Utis (*Alnus nepalensis*) and Amriso (*Broom grass*) in landslide areas which had somehow effectively help to checked soil erosion. Similarly, they had also used the gabion walls in protecting the landslides prone areas. It helped protect the lands and houses located at vulnerable sites. Change in precipitation patterns had affected the sources of irrigation water. Therefore, communities have also adapting the water storage system gradually. But, they were slowing adapting the water storage system. Hence, they have constructed water tank for storing water. Water management was made through pipeline system. Now many household had access of drinking water through this system.

In addition, local communities have diversified their income source from various means like agriculture and off-farm employment which help to strengthen their capacity in the needy time. Community members also engaged in seasonal employment outside their communities especially trekking in Langtang route and some worked as wage labourers within community. Some farmers have started farming livestock (goats) with external organizations support. Similarly, some members also migrated to India and Gulf countries for in search of jobs and employment. Social network such as neighbours, relatives and friends supports helps increase the resilience power of communities.

There was limited awareness, knowledge and capacity at local level to understand climate change scenarios. Therefore, from this study, it can be concluded that the few existing coping and adaptation strategies adopted by the communities are not designed to direct response to climate change but it plays crucial role for increasing

adaptive capacity of communities. Some factors like adequate financial opportunities, shortage of land, manpower, infrastructure and development and lack of information are existing barriers to successfully adapt.

Coping and adaptation strategies were inadequate to deal with worse effect of landslide and drought. Majority of the people were helpless during the disaster due to its severity and impact. Inadequate interventions were implemented by local people to minimize the impact of landslide and drought. The intervention included plantation of vegetation, changes in cropping pattern and crop seeds. The impact level clearly indicated that the government and civil society should act urgently and immediately to implement the appropriate intervention in such place to solve the problem. With the focus group discussion and key informants interview suggested that there were multiple organizations working in the area. Their work was however not effective and are implemented inadequate.

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