

CHAPTER-ONE

INTRODUCTION

1.1 Background of the Study

In precipitation pattern, vegetation shift in higher altitudes and retreat of glaciers. It is predicted that climate change will trigger the rise in extreme climatic events and increase number of climatic refugee. Due to rise in temperature and climate induced hazards such as drought, flood and soil degradation, there will be decline in agricultural productivity subsequently Climate Change is defined as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (UNFCCC, 1997). Climate change (CC) is a global challenge of our time which refers to a change in the state of the climate that can be identified statistically and that persist for an extended period typically decades a longer (LFP and UKAID 2010). Climate Change has now been a matter of concern to both developed and developing worlds, which first came to wider attention when Intergovernmental Panel on Climate Change (IPCC) published its first assessment report in 1990. Several studies have shown that the impact of Climate Change have already been observed on natural resources, food security, human health, environment, economic activity and physical infrastructure. Projections of future impacts of Climate Change are sobering as, almost 50 million additional people may be at greater risk of hunger by 2020 (IFAD 2009).

The impacts of climate change have been witnessed in different regions globally with rise in sea level, change affecting food security (IPCC, 2007a).

Increased concentration of Green House Gases (GHGs) in the atmosphere is widely accepted as the single source of global warming and CC for which humans are mainly responsible (IPCC 2007). These GHGs are mainly produced from the burning of fossil fuel, agriculture, forestry and land use change. The change in temperature has led to unpredictable precipitations and frequent extreme weather events. With reference to the Global Climate Risk Index 2010, an estimated 600,000 people died in 11,000 extreme weather events from 1990 to 2008. It has been universally accepted

that world climate is changing more vigorously at present than any time period in the past putting greater threats to the wellbeing of human beings as well as earth system. Air temperature near the earth surface rises by $0.74 \pm 0.18^{\circ}\text{C}$ during 20th century (IPCC 2007). Scientists estimate it could increase as much as 6.4°C (11.5°F) on average during the 21st century (Wigley1999 IPCC 2007). The number of days in summer is increasing with extreme heat and winters are becoming warm and dry with less snow (Schiermeier 2008). Increased amount and intensity of rain is experienced in higher altitude regions during the summer (Shrestha et al. 2000) and in the middle and high latitude regions of the Northern hemisphere, where frequencies of heavy precipitation events have been increased (Easterling et al. 2000).

Nepal is a Himalayan landlocked, located in geologically young and unstable rugged terrain in the mountain. Nepal has diverse geo-physical and climatic conditions within short distances, and thus the impact of climate change varies from place to place and from region to region. Although, Nepal's total GHGs emission share is negligible in the global scenario, it has already encountered some of the negative effects of global CC. Being mountain topography; the temperature is rather increasing at a high rate at higher altitudes. Nepal's average temperature is rising at the rate of 0.03 to 0.06 degree Celsius per annum from 1977 to 1994, with higher rate in the mountains (0.08) than in low lands (Gurung & Bhandari 2009). Furthermore, warming in winter is more pronounced than other seasons. The maximum temperature is increasing faster than minimum temperature that is widening the differences. Similarly rainy days are decreasing but the intensity of rainfall is increasing. This change has brought about new challenges; its impact is seen on local natural resources, biodiversity and environment which lead to changes in geophysical, biological and socio-economic systems (Burton et al. 2002).

In Nepal more than half of the population lives in the hills, 80 per cent of which rely on subsistence agriculture for their livelihoods (CBS 2005). Many of the communities are already suffering from ongoing impact of CC and their livelihoods are extremely vulnerable to any stress. While gaining a livelihood, or attempting to do so, people, at the same time, may have to cope with risks and uncertainties. Those who are unable to cope or recover from shock and stress are inevitably vulnerable and unlikely to achieve sustainable livelihood. So, vulnerability assessment should be carried out at

local level by raising awareness of vulnerability in different sectors like agriculture, forestry, health and environment.

1.2 Statement of the Problem

Climate change has already been happening across the country with varying degree of impacts. Evidence of its impact is visible in vegetation, hydrology, and rising temperature affecting the normal productivity and availability of ecosystem services. Rainfall in the Terai and Siwaliks has been erratic with frequent flash floods and droughts. Rural people are on the front line to bear the brunt of these changes. Their mainstay of livelihoods is agriculture, which depends largely on weather and climate change sensitive factors like forest and water resources. Livelihoods of forest-based people are projected to be seriously challenged due to climate change resulting in loss of land and land productivity. Events such as forest fires, floods, landslides and drought are prominent risks. Though they have adapted to hazards for all the time with their traditional knowledge and survival skills, the current changes in climate and its impact could be well overwhelming to deal with.

Since livelihood diversity of rural community is limited, it is important to understand the level of impact on their livelihood in order to plan support program to enhance their resilience to the impact of climate change. For this, we need to know the degree of their vulnerability and areas of livelihood support systems that are at risk. The knowledge that rural people have acquired over time needed to be well understood to recommend appropriate techniques that suit their need for climate adaptation.

1.3 Objectives of the study

The general objective of the study is to assess natural resource dependent rural community's vulnerability to negative impact of climate change. The specific objectives are as follows:

- a) To assess the impacts of climate change on people's livelihood
- b) To assess the vulnerability of climate change
- c) To identify the existing and potential adaptation measures applied by Rural Community

1.4 Justification of the Study

Nepal covers 0.04% of the world population and its share on green house gas emission is negligible however, Nepal is one of the most vulnerable countries from climate change. Its temperature is increasing at alarming rate 0.06°C per annum more than the global average. This phenomenon of climate change has directly affected the natural resources like land, water and forest resources. Those people who directly depend on these resources are becoming vulnerable day by day. Temperature observation in Nepal from 1977-1994 had shown a general warming trend. The temperature differences are most pronounced during the dry winter season, and least during the height of the monsoon. Analysis of recent climatic trends reveals a significant warming trend in recent decades, which has been even more pronounced at higher altitudes. Climate change scenarios for Nepal across multiple general circulation models meanwhile show considerable convergence on continued warming, with country averaged mean temperature increases of 1.2°C and 3°C projected by 2050 and 2100 (Shrestha et al.1999). While there is much anecdotal evidence of climate change, no comprehensive studies have yet been conducted on vulnerability and adaptation in the Nepal. Studies on (a) vulnerability of the local livelihoods and (b) adaptive strategies at the household and community levels, as well as lessons learned, can provide the basis for concepts and methods of assessing climate change impacts, vulnerability, and adaptation.

Climate change is global but its impact is always at local level and hence local level case studies are vital for both policy formulation and adoption, and blend local knowledge on present day's most challenging issue. In this background, there is an urgent need of study about the local understanding, their vulnerabilities and adaptation strategies to climate change. Considering these issues this study is focused on mid hills of Nepal.

The observed trend of change in temperature, rainfall pattern and increase in extreme climate events has incurred loss of agricultural yield, property and lives. Such extreme climatic events hamper people's adaptive capacity and undermine their resilience. Different adaptation measures have been adopted in different parts of the world to cope with climate change impacts. Such measures can be introduced in Nepal as well; however, various local factors such as physical, socio-economic, institutional factors

will have to be considered to achieve desirable outcome of the measures. The vulnerability assessment will help to assess these local factors. Then, based on the assessments at local level, different adaptation measures can be introduced with modification, if necessary.

This study was focused on some research questions like; how the rural perceive and understand climate change in their local context? What are the livelihood options for the rural people? What class and characteristic of people are more vulnerable? And what are the major adaptations strategies adopted by the rural people to cope with climate change impacts?

1.5 Limitations of the Study

The major limitations of the study are as follows:

- As it was a case study of a small community, the finding might not be equally applicable for all rural communities. Hence, it needs to be generalized carefully.
- Because of fear of expert bias, equal weight age was given to each climatic hazard indicator, while analyzing vulnerability could have differential weight age.
- The data on temperature and precipitation were collected from the existing meteorological stations in and around the study, and not exactly from where the villages are located.
- Field data was collected at the end of 2013 so recently might have change some information.

1.6 Organization of the Study

The study is structured in five broad sections, including this Introduction. The introductory section begins with the definition of climate change and overview of the vulnerability of local community across all regions to climate change. The statement of problem is to points out our inability to identify vulnerable communities to climate change and adopt due measures by involving their participation. It also gives an account to the objective of the study and tries to justify its rationale.

The next section is literature review. Informed by relevant literature on climate change and its impacts on socio-economic aspects, it tries to unfold root causes of climate change. It also discusses on climate change, specifically, in Nepalese context, and its impacts across different sectors such as agriculture, forest and health. This section draws on various literatures that have assessed the vulnerability from geological, social and economic perspectives. It also discusses on different measures that enable to adapt to climate change.

The third section of the study is methodology. This section discusses on the methodological framework to assess the impacts of climate change in the lives of poor and marginalized people of specific geographical region of Nepal. It explains the sampling techniques and methods of data collection adopted for this study. This part also makes an elaboration of techniques on vulnerability analysis.

The following section is analysis and presentation. This section analyses the impacts of climate change in socio-economic spheres. More succinctly, it assesses the direct impacts of climate change on the mode of occupations of local community. The impacts of adverse climate conditions such as drought, scanty rainfall and floods, that pose serious threat to the livelihood of poor communities, are analyzed. Empirical analysis that look at the impacts of climate change on vulnerable sections of the society pave the way for developing climate change resilient strategies.

The final section of this study comes up with a summary of various dimensions of climate change being discussed. Based on the analysis, it makes a conclusion that poor and marginalized communities need to be empowered to combat against negative impacts of climate change. It also makes recommendations for devising resilience policies, primarily targeted to vulnerable communities.

CHAPTER-TWO

LITERATURE REVIEW

Following the industrial revolution, the rate of exploitation of natural resources as well as human population increased exponentially. Within a decade the impact of exploitation in environment started being visible in the form of ozone layer depletion, acid rain etc. After the historical Stockholm Conference on Human Environment in 1972 AD, the world for the first time was attracted towards the environmental issue. It was in this conference that the relationship between economic development and environmental degradation was first place on international agenda. It paved the way in succeeding years to integrate environmental concerns into national economic planning and decision-making. (Hoskins, 2002)

In 1983, the United Nation General Assembly created the World Commission on Environment and Development headed by Gro Harlem Brundtland, the then prime minister of Norway. The Commission put forward the concept of sustainable development as an alternative approach based on economic growth and defined it as “the development, which meets the need of present without compromising the ability of future generation to meet their own need”. It warned that unless people change the ways in which they do their business, the world would face unacceptable level of human suffering and environmental damage. The Brundtland Commission published the Brundtland report in 1987. The report was primarily focused on securing the global equity, redistributing resource towards poor nations whilst encouraging their economic growth. The report highlighted three fundamental components to sustainable development: environmental protection, economic growth and social equity.

In 1992, the UN organized the UN Conference on Environment and Development, which is also known as “The Earth Summit” at Rio de Janeiro of Brazil. The primary goal of the summit were to come to an understanding of “development” that will support socio-economic development and prevent deterioration of the environment, and to lay a foundation for a global partnership between development and the more industrialized countries, based on mutual needs and common interests, that will ensure a healthy future of the planet. The Rio Conference produced two international

agreements, two statements of principles and a major action agenda on worldwide sustainable development, in which it particularly emphasized the issue of climate change that was being unfolded with more fact-based evidences emerging (UNFCCC, 1992). It also underscored the importance of preserving biodiversity that sustains human society.

The five principles adopted the Rio Conference were:

1. The Rio Declaration on Environment and Development
2. Agenda 21
3. The Statement of Forest Principles
4. The United Nation Framework Convention on Climate Change
5. The Convention on Biological Diversity

Human activities are releasing substantial amount of gases including carbon dioxide, which increases the natural green house effect in the earth's atmosphere. There is a growing concern that the addition of such gases will cause a further warming of the earth surface and atmosphere, which will have adverse effects on human and natural ecosystem.

The aim of UNFCCC is to stabilize greenhouse gases in the atmosphere at levels that will not dangerously upset the global climate system. This will require a reduction in our emissions of such gases as Carbon dioxide, a byproduct of the use of burning fuels for energy.

IPCC was established in 1988 with joint efforts of UNEP and WMO with an objective to provide information about climate change to decision-makers and other interested parties. UNFCCC was adopted in 9 May 1992 and entered into force on 21st March 1994. IPCC's Assessment Report were pressing government to take initiatives for protection of global climate for present and future generation and UNFCCC is the outcome of need felt by countries for tackling climate change (UNFCCC, 1992). The Conference of Parties (COP) meets annually to discuss their progresses and emerging concerns to tackle climate change.

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Kyoto Protocol, adopted in 11 December 1997 in Kyoto Japan, has given responsibilities to 39 developed countries to reduce their emission at least by 5.2% below baseline year 1990 level, during first commitment phase of 2008-2012. The protocol offers three different flexible market-based mechanisms for these countries to limit or reduce their GHG emission-

- a) Emissions trading (ET)
- b) Joint implementation (JT) and
- c) Clean Development Mechanism (CDM)

Emission Trading allows countries to either sell or buy their spare emission unit to any other countries that are beyond meeting their emission targets. While Joint implementation mechanism, countries can reduce the emission to meet the either by purchasing emission reduction units (ERU) or hosting any emission reduction project in another Annex B country (UNFCCC, 1998). There is provision of commitment period, which entails Annex 1 countries to reserve minimum emission credit for itself, so that it may not oversell to credits and later deficit (UNFCCC, 1998). These mechanisms are applicable only to 39 developed countries enlisted as Annex 1 in Kyoto Protocol. Kyoto Protocol defines the purpose of Clean Development Mechanism in Article 12 as "to assist Parties not included in Annex 1 in achieving sustainable development and in contributing to ultimate objective of the Convention, and to assist reduction commitments under Article 3" (UNFCCC, 1998). This also generates adaptation fund to finance adaptation projects in developing countries by collecting 2% of revenues earned from selling certified emission reductions.

Governments of Australia, China, India, Japan, Republic of Korea and United States of America adopted Asia-Pacific Partnership on Clean Development and Climate in January 2006. This is intended to provide a framework among these six countries for

building partnership in common interests such as energy, environment and climate change, being consistent with the principles of UNFCCC. The charter mainly emphasizes for cooperation between these countries for developing cleaner technologies, transfer of technology and information sharing between these countries (Asia-Pacific Partnership on Clean Development and Climate Charter, 2006)

Compensating tropical forest conservation was proposed by environmental scientists in 1980s and 1990s but it wasn't until the latter half of 1990s that the idea gained much currency at international level, when it was discussed at various United Nations Framework Convention on Climate Change (UNFCCC) events, including COP 3 in Kyoto in 1997. The concept of "avoided deforestation" re-emerged on international stage in 2005 with the formation of Coalition for Rainforest Nations (CfRN), a group of tropical countries lobbying for the inclusion of forest conservation as a way to mitigate climate change. Led by Papua New Guinea and Costa Rica, the Coalition for Rainforest Nations presented a draft proposal "Reducing Emission from deforestation in developing countries: approaches to stimulate action" at cop 11 in Montreal in 2005. Two years of negotiation and technical advancements culminated in Bali Action Plan of December 2007 which called for "policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries (REDD) and the role of conservation, sustainable management of forests and enhancement of forest carbon stock in developing countries." Over next two years, the concept of "REDD plus" emerged, calling for activities to address issues relating the implementation of REDD and implications for local communities, indigenous people and forests which relate to reducing emission from deforestation and forest degradation. In 2009, at COP 15 in Copenhagen, an Accord was drafted on the 18th of Dec 2009 noting in section 6 the recognition of the crucial role of REDD and REDD plus and the need to provide positive incentives for such actions by enabling the mobilization of financial resources from developed countries.

2.1 Review of Earlier Studies

This research is not completely a new in the area of climate change and its impact on the human population. It is being guided from a large volume of research works carried out by different international organizations and scholarly people. Publications, research articles, articles published on international journals and reports are major

sources of this study. Unlike other, it simply has tried to look into the microscopic detail of a small rural community while studying the impact of climate change. This study gauges at the socio-economic impact of climate change, primarily, in the manifestation droughts, flood and land-slide in rural poor community of Nepal.

Various publications of UN organizations have given impetus for carrying out this research. Human Development Report, 2008 sheds light on the deterioration in the human wellbeing resulting from negative consequences of climate change. It specifically illustrates the hardships posed on the life of Asian and African people; and thereby suggests respective governments to adopt appropriate measures on time. Global Environment Outlook 3 published by United Nations Environment Programme is equally worth-mentioning research documents as it traces out the rising temperatures and its effects in the agriculture of African poor families. This gives an insight into the correlation between climate change and livelihood of lower section of the community that can be compared to the situation of Nepal. Series of publications of Inter-governmental Panel on Climate Change have analyzed various dimensions of climate change reflected in the form of flood, landslide, drought, melting glacier and their impact on the human life.

Blaikie, P. & Cannon, T., (1994) makes a study on the vulnerability of poor people because of natural hazards such as floods, land-slides and drought in South Asia. Even though the study has covered different ecological regions of South Asia, it does not discuss on the impacts in detail. Chaudhary, P. & Aryal, K.P., (2009) has tried to identify the causes and consequences of climate change in Nepal. It highlights on the temperature rise and glacier lake outburst as the consequence that ultimately result in occurrences of health hazards such as diarrhea, mal nutrition. It does not analyze whether the incidence of impacts is equally distributed among all class of people or vice versa.

Ghaire, D., Subedi, M.,& Amatya, J. (2008) is also worth mentioning article that gave an idea to look at a specific region while making an impact assessment of climate change. This article takes one of the districts of inner terai region of Nepal. It covers entire district without focus on lower class of community that is supposed to be more vulnerable to climate change. Similarly, Gurung, G.B.,& Bhandari, D. (2009) has made a study of the impact of climate change in the life of terai people living in

Chitwan district. Instead of explaining the various impacts of climate change in poor people, it generally discusses on the appropriate measures of climate change adaptation.

2.2 Climate Change and Its Causes

UNFCCC (2001) defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere.” The term climate change is often used interchangeably with the term global warming but according to the National Academy of Sciences the phrase “climate change” is growing in preferred use to “global warming” because it helps to convey meaning of other terms related to climate change in addition to rising temperatures. Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period, decade or longer. Climate Change occurs from different causes physical as well as human influences on nature. Global warming causes change in climatic factor and affects ecosystem (ecological processes and functions) and biophysical systems.

On Earth, human activities are changing the natural greenhouse. Over the last century the burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO₂). To a lesser extent, the clearing of land for agriculture, industry and other human activities have increased concentrations of greenhouse gases.

The greenhouse gases that help in global warming are Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (NO₂), Hydrofloro Carbon (HFCs), Perfloro Carbon (PFCs) and Surpher Hexafluoride (SF₆). These gases are emitting naturally but human induced activities are accelerating the rate of emission of these gases from different activities (Dahal, 2007)

2.3 Climate Change in Nepal

Nepal’s contribution for causing climate change is negligibly small. Nepali citizens comprise less than 0.4% of world population and are responsible for only about 0.025% of annual greenhouse emissions. Nepal’s vulnerability to damage from

climate change is however large. Temperature is likely to increase more in high mountain area than elsewhere. Glaciers and snowfield will reduce, even may disappear, reducing Nepal's dry season river water source. This will have major impact on irrigation and drinking water supply as well as on the reliability of hydroelectricity. Global climate change will also shift monsoon patterns in the way that threatens Nepal's current agricultural practices. United States Country Studies Program (USCSP) has also contributed some climate change related activities in Nepal. Under this program preliminary GHG inventory was constructed that identified mitigation option of GHG emission in energy sector. Vulnerability adaptation assessment for water resources and agriculture were carried out.

Nepal has ratified the UNFCCC on 2nd May 1994 and came into force on 31st July 1994. Under UNFCCC commitments, Nepal is supposed to prepare and periodically update the national green house gas inventory and submit "National Communication" to UNFCCC. Global Environment Facility (GEF) is the financial operating entity of the convention with the help of UNEP and UNDP supporting non-Annexed countries under its enabling activities. Nepal has received US \$0.31 million (in full cost basis) from GEF through UNEP to carry out stage I activities related to climate change. Ministry of Science, Technology and Environment (MoSTE) is the principal focal point for climate related activities.

The interim plan, prepared as guideline for development during interim period does not pay any special attention to climate change but simply identifies potentiality of forestry sector to benefit from carbon trading. The Government of Nepal in cooperation with World Wide Fund has prepared a draft on Climate Change Policy, 2009. The policy highlights over seeking opportunities from Clean Development Mechanism (CDM), Reducing Emission from Deforestation and Forest Degradation (REDD) and Least Developed Country Fund.

This strategy designed to deal with climate change include institutional capacity building, management of natural resources, disaster management and risk minimization and adaptation (MoSTE, 2009).

As a Least Developed Country, Nepal has prepared the National Adaptation Plan of Action (NAPA), which was endorsed by the Government in September 2010. The

Government of Nepal has started the implementation of the Climate Change Policy 2011 which has the goals of improving livelihoods by mitigating and adapting to the adverse impacts of climate change, adopting a low-carbon emissions socio-economic development path and supporting and collaborating in the spirit of the country's commitments to national and international agreements related to climate change. During the NAPA inception workshop in May 2009, participants suggested to formulate Local Adaptation Plans for Action (LAPA) for the effective implementation of NAPA. The National Framework for LAPA has been formulated in order to translate the suggestions into action and to assist identification of local adaptation actions with people's participation as prescribed in NAPA, development and implementation of action plans, including support for the integration of climate change adaptation into sectoral and area-specific plans. The LAPA framework was designed and piloted in 10 districts namely Ilam, Udaypur, Nawalparasi, Kapilvastu, Kaski, Dadeldhura, Pyuthan, Rukum, Achham, and Kalikot in 2010. This LAPA framework will help to integrate climate adaptation and resilience aspects in local and national plans.

2.4 Impacts of Climate Change

According to UN Climate Change report, the following impacts of climate will appear and affect the livelihood of people. About 20 to 30% of plant and animal species assessed so far are likely to be at risk of extinction if increase in global average temperature exceeds 1.5 to 2.5 degree C. The mountainous area of Europe will face much greater species losses, in some areas up to 60% under high emission scenarios by 2080.

By 2020, 75 to 250 million people in Africa are projected to be exposed to an increase of water stress due to climate change. By mid-century, annual average river runoff and water availability are projected to increase by 10-40% at high latitudes and in some wet tropical areas, and decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water stressed areas.

Over the course of the century, water supplies stored in glaciers and snow cover are projected to decline, reducing water availability in regions supplied by melt water

from major mountain ranges, where more than one-sixth of the world population currently lives.

By 2080, millions of people are projected to be flooded every year due to sea-level rise, the report predicts. The number affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable. Glacier melt in Himalayas is projected to increase flooding and avalanches and affect water resources within the next two to three decades. This will be followed by decrease river flows as the glaciers recede.

Poor countries that bear least responsibility will suffer most- and they have no money to respond- but people should also be aware that even the richer countries risk common damage.

2.4.1 Agriculture

Climate Change will have far reaching consequences for agriculture that will disproportionately affect poor and marginalized group who depend on agriculture for their livelihood and have lower capacity to adapt (World Bank 2007). Nepal's economy is overwhelmingly dependent on agriculture. Climate related crop failures, fishery collapses and livestock deaths are already causing economic losses and undermine food security, and these are likely to become more severe as global warming continues.

Some systems are less vulnerable to short-term climate effects (e.g. some irrigated farming systems). Others (e.g. those relying on rain-fed agriculture) have always been exposed to uncertain and extreme climate but may now face variability beyond the current 'coping range' (Tiwari 2010). In vulnerable systems, CC threatens food security, livelihoods and economic prosperity (UNDP 2007). The expected increases in temperature and shifts in precipitation regimes are predicted to cause significant changes in crop productivity across the globe, through direct abiotic influence or through associated changes in pest and disease pressure. Cold wave in Nepal in 1997/98 had negative impacts on agricultural productivity and showed reduction in the production of crops by 27.8, 36.5, 11.2, 30, 37.6 and 38 per cent in potato, toria, sarson, rayo, lentil and chickpea respectively (NARC 1999, cited in Malla 2008) and

it was also known that Early Maturity of the crops due to increase in temperature may help to have more crops in the same crop cycle (Malla 2008).

Out of 2.64 million ha of cultivated land in Nepal, only 43 per cent has access to irrigation facilities, of which only 70 per cent, 20 per cent and 10 per cent irrigation water in monsoon, winter and spring seasons respectively (ADB 2004) and remaining depend on natural precipitation. The crop yield is sensitive to the amount of precipitation and these may fall in western region where a larger population of the poor live and this could threaten overall food security (DFID 2009 cited in NAPA 2010). Assessment shows that CC is posing a threat to food security due to loss of some local and land races and crops (Regmi & Adhikari 2007).

2.4.2 Forest and Biodiversity

CC and biodiversity are closely interconnected, not only through CC effects on biodiversity, but also through changes in biodiversity and ecosystem functioning that affect climate change. Nepal is a landlocked country with rich natural, cultural diversity - one of the world's top 20 hottest global biodiversity hotspots and having extreme spatial climate variation (LFP 2010). Biological diversity is considered as a fundamental strength of the economic prosperity of Nepal as these are the sources of food, fodder, medicine, fuel, timber, shelter and wood fiber (Tiwari 2010).

About 20 to 30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5 degrees. A recent study projected that doubling of atmospheric carbon dioxide (CO₂) concentration will reduce Nepal's forest types from 15 to 12 and habitats and ecosystem will be destroyed. Climate change will also affect the productivity of natural ecosystem, particularly provision of environmental services such as clean air, water, food and aesthetic values. The impact varies from region to region. The most rapid changes in climate are expected in the far north and south of the planet, and in mountainous regions. However, several studies clear that vegetation zones are shifting and hence the people are compelled to change their land use pattern and in some instances to migrate. CC will also have a direct impact on wildlife. Furthermore shift in vegetation and decline in biodiversity will have further adverse on wildlife.

Climate change will alter the world's habitats and ecosystem. It will alter the fragile ecosystem of Himalayas. As it warms up, vegetation and wildlife will move to higher altitudes. This change will upset the ecosystem balance and seriously endanger the survival of many plants and animal species. Rapid climate change will not give plants and animals enough time to adapt to the new situation. Biodiversity loss, besides the immediate impacts on species, will affect the health, wellbeing and livelihood of the people who rely on such resources

2.4.3 Water Resources

It is obvious that impacts of CC in water cycle are direct. Long dry season, abnormal rainfall and less rainfall will affect the water recharge towers as well as water resources like well springs, river and rivulet. Himalayan region is the source of 10 major rivers of Asia and also known as water tower on which million of people depend on it (B.K. 2009). Because of steady rise of temperature, glacier retreat is the most serious and challenge impact on Himalayan (B.K. 15

2009). Nepal has more than 6000 rivers. So, it is considered as one of the richest country in water resources. The river of Nepal contributes about 40 per cent of the average annual flow of Ganges Basin. The most important is that rivers of Nepal contribute about 70 per cent of the flow in the dry season of Ganges Basin and 30 per cent of the peak flow. Nepal is Vulnerable to GLOFs in the future because of the numerous glacial lake situated along the Himalayan. E.g. TshoRopla Glacial Lake in Dolakha is increasing annually by 0.019°C (Chaulagain 2003). The temperature in the Himalayas is increasing at faster rate however this has serious implication for the country's glacial lakes and those living in downstream from them. According to the study carried by International commission for snow and ice, snow in the Himalayas will disappear by 2035 if no proper step is taken to reduce the warning (Chaudhary & Aryal 2009).

2.4.4 Weather Related Disasters

Weather refers to the specific condition of the atmosphere at a particular place and time. It changes in short period of time. Even in a day, the weather can change from sunny morning to rainy afternoon. It is measured in terms of states of temperature,

wind, atmospheric pressure, cloudiness, humidity and precipitation. The occurrence of sub-normal weather conditions is known as weather extremes. Intensive precipitation, prolonged drought, hailstorms and windstorms are the main weather extremes that frequently result into disasters. A disaster refers to the phenomenon that causes severe damage to the livelihood of the significant number of vulnerable people (Blaikie et al. 1994). Frequency and severity of natural disasters are increasing worldwide. More than 4,000 died in the last ten year due to climate-induced disaster causing an economic loss of US \$ 5.34 billion. Data from ministry of Home affair shows that every year more than one million people are susceptible to climate induced disaster such as flood, landslide, and droughts (NAPA 2010). Flooding is closely related to the effect of higher temperature on glaciers. As a result of increased glacier melt, there are 20 glacial lakes which are at risk of bursting (UNEP 2002). Out of them six have been identified as critical (NAPA 2010). Hundreds of thousands of poor people in developing countries live with constant threats to their lives and livelihoods due to weather-related natural disasters—drought, flooding, landslides, soil erosion and desertification (IFAD 2009).

2.4.5 Health

Health includes physical, social and psychological wellbeing (IPCC 2007). Human beings are exposed to CC through changing weather patterns (for example more intense and frequent extreme events) and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, livelihoods and infrastructure (IPCC 2007). The impacts of CC on human health in Nepal are still not much known. Many vector –borne and water –borne infectious diseases are known to be sensitive to changes in climate. Human health is the outcome of several factors, the main being the environment. The analysis reveals potential impact of CC on health especially on growing risk of malaria, kala-azar and Japanese encephalitis with increase in mosquito. Subtropical and temperate region of Nepal would be vulnerable to malaria and kala-azar. Many of the common disease in Nepal are climate related. With changes in climate, disease such as malaria, Japanese encephalitis and kala-azar may spread to new region (Regmi & Adhikari 2007).

2.5 Climate Change Vulnerability

Vulnerability is a term that describes the susceptibility of a group to the impact of hazards. It is the degree to which a system is likely to experience harm due to its exposure to hazard. It is determined by the capacity of a system to anticipate, cope with, resist and recover from impact of hazard. Exposure to natural hazard of community is increasing day by day making it more vulnerable with increasing global change and frequent extreme event (Tanner II, 2003). Vulnerability is deeply rooted within the framework of societies, since it is determined by social systems and power at local, national and international level, not by natural environment.

In fact, the poor and marginalized are most vulnerable to CC as a result of their reliance on the natural resource base for their livelihoods, and their limited access to resources that would facilitate adaptation. Himalayan region is one of the most vulnerable region to climate change in the world, not only because of more rapid increase in temperature but also because of the inhabitants being among the world's poorest group.

Nepal demonstrates diverse geo- physical and climatic conditions within relatively small areas resulting vast biological diversity. Therefore, it is an ideal place to study climate change impacts on natural and socio-economic spheres. In context of Nepal, a few studies have been carried out on vulnerability and risk assessment of natural hazards and most of them are based on the available information of the past.

The degree of vulnerability for livelihood will depend on availability and accessibility of factors such as arable land and water resources, farming technology and inputs, crop varieties, knowledge, infrastructure, agricultural extension services, marketing and storage systems, rural financial markets and wealth etc (Smit and Pilifosova, 2011). The poor and marginalized people are more vulnerable to impact of climate change as they are heavily dependent upon natural resources, lack of access to technology, information and infrastructure (Regmi et.al, 2008).

The vulnerability of rural communities can be reduced through effective governance over natural resources (Cleaver and Schreiber, 1994), increasing access to market and enhancing human capital (Paavola 2008). Adaptation strategy can be of various types

viz. shifting natural resources management practices and agricultural practices, building institutions and strengthening communities, raising awareness about climate change and possible ways to adapt, development of new technology and better infrastructure etc (Hedger et al., 2008). Depending upon degree of severity of climate change on different sectors, different measures have to be considered. Despite of availability of wide range of adaptation strategies, there are numerous barriers such as technological, financial, behavioral, cognitive, social and cultural (IPCC 2007). The international communities have important role to play for building adaptive capacity of least developed countries. The costs required for adopting different adaptation measures ranges from US\$10-40 billion to US\$86 billion. The amount equals to 0.2% GDP of developed country or one tenth equivalent to their current military expenditure (UNDP 2008).

The adaptation measures complementary to development are desirable. The adaptation measures are aimed at reducing vulnerability of people to climate change and necessary care should be taken that these measures do not have detrimental effect upon the vulnerability (Hedger et al., 2008). However, some adaptation measures aggravate existing vulnerabilities (Westerhoff and Smit, 2009). For example: the shrimp farming though has economic and livelihood benefits but worsens vulnerability to sea-level rise (Agrawala et al., 2005).

2.6 Adaptation to Climate Change

Adaptation is a process through which societies make themselves better able to cope with an uncertain future (IPCC 2007). Adapting to CC entails taking the right measures to reduce the negative effects of CC (or exploit the positive ones) by making the appropriate adjustments and changes. In recent years, adaptation has become a key focus of the scientific and policy-making communities and is now a major area of discussion in the multilateral CC process. CC will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons, which affects food security, and changes in the distribution of disease vectors putting more people at risk

from diseases such as malaria and dengue fever. There are many options and opportunities to adapt. These range from technological options such as increased sea defenses or flood-proof houses on stilts, to change behavior at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water management, an improved risk management, various insurance options and biodiversity conservation (IPCC 2007). As in the case of Nepal different types of adaptation practices were found in upstream and downstream sites. In the upstream sites, local people have been managing forest as a CF, which may increase the resilience of community by fulfilling the demand of forest products and stop shifting cultivation (Tiwari 2010). Additionally, river training, and embankment construction were adaptive to protect their agriculture land and forestland. They have also adopted use of high yielding varieties, multiple cropping and use of chemical fertilizer and pesticides for crop production (Tiwari 2010).

Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to CF is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on CC but also on the type of development path that is pursued (IPCC 2007). Thus adaptation should be implemented in the context of national and global sustainable development efforts.

Adaptation aims to reduce the vulnerability and improve the adaptive capacity, or resilience, of people who rely on climate-dependent resources for their livelihood (FAO 2009). It is predicted that global temperature will continue rising in upcoming days and expected to increase. As the result of these changes, world biodiversity is at risk and many species and ecosystem, already at risk from human development, may not be able to adapt new climatic condition and stress, increase the scarcity of water and induced conflict, threatens food security, human health, sea level rise, cultural loss through to indigenous culture and historical monuments will occur. Adaptation is a question of both mitigating or eliminating the negative impacts and taking advantage of the opportunities (Sharma 2009).

CHAPTER-THREE

RESEARCH METHODOLOGY

This chapter provides the explanation of research methods and procedure followed to achieve the research objective. It includes research design, source of data collection, study area, methodological framework, sampling size and sampling techniques, method of data collection and vulnerability analysis.

3.1. Research Design

This study is carried out using descriptive research design as it takes raw data and summarizes it in a useable form. The design is qualitative as well as quantitative in nature as the sample size is small and data are collected from questionnaires, interviews or observations.

3.2. Nature and Source of Data Collection

Primary data were collected from interview survey. Secondary data were collected from reports, published and unpublished documents, individual's presentation, websites etc.

3.3. Study Area: Brief Description of Bajura District

Bajura district, a part of Seti Zone, is a remote hilly area and one of the seventy-five districts of Nepal in the far western region of the country. The district is divided into three parts, highmountain, high hill and mid hill, and area coverage is 13.5%, 84.7% and 1.8%, respectively.

There are 27 VDCs in the Bajura district, and Martadi is a headquarters of the district. The major rivers in the Bajura district are Budhi Ganga, Karnali, Kawadi, and Kunna.

The staple foods for people in this district are rice, wheat, maize, barley and millet. They also produce lentils, black gram, white gram, and peas. Similarly, they also produce oil seeds like mustard seeds, rape-seed, and sesamum. Buffalo, cows, goat, sheep, and hens are well domesticated.

Physical Characteristics of the District

Latitude: dg. 29° 19' to 29° 57' north latitude and 81° 09'

Longitude: 81° 09' to 81° 49' east longitude.

Area: 2,188 km².

Height: 726m to 7036m meters above sea level

Precipitation: 1343.0 ml

Average maximum temperature is 36 °c

Average minimum temperature is 1 °c.

Climate: Sub tropical, temperate, cool temperate and Alpine.

According to the MoE/NAPA project (2010) Climate Change Vulnerability Mapping for Nepal, Bajura is one of the moderate (0.356-0.600) Vulnerability Ranking district.

Atichaur is one of the remote VDC of Bajura District. People are poor with very few livelihood alternatives and oppertunities. They have poor access to public services on health and sanitation, education, agricultural lands in slopes, mostly the shifting cultivation plots. Food deficit is prevalence in VDC. This research focus on the different dimentions and people's perception on Climate change and its impact on their livelihood. How do climate change effect their livings. How do changing patterns of rainfall effects their rainfed agriculture system. What are the concequences of climate change in their livelihood.

3.4 Methodological Framework

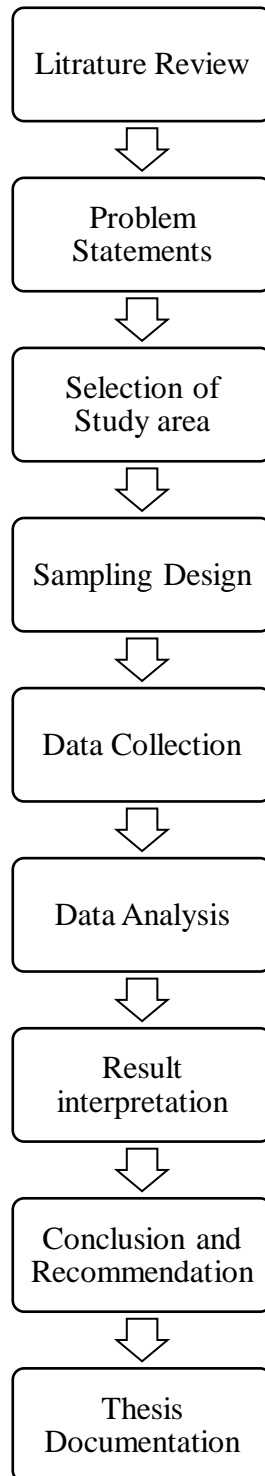


Figure 1: Methodological framework

3.5 Sampling Size and Sampling Technique

The sampling technique used in this research was stratified random sampling. Well-being ranking of that VDC was used as a stratum and household were randomly selected from each stratum (rich, medium, poor). The number of household in ward no 8 Naina & 9 Sudadha of Atichaur VDC were 182 of which around 17% (30 HH) were chosen for the survey.

3.6 Methods of Data Collection

3.6.1 Data Collection

The selection of appropriate methods is the most important part of any type of research. Participatory methods were used to collect data on the experience and knowledge of local people on CC. By nature, to get the information about the climate change and its effect to rural people, both qualitative and quantitative research techniques were applied. Primary data were collected through HH survey, focus group discussion, key informant survey and direct observation whereas secondary data through different published and unpublished documents, concerned literatures, reports, net surfing, library search and relative journal of different aspect of study.

3.6.1.1 Primary Data Collection

Household Interviews

Household interviews were the most crucial component of the data collection process in this research, and were conducted in all the sampled households using a semi-structured and structured questionnaire. The questionnaires mainly focus on socio-economic information, impact and adaptation measure, and vulnerability of climate change. HHs were interviewed with eldest of the available family members and most experienced about HH affairs. The respondents were asked to compare the condition of their forests, agriculture land, source of water, ambient temperature and rainfall of past with current years.

Key Informant Interview

Key informant interview was next important method for this study. Elderly individuals, teachers, farmers were key informant for realizing the change. They were encouraged to recall past disaster and coping strategies. Five persons were interviewed in the study area with the consultation of local people and with minimum age of 45 years. They were interviewed by using a checklist. From this discussion, major disaster, affected plants species and coping strategies were found. Key informant method was also used to memories the condition of the past.

Focused Group Discussion (FGD)

Groups were considered as a means to elicit information through a consensus building in group. Two focus group discussions (FGD) were conducted with farmers group and mother group. These were conducted to supplement and triangulate information gathered from the household interviews and other sources. During FGD open-ended questionnaire were used to capture their perception and coping strategies.

Direct Observation

Information collected through direct observation was used to triangulate with the information gathered from FGD and questionnaire survey. Direct observation and simultaneous discussion about physical phenomena (landslide) allowed the participants to recall and explore more information regarding CC and adaptation which supports the collection of evidence of CC impact in research site.

3.6.1.2 Secondary Data Collection

Secondary data were also the major source of information for the study. During the preparation of final report, documents related to the objectives such as research articles, case studies, papers, journals, published and unpublished reports were reviewed. Libraries of DNPWC, ICIMOD, Central library TU, LI-BIRD and different organization working on climate and its implementation were also used to carry out literature survey. Furthermore, essential information was downloaded from the related websites.

Climatic data published from Department of Hydrology and Meteorology (DHM) was used to analyze climatic pattern. The data published from Central Bureau of Statistics were also used to analyze socioeconomic status of the study area.

3.7 Data Analysis and Presentation

All the quantitative data were entered in Microsoft-Excel Program. Data processing, analysis and interpretation of the information collected through questionnaire survey and interview was done using MS-Excel 2011. The results were then represented in the form of tables, graphs, and charts. The rainfall and temperature data obtained from the Meteorological Department, Kathmandu were analyzed using the Ms-Excel in the form of rainfall and temperature curves.

3.7.1 Vulnerability Analysis

The research has followed CC vulnerability approach (Figure 2). In this approach vulnerability is based on three primary variables (1) Exposure (2) Sensitivity and (3) Adaptive capacity.

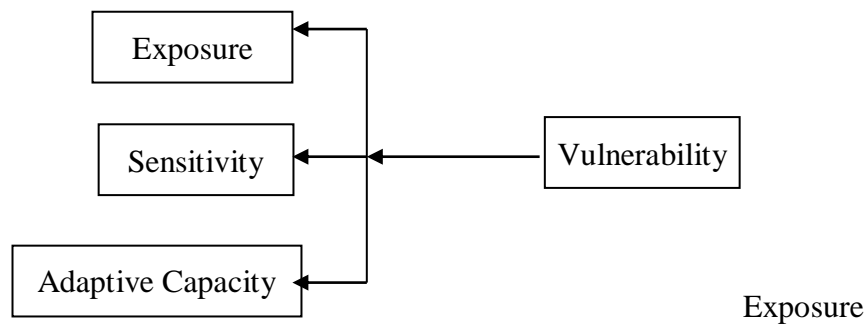


Figure 2: Conceptual Model of Vulnerability

Exposure incorporates nature and degree to which the system is exposed to significant climatic variations. Sensitivity is the susceptibility the degree to which a system is affected; either adversely or beneficially, by climate related stimulation. Adaptive capacity is the ability of the system to adjust to CC (including to climate variability and extremes), to moderate the potential damage from it, to take advantages of its opportunities, or to cope with its consequences. The combination of these three components results in vulnerability to the climatic hazards.

Using this approach, vulnerability was determined by using following equation.

$$V = (E+S)/A \text{ (adapted from Matthew M. Fontaine and Anne C. Steinmann, M.ASCE)}$$

Where V= vulnerability, E= exposure and A= adaptive capacity

Vulnerability was analyzed by ranking into 4 points (1= very low, 2= low, 3= medium, 4= high) to assess each of three components (exposure, sensitivity, adaptive capacity). To conduct the assessments, in-depth study was performed using questionnaire survey, key informant survey and FGD. Climatic hazards were identified by the focus group discussion and the HH survey on the basis of people's exposure like drought, flood, landslide and hailstone. They were further ranked on the basis of exposure, sensitivity and adaptive capacity. Table 7 shows the indicator used for analyzing comparative vulnerability of individual rural households in the community. They were developed based on their socioeconomic conditions in such a way that they could be compared among the households surveyed but not with any other communities.

CHAPTER-FOUR

ANALYSIS AND INTERPRETATION OF SURVEY DATA

4.1 Socioeconomic Findings

4.1.1 Age class and Gender of the Respondents

House heads were targeted to have interviewed, however, it was not always possible so eldest of the available family members were interviewed. The age of respondents was between 25 to 60 years. About 43% of the respondent fall below 35 years, 26% fall between 35-45 years while remaining 31% fall above 45 years of age. Similarly, Out of forty sampled respondents, 40% were male and 60% were female.

Table 1: Respondent by Gender

Respondents Age Group	Percentage
Below 35 years	43%
35-45 years	26%
Above 45 years	31%
Total Male respondents	40%
Total Female Respondents	60%

Source: Field survey 2013

4.1.2 Caste of the Respondent

The study area is home to ethnic and dalit communities. Thirty households from the ward were selected for the study. Out of these, 59% of the households were Bhramin/Chhetri and 41% were Dalit and Janajati as illustrated in Fig 4

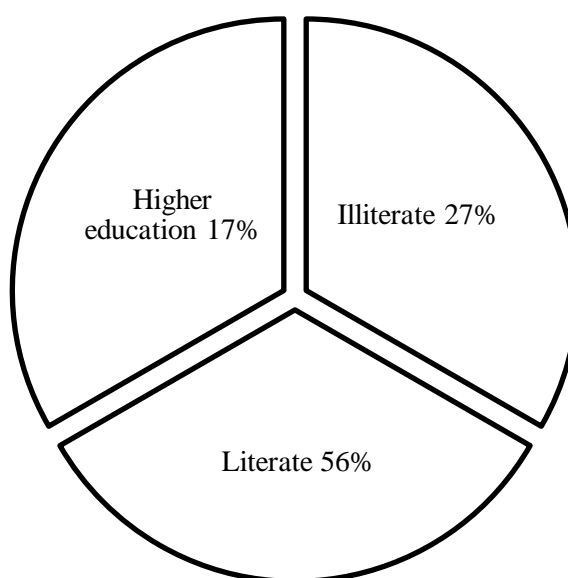
Table 2: Respondent by Caste

Caste of Respondent	Percentage
Bhramin/Chhetri	59%
Dalit and Janajati	41%
Total Respondent	100%

Source: Field Survey, 2013

4.1.3. Education Status of the Respondent

Education, being the key factor to people's knowledge, decides the power of understanding to the subject matter (Climate change). So, education was classified as illiterate, literate and higher education. As illustrated in the figure, 27% of the total respondent were illiterate, 56% were literate while only 17% were from higher education level.



Source: Field Survey 2013

Figure 3: Education status of sampled household

4.1.4. Occupation of the Respondents

Occupation refers to what people do in their daily lives for their survival. The main source of income of the respondents was agriculture, daily wages, foreign employment and services. Out of 30 respondents, 23% responded that they depend both on agriculture and foreign employment. Similarly, 30% depends only on agriculture, 17% on foreign employment, 17% on wage labor and only 10% on service.

Table 3: Occupation of the Respondents

Occupation of the Respondents	Percentage
Agriculture and Foreign Employment	23%
Agriculture	30%
Foreign Employment	17%
Wage Labor	17%
Service	10%
Total	100%

Source: Field Survey, 2013

4.2 Climatic Condition

This section deals with the analysis of climatic data mainly, rainfall pattern. The yearly rainfall data of Nepal was taken from website as there wasn't any district rainfall data available in the study time.

4.2.1 Rainfall Pattern

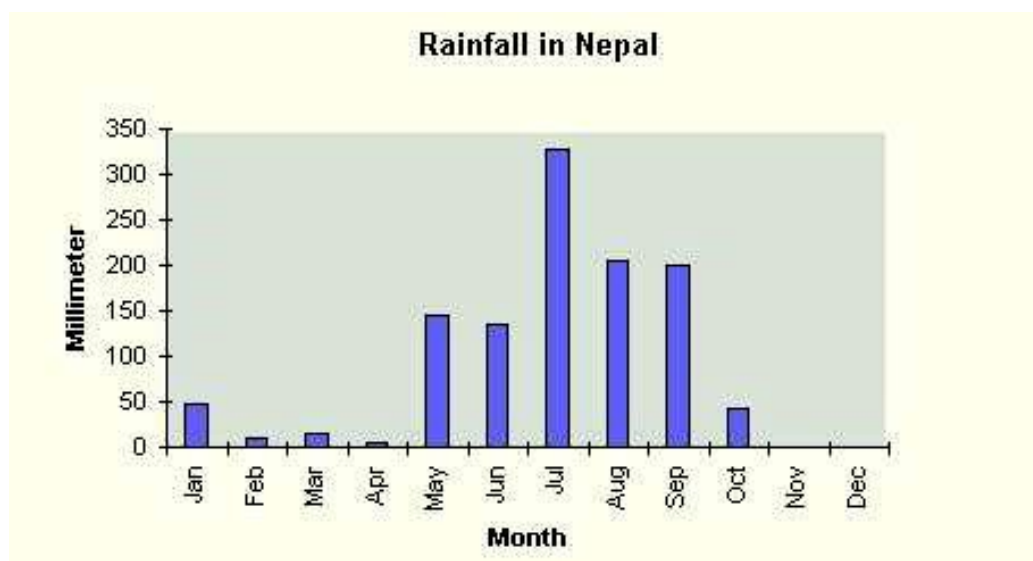


Figure 4: Rainfall in Nepal

Sources: rainfall-in-nepal <http://www.imnepal.com>

4.2.2 Temperature

Temperature change (increase) is the direct indicator of climate change. For this study, yearly temperature trend data was used as climatic indicator of changing climate. Mean Annual temperature analysis is shown in the figure. The analysis shows that temperature is increasing.

Temperature (average annual increase 0.06)

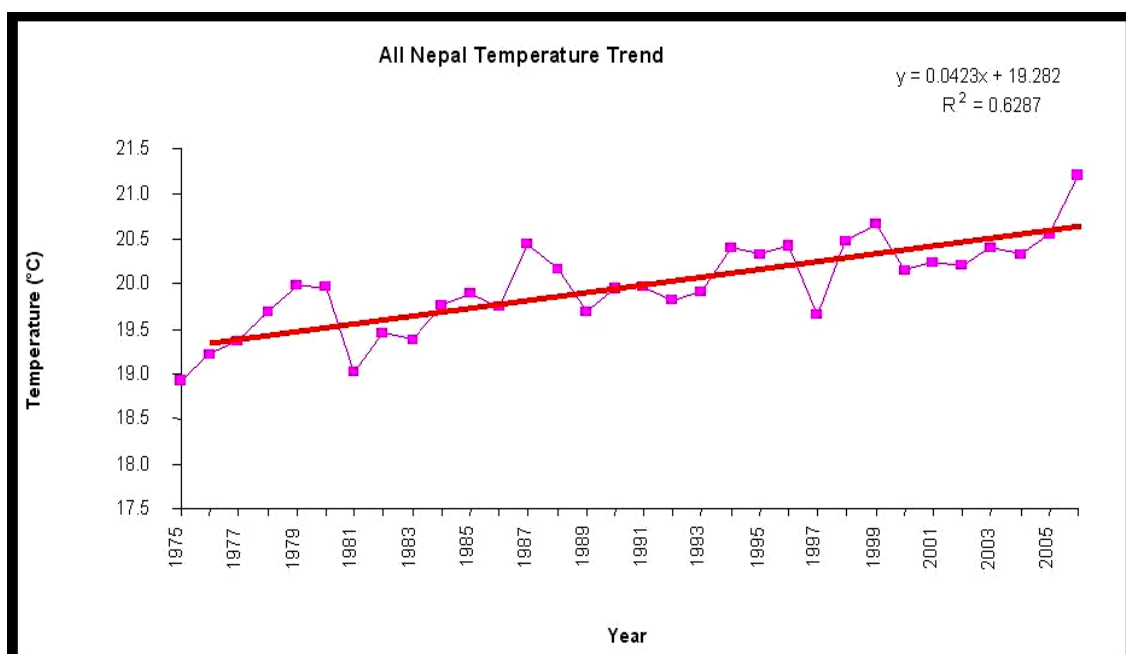


Figure 5: All Nepal Temperature Trend

4.3 Impacts of Climate Change

4.3.1. Agriculture

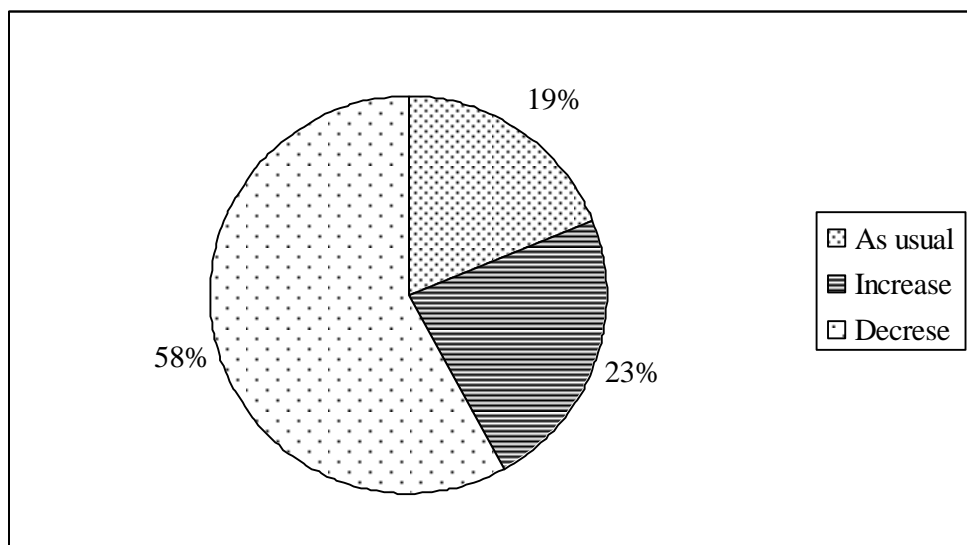
Despite the majority of the population were farmers; the nature of agriculture was subsistence and dependent on natural climate. Once the climate is disturbed, the whole agriculture system is affected. 100 per cent of respondents were found to have owned some form of agricultural land, which was categorized into, irrigated, non-irrigated and barren land. The agriculture crops grown were rice, maize, millet, and wheat. Regarding the agricultural production sufficiency, 26.67 per cent had enough food production for 6-9 months, 30 per cent had 3-6 months and the rest for 1-3 months.

Table 4: Food Sufficiency for a Year

Month	Frequency	Percentage
0-3	13	43.33
3-6	9	30.00
6-9	8	26.67
9-12	0	0
Total	30	100

Source: Field Survey, 2013

Figure indicates that agricultural production was decreasing in the study area. Out of 30 respondents, 58 per cent said that agricultural production was decreased, 23 percent said that agriculture production was increased while 19 per cent opined that it was as usual. The reason behind of decrease in production was increase in temperature increase, less rainfall and drought. The community largely depends on rain-fed agriculture for their livelihoods. However, due to unpredictable rainfall pattern in current years, it is difficult for farmers to cultivate. Respondents mentioned that they sowed seed expecting rainfall in usual time like earlier years but delayed rainfall destroyed their seed resulting in low production. Likewise, drought had heavily reduced the productivity of the crops especially maize. Different types of pest and diseases were occurring on different type's crops like cauliflower (lai) and maize.



Source: Field Survey 2013

Figure 6: Respondents view on the agriculture production

The production of crop in the recent years was increased in Mustang because farmers were growing new vegetables (cauliflower, Cabbage, Radish, Potato and Cucumber) due to increased road network, awareness among locals, establishment of organizations working on agriculture, availability of better variety of seeds and use of pesticides and insecticides in the area. However, the production of agricultural commodities was found to be decreased in the study area. This might be due to long drought, low rainfall, people's motivation towards foreign employment.

4.3.2 Impact on Water Resources

Anticipated changes in hydrological cycle and the depletion of groundwater table are some of the top environmental challenges in Nepal, which are going to be face due to CC. From the community survey it was found that natural spring has dried up. About 63 per cent respondents said that natural spring has dried in 15 years while few of them responded that it was usual as before.

Table 5: Respondent View on Natural Springs

Natural spring	Frequency	Percentage
Decrease	19	63.33
Constant	11	36.67
Total	30	100

Source: Field Survey, 2013

The main cause of drying of natural spring by the respondents during FGD was because of less rain and deforestation resulting long drought.

4.3.3 Impact on Human Health

Human beings are exposed to CC through changing weather patterns (temperature, precipitation, sea-level rise and more frequent extreme events) and indirectly through changes in water, air and food quality with changes in ecosystems, agriculture, industry, settlements and economy. Changes in climate and increase in temperature are creating favorable environment for pests and diseases to develop and spread into

human settlements. So, this study wanted to know specific change in human health.

Table 6: Frequency of Disease

Disease	Frequency	Percentage
Diarrhoea	27	90.00
Eye paining	19	63.33
Fever	12	40.00
all of above	9	30.00

Source: Field Survey, 2013

Table shows that diarrhea and eye paining as major problem and increasing currently. Similarly, 40 per cent said that people suffered from the fever whereas 30 percent said that they were suffered from all the disease. From the study, it was revealed that high temperature and less rainfall was the main cause of diarrhea with high fluctuation of temperature resulting to common cold and fever.

In the study area, another main reason for rise in health hazard was due to increase in mosquito and flies. Sixty per cent respondent reported that mosquito and flies has increased.

Table 7: Frequency of Mosquito and Fly

Mosquito & Fly	Frequency	Percentage
Rapidly Increasing	8	26.67
Increasing	18	60
Constant	4	13.33
Total	30	100

Source: Field Survey, 2013

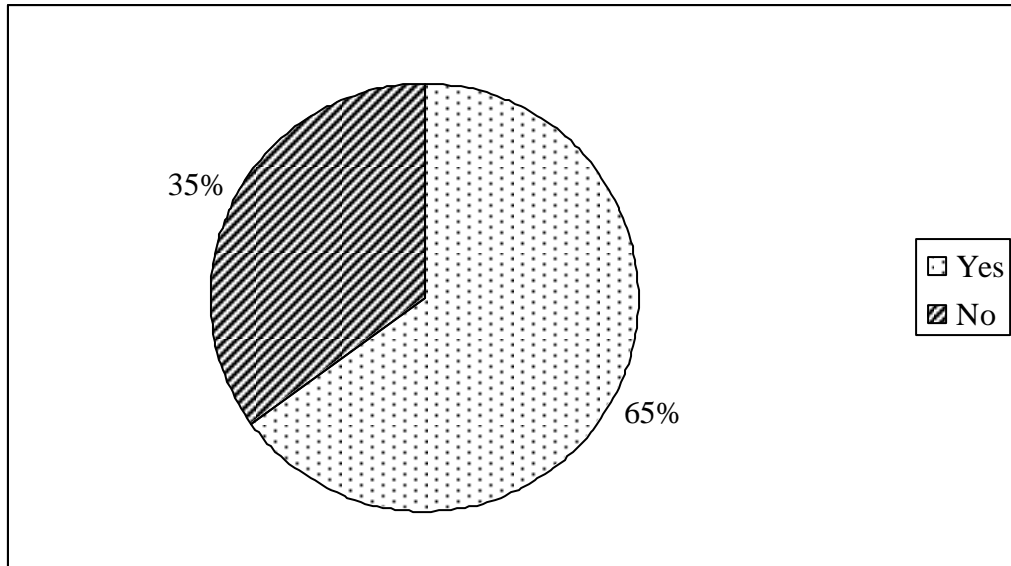
Field observation also supported that the increase of mosquito was due to rise in temperature and improper disposal of waste material.

4.3.4 Impact on Forest and Biodiversity

People have been continuously using forest as a source of firewood and fodder for their live-stocks. Nearly 58 per cent respondents said that they spend more time for the collection of fuel wood and also pointed reduction in grassland, fodder and forage production as compared to last 10 years. New species like Dumre (*Ficus glomerata*), Bodha (local grass), Banmara (*Lantana* spp) were increasing and species like Katus (*Castanopsis indica*), Chilaune (*Schima wallichii*), Uttis (*Alnus nepalensis*) were decreasing.

According to the respondents the species were decreased due to increase in temperature and drought in these years. As result of excessive spread of invasive species, the local species, which were in once abundance, was decreasing in recent years. According to 65.4 per cent respondent, invasive species were increasing in the forest. Among these respondent, 34.6 per cent said that species of Banmara was increasing and 11.5 per cent said that Bodha was increasing and remaining did not recognize the invasive species. Lamichhane and Awasti 2009 studied the occurrence of invasive species plants to higher elevations. The invasive species, which were not seen even at the elevation of 1500 m, (not common 15 or 20 years ago) can be correlated with the warming trend within the watershed. Similar conclusion can be drawn from present study, which lies below 1200 m that the new plants having invasive character were noticed increasing. From one of the key informant survey (pers.com Puridevlal), it came to know that the species were seem to change their leaf types, the new one being smaller than the earlier and also the height was also smaller than in past especially in the case Pipal (*Ficus religiosa*).

Likewise, 65% of the respondent said that composition of forest has changed.

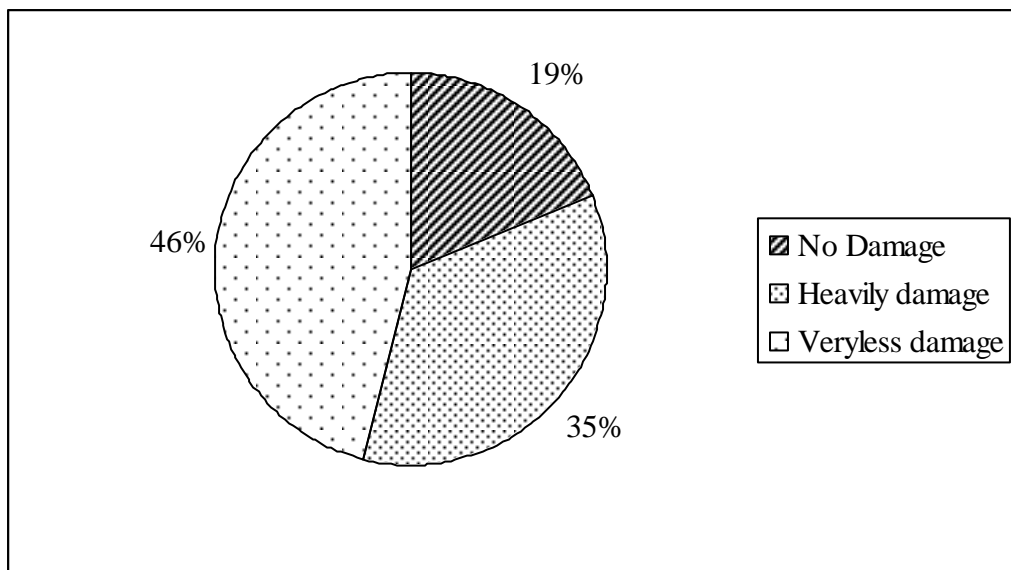


Source: Field Survey 2013

Figure 7: Respondent view Change in Forest Composition

4.3.5 Impact on Human Assets

Human property like house, shed, and agriculture land were mostly destroyed by weather related disasters like landslide and forest fire. 35 per cent respondent reported that of heavy damage, 46% was said very less damage while 19 per cent said that there was no occurrence of damage as compared to last 15 year



Source: Field Survey 2013

Figure 8: Respondents view on degree of physical damage

4.4. Vulnerability of local People to Climate Change

Vulnerability is not an outcome of a single factor; rather it is caused due to physical and biological issues, poverty and lack of access to the knowledge. Vulnerability has two sides: external and internal. The external side includes risks, shocks and stress to which an individual or a household are subjected whereas, internal side mainly contributes to the lack of means to cope without damaging loss.

In this study, vulnerability of rural people was analyzed by using the conceptual model provided by the third assessment report of IPCC. During the study, major climatic hazards of the study area were identified in participatory way based on people's exposure to these hazards. The major climatic hazards are 1) **Long drought** 2) **Landslide**. Each climatic hazard has its own criteria and indicators. Based on the criteria and indicator, the vulnerability of locals according to the economic class was analyzed.

Table 8: Vulnerability Indicators

Drought indicators	Very Low (1)	Low (2)	Medium (3)	High (4)
Exposure				
Landholding size	<2 ropani	2.1-4 ropani	4.1-6 ropani	>6 ropani
Livestock unit	Livestock unit <2	Livestock unit 2-4	Livestock unit 5-7	Livestock unit >7
Use of drinking water	Private tap	Common drinking water	Use of well and stream	
Sensitivity				
Land type (ratio of irrigated and non-irrigated land)	Irrigated /non-irrigated more than 1	Irrigated/non-irrigated=1	Irrigated/non-irrigated= less than 1	
Frequency of diseases	Less than 2 or no Occurrence	2 times	3 times	4 Times Diarrhea

No of crop production	More than 3	3	2	1
Adaptive capacity				
Livelihood options	Agriculture only	Agriculture +1	Agriculture +2	Agriculture+ 3
Social network	No local and regional linkage	Limited local and regional linkage	Good local and regional linkage	Having very high local and regional linkage
Education level of the family members level of income per year	Literate/illiterate ratio less than 1 <NRs. 60000	Literature/illiterate ratio greater than one NRs. 60000-90000	At least 1 SLC person passed NRs90000-120000	At least 1 person with college more than NRs.120000
Lands like indicators				
Exposure				
Distance of house from landslide area	more than 1km	750m to 1km	500-570 m	Less than 500m
Distance of land from landslide are	more than 1km	750m to 1km	500-570 m	Less than 500m
Land and crop loss	< 2ropani	2-4 ropani	4-6 ropani	>6 ropani
Sensitivity				
Linkage with economic institutions and other CBOs	District level linkage with bank and cooperatives	Good linkage with cooperatives	with local cooperatives only	No link
Livelihood option	Multiple	Three option	Two option	Single
Adaptive capacity				
Livelihood options	Agriculture or no options	Agriculture+1	Agriculture +2	Agriculture+3

Education	Literate/illiterate ratio less than 1	Literate/illiterate ratio greater than one	At least 1 SLC person passed	At least 1 person with college
Landholding size	<2.1 ropani	(2.1-4.1) ropani	(4.1-6.1) ropani	> 6.1 ropani
Working population ratio	0-0.5	0.5-1	1-1.5	1.5-2.5
Income	Income NRs. < 60,000 per year	Income NRs. 60,000-90,000 per year	Income NRs. 91,000-121,000 per year	Income less than NRs. >121,000 per year

4.4.1. Long Drought Vulnerability

In local people's experiences, the cases of droughts are in increasing trend. Most of the droughts cases are found when there is a need of rainwater. Such events are generally during the seedbed preparation, flowering stage of paddy, irrigating wheat and other winter crops. It was found that frequent droughts destroy and erode social assets, which are the very means for adaptation.

Long drought is the major climatic hazard in the study area. Rainfall data shows that the summer rainfall is in decreasing trend, which is the major indicator of long drought. In addition, average annual maximum mean temperature is also in increasing trend as shown in fig 5. It has also supported from the perception of local as 75% locals expressed that the climatic hazards are in increasing trend. Local people expressed that the long drought has directly affected the forest species germination and growth. The traditional water sources like Pandhera are lowering per year. This is making rural livelihood more vulnerable day by day. Analysis showed that 36 per cent HH were less vulnerable, 53 per cent were medium vulnerable and 10 per cent highly vulnerable among themselves.

Since the household were more or less equally exposed, sensitive and have similar adaptive capacity, there was not much variation among the HH. However, the degree of vulnerability within the low scored household might be high due to prevalence of poverty, education, livelihood options, working population and social protection mechanism.

4.4.2. Vulnerability to Landslide

It was found that the erratic rain, droughts and other natural calamities are common phenomenon in the study area and people experienced these unusual situations for more than 10 years. These situations are inviting new fear and trauma. Landslides have affected livestock, agriculture, land, crop and mobility of people. Landslide has occurred in sloppy and fragile land. Households near sloppy and fragile area are highly vulnerable to landslide.

The study area is home to forest dependent people. The area has steep topography making it vulnerable to landslide. Most of the people households are in fragile, marginal and near to stream. Heavy rainfall is responsible for this disaster. Thirteen percent, fifty percent and thirty-seven percent are highly, medium and less vulnerable to landslide respectively. Most of the people were found to be suffering from different types of water borne diseases. The frequency of disease was found different on different people thought they were equally exposed.

4.5 Adaptation Strategy

Although a mitigation strategy is essential for reducing carbon molecules on air and soil, it is not sufficient to save our world from climate change impacts. Moreover, Nepal is poor in infrastructure and lacks resources to immediately and effectively practice any mitigation measures in the short term. Thus, it will be prudent to increase peoples' ability to adapt to climate change while continuing our efforts to mitigate carbon emissions. Adaptation is mainly about warning people about certain events in advance and preparing them to deal with vulnerability and uncertainty. Effective predictability, awareness, provision of certain support systems and better planning are some of important things to consider in local preparedness for reducing vulnerability and enhancing resilience. Construction of watch towers; provision of emergency materials and emergency shelters; and considering risk-free or low risk locations for new settlements and resettlement are important strategies to improve local adaptation capacity.

Though people have poor knowledge on the technical matters of climate change, they have shown several evidences, which demonstrate that they have perceived, felt and

experienced about its effect. The amount and patterns of rainfall, the frequency and extent of droughts, the trends of crop failure due to emergence of new crop diseases, etc. are some of the visible impacts. Through the exercise of historical timeline, people have told the stories transferred from one generation to another about the changes of climate and its impacts in local context. They sometimes have used the local knowledge on the basis of position of clouds, wind flows, position of stars, rainbow and with insects, pest and animal behavior for the prediction of weather but such predictions could not be completely relied upon. People linked that these were due to climate change. Nepal is closely linking climate change adaptation to poverty alleviation, in addition to maximizing synergies with other environmental concerns such as land degradation, biodiversity, and disaster reduction. At a conceptual level, adaptation in human systems can be thought of as driven by two core processes: selective pressures (the equivalent of natural selection in ecosystems) and what might be termed agency-driven innovation (that is, proactive forms of innovation or action in response to perceived constraints and opportunities). These two processes are not separate; they interact as agents experience selective pressures or perceive opportunities and most commonly act pro-actively or 'adapt' within the limits of their capacities, perceptions and priorities. Nepal's complex topography and geography leaves it quite vulnerable to climate change. Mainly the agriculture, animal husbandry, health, forestry, water and biodiversity, among others, would have serious consequences by the effects of climate change. The following section deals with the adaptation strategies adopted by the people in the study area in different sector.

4.5.1 Adaptation Strategy in Agriculture

The major adaptation strategies adopted in Agriculture sector are

a. Farm off-seasonal and alternative crop varieties

In order to escape from continuous crop failure from frequent droughts, people are forced to seek some alternatives. For instance, some people have been trying to reduce the paddy land and introduce vegetables and other crops that are less susceptible droughts in additional land. Cauliflower, cabbage, chilly, tomato and cucumber are widely cultivated as alternative options to paddy.

b. Establishment of dairy co-operative

The practice of stall-feeding was widely adopted in study area when the yields of conventional crops are continuously reduced. The development of dairy is the new initiative in the study area. Now, selling milk is one of the potential occupations.

c. Accommodate in the crop-growing season

Changes in rainfall have resulted in changes in crops grown. People are not willing to carry out these practices but the changing climate has forced them to do so. For instance, late cultivation of paddy hampered the cultivation season of wheat and rice. In the other hand, people used to transplant hybrid paddy quiet earlier otherwise it is affected by insecticide and pests. All these practices were carried out on the basis of their own experiences.

4.5.2 Livestock Rearing

The major adaptation strategies adopted in livestock rearing are:

a. Raise improved varieties of livestock

With the changing pattern of climate, people prefer to raise improved variety of livestock instead of local. Now the emphasis was given to milk and then compost manure. **Goat**, cow and hen **varieties** of improved livestock are common. More milk and meat giving livestock are popular because selling milk is very easier because of dairy development and goat market is good enough.

4.5.3 Water Resources

The major adaptation strategies adopted in the water resources are:

a. Protection of watershed to retain the water resources

Once the watershed resources are depleted by the human activities along with physical factors, regeneration practices are now being performed. This includes control of open grazing, setting strict rules and regulation, social fencing, community plantation of fast growing species. Protection of water sources in many places was resumed in the recent years.

b. Rehabilitation of traditional ponds/water bodies

The traditional ponds are lost in many places. Some ponds are filled by siltation others are either encroached or have dried up. But now with the implication made by the absence of traditional ponds, people are building awareness on the importance of traditional ponds. Now people in many places have started to harvest monsoon rain that, later it could be used in feeding and swimming for livestock.

CHAPTER-FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

From the above result and discussions, different conclusions are made and some recommendations are listed on the changing weather pattern, climate change and their impacts on agriculture, animal husbandry, forest and water resources as well as in biodiversity.

5.1 Summary

Climate change is a burning issue of contemporary world. Most of the people have been affected from the global phenomenon. Everywhere, climate change is the matter of debate, from grass root to regional, national, international and global level. It is subjected to the balanced growth and sustainable development and concerning the prosperous future of the earth. All nations of the world have been affected from this issue. Because of low capacity to cope with and to adapt, Least Developed Countries (LDCs) are being affected more than Developed Countries (DCs). As most of LDCs have dependency on traditional agriculture, living opportunities are connected with climate change in these countries.

Many people have been affected from climate change in the third world country like Nepal. Until this time, researchers are concentrating to find out its effect in various sectors relating to livelihood. Very few studies have been conducted in this issue on national level and grass root level.

This study tries to assess and evaluate climate change vulnerability of rural communities of Atichaur VDC of Bajura district. The purpose of this study is to find out the effect of climate change at grass root level. For this purpose, primary data were collected by household interviews, key informant interviews, focus group discussion and direct observations. Secondary data were collected from various relevant publications, newspapers, reports and other national and international published journals. Collected information were accumulated, tabulated and analyzed through MS Excel.

The analysis indicates continuously rising temperature, low volume of rainfall and inconsistency in livelihood of local people. In recent years, rainfall is recorded in decreasing trend with erratic pattern. Similarly, temperature is also rising in an unpredictable and strange way. Plant behavior regarding flowering, shedding and germination of seeds are also shortening that indicates the trend of increasing temperature.

The production and productivity of agricultural products have been decreasing. There is scarcity of grass and fodder in forest as it has been replaced by invasion species. To adapt with these, people are replacing traditional seeds and livestock to hybrid ones.

Diseases and pests that were prone only to tropical climate are found in mountain regions as well. Human health has been affected from different diseases like diarrhea, eye pain, fever etc.

5.2 Conclusion

Long drought was identified as the most threatening hazard among all climatic hazards. It has impact on agriculture, livestock and forest resources. Most of the respondents expressed that long drought has severely affected forest ground grass, water resources and agriculture crops. The study explored that the locals are vulnerable to long drought. Local had also expressed shrinkage in drinking water supply through spring and wells, the population of Mosquito and flies have rapidly increased resulting in increased incidence of various diseases. Prolonged drought, which is the main climatic hazard experienced by locals, had directly affected forest species while invasive herbs such as *Lantena* spp. have gradually invaded the forest. Landslide was identified as the second most threatening climatic hazard in the study area. Most of the respondents are in higher degree of vulnerability to landslide due to higher exposure and lesser adaptive capacity. Due to high exposure of hazards and poor adaptive capacity, communities are highly vulnerable to climate change. Among the households, most of them are vulnerable, majority having medium level vulnerability within the community. Majority of the respondents have not adopted proper adaptation practices to cope with these climatic hazards. Some of the respondents have changed cropping pattern and have planted hybrid variety of crops. In addition, some of the respondents have replaced the local variety of livestock with

other cross variety. During field observation and data collection most of the HH member went to India for seasonal migration for earning and income. This is not only having negative impact on social structure but to the district agricultural productivity. Seasonal migration is big challenge for Bajura district.

The study shows that people have been using indigenous practices in agriculture, livestock rearing and forest resource management. But these indigenous practices are short-term solution for sustainable resource management and to cope with adverse effects of climatic hazards. So, it must be compounded with new technology to cope with the climate change impacts.

5.3 Recommendations

Based on this study, Government or DDC can introduce improved agriculture technology and mixed cropping system in agricultural production. Different training and awareness program can be organized to farmers group. Improved varieties and drought resistance varieties are recommended to combat climate change. This is indirectly solved the seasonal migration in the district too. Water sources within the forest must be conserved and equitable sharing must be ensured. Bioengineering methods should be introduced in landslide affected area. Local adaptation plan must be prepared and executed to mainstream the adaptation into practice in local level. Conduct specific research about climate change impacts on forest resources, agriculture, and livestock rearing and water resources. Finally this is purely based on peoples view point and answer given by them, and negative impact of climate change really happening and worsening locals life day to day so I strongly recommend government of Nepal that there is highly need of some scientific researched in this area to cope negative impact of climate change.

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ANNEXES

Household Survey Form

General Information (first write HH head name)

Name	Age	Relation with HH head	Sex	Main occupation	Other occupation	Marital status	Education

Types of Land

Types	Garden	Irrigated valley	Non irrigated terrace	Food sufficiency	What to do in food scarcity
owned					
others					
rented					

Food sufficiency from agricultural production.....

What will you do when there is food scarcity.....

No. of Livestock

Cow/ox	Buffalo	Sheep/goat	hen

Vulnerability exposure study

Income source for livelihood?

Income sources	Annual income
livestock	
agriculture	
Fishery	
Labor work	
Remittance	

Experience of natural disaster

Description	difficulty	Coping strategy	Get help by any organization
Flood			
Landslide			
Drought			
Forest fire			

Area affected by natural disaster?

Area/ sector	consequences
Agriculture	
Forest	
Fishery	
Water resource	
Others	

- Have you found any changes in yearly temperature and rain in this place?

Yes/No

If yes then how?

Consequences and means of Adaptation

Sector	Effect	Consequences	Adaptation
Agriculture and food security			
Crop production and livestock	Increased Decreased		
New disease in crops	yes No		
Food insecurity	yes No		
Irrigation facility			
River/Natural source	yes No		
Status/condition	Good Bad		
Drinking water			
Level of water in river	Increased Decreased		
Water availability	yes No		
Forest and bio diversity			
Forest fire	Increased Decreased		
Invasive species	Increased Decreased		
Species endanger	yes No		
New species of plant and animals	yes No		
Health			
New disease	yes No		
Malnutrition	Increased Decreased		

Checklist for Focus group discussion (FGD)

1) In past 10 years, the consequences of flood and landslide?

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2) Any changes in rain and temperature?

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3) Status of cropping?

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4) Impact of Climate Change (in agriculture, natural resources, human health etc.)

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5) Main organization (government, non government, community)

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6) Organization working on Climate change

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7) Any climate change related training

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8) Any changes occurred in plant and animals?

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Observation checklist

Types of crops

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Types of livestock

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Water sources

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Any natural disaster

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Different institution/ organization

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Main occupation of villagers

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Health and sanitation

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