Impact of Climate Change on Livelihood and Biodiversity in Rural Communities

(A Case Study of SiddhiGanesh and Nepane Community Forestry User Groups of Sindhupalchwok District of Nepal)

A Thesis
Submitted to Central Department of Rural Development in partial fulfillment of the requirements for the degree of Master of Arts in Rural Development

Submitted By
Digambar Singh Dahal
Examination Roll No. 2468
Central Department of Rural Development
Kirtipur, Kathmandu

November, 2011

Date: 2068/7/17

Letter of Recommendation

This thesis entitled ***Impact of Climate Change on Livelihood and Biodiversity in Rural Communities: A Case Study of SiddhiGanesh and Nepane Community Forestry User Groups of Sindhupalchwok District of Nepal*** has been completed by Mr. Digambar Singh Dahal under my guidance and supervision in partial fulfillment of the requirements for the Degree of Master of Arts in Rural Development. I hereby forward this thesis for its final evaluation and approval.

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Dr. Uma Kant Silwal
Associate professor
(Thesis Supervisor)
CDRD, Kirtipur Campus, November, 2011

Date: 20th November 2011

Approval Letter

This is to certify that the thesis entitled ***Impact of Climate Change on Livelihood and Biodiversity in Rural Communities: A Case Study of SiddhiGanesh and Nepane Community Forestry User Groups of Sindhupalchwok District of Nepal*** and submitted by Mr. Digambar Singh Dahal, in the prescribed format of the Faculty of Humanities and Social Sciences, has been examined and accepted as partial fulfillment of the requirements for the Degree of Master of Arts in Rural Development.

Evaluation Committee

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External Examiner

_____

Dr. Uma Kant Silwal
Research Supervisor

_____

Prof. Dr. Pradeep Kumar Khadka
Head of Department

ACKNOWLEDGEMENT

Thesis on **Impact of Climate Change on Livelihood and Biodiversity in Rural Communities:** ***A Case Study in SiddhiGanesh and Nepane CFUGs of Sindhupalchwok District of Nepal*** is the result of extensive co-operation of various intellectuals, family members and my friends. My deepest gratitude and sincere thanks goes to my respected Supervisor Dr. Uma Kant Silwal, Associate Professor at CDRD for his valuable suggestions and encouragements, this work would not have been completed without his support and guidance.

My special thanks to Federation of Community Forestry Usersô Nepal (FECOFUN) Local, district and National for arrange the situation which made my study possible.

I am finding it difficult to write this page because too many people have helped me during the course of my research. It does not seem possible to include all those names here. Among those unnamed ones are the people in the study area who made a warm welcome and shared with their experiences and struggle relating to the changing climate. The inputs derived from their experiences have proved to be extremely helpful in meeting the objectives of my study. The greatest part of credit for my success in this project, thus, goes to them.

I extend my heartfelt thanks to the respondents of ***SiddhiGanesh and Nepane CFUGs*** of Sanosirubari VDC for their kind co-operation and precious time for answering the questionnaires despite the fact that they were busy in their farms and other household activities. I am also thankful to Mr. Durga Prasad Dhungel (Secretary- Sanosiruwari VDC), Keshab Napit (Assistant Health Worker-Sanosiruwari health post), Chair person of both CFUGs (Mr. Nanda Lal Nepal and Mr. Chardra Hari Nepal) for helping me to providing the necessary details.

I would like to thank Mr. Netra Prasad Dhital (CF Facilitator) for his kind co-operation in my study during the field data collection and also thanks to Mr. Shiva Prasad Adhikari (RIMS-Nepal) for their help and constructive suggestions during the preparation of this report. I am also grateful to Mr. Prushottam Niraula (FECOFUN) for providing me essential information and literature.

Last but not the least, I am indebted to my mother, my dear wife and all my family members for their constant encouragement, inspiration and support throughout my study period.

Digambar Singh Dahal
CDRD, Kirtipur Campus, November, 2011

ABSTRACT

Climate change is contemporary global threat to the animal world. Green house gases are resulting global warming which is creating different impacts in the world. Because of human activities green house gases are increasing. Nepal's temperature is increasing at an alarming rate. Increasing temperature is creating different impacts on biodiversity, health the environment and other aspects of life of the animal world. Nepal is also facing the threat of climate change. This study was conducted on Sanosirubari VDC of Sindhupalchwok district during the period of February to September.2011

The main objective of the study was to assess the impact of climate change on agriculture; people's health; economy and on biodiversity. Interview survey, key informant interview, focus group discussion were conducted in collecting primary information. One hundred and twenty four households were sampled out of total 370 households (I.e., 62 from each CFUG) with random sampling for ***interviews survey****. The data were analyzed using SPSS computer software.*

It was found that some special signs of climate change are experienced by rural communities of the study area. Local communities experienced increasing warm days and shortening cold/winter days. The pattern, intensity and amount of rainfall also changed, resulting in the scarcity of water. Moreover people started feeling of scarcity of water for irrigation and drinking. Climate change was affecting agriculture; production of main crops and cash crops has decreased. Different invasive species, pests and insects were increasing in farm. Many species of main crops such as rice, maize and millet species are in threat. Livestock are also affected from climate change, because of less germination of fodder. Number of livestock had decreased, resulting in declining incomes from livestock and related activities. Community members had experienced different new diseases resulting from including mosquitoes. Different health problems were increasing; especially women and children have been affected from itching problem, skin diseases, menstruation cycle, uterus infection (disease) and eye infection problem. On the other hand, flowering time of different species including shorea robusta, Aamala, maize etc was changed and so were the germination, harvesting and maturing times of different crops had changed. Income level from agriculture and livestock had decreased, so people are separating from their traditional occupation, way of life and they are seeking alternative professions.

It is concluded that climate change is creating multidimensional impacts on the life of rural communities. Adaptation practices must be developed and awareness level of the people on climate change must be increased.

Table of Contents

List of Tables

List of Figures

Annexes

Abbreviations/Acronyms

CH4	=	Methane
CO2	=	Carbon dioxide
CFUG	=	Community Forestry User Group
CDRD	=	Central Department of Rural Development
DCs	=	Developed Countries
FECOFUN	=	Federation of Community Forestry Usersô Groups, Nepal
GHG	=	Green House Gases
HFCs	=	Hydrofloro Carbon
IPCC	=	Intergovernmental Panel for Climate Change
LDC	=	Least Developed Countries
NO_2	=	Nitrous Oxide
PFCs	=	Perfloro Carbon
SF6	=	Sulpher Hexa Fluoride
SPSS	=	A Software program (Statistical Package for the Social Sciences)
UDC	=	Under Developed Countries
UNFCCC	=	United Nations Framework Convention on Climate Change
VDC	=	Village Development Committee

Glossary

Jagat Mara (Lantana species) = A kind of bush which is a newly appeared in forest and agriculture land of the Sidhaganesh and Nepne CFUGs. It is said that this species has migrated from tropical region to subtropical and temperate region because of temperature increase.

Aalu Jhar: A kind of herb which is newly observed its leaves looks like a potato. Found in barren/abandon forest and agriculture land.

Badame Jhar: A kind of herb which is newly observed in study area its leaves looks like a peanuts. Found in barren/abandon land of forest and agriculture.

Chapter - One

INTRODUCTION

This chapter covers background of the study including general introduction of Nepal, statement of problem, rational for the study, objectives of the study, scope and limitation of the study, and organization of the study.

1.1 Background

Climate change is a global problem that affects all of us. Nepal's average temperature is rising at the rate of 0.03^0C-0.06^0C per annum between 1977 and 1994 with a higher rate in the mountains than in low lands (Gurung and Bhandari 2009). Nepal is warming at a significantly higher rate compared to the global average of 0.74^0C, recorded in twentieth century. In addition to increase in extreme temperature, weather has been observed changing in recent years. Because of the extreme temperature there has been change in weather conditions. Number of monsoon days has been shortening, with early onset and late withdrawal, and the intensity of monsoon rain has shown increasing trend (Gurung and Bhandari 2009). Livelihood of third world's people has been changing and threatening from climate change.

Climate change brings out 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. Changes in rainfall pattern are likely to lead to severe water shortages and flooding. Melting of glacier can cause flooding and soil erosion. (UNFCCC, 2007). Developing countries are most vulnerable to the impacts of climate change. Nepal is one of the most vulnerable countries affected from Climate change (UNFCCC, 2007).

Nepal is a beautiful country situated on the lap of Himalayas. This is surrounded by India in the east, south and west and by China (Tibet) in the north. The total territory is 147,181 sq km which is 0.03% and 0.3% of total land area of the world and Asia respectively. It is laid from east to west with mean length of 885 km and from south to north and the mean breadth of 193 km. Geographical location of Nepal is $26^0$22' to $30^0$27' latitude and $80^0$4' to $88^0$12' longitude (DoI, 2061).

Topographically, the country is divided into three ecological zones named Mountains, Hills and Terai. They cover 15%, 68% and 17% of the total land area of the country respectively.

Economically, Nepal is known as a least developed country (LDC). The World Development Report, 2007 ranked Nepal in 142nd place of developed countries out of 177 countries. Its per capita income is about $400 per year. Total domestic production increase rate is 4.7% per annum (2007). Contribution of industrial sector to the economy is only 7%. Nearly one third of the population (30.8%) lives below poverty line and the Ginny Coefficient is 41.4 (*CBS, 2003/04*).

The annual growth rate of population is 2.24 percent and the total population of the country in 2007 has reached about 270 millions of which the proportion of male and female is almost equal. Likewise, Forty eight percent of the population lives in the Terai region, 44.2% in Hills and rest 7.3% in Mountain region respectively (*CBS, 2001*).

More than 85% of the population is still living in the rural areas. Agricultural practices are still at subsistence level. More than 76% of people are depending on agriculture. Large segment of population is unemployed or seasonally unemployed. More than 40% of the population is still illiterate. People of the productive age are leaving the nation to search for employment. The nation is earning remittance of 200 million per annum through foreign employment.

The topographic condition of Nepal is diverse; it varies from 60 meter from sea level to 8848 meter Mount Everest. Although, Nepal is small in land size, it is very rich in biodiversity, diverse climate and with topographical spatial diversity. Different Flora and Fauna has earned its specific importance. All the topographical variations have their specific quality which provides natural resources to the community among different locations. By managing those natural resources, people are earning livelihood and preserving natural resources as well as conserving biodiversity.

The variation of topography brings out the diversity on climate. The livelihood pattern varies according to social, cultural and economical status of the people which is determined by the environment. All the human activities are related to the environment. Environment is determined by its own factors, like temperature,

humidity, rainfall etc. Change in the component of environment also affects livelihood of the people.

Sindhupalchok district, a part of Bagmai zone of mid development region, is one of the seventy-five districts of Nepal. Chautara is the district headquarters of Sindhupalchwok district. The study area is Sanosirubari VDC which one of the seventy nine VDC of the district. Sanosiruwari is surrounded by North-Pipaldanda VDC , East-Chautara and Irkhu VDC, South-Thulosiruwari VDC and West-Bhotsipa and Kunchok VDC. Sanosiruwari is remot VDC but beautiful and rich in biodiversity.

1.2 Statement of Problem

Atmospheric temperature is increasing at the high rate around the world. Warming seems to be consistent and continuous after the mid 1970s. Between 1977 and 1994, average warming in annual temperature was 0.06^0C per year. Warming was much in the Himalayan regions of Nepal such as the Middle Mountain and high Himalaya, while warming in the winter was higher as compared to other seasons. Nepal's temperature is rising by about 0.41^0C per decade (CARE, 2009).

Weather related events such as erratic rainfall, longer drought periods, landslides and floods are increasing in terms of both magnitude as well as frequency. Such events have negative impact on people's livelihood. Such events have been creating natural hazards. The negative consequences of natural hazards hamper the development process as well as livelihood of people.

Flood and glacier lake outburst destroy irrigation channel, water supply systems, road, bridges, settlement, productive land as well as other development infrastructure. Flood related deaths and environmental refugee problems are also increasing. Land degradation will reduce crop yield and place higher pressure on remaining fertile land. During the dry season, increased evaporation will lead to water scarcity, soil moisture deficit, droughts, forest fire and possible outbreak of pests will decrease crops yields.
The impacts of climate change such as unpredictable weathering patterns, loss of biodiversity, water scarcity, spread of tropical diseases, malaria, dengue, decreases food productivity, and increased intensity and frequency of landslide and flooding are increasing in Nepal. These various impacts threaten people's livelihood, biodiversity conservation, safety, security and the national economy.

Himalayan region is the most vulnerable region for climate change. Many changes have been observing in the period of few decades. So this study has been conducted on Mountain district ***Sindhupalchwok***. Increasing flood and landslide and changing the pattern of rainfall have been observed by locals. This study area covered important area of Sanosirubari VDC having biodiversities. ***The change in vegetation cover, loss of biodiversity, change in the pattern of agriculture and overall change in income level have been studied.***

1.3 Rationale for the Study

Climate change is emerging issue in the world, which is one of the greatest threats to environment conservation and living security. Increasing emission of greenhouse gases into atmosphere, human intervention to environment are further compounding this problem. Although the contribution of underdeveloped countries in climate change is minute, they are most vulnerable to climate change impact. Nepal's contribution to global greenhouse gas emission is only 0.025%; it is among the most vulnerable countries to climate change. Nepal's atmospheric temperature is increasing at an alarming rate (0.06^0C per year).

With the change in temperature there is increasing number of natural hazards. Rainfall pattern is changing; the problem of tropical diseases can be seen in Hills and Himalaya also. Glacier lake outburst, avalanches, flood, drought etc are increasing. Flood related natural hazards increased the loss of human being and wealth.

Agricultural production and productivity is decreasing because of climate change. Our agricultural practice is depending upon rainfall pattern. Rainfall pattern is changing due to climate change.

In this regard, climate change is most prominent issue in Nepal. This study assessed the problem faced by the people in study area. The emerging issue of the climate change and its impacts to livelihood and biodiversity is the main focus of this study.

1.4 Objectives of the Study

The broad objective of this study is to assess the impact of climate change on livelihood of poor and vulnerable communities and the specific objectives of the study are the following:

1. To assess impact of climate change on agriculture;

2. To examine the impact of climate change on people's health;
3. To measure the impact of climate change on overall economy; and
4. To assess the impact of climate change on biodiversity

1.5 Scope and Limitation

The study was conducted in limited time with limited resources and concentrated in a specific area. The study was conducted in one season. So its result may not be applicable for other areas, context and other seasons.

The limitations of the study were

1. Concentrated on one ecological zone. It may not be applicable to other ecological zones.
2. Major focus on the impact of climate change on livelihood and general biodiversity. It did not research the overall impact on environment and impact on flora, fauna and biodiversity.
3. In small scale and may not be replicable to the other locations of country.
4. Limited only in 2 CFUGs of Sanosiruwari VDC, so result may not be applicable for other areas.

1.6 Organization of the Study

This study has been divided into seven chapters these are as follow:

Introduction: The first chapter deals with background, introduction of climate change, statement of the problem, rational of the study, objective of the study, scope and limitation of the study and organization of the study.

Literature Review: The second chapter deals with introduction of climate change, causes of climate change, climate change and Nepal, impacts of climate change in Nepal, impact of climate change on agriculture, peopleôs health and overall impact on economy and biodiversity of rural communities.

Research Methodology: The third chapter contains research methodology adopted for the study. In this chapter research design, sources of data collection, rationale for the selection of the study area, sampling size and procedure, data collection techniques and tools, interview survey, key informants interview, field visit and observation, data tabulation and analysis.

Study Area: This chapter deals with introduction of the study area, background, agriculture, natural resources, demographic scenario etc.

Finding and Discussion: This chapter contains findings from study area, local peopleôs perception of climate change, Impact of climate change on agriculture, effect of unusual rainfall on agriculture, effect of risen temperature on agriculture, impact of climate change on peopleôs health, biodiversity, livestock and overall economy and impact on income due to change in livestock pattern.

Impact of Climate Change: This chapter deals with impact of climate change observed from field study and compared with literature. It includes impact of climate change on livestock, agriculture, biodiversity and overall income.

Summary, Conclusion and Recommendations: The seventh chapter contains summary and conclusion of the study. After that some necessary recommendations are presented.

In the last part of the study, photographs of the study area, maps of the study area and bibliography have been included. Necessary annex are also included after bibliography.

Chapter - Two

REVIEW OF LITERATURE

The main objective of this chapter is to analyze the research work and clarify the need for the study on rationale basis. This chapter includes review of literature as introduction of climate change, causes of climate change, climate change and Nepal and various impacts of climate change.

2.1 Introduction of Climate Change

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

The term climate change is often used interchangeably with the term global warming but according to the National Academy of Sciences the phrase 'climate change' is growing in preferred use to 'global warming' because it helps to convey meaning of other terms related to climate change in addition to rising temperatures. Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period, decade or longer (SPAN, 2008). Sudden and unexpected change in weather or season is known as climate change (Sapkota, 2064).

2.2 Causes of Climate Change

Climate change occurs from different causes physical as well as human influences on nature. Global warming causes change in climate factors and affects ecosystem (ecological processes and functions) and biophysical systems.

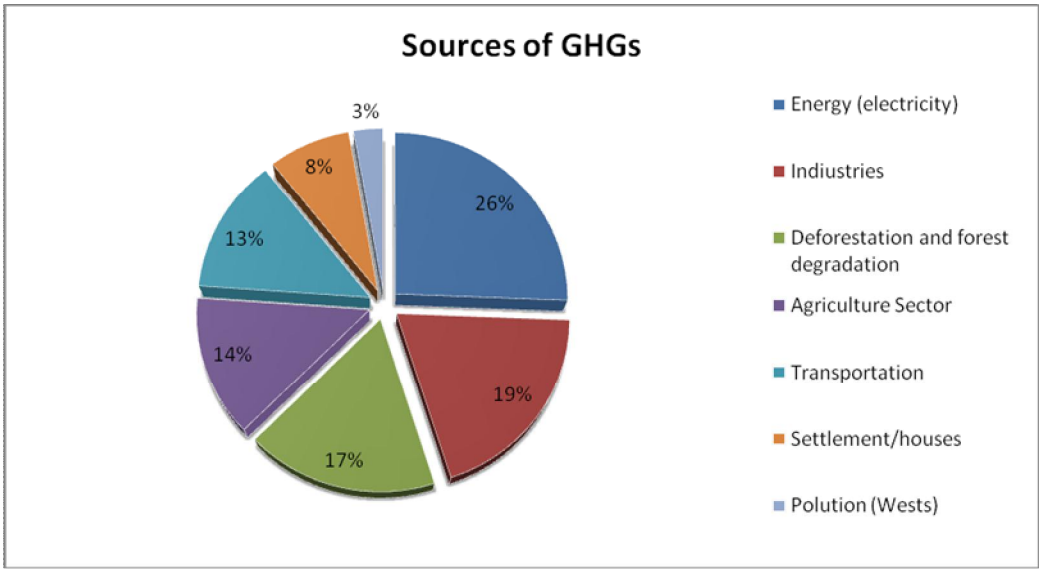
Global average temperature has warmed and cooled many times in the twentieth century and is likely to rise constantly in the future mainly due to an increased concentration of Green House Gas (GHG) in the atmosphere. Without GHGs, the earth surface temperature was raised by 0.74^0 and 0.18^0 (1.33± 6.0F) during 20^{th}

century and scientists estimated that it could increase as much as 6.4^0C average in the 21^{th} century (UNFCC, 2007).

Concentration of GHGs in atmosphere determines the temperature on earth. If concentration of GHGs becomes low temperature of earth become less and if increased it results raising temperature on earth. GHGs forms layer on atmosphere which allows entering sun light and heat on earth through atmosphere. The earth absorbs some of the heat gained from sun and reflects some fragment of heat on atmosphere. If the GHGs layer becomes thin the heat passes from atmosphere and the temperature on earth becomes low, otherwise the GHGs layer obstruct the passing process of heat and again reflect the heat to the earth which causes increasing temperature on earth.

GHGs comprise Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (NO_2), Hydrofloro Carbon (HFCs), Perfloro carbon (PFCs), Sulphur Hexafloride (SF6), these gases are emitting naturally, but human induced activities are accelerating the rate of emission of these gases from different activities (Dahal, 2007). Sources of GHGs are shown in the following figure 1.

Figure 1: **Sources of Green House Gases (GHGs)**



Sources: IPCC, 2007.

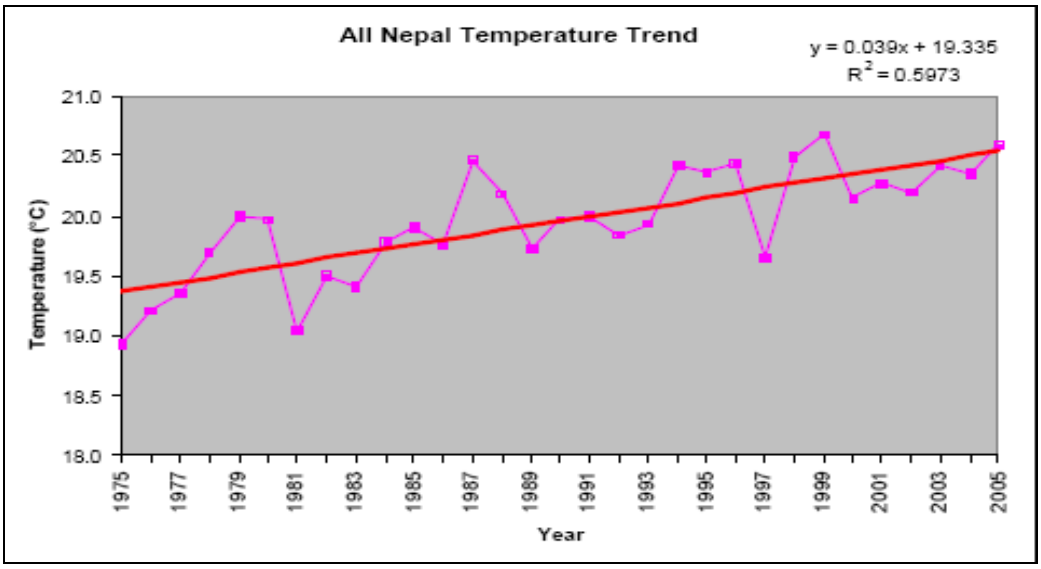
The main causes of increasing GHGs are human intervention on environment and excessive use of resources from Nature. Anthropogenic gases of GHGs are causes of increasing global temperature.

2.3 Climate Change and Nepal

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

According to the study carried out by Metrological Department of Nepal, there is increasing phenomenon of melting of glacier and Glacier Lake may cause outburst and increases flooding. According to the report 0.12^0C in Himalaya, 0.03^0C in Hill and 0.06^0C in Terai temperature is increasing annually. (Sapkota,2064). Figure 2 shows the increasing trend of temperature in Nepal.

Figure 2: **Trend of Temperature in Nepal**



Source: Department of Hydrology and Meteorology, Nepal.

Climate change is contemporary issue for Nepal. The following impact will be seen from climate change (Sedhai, 2064).

1. Increase in temperature causes the spread of tropical insect mosquitoes, flies and other diseases in upper part that will cause epidemics.
2. The pasture land of Himalayas will be cover of bushes that lead to scarcity of pasture land and negative impacts on livestock rearing.
3. Scarcity of water, poverty, decrease in agricultural productivity, effects negatively on sustainable tourism development.

Strange climate is being observed in Himalayan area of Nepal due to global climate change. Opposite character of the climate is seen in some topographical areas of Manang and Mustang. Rainfall pattern is changing, the area where minimum rainfall occurred during same season last year's maximum rainfall occurred this year and vice versa. 17ml of rainfall was recorded on May at Mustang in 2008. Three fold quantity of rainfall (53.5 ml) is recorded in the same period this year. In the same period, in Manang last year 356.6 ml of rainfall was recorded this year only 7ml was recorded. Dramatic change in temperature also recorded in these districts during that season. 4^0C temperature rise is recorded in Manang in one year (Nagarik, Shrawn 8^{th} 2066).

Because of increase in rainfall and decrease in snow fall traditional mud house structure is being damaged, local dwellers of Mustang have started to house roof with corrugated sheet. (Dahal, 2008).

Periodic monsoon pattern has been changing and monsoon period shortened. Thousands hector of land is being barren due to lack of irrigation, which are depending upon rainfall. Epidemics and tropical disease outburst is taking place due to lack of monsoon in season (Kantipur 2066)

2.4 Impacts of Climate Changes

According to UN climate change impact report the following impacts of climate will appear on climate and affects the livelihood of the people:

- About 20 to 30 percent 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 C (2.7 to 4.5 degrees F). The mountainous areas of Europe will face much greater species losses, "in some areas up to 60 percent under high emission scenarios by 2080.

- By 2020, between 75 and 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 percent at high latitudes and in some wet tropical areas, and decrease by 10-30 percent 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 the 2080s, millions of people are projected to be flooded every year due to sea-level rise, the report predicts. The numbers affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable.
- Glacier melt in the Himalayas is projected to increase flooding and avalanches and affect water resources within the next two to three decades. This will be followed by decreased 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 enormous damage.

As a low-lying delta, much of the land in Bangladesh is barely above sea level and is intersected by 230 rivers. Half of its 140 million people live below the poverty line and many of the poorest live in the most vulnerable areas - for example 2 million people have set up home on riverbanks. Sea levels are rising and monsoon downpours are heavier, leading to more flooding. As a result, the poorest people in Bangladesh are suffering most; their homes are destroyed and their land - the very land that provides their family with food is washed away.

2.4.1 Impact of Climate Change on Agriculture

Climate change will have far-reaching consequences for agriculture that will disproportionately affect the poor. Greater risk of crops and livestock death are already imposing economic losses and undermining food security and they are likely to get far more severe as global warming continues. Climate change threat to

agriculture is now unambiguous, but the exact magnitude is uncertain because of complex interactions and feedback process in the ecosystem and the economy. Five main factors will affect agricultural productivity: *change in temperature, precipitation, carbon dioxide fertilization, climate variability, and surface water runoff.*

For temperature increase above 3^0C, yield losses are expected to occur everywhere and be particularly severe in tropical regions. In parts of Africa, Asia and Central America yields of wheat and maize could decline by around 20 to 40 percent as temperature rises by 3 to 4^0C, even assuming from-level adjustment to higher temperature. With full CO_2 fertilization the losses would be about half as large. Rice yields would also decline, though less than wheat and maize yields (WDR, 2008).

As a result of climate change, rainfall levels in many parts of the developing world are falling. This creates a 'domino effect'; with less rain, water levels drop in reservoirs or rivers and people have less water to use. The quality of that water deteriorates as sewage and industrial effluent becomes more concentrated; as a result waterborne disease is rife. With a lack of water, vegetation doesn't grow so livestock have less to graze on. There is also less wood for cooking, so women have to spend more time searching for fuel to cook for the family.

Our greatest concern about climate change is the damage it is causing to our agriculture. Sudanôs economy, like that of many developing countries, is heavily based on farming and livestock keeping, the major employment sectors of the country. More than 70% of the population relies on traditional and subsistence agriculture, the majority of which are dependent on rain-fed agriculture and pastures. This all makes our economy extremely vulnerable to any slight changes in the weather. These changes are happening now and many peopleôs livelihood is under threat (Abdalla, 2009).

According to IPCC the following are some important factors directly connected to climate change and agricultural productivity:

- **Average temperature increase:** An increase in average temperature can 1) lengthen the growing season in regions with a relatively cool spring and fall; 2)

adversely affect crops in regions where summer heat already limits production; 3) increase soil evaporation rates, and 4) increase the chances of severe droughts.

- **Change in rainfall amount and patterns:** Changes in rainfall can affect soil erosion rates and soil moisture, both of which are important for crop yields. The IPCC predicts that precipitation will increase in high latitudes, and decrease in most subtropical land regions some by as much as about 20 percent. While regional precipitation will vary the number of extreme precipitation events is predicted to increase (IPCC, 2007).

- **Rising atmospheric concentrations of CO_2:** Increasing atmospheric CO_2 levels, driven by emissions from human activities, can act as a fertilizer and enhance the growth of some crops such as wheat, rice and soybeans. CO_2 can be one of a number of limiting factors that, when increased, can enhance crop growth. Other limiting factors include water and nutrient availability. While it is expected that CO_2 fertilization will have a positive impact on some crops, other aspects of climate change (e.g., temperature and precipitation changes) may temper any beneficial CO_2 fertilization effect (IPCC, 2007).

- **Pollution levels such as troposphere ozone:** Higher levels of ground level ozone limit the growth of crops. Since ozone levels in the lower atmosphere are shaped by both emissions and temperature, climate change will most likely increase ozone concentrations. Such changes may offset any beneficial yield effects that result from elevated CO_2 levels.

- **Change in climatic variability and extreme events:** Changes in the frequency and severity of heat waves, drought, floods and hurricanes, remain a key uncertainty in future climate change. Such changes are anticipated by global climate models, but regional changes and the potential effects on agriculture are more difficult to forecast.

Experience of Nepali farmers is similar to Uganda, Malawi, Haiti, Bolivia, Vietnam and South Africa. Farmers are in the trap of decreasing production and productivity of crops. Farmers of Baitadi Roshi have not seen any drop of water in monsoon season and say "In this year production of Barley is reduced, and production of other crops is also decreasing. Dila Pulami of Surkhet was not successful to preserve seed because

of less rainfall. She says in past year we were successful to predict on rainfall but this year we are not able, so that we are not able to preserve seed and plant. Local farmers' ability to prediction of weather system is distorted because of uncertainty in season and rainfall. Rainfall pattern is opposite in comparison with past years (Tandan, 2066).

Over two-thirds of Nepal's population depends on agriculture for their livelihood. Farmers follow traditional agricultural patterns, relying on rainwater and seasons. Changes in local and regional temperatures, the form and amount of precipitation, rainfall patterns, soil moisture content, and sunshine and cloudiness threaten traditional agriculture in Nepal. Moreover, climate change will increase the occurrence of extreme events like floods, droughts and hailstorms, which can also have a drastic effect on agriculture. Rising temperatures and increased rainfall may also lead to more pests and weeds, which will reduce agricultural productivity. (www.climate4life.org)

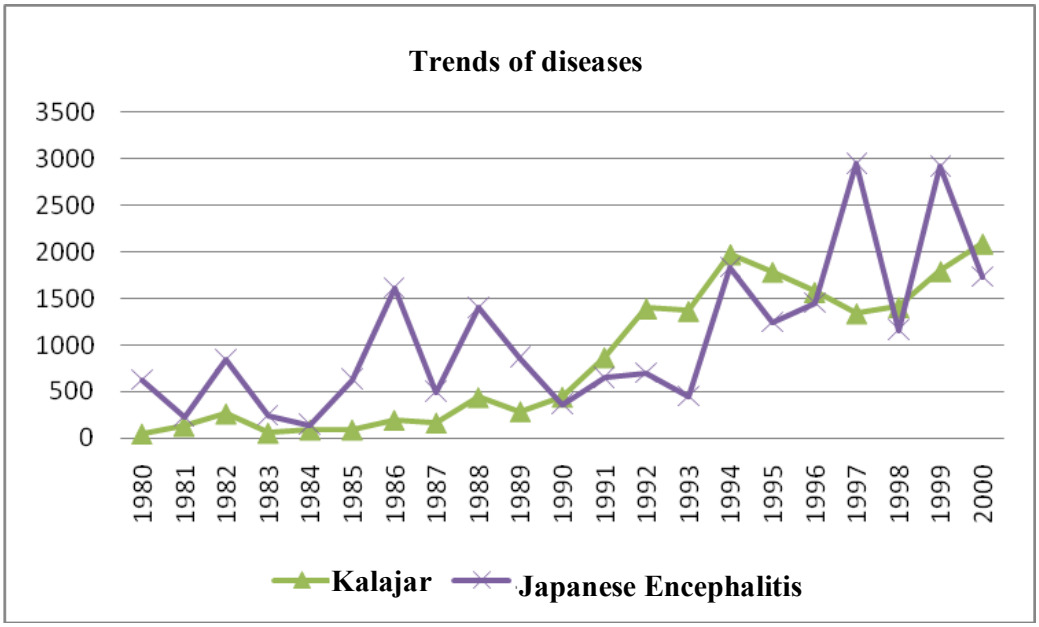
2.4.2 Impact of Climate Change on People's Health

Climate change is expected to have many consequences for human health. Diseases such as malaria and Japanese encephalitis have spread to new areas. Temperature 22-23^{0}C favors development of mosquitoes and completion of its cycle, increasing average temperature making favorable environment for different kinds of diseases. (CARE, 2009:22).

Health hazards from climate change are diverse, global and difficult to reverse over human time scales. They range from increased risks of extreme weather events, to effects on infectious disease dynamics and sea level rise leading to salinization of land and water sources. Based on WHO estimates around 150,000 deaths now occur in low-income countries each year due to climate change from four climate-sensitive health outcomes ï crop failure and malnutrition, diarrheal disease, malaria and flooding. Almost 85% of these excess deaths are in young children. (www.who.int)

Projected climate change-related exposures are likely to affect the health status of millions of people through increases in malnutrition, heat waves, floods, storms, fires and droughts; the increased frequency of cardio-respiratory diseases due to higher concentrations of ground level ozone related to climate change; and, the migration of some infectious diseases.

Figure 3: **Trends of Diseases Spread**



Source: Gurung, 2009.

Despite the fact that increasing medical facilities and services tropical diseases like, Kalajar & Japanese Encephalitis are increasing (Gurung, 2009). Figure 3 shows the trend of increasing Kalajar and Japanese Encephalitis.

Whether itôs the 70,000 excess deaths from the heat wave in Europe in 2003, or new malarial deaths in the central African highlands, the people at greatest risk for climate-related health disorders and premature deaths are the poor, the geographically vulnerable, the very young, women and the elder people. The populations considered to be at greatest risk are those living in small island developing states, mountainous regions, water-stressed areas, megacities and coastal areas in developing countries (particularly the large urban agglomerations in delta regions in Asia), and also poor people and those lacking access to health services.

Climate change may directly affect human health through increase in average temperature. Such increase may lead to more extreme heat waves during the summer while producing less extreme cold spells during the winter. Rising average temperature is predicted to increase the incidence of heat waves and hot extremes. In the United States, Chicago is projected to experience 25 percent more frequent heat waves and Los Angeles a four-to-eight-fold increase in heat wave days by the end of the century Particular segments of the population such as those with heart problems,

asthma, the elderly, the very young and the homeless can be especially vulnerable to extreme heat (IPCC, 2007).

2.4.3 Impact of climate change on overall economy

A recent study conducted by the Climate Change Group (CIG) at the university of Washington and Climate Leadership Initiative (CLI) at University of Oregon on Washington's environment and economy, had revealed that each household in Washington will pay on average an additional $1,250 each year by 2020, $1,800 by 2040 and $2,750 by 2080 due to climate change (CLI, 2009).

Developing countries are most vulnerable to the economic impacts of climate change. The increased frequency and severity of extreme weather events can have serious economic consequences. The impact of climate change on agriculture and the fragile ecosystems in Nepal will have a direct impact on agricultural productivity and tourism, and consequently on the country's economy (www.climate4life.org).

2.4.4 Impact of Climate Change on Biodiversity

About 20 to 30 percent 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 C (2.7 to 4.5 degrees F) (UN 2008).

A recent study projected that doubling of atmospheric carbon dioxide (CO_2) 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 ecosystems, particularly provision of environmental services such as clean air, water, food and aesthetic values. Communities of various parts of Nepal have already experienced loss of native plants and species.

Climate change will alter the worldôs habitats and ecosystems. Climate change will alter the fragile ecosystems of the 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 plant 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 impact on species, will affect the health, wellbeing and livelihood of the people who rely on such resources (www. climate4life.org).

Chapter - Three

RESEARCH METHODOLOGY

This chapter includes research design, rationale of the selection of study area, sampling procedure and sample size, sources of data collection, data collection tools and techniques.

3.1 Research Design

This study is carried out on the basis of exploratory research design because the study was focused on to investigate the impact of climate change on local communities. Moreover the objective of the study was to find out the effects of climate change on livelihood of communities, effects on income and health condition of people. In this regard, it is an exploratory research.

Besides, the study attempts to describe the effects of climate change on agriculture, livestock on the basis of local people's perception and explored findings is described. Thus, this is both descriptive and exploratory.

3.2 Sources of Data collection

The primary data were collected from interview survey. Secondary data were also studied, acquired from different reports, published and unpublished documents, presentations, from individuals, experts and organizations related to environment and related websites.

3.3 Rationale of the Selection of Study Area

Nepal is affected from climate change and besides this hill region is mostly affected. The particular area is chosen for the study because it is easily accessible, and heterogeneous in socioeconomic, cultural and geographical structure. Most of the people in this area are engaged in agriculture and livestock farming which are widely affected area from climate change. It is rich in biodiversity, water resources. Thus the area is selected to assess livelihood impacts, health impact, impact on biodiversity and overall economic impact of climate change in community.

3.4 Sampling size and Sampling procedure

The community Forestry User groupôs members were potential respondents of the study. Sampling size of the study was 124. The respondents were taken from ***SiddhiGanesh and Nepane CFUGs*** of Sanosiruwari VDC ward no (1, 2, 3) and 5 respectively. The universe of the study was the total households of both CFUGs of Sanosiruwari VDC. One hundred and twenty four households were sampled out of total 370 households (I.e., 62 from each CFUG) with random sampling for ***interviews survey***.

3.5 Data collection techniques and tools

The study used questionnaire, interview and observation methods. Primary information was acquired through filling questionnaires. Interview to key informants was another method adopted for the study. Secondary data were acquired from different reports, documents and related websites.

3.5.1 Interview survey

Structured questionnaires were prepared to generate primary data from the study area. The researcher requested to fill the questionnaire to the respective respondents. The respondents who were unable to fill up questionnaire, the questions were asked to the respondents and answers were filled up to collect the required data by the researcher.

3.5.2 Key informants interview

The primary data also were collected from key informants using the direct or indirect interview method. The interview is taken as cross reference (checking) for the data obtained from the questionnaire. The informants were interviewed on the impact of climate change, biodiversity, impact on human health, impact on agriculture and overall impact on income level. Respondents were also chosen by the help of key informants.

3.5.3 Field visit and Observation

The data were generated from field visit and observation method observing the household environment, agriculture field and sites.

3.5.4 Group discussion

To acquire information necessary group discussion was made. Group discussion was carried out with farmers and Community Forestry Users.

3.6 Data tabulation and Analysis

The collected questionnaires were tabulated by the help of SPSS program statistical analysis software widely used in research and data analysis through computer. All the necessary statistical tools like tables, graphs, means and medium were calculated from the program.

Chapter - Four

INTRODUCTION OF THE STUDY AREA

This chapter includes the introduction of study area, geographical, demographical, political introduction of Sanosiruwari VDC and Sindhupalchwok district. See Annex 2 for map of study area.

4.1 Background

It is said that the Name of Sindhupalchwok is called after the joint agreement between Sindhu Thum and Palchwok. Sindhupalchwok is one of the districts seventy five district of Nepal, located in Bagmati Zone in mid development region. It is bordered with Tibet of China and Rasuwa district in north, Tibet of China and Dolakha district in east, Nuwakot and Kathmandu in west and Kavrepalanchwok and Ramechhap district in South. It is located between 27^0 27ò to 29^0 13" longitude and 85^0 27" to 86"06" latitude. It is full of diversity, biodiversity, cultural diversity and vast as well as difficult geographical situation. The total area of the district is about 248837 hector. It covers 1.69% of the total land of Nepal.

The study site Nanosiruwari VDC is situated in the south west part of the Sindhupalchwok district. This is bordered with Pipal Danda VDC in north, Chautara and Irkhu VDC in east, Thulosiruwari in south and Bhotsipa and Kunchwok VDC in west parts. The name of VDC is named after the name of a Siru (a long Grass). Its height is about 778 to 1594 meters from sea level. Subtropical climate can be found in this region. Its south east faced landscape may be suitable for cultivation of cash crops. The total area of the VDC is about 1104 hector. It covers 0.44% of the total land of district.

4.2 Agriculture

More than 80 percent of the Nepal's population is dependent on agriculture. Traditional, subsistence agriculture is pre-dominant in Nepal. More than 80 percent people depended on agriculture and livestock in the study area. Rice, maize, millet are major crops in study area. Kodo, Amriso, mustard are cash crops of the study area. Ghaiya dhal (Rice spps.) is one of the most important endemic crops found in this study area. Traditional system of cultivation, mono crops cultivation and subsistence

farming are agricultural characteristics. So the economy is dependent on agrarian activities.

4.3 Natural Resources

Among the natural resources forest, water resources and mines are major natural resources of Sindhupalchwok. Diverse timber species and Non timber forest product (NTFPs) can be found on different geographical region. Up to 1200 m altitude sub tropical forest, similarly between 1200 m to 2100 m deciduous plants can be found, at the altitude of 3000 meter evergreen forest grow and above 5000m Alpine is found. Hill Sal forest, Sal and Khote Salla Mixed Forest, Khote Salla plantation forest, Chilaune Forest, Sal and Broad Leaves mied forest and Rhododendron, Khasru mixed mountain forest are the major forest types of this district.

Water resource is precious resource of this district. Level of precipitation is high in northern part of Sindhupalchwok. The main stream of Saptakoshi that is Bhote Koshi and Indrawati(Melamchi) river flow from its mid and Sauthern parts. High potential of hydro and irrigation are available in this area.

4.4 Demographic Scenario

Although, the majority of Adibasi Janajati (indigenous) people are residing the Sanoirubari VDC, there is heterogeneous society. Different casts of people are residing in the study site. Brahman, Tamang, Newar, Ghale, Chhetri, Gurung, Magar and Dalit Community people are residing in Sanosiruwari VDC. According to census 2001, 3825 people were residing in Sanosiruwari VDC. Some data on demographic scenario are given in Table 1:

Table 4.1: Demographic Statistics of Sanosiruwari VDC

Facts	2001 Census	2009 Projected
Total Population	3,825	4,344
Male	1871	2,168
Female	1954	2,176
Total household	719	797
Literacy Rate	47%	67%
HH Size	5.31	5.45
Population density	45.90	50
Growth rate	1.47	

Source: Village Development profile, 2009 Sanosiruwari

Chapter ï Five I

Impact of Climate Change

As described in research methodology section, primary data is collected from one of the high undulating village, Sanosirubari of Sindhupalchwok district. All interviews and group discussions are focused on climate change and its impact in the rural life. Change in climate and its effects to the daily life are experienced differently in different aspects. The impact of climate change can be seen through the study of rainfall, appearance and disappearance of various species of vegetation and insecticides, the nature of weather, humidity and temperature.

The questionnaires are designed to get information about rainfall pattern, environment and temperature changed and seen in the biodiversity of the area. This study intends to find out the impact of climate change in the daily life of the rural people and in the sector in which they are engaged for livelihood, including agriculture and livestock. Acquired information and their interpretation is presented below, dividing in to different sectors, reveals the situational pressure of climate change which is affecting the traditional ways of living and the effort for livelihood is being harder each year.

5.1 Local People's Perception of Climate Change

Group discussions and key informants interview indicate that the communities experienced on water stress and increased temperature in recent years. Rainfall and its duration are also in decreasing trend in comparison to previous years. People's sensation of temperature is beyond their understanding. They feel increase in temperature but they do not have any idea on cause of increasing temperature. Most of the respondents (86.67%) realize that rainfall pattern is changed diversely. Unseasonal rainfall, enormous but short period rainfall, irregular and erratic rainfall and drought are affecting agriculture. Respondent's perception on rainfall pattern is presented in Table 2.

Likewise, most of the respondents (82.54%) said temperature is increasing every year. While other 10.88% and 1.81% has indicated constant and decrease in temperature. They indicated deforestation and population are the main causes of less rainfall and

temperature increase as well as overall change in the climate. Many respondents indicated that they have experienced four days of September 22-27 as warm days in 2004. Natural calamities like drought, hurricane, hailstone and wide spread diseases have been extended. Wind pattern is getting warmer and stronger.

5.2 Impact of Climate Change on Agriculture

Among the respondents 82% were depending upon agriculture and livestock. Agriculture heavily depends on seasonal rainfall, due to less and irregular rainfall adverse effect on agriculture and livelihood has been noticed.

Unseasonal rainfall, irregular and erratic rainfalls have resulted in flood and drought. This has adverse impact on crops production (food and crops), which is threatening food security, and wellbeing of the people. People have to work harder to meet their necessary food needs.

Due to less rainfall and increasing temperature, water resources are drying up slowly. Wet-land is decreasing and becoming arid. The feeling of respondents on changing of environment in terms of impacts of less rainfall on water resources are presented below:

Table 5.1: Impact of Less Rainfall on Water Resources

S.No.	Effect on water resources	Respondents	
		Number	Percentage
1	Drying water resources	18	14.29
2	Reduction in water level in rivers	4	2.86
3	Loss of wetland	21	17.14
4	Drying water resources, reduction in water level in rivers	2	1.90
5	reduction in water level in rivers, loss of wet lands	4	2.86
6	Drying water resources, loss of wet land	20	16.19
7	Drying water resources, reduction in water level in river	39	31.43
8	N.A. (Not answered)	17	13.33

Source: Field Study, 2011.

The above table -2 shows that scarcity of water has impact agriculture. Water resources are decreasing and wetlands are also slowly disappearing. Among the respondents 86.66% responded that the water resources are drying out, wetlands are disappearing and level of water on ponds and river is decreasing. Many of the respondents noticed less rainfall as the main cause of decreasing flow of water in river. Wetland has been lowered resulting to water scarcity for household use and irrigation area turning to arid region. Delays in the monsoon in the past few years have changed cropping patterns and crops maturity period. Planting and harvesting of key crops has been pushed back by a month and rotational cropping systems have been consequently affected.

The change in rainfall pattern has affected the agriculture system. Its effects may not be easily predicted, but actual feeling of the people brings forth the reality. Cultivation is becoming difficult and production is decreasing. The table given below presents the effects of rainfall on agricultural system.

Table 5.2: Effects of Rainfall on Agricultural System

S.No.	Effect of less rainfall	Respondents	
		Number	Percentage
1	Rise in production	0	0.00
2	Decrease in production of crops	25	20.00
3	No change on production	4	2.86
4	Difficult to cultivate	15	12.38
5	Other	7	5.71
7	Decrease in production of crops, difficult to cultivate	48	39.05
8	Decrease in production of crops, difficult to cultivate and others	5	3.81
9	Difficult to cultivate, others	4	2.86
10	Rise in Production, others	4	2.86
11	N.A.	13	10.48

Source: Field Study, 2011.

Note: Others include, less production, threatening food security and causing famine, xerophytes species (species available in arid places) is being cultivated, no irrigation facilities)

The above table-3 shows the effect of erratic and unpredictable rainfall in production of crops and its effects to cultivating process. Scarcity of water resource is creating various problems of agriculture sectors; both cash crops and food crops have been affected.

Many respondents share their experiences about the effect of less rainfall on agriculture; it is difficult to harvest paddy, maize and other food crops on time. Growth of crops is also affected when if it is harvested. The pattern of production and productivity of crops has been changing day by day. 20% of respondents believed unseasonal rainfall causing decrease in production of crops, while 12.38% replied that difficult to cultivate. (See on table 3).

5.2.1 Effect of Unseasonal Rainfall on Agriculture

Irregular and unseasonal rainfall has been increasing from last few years, which is affecting cultivation of crops. Among total respondents 7.62% replied they are facing problem on cultivation of crops while 42.86% of respondents replied irregularities on production of crops (Table 4).

Table 5.3: Effect of Irregular Rainfall on Agriculture

S.NO.	Effects of irregular rainfall	Respondents	
		Number	Percentage
1	Effect on cultivation	9	7.62
2	Drawn of crops	0	0.00
3	Flooding	2	1.90
4	Irregularities on production of crops	53	42.86
5	Others	8	6.67
6	Effect on cultivation, irregularities on production of crops	31	24.76
7	Effect on cultivation, flooding and irregularities on production of crops	5	3.81
8	N/A	15	12.38

Source: Field Study, 2011.

Note: Other includes, decreasing production due to unseasonal rainfall, growth of crops is limited, Cultivation of crops is being impossible of irregular rainfall, more input low output.

5.2.2 Effect of Rise of Temperature on Agriculture

According to respondents, new insects have appeared and spread on crops as well as fodder and other vegetations. To cure these insects/diseases on key crops uses of pesticides are also increasing. The respondents realized rise in temperature as main cause of early flowering of different species of fruits and crops. Crops' species and fruits which are known as suitable for summer season are also being suitable for winter season. Crops species which are found on tropical region are also found on Himalayan region including in the study area. The rate of spread and growth of these species is very high in comparison to endemic species. Increasing temperature is creating many consequences; decreasing the period of maturation of crops, decreasing the time period of breeding of seed and wide spread of insects and disease etc.

Table 5.4: **Effects of Increasing Temperature on Crops**

SN.	Effect of increasing temperature on crops	Respondents	
		Number	Percentage
1	Decreasing the maturation period of crops (A)	17	13.33
2	Decreasing the time period of germinating seed (B)	2	1.90
3	Wide spread of insect/diseases (C)	41	33.33
4	(D)	5	3.81
5	Decreasing the maturation period of crops, decreasing the time period of germinating seed	7	5.71
6	Decreasing the maturation period of crops, wide spread of insect/diseases	13	10.48
7	Decreasing the time period of germinating seed, wide spread of insect/diseases	8	6.67
8	Wide spread of insect/diseases, Others	2	1.90
9	Decreasing the maturation period of crops, decreasing the time period of germinating seed and wide spread of insect/diseases	22	18.10
10	N.A.	6	4.76

Source: Field Study, 2011.

Note: Others includes, irregularities in flowering of plants species, shedding time of plant is changed, change in harvesting time of crops and Increasing different pests and insects.

Slightly more than 33 percent of the respondents of the study sites indicated wide spread diseases/insects due to increase in temperature and less rainfall, while the other 13.33 percent felt decreased the maturation period of crops and 1.90 percent of the respondents felt shortening the time of germinating seed (Table 5).

5.3 Impact of Climate Change on People's Health;

The impact of climate change on human health is widely felt. Respondents at study sites experienced various kinds of diseases, Malnutrition on child, viral influenza, Frenzitise, allergies and itching, and menstruation problem in girls as well as skin diseases. Many respondents pointed out the need for using mosquito nets these days. But the elder people say there were not any mosquitoes, so that there is no need of using mosquito nets. Some other unknown diseases also have appeared on the study site. Tropical and viral diseases have been frequent in all seasons.

Table 5.5: Problem Occurred from Increasing Temperature

S.No.	Problem from increasing temperature	Respondents	
		Number	Percentage
1	Increasing flies, mosquitoes and other insects	28	22.86
2	Appear new diseases on human beings (B)	13	10.48
3	Others (C)	2	1.90
4	Increasing flies, mosquitoes and other insects, appear new diseases on human beings	45	36.19
5	Increasing flies, mosquitoes and other insects, others	4	2.86
6	Appear new diseases on human beings, others	2	1.90
7	Increasing flies, mosquitoes and other insects, appear new diseases on human beings and other	26	20.95
8	N.A.	4	2.86

Source: Field Study, 2011.

Note: Others include, increasing death of sheep, increasing in infection of diseases, increasing death rate of old people.

Increasing temperature is creating problematic condition on day to day life of the people. Among the respondents 22.86 percent noticed increased in flies, mosquitoes and other insects, another 10.48 percent of the respondents experienced appearance of

new diseases in human life, 36.57 percent of the total respondents experienced both problems (Table 6). Other impacts include increasing mortality rate of aged people; new diseases on livestock and poultry farming.

Increasing diseases are making local life harder and exclusive. Expenditure for cure of diseases on medicine and health services is increasing unbearably. The following table shows the increment in medicine and health service costs.

Table 5.6: Increment in Medicine and Health Service Costs

SNo.	Level of expenditure	Expenditure increment over the previous year	Annual expenditure on medicine and health services
1	Maximum	25%	50000
2	Minimum	5%	500
3	Average	11%	9421

Source: Field Study, 2011.

Because of increased in diseases, the expenditure to cure diseases is rising annually. Though, primary health service has been made free by government; annual expenditure on medicine is increasing. Among the respondents 77% to responded this question and half of them said their annual expenditure is increasing by 11% on an average and half of them said their average expenditure in medicine is approximately rupees ten thousand (Table: 5.6)

5.4 Impact of Climate Change on Biodiversity

Natural ecosystem and biodiversities are also affected from changing climate. Community (respondents) of study site has already experienced loss of some native plants and species. The key informants reported that forests, lakes, grass land, wetland and agricultural ecosystems are continuously degrading. Grasslands have been converted to barren wasteland due to less rainfall and drought.

Most respondents reported the loss of forest species such as Kafal (*Myrica esculcuta*), Kaulo (*Maesa chisia),* Lapsi (*Choerospondia axillaris*), Bimiro (*Citrus medica*), Pipal (*Ficus religiosa*), Dhayero*(woodfordia floriburda),* Pakhuri, Totela*(Origanum*

vulgare), Dar, Bar, Khayar, and many other species in the last one decades. Likewise, they mentioned that forest species of Sal *(Shorea robusta)*, Aamba *(Psidinum guyava)* and Chilaune are dying these days.

They also talked about that medicinal plants and Non timber forest products (NTFPs) including *Pipla(Piper longum),* Aamala, Khereto, Aamba *(Psidinum guyava), Gurjo (Tinospora Condifolia)* have also disappeared.
Respondents revealed that different plant species had been flowering irregularly. Orange was mature in September/October, *Kavro* (*Ficus lacor*) was sprouting in September, which is not seen as normal time.

Many key crops species were lost in recent years. Many species of paddy like, *Achhame,Ghaiya Aanga, Khumal-4,Chhate, Kathe* and other crops like millet, bean species have disappeared. Likewise, local varieties of vegetable crops like *Local-Rayo, Cucumber, pumpkins, chilies* etc are not found these days because their seeds are replaced by improved and exotic varieties. It was found that, farmers were using large swamps and wetland area. Villagers used to cultivate a local rice landrace Ghaiya, Achhame, Aanga, Sinuwa, which grew well in these areas. However, irregular watering from Jhyandi River and its tributaries deposited massive amount of sand and mud, thereby turning this swampy area into dry agricultural land. As a result above mentioned rice were no longer grown and were replaced by modern verities such as Khumal-4, and Mansuli. On the other hand villagers cannot find seed of local landraces, and they are facing difficulties with production and expenses of growing modern verities.

Similarly, the respondent said that the wild fauna (I.e. birds: Mayur, Sparrow, Crow, Chibe and Gauthali and Kalij, and wild animals: jackal, rabbits) are hard to see these days because of migration.

5.4.1 Spread of Invasive Species:

Change in temperature, rainfall pattern are creating favorable environment for pests, diseases and invasive species to emerge, spread and encroach in agriculture and forest lands. Respondents have already experienced the emergence of species that they have never seen in their field area. Invasive species like Banmara (*Lantana species*), Gande

Jhar (*Ageratum Conyzoides*), Aaloo Jhar, badame Jhar, Kande Jhar & Titepati (local weed) are evident in the study area.

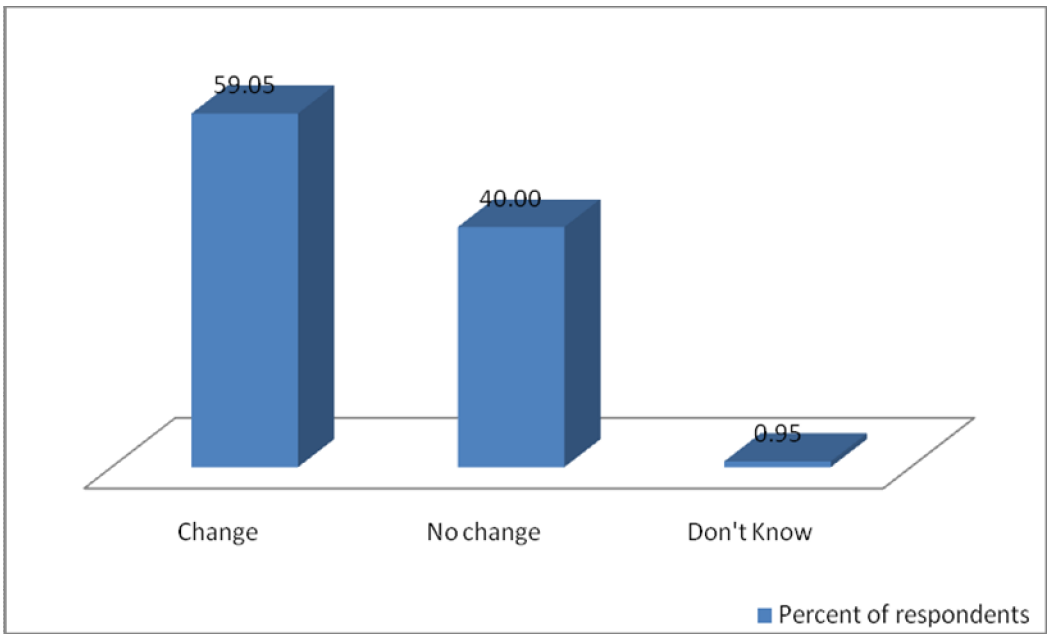
Furthermore, respondents perceive that invasive species are spreading very fast and damaging agriculture, pasture and forest lands. They were worried on production of staple food crops and cash crops *mustard* and *Amriso* are also affected form these invasive species.

5.5 Impact of Climate Change on Livestock

Due to extreme drought, there was direct impact on the growth of *palatable* grass species. Regeneration of fodder species in pasture and forest fodder is also decreasing, because of less rainfall. As a result, there is a shortage in diversity and quality of livestock fodder. This has affected livestock which has further affected on production of milk, milk products and meat. Livestock population is also decreasing. Drought affected livestock by drying wetlands, pasture land and water resources, streams and decreasing availability of drinking water to live stock. Increasing temperature is also affecting livestock having different new born diseases.

The scarcity of fodder and space for livestock rearing community is forcing the farmer to change their livestock pattern. Most of the people who have changed their livestock which needed less fodder, grass the study shows that majority of the people (59.05 %) have changed their livestock, where and 40% said they haven't changed their livestock pattern. Figure 4 shows the status of livestock changing pattern.

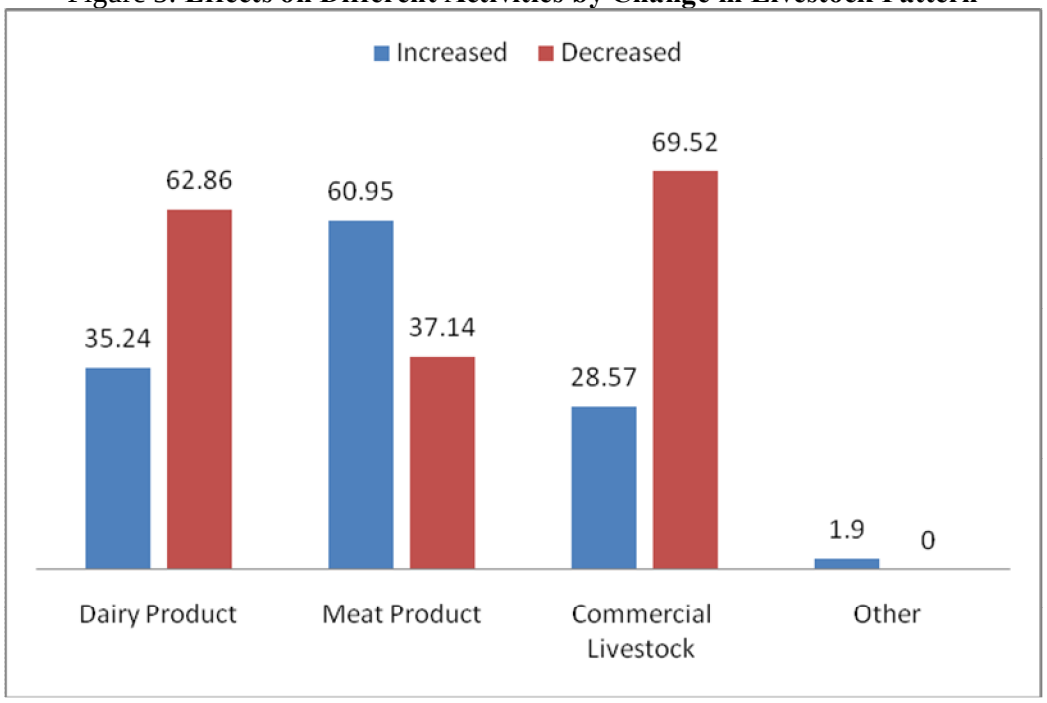
Figure 4: **Change in Livestock Pattern**



Source: Field Study, 2011.

5.5.1 Effect on Different Activities by Change in Livestock Pattern

Figure 5: **Effects on Different Activities by Change in Livestock Pattern**

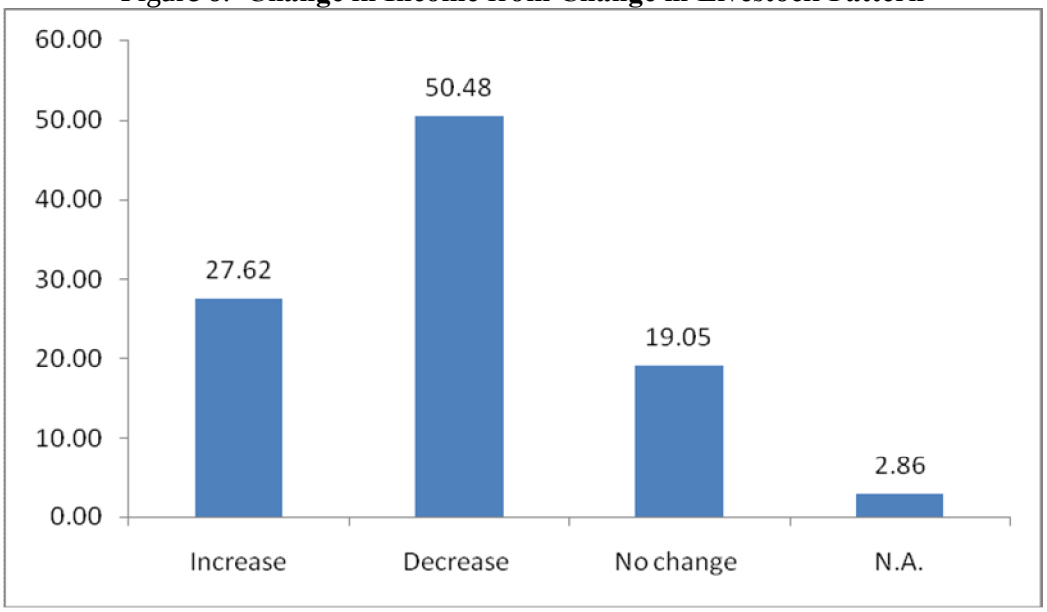


Source: Field Study, 2011.

Due to scarcity of resouces for livestock, change in livestock pattern has been observed. According to respondents dairy products have decreased significantly, while meat product is increased due to the poultry farming. Figure -5 shows the effects of changing pattern Sixty two percent of the respondents noticed direct impact on dairy product, 60.95 percent noticed increase in meat products and 69.52 percent of the respondents notice decreased in livestock. Nearly 2 percent of respondents have noticed change in occupaiton, migration etc.

5.5.2 Impact on Income Due to Change in Livestock Pattern

Figure 6: **Change in Income from Change in Livestock Pattern**



Source: Field Study, 2011.

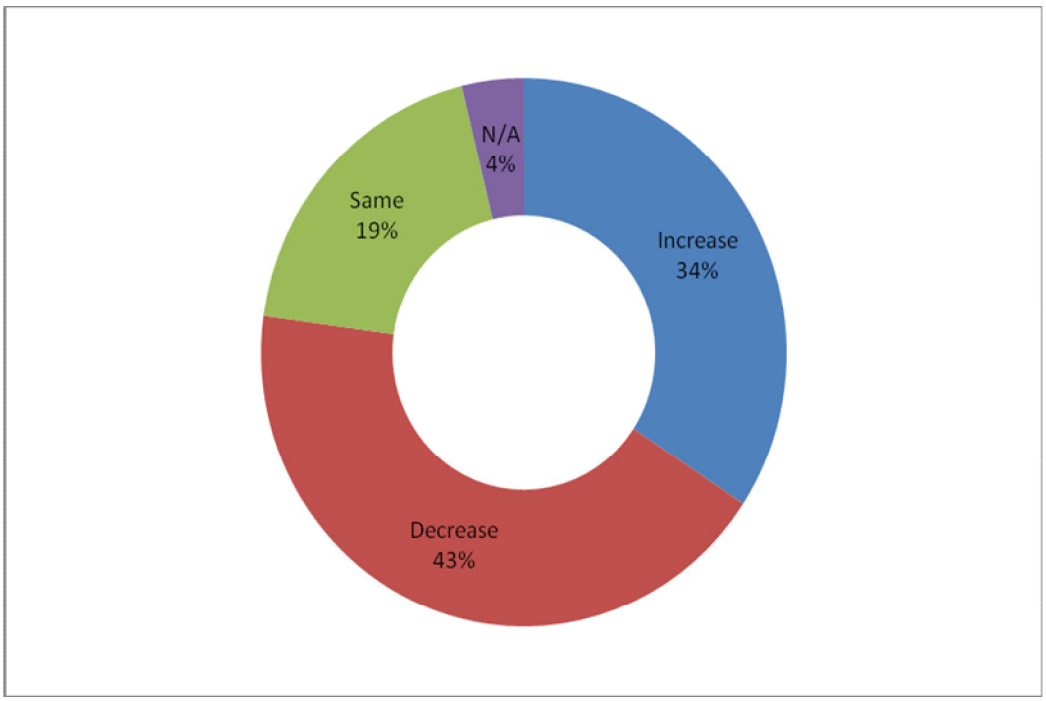
Slightly over 50 percent of the respondents said that their income level is decreased due to change in livestock pattern while 27.62 percent of the respondents said that their income level was increasing. On the other hand, 19.05 percent of the respondents said that their income level was constant. Figure 6 shows change in the income brought by livestocke pattern change.

5. 6 Impact of Climate Change on Overall Economy

Livelihood can be measured from the dependency of household on which they are depending. Economic status is also measured from the dependency and occupation. More than 82 percent of the households were depending on agriculture and livestock on the study area. It indicates that if there is threat on agriculture and livestock the direct impact falls upon livelihood of the people. Impact of climate change has been observed on agriculture and livestock thus impact on income and overall economy also is seen.

As agriculture and livestock are main sources of income, the loss or degradation in agriculture threatens the income level of the household. To fulfill the income gap from agriculture and livestock, youth members of the households are engaged in alternative profession like business, foreign employment and wage labor.

Figure 7: **Overall Income Pattern**



Source: Field Study, 2011.

Figure 7 shows that many respondents (43 percent) have said their income level is decreased, another 34 percent of the respondents said their income is increasing and other 19 percent of the respondents replied that their income is constant.

Chapter - Five II

IMPACT OF CLIMATE CHANGE

Respondents' perception and observations of climate change and related impact are found to vary. Although, many of their observations, experiences, feelings and perceptions are inconsistent or even contradictory, apparently most of them are valid even from scientific perspective. However, they may not have full explanation for all the observation and experiences; they can help advance understanding of climate changes and their diverse impacts on communities.

The respondents or community observation tells interesting stories about climate change and its impact of the diverse aspects of the natural phenomenon. Climatic variation is prominent among them. According to their observation the summer is getting hotter, longer whereas the winter is getting shorter and warmer. The intensity of rainfall has been increased but the length of the rainfall, particularly during winter, has decreased. The observation also supports the scientific studies in general (IPCC 2007). Similarly, the observations also correspond with the estimates of temperature rise of 0.41^0 Celsius per decade in Nepal based on long-term metrological data (GON 2004) on climate change and its impact is visible in the study area.

Similarly, the overall average trends of climatic conditions in Nepal indicate that the precipitation is decreasing at the rate of 9.8 millimeter (mm) per decade on annual basis (GON 2004). But there are variations in perception level in different parts of country, which matches with the respondents experiences and perceptions on rainfall and its variation. The local communities have experienced shortened monsoon which is also correlated with scientific observations shows that monsoon has onset in faster by 70% of a day per annum and withdrawal is delayed by 15% of day per annum (Chapagain, 2009). Respondents of study site have experience of new plants which were found in tropical region which is supported by the study by Chapgain B.K. According to him many of the tropical region plants now also grow in the temperate zone, which is a clear indication of the rising temperature. The local people have also observed new weeds and other plants invading their farms and forests. Similarly, trees are shedding their leaves much earlier than usual. The temperature fluctuation may have changed the distribution of plants.

Most of the respondents in the study area have experienced decreasing rainfall pattern and increasing temperature. According to them the unpredictability on monsoon has been increasing every year. They can't predict the monsoon which is creating difficulty on harvest. Those experiences are same as the report published by Government of Nepal (GON).

The erratic rainfall pattern has affected regular paddy cultivation. Farmers are looking for alternative crops that would be produced under irregular rainfall conditions. Some farmers have replaced rice with millet and some have replaced by *vegetables* and *Amlisho* because these crops may be the best alternatives. The main reason for such replacement was not for the value of cash crops but to protect farm land. Same effect and condition was studied by CARE Nepal in Dhading, Rasuwa, Banke and Bardiya.

It was found that most of the respondents are facing difficulties on cultivation of crops. Irregularities on rain fall and its changing pattern are affecting overall life style of the people. Drought has been increasing every year. Drought has multiple effects because it affects not only water resources, but also agriculture, and subsequent food security. Study site at Sanosiruwari is now facing challenges of drought and insufficient water. They are forced to reuse water and store of water (roof water collection) for the fulfillment of household and farming activities. Change in rainfall pattern had drastically decreased yield and production of staple crops such as rice maize, wheat and the cash crops, were also found affected from change in rainfall pattern. It is also found that the people of Sidhiganesh and Nepane CFUGs are using hi-breed variety of agricultural crops which also increase the cultivation cost. It was found that the water level and flow of water in river and river tributaries has been lowered resulting in water scarcity for irrigation and the farm land, terrace and wetland are turning to arid. Same result was found on the study conducted by CARE Nepal on Banke, Bardiya, Dhading and Rasuwa.

The cash crops have also been found affected from different unidentified diseases and the production and productivity were also decreasing.

Several new pests which are found in low land or warm climate are also found on the study site. Many insects and weeds have been identified in crops and agricultural

field. Striped borer (*Chilozonellus swin*), pink borer (*Seesamia infers walk*), arm worm (*Mythyma separata*), Small butterfly, Grass hopper (*Chrotogonous sp*) have increased on the study site. According to the respondents paddy cultivation has been affected from different pests and disease such as Rice wilt (*Stiophilus oryzac*), Angownios grawin motha (*Sitotroga cerealella*), Khapra Reetle (*Traogoderma granasium*), borer, rice bug and leaf roller. Traditional species of rice are disappearing and productivity is decreasing. Traditional and endemic species of rice have been lost. This finding is supported by Regmi (2009) on Talbesi Tanahun. According to study it was found that, farmers were using large swamps and wetland area. Villagers used to cultivate a local rice landrace Gauriya, which grew well in these areas. However, frequent flooding of the Talbesi River and its tributaries deposited massive amount of sand and mud, thereby turning this swampy area into dry agricultural land. As a result Gauriya rice was no longer grown and was replaced by modern verities such as Radha and mansuli. On the other hand villagers cannot find seed of local landraces, and they are facing difficulties with production and expenses of growing modern verities.

It was found that the respondents are also facing difficulties in livestock. It is being difficult to find fodder from jungle and pasture land is also decreasing because of less rainfall. Grazing area is decreasing because of encroachment of forest and land slide. Livestock are also being affected due to different new diseases which were not seen before.

Milk production is decreasing; some villagers have replaced their livestock which requires less fodder and grass. Some of the respondents were replacing livestock by pig, goat and poultry farming which are easy to handle and manage.

5.7 Impact on Health of People

It was found that community at study site has experienced intense heat for the last few years that resulted in development of different kinds of diseases, insects and affecting human health. Allergies and itching problem are increasing particularly in women and children. It was found that different temperate diseases have been increasing. There were no mosquitoes six to seven year ago but now villagers are using mosquito net at even in October. Mosquitoes, flies, moths and other insects are increasing, which are resulting increasing in frequency of illness among children. Fever, malaria,

chickenpox, diarrhea, uterus infection and water born diseases are increasing every year. Same result was obtained by the study carried out by Regmi (2009) on Kaski and Tanahun districts. According to study the village communities reported of increasing in the number of mosquitoes and flies, which is resulting in frequent illness among children.

It was found that expenditure over medicine and curing diseases has been increasing every year. Increasing expenditure is creating pressure on households to search for alternatives. Moreover, youth population is migrating toward urban and semi urban areas as well as abroad for employment to cover the increasing expenses.

5.8 Impact on Biodiversity

It was found that biodiversity is also affected from climate change especially by increase in temperature. Change in temperature and rainfall pattern is creating favorable environment for pests, diseases and invasive species to emerge, spread and encroach the agricultural land, forestlands and other pasture land. Respondents experience that invasive species is spreading very fast and damaging both agriculture and forestlands. They were worried that production of cash crops had declined to some extent due to invasive species Banmara (*Lantana Camara*). It was found that some behaviors of plants have been changed.

Furthermore, It was found that plant species which did not exist in that location before were also found in study areas. Traditional species of crops like varieties of paddy have been lost and disappeared. New species which are best fitted in warm temperature were growing up. Moreover, those plant species and crops species which were only farmed in warm temperature and only in summer season were also cultivated in winter season but invasive species and pests and parasite had increased.

Seeding of the plant has been changed which is unusual. Flowering time of different plants has been changed.

5.8 Impact on Income and Overall Economy

Many respondents' have said their economic level has been decreasing. Income sources have been narrowing, income from agriculture and livestock is decreasing every year.

However, respondentôs argument seem to be contradictory because their living standard seems to be better than few years before. Some of them are providing education to their children sending to private institutions. They are migrating to semi-urban and urban area for searching alternatives of traditional occupation.

The production and productivity of livestock and agriculture have been declining. Because of that, the key informants argued that the gap between rich and poor is increasing. The gap between have and have not is also increasing. The rich and economically able people are changing their occupation and seeking better alternatives of agriculture and livestock but those people who have no access to such alternatives are threatened from change in climate.

Chapter - Six

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Climate change is burning issue of the contemporary world. Most of the people have been affected from the global phenomenon. Everywhere, climate change is the matter of debate, from grass root level to national, international, regional and global. 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, Under Developed Countries (UDCs) are being affected more than Developed Countries (DCs). Most of the UDCs are dependent on agriculture and agrarian activities. Because of 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, 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. Effect of climate change has not been assessed minutely in the local level yet. Understanding this matter is different in national level and local level. No effort can be found for understanding and minimizing its effect in the grass root level.

These studies try to asses and evaluate the impact of climate change on livelihood and biodiversity in rural communities of Sanosiruwari VDC of Sindhupalchwok district. The purpose of this study is to find out the generally seen effect of climate change and to complete the course of Masters Degree of Rural Development under Tribhuwan University. For this purpose primary data were collected by interview survey, key informants interview and observation method. Secondary information was collected from various relevant publications, newspaper reporting and other national and international journals published recently. In this process, I tried to present local people's perception in the same way as they expressed.

Collected information were accumulated, tabulated and analyzed by the established research techniques and in this process, recently developed computer software is used to measure data consistency.

The analysis indicates continuously rising temperate, low volume of rainfall and inconsistency in livelihood of the local people. They have also interpreted these events as a result of climate change. In recent year rainfall pattern is recorded fluctuated, altered, delayed monsoon, erratic and abnormal duration of rainfall etc. Winter season rainfall is also decreased and many activities of this season became uncertain. On the other hand natural calamities like hailstone and hurricane are occurring unpredictably and seem to have increased in recent days. Temperature rising pattern is also an unpredictable and strange matter. The plants' lifecycle behavior regarding flowering, shedding and germination of seed are shortening, maturation time of fruits and crops also indicates the pattern of increasing temperature.

The production and productivity of agricultural product have been decreasing because of less rainfall. Scarcity of water for irrigation has been started so the communities are being unable to cultivate in time. Damp and Swampy areas and farm land are disappearing day by day. The availability of grass on forest and field is also in decreasing pattern, scarcity of grass and fodder is increasing, the pasture land has been converted to arid desert and due to the scarcity of water and fodder, it is resulting in decreased number of livestock. Because of the lack of adequate fodder and difficulty to manage it, livestock pattern has started to change. People are replacing those animals which consume large amount of grass by that animal consuming less fodder and other alternative by which they gain comparative benefit. Different diseases have been spread out on livestock. The benefit from livestock has been decreasing and the agrarian livelihood is narrowing down to the subsistence level.

Many species of the area and biodiversity are found affected from changing climate. Most of the endemic and traditional species of staple crops have been difficult to find and some of the species are completely lost. Different invasive species, weeds and pests have been increasing.

Diseases and insects which were found on tropical climate are also found in cold hilly and mountain region. Mosquitoes, flies and other insects are spread out on high altitude including study area. Human health is affected from changing climate, especially women and children have been affected from different diseases. Jaundice, diarrhea, cholera and other water born diseases, itching problem have been increased. The cost of living is increasing because of increasing medical expenses.

Changing climate increasing problem in rural life, even they are using different local adaptation mechanisms they are not sufficient. Rural communities are experiencing difficulties on their occupation and on which they are depending on. People are changing their profession from agriculture, livestock farming to easy sector business like construction labor and foreign employment. People are compelled to change their traditional occupation, because of low productivity, less of fodder, grazing land and pasture land. Many people are migrating toward urban, semi-urban places searching alternatives professions. Young people are disappearing to foreign countries for employment. When they earn money they do not return to village. Migration of youths is creating vacuum and creating scarcity of human resources to cultivate.

6.2 Conclusion

Climate change is a natural process but human activities are accelerating the speed of change. Increasing temperature is the main cause of climate change. Increase in temperature has different consequences in physical world as well as biological. Change in rainfall pattern, melting ice from Himalaya, increasing sea level affecting coastal areas, drought have been increasing. Due to the scarcity of water for irrigation, agricultural production and productivity is decreasing. Threat to biodiversity and human health also has been experienced on different geographical region.

Because of less adaptation and mitigation capacity LDCs have been affected more in comparison to DCs from climate change. Despite the fact that Nepal's contribution on global warming and increasing GHGs is negligible, Nepal is the most vulnerable country. Annual temperature rise is higher in comparison to other countries. Increase in temperature in Himalayan region is clearly noticeable in context of Nepal.

Rural communities are experiencing increased temperature and changing pattern of rainfall. Even they are experiencing climate change they do not seem to be aware on

causes of climate change and its long term consequences. Rural communities are experiencing changing pattern of rain fall, strange climatic change, changing time of cultivation of crops, changing behavior of animal.

The production and productivity of the food grain as well as cash crops has been decreasing every year. Due to the low productivity threat to food security is rising as a big issue. Income level is decreasing because of reduction on production of cash crops. Cultivation of crops is being difficult because of scarcity of water for irrigation.

Livestock also has been affected from climate change. Area for livestock rearing, getting grass and fodder is reduced because of drought. Due to less availability of fodder livestock pattern has been changed, resulting reduction on milk and milk product. On the other hand, changing pattern of livestock, commercial poultry, pig and goat farming is increasing, so that availability of meat is increasing.

Biodiversity also has been affected from the changing climate. Different crop species have disappeared and lost behavior of plant and animal is changing. Germination, flowering, maturation and shedding time of plants species have been changing. Different species of herbs and weeds (Aalu Jhar*) have been spreading on farm land and forest. Although, the density of jungle is increasing the number of wild animals have been decreasing. On the study site the unique species of Local rice is in extinction phase. Different species of beans, rice, millet and barley have disappeared already.

With increasing temperature threat to human and livestock is growing too. Especially problem of skin diseases, itching, uterus infection, eye infection, water born diseases have increased. Tropical diseases, insects, pests have increased in cold climatic zone including study area. It is found that number of mosquitoes, flies and other insects are increased; as a result Fever, Typhoid, and other communicable disease are increasing. It is found that medicinal expenditure and expenditure on rehabilitation of patients is increasing every year.

Because of lack of labor forces traditional agricultural system and livestock farming are decreasing. Number of livestock has been decreased because of scarcity of fodder, water and grazing land, as a result, the income from livestock is decreasing. Natural hazard and uncertainty on whether threatening agricultural production which is

leading toward less production, threat on food security. Cash crops such as Tomatoes, orange, Amriso, medicinal herbs are also threatened from extreme drought and spread of pests. In addition, increasing temperature is creating health problem in human as well as livestock. They are putting pressure on monitory burden on households. To maintain these expenditure youth member of household are migrating to semi urban, urban and abroad also. Overall economic status of people of the study area seemed to be satisfactory. People in study area are facing problem of scarcity of farm labor and other agricultural problems because of migration of youth. Moreover, the cause of returning of migrated people from village is found very less so the financial capital is flying away from village.

In nutshell, climate change is threatening the life of people in rural areas and opportunities for livelihood have been narrowing down. Traditional sources of income are being inconvenient for survival. Poor, marginalized, women and children are affected more from climate change.

6.3 Recommendations

Different impacts of climate change have been observed in study site. To combat against the impact of climate change some of the recommendations are made as follows:

6.3.1 Recommendations for Planning and Program Implementation

- Awareness on climate change and its impact must be raised on rural communities. People are experiencing changing climate but they don't know the cause and consequences of climate change.
- The capacity for coping with the impacts of climate change must be strengthened. Local adaptation practices must be preserved and promoted. Mitigation of climate change seems to be impossible for our country and from our effort so adaptation practices must be increased.
- To reduce uncertainty on production of main crops and cash crops, insurance of crops must be done in local level. To preserve seeds of main crops and endemic crops gene bank should be established.

- To reduce uncertainty on livestock farming, livestock insurance policy should be implemented. To increase availability of water for irrigation and for the use of livestock reservoir and ponds/wells should be established. Rain water collection and rainwater harvest system should be promoted. Improved irrigation facilities can improve the productivity of crops. Crop diversification and crops intensification should be promoted. Subsistence farming should be changed and should be commercialized. Cash crops should be promoted as the alternative to key crops, cash crops such as Tea, Alaichi (Cardamom), Amriso plays vital role in improving livelihood of people. In commercializing crops organic farming must be promoted.

- To reduce damage from natural calamities like hail stone, water hazard (flood, flash flood/drawn, droughts) and changing rainfall weather forecast system must be developed.

- To reduce encroachment on forest intensive farming should be done so that wild animal could also be protected and their habitat is preserved too.

- Awareness level for curing diseases and improving deteriorating health condition should be improved using traditional, indigenous techniques of preserving and utilizing medicinal herbs and aromatic plants.

- Indigenous knowledge on agriculture, livestock keeping, handicrafts making and coping changing climate must be preserved and promoted.

- To preserve biodiversity on local area, awareness level of biodiversity on rural communities must be increased.

- To improve economic conditions of rural communities, local resources must be utilized proporely.

6.3.2 Recommendations for Action Research

- More studies need to the conducted on cultivation of cash crops and food security

- More in depth study is needed to determine which species of main crops and other plants are lost and why and what implication has on livelihood strategies for local community implementing to preserve them.
- More studies need to be conducted on climate change and change in livestock pattern.
- Research is also required on changing life style of the people in relation to climate change, production and productivity of crops and income generating activities and direct impact on health.
- Research is also required on spectral impact of climate change such as water resources, agriculture production mainly cash crops and livestock management.
- Loss of biodiversity and its implications on lives of the people
- Research is also required what should be the impact of youth migration to urban area in village and what should be the relation to climate change.
- Increasing invasive species spread of diseases and use of pests and its implication on health.

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Annex - 1: Questionnaires for Data Collection

Namaste!

I am Digambar Singh Dahal from Central Department of RD, TU, Kathmandu. I am here to conduct a research on Assessment of the ñ*Impact of Climate Change on Livelihood and Biodiversity in Rural Communities*ò of Sanosirubari, Sindhupalchwok district. For the purpose of the research, I am going to ask you some questions related to the research topic. So please help me providing the accurate information, so that I can incorporate the real facts in my report. Please feel free to provide information and I promise your identity will be kept secret.

Introduction of Respondent

Name: Address:

Occupation: Age:

Questionnaires

1. How many family members do you have in your family?
   Female é é é é . Person Male é é é é Person Total é é é . Person
   0-15 Years é é é Person 15-60 Years é é Person More than 60 é é .Person
2. Please mention Literacy status of your family
   Unable to read/write é é é é é . Person Literate é é é é .. Person
   Up to Class 5 é é é é é Person Up to Class 8 é é é . Person
   S.L.C or equivalent é é é é é Person Intermediate and above é ... Person
3. What is your family's main occupation?
   Agriculture/Livestock Employment Other é é é é é é é é é é é
4. What kind of change you have felt in raining pattern in comparison with past years?
   a. Less b. More c. Same
5. What may be the cause in reduction of rain?
   a. Increase in deforestation b. Increase in population
   c. Other é é é é é é ..
6. What kind of change in monsoon season?
   a. Increase/Decrease in winter b. Increase/Decrease in monsoon season
   c. Increase/Decrease in both seasons
7. What kind of effects has been occurred due to excessive/less rainfall?

a. Increase/Decrease in winter b. Increase/Decrease in monsoon

c. Increase/Decrease in both seasons

8. What Kind of effects have been observed from less rainfall?

a. Rise on production b. less production of crops

c. No change d. Effects on Cultivation/no cultivation

e. Other é é é é é é é .

9. What kind of effects has been occurred from irregular rainfall pattern?

a. Effects on cultivation b. Drown of harvested crops

C. Waste harvested crops d. Irregularities in production

e. Other é é é é é é é é é

10. What Kind of Problems have been observed from less rainfall?

a. Effects on cultivation b. less production

c. Dry up of water resource d. Effects on Livestock

e. Other é é é é é é é ..

11. What Kind of effects have been observed due to excessive rainfall?

a. Flood b. Landslide

c. Drowned d. Other

12. Who are more affected from dry up of water resources?

Class/Effected	Male	Female	Child
Rich			
Medium Class			
Poor			

13. How much time has been added from dry up of water resources?

a. Half an hour b. More than half hour c. More than one hour

14. What kind of change in temperature in comparison to last yearôs?

a. Increase in temperature b. Decrease in temperature

c. same as previous

15. What effects have been observed from increasing temperature?

a. Increase in population of Mosquitoes, Flies

b. Diseases have been appeared in human being

c. Other é é é é

16. What kind of effects on crops has been observed from increasing temperature?
    a. Shortening the time of reaping of crops
    b. Shorten the time of germinating seeds
    c. Increase the number of insects and diseases
    d. Other
17. What kind of species of crops have been abandoned cropping now a days in comparison
    a. é é é é é é é é é é é . b. é é é é é é é é é é é
    c. é é é é é é é é é é é .. d. é é é é é é é é é é é .
18. What sort of change has been observed due to climate change on cash and food crops?
    é
19. What kind of effects you are facing on livestock after reduction of production of crops and grasses?
    a. Reduce in number livestock b. Increase in livestock c. same as previous
20. Have you changed livestock due to change in the availability of grass/fodder? (Example Cow instead of Buffalo, Pork instead of goat and poultry farming)
    a. Changed b. No change
21. What type of livestock are changed and which are started farming?
    a é é é é é é é bé é é é é é é é cé é é é é é é é é é
    dé é é é é é é é é
22. What is the effect of such change on income?
    a. Increased b. Decreased c. No change
23. Which activities have been increased/ decreased by change in livestock?
    a. Milk production increased/decreased
    b. Meat production increased/decreased
    c. Commercial livestock increased/decreased
24. What kinds of diseases have been appeared on livestock with increasing temperature?
    é
25. Fluctuation on income (estimated) due to change of livestock?
    é
26. What are the effects on livelihood from reduction in income?

a. Difficulties in livelihood b. Effect on food security

c. Compel to change occupation d. other

27. What species of plants have disappeared recently?

aé é é é é é é .. bé é é é é é é é é é é ..

cé é é é é é é é é . dé é é é é é é é é é ..

28. Increase or decrease the number of Wildlife?

a. Decreased b. Increase

29. Which species of animal has decreased more?

é é

30. What kind of insects has appeared which didn't appear first?

é é

31. What kind of diseases have appeared and increased by increasing temperature?

a. é é é é é é é é é b.é é é é é é é é é é é é é .

cé é é é é é é é é dé é é é é é é é é é é é é ..

32. How much more is costing to heal diseases? (Estimated)

é é

Thank You!

Annex - 2: Map of Study Area

Annex-2

Study Area Location

Annex 3: Photographs

Photo 1: The study area Sanosiruwari

Photo 2: A young man feeding to baby goats

Photo 3: Collecting information

Photo 4: Group discussion in field

Photo 5: **Female users answering the questioner**

Photo 6: **Early maturation in paddy crops**

Photo 7**:** Using Mosquito nets, this has been a recently trend.

Photo 8**:** Child suffering from nose infection.

Photo 9: Decreasing water level in river

Photo 10**: (Aalu Jhar)** unidentified new invasive species

Photo 11: **forest degradation caused of forest fire**

Photo 12: **practice of roof water collection**

Photo 13: **consultation with health worker**

Photo 14:Nepane Community forest

Photo 15: A old gentle man sharing his experienced about climate change

Photo 16: A water mill in study site

Photo 17: reduction of milk

Photo 18: uncertainty of water

Photo 19: unidentified disease in paddy crops

Photo 20: unidentified new invasive species in agri-field

Photo 21**: (Badame Jhar)** unidentified new invasive species

Photo 22**: Vegetable farming (home pl garden) affected by water scarcity**