community vulnerability to climate change and local coping mechanism

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Jitendra Bikram Shahi

Abstract

Community Vulnerabilities to climate change and local coping mechanisms at Ramshikharjhala VDC of Kailai

J.B.Shahi

The Ramshikharjhala VDC is located in the Kailali district of the far western Nepal. Total area of this VDC is 157.95 square km and its altitude ranges between 142m to 1474m from sea level. There were 45.3% Brahmin/Chhetris, 33.6% Tharus and 21.1% others.

Temperature and precipitation data analysis of Ramshikhar Jhala between 1981 to 2010 showed some changes. The mean maximum temperature was increasing at 0.37c per decade where as the mean minimum temperature was increasing at 0.26˚C per decade. Average monthly rainfall shows that November is the driest month with 3.94 mm of average rainfall where as it is 497.3 in July which is the wettest month. The analysis of the seasonal rainfall shows increasing trend in monsoon and decreasing trend in winter which makes the area more prone to water related disasters. Regarding the experience of local inhabitants of that area, more than 90% of respondents felt the increased frequency of flooding, more than 72% said they have experienced increasing temperature and 88% of respondents have experienced unusual rainfall events.

About 55% of the respondents believed that the agricultural production has decreased. Most of the farmers experienced unusual weather patterns which affect the productivity. They also have experienced the scarcity of water and more frequent climatic disasters.

"The people in the area did not have local adaptive capacity, so there was a need to formulate adaptive measures for the security of food and dealing with scarcity of water and climate change induced disasters."

Key word: Climate change, Nepal, Terai, Temperature, Precipitation, Disaster, Adaptive capacity, Vulnerability, Experience of local inhabitants, Community, Coping mechanisms.

Acronyms and abbreviations:

˚C	Degree Celsius
ADB	Asian Development Bank
AR4	Fourth Assessment Report
CBO	Community based organization
CBS	Central Bureau of statistics
CC	Climate Change
CO_2	Carbon dioxide
DHM	Department of Hydrology and meteorology
GHS	Green Houses gas
INGO	International non-governmental organization
IPCC	Intergovernmental Panel on Climate Change
KM	Kilometers
MOG	Millennium Development Goal
MM	Millimeter
NGO	Non-governmental organization
PPM	Parts per million
TAR	Third assessment Report
UNFCCC	United Nations Framework Convention on Climate Change.
VDC	Village Development Committee
WB	World Bank
GoN	Government of Nepal
MoE	Ministry of Environment.
Ha	Hectare
M	Meter
GNP	Gross National Product.
DFID	Department for international Development.
CEN	Clean Energy Nepal.
UN	United Nations
MFSC	Ministry of forest and soil conservation
SLC	School Leaving Certificate.
FMs	Frequency Modulations.

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1. Introduction

According to United Nations Framework Convention on Climate Change (UNFCCC 2002), "Climate change can be defined as change of climate that is attributed directly or indirectly to human activity which alters composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods". The variation in the earth's global climate or regional climate over time is one of the greatest environmental issues. The climate of the world is changing more rapidly in present in comparison to the past which leads to the great threat to human beings as well as the earth system. The global temperature increased by 0.3˚c to 0.6˚c in last century and by 0.2˚c to 0.3˚c the last 40 years (1960-2000)(Liu & Chen 2000) making earth more vulnerable. It rose by 0.8˚c in the last 150 years. As compared to the scenario of the world, the temperature of the Nepal is increasing at the rate 0.06˚c per year (GON/MOE, 2066 B.S.). This change in temperature is challenging all of the developing as well as the developed countries. According to Intergovernmental Panel on Climate Change (IPCC, 2007a), the average rise in global temperature was 0.74˚c in the last 100 years (1906 - 2005) and 0.13 per decade in the last 50 years (1956 - 2005).

Climate change is a global problem which impacts various sectors and areas. Sometimes there are dramatic changes with huge economic costs at community level to regional level. In developing countries some coping mechanism are developed at the community level which counts for climate change risk reduction.

Changes in precipitation pattern, sea level rise and more uncertain and intense weather events are some of the physical consequences of climate change. People are faced by erratic rainfall, longer drought, flood, landslides etc. faced by such types of extreme events people try to cope and adapt by using their traditional knowledge, skills and experience. According to the IPCC report, atmospheric concentration of three green house gases i.e., carbon dioxide, methane and nitrous oxide have increased sharply since 1750. Global concentration of carbon dioxide is increased due to the use of fossil fuel and land while that of methane and nitrous oxide are because of agriculture. Due to the human activity the earth's climate is changing which is not good for the sustainable continuity of the living planet (American Geological Union, 2003). Because of human activities, concentrations of these gases are increasing which threatens to cause more disasters and unsustainable livelihood. Adaptation techniques may help minimize the risk of vulnerable communities.

If the fossil fuel consumption remains constant or increased and no adaptation measure are implemented by 2080, the number of people exposed to frequent flooding will be in hundreds

of millions (Nicholls et al. 1999). It is assumed that in the drier part of the world approximately 135 million environmental refugees have been projected for 2020 due to desertification, where sixty millions are expected from sub-Sahara Africa alone (FAO, 2007).

It is a fact that climate of the world is changing more rapidly at present than in the past which puts great threats to the human beings as well as the earth system. According to the Intergovernmental Panel on Climate Change (IPCC) climate change synthesis report (2007b), over the past 1000 years, the 20th century increase in temperature is the largest one and 1990 was likely the warmest decades which is shown in fig.1

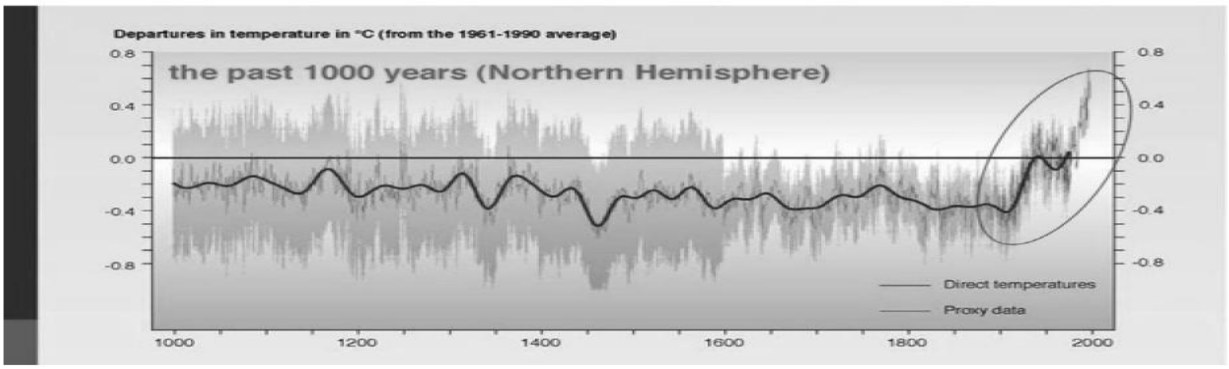

Fig1: The past 1000 yrs temperature Northern hemisphere (after IPCC 2001), the oval indicates increasing trend.

Global and national data indicate that natural disaster events are increased nowadays due to which socio-economic conditions are affected. In recent years, extreme weather events have caused extensive damages and heavy loss of life which is shown by figure 2. Just like famous Yiddish "proverb you cannot control winds but can adjust your sails" it's necessary to work for the reduction of climate change risks.

In the 5 years period 2000-2005, extreme weather events caused more deaths figure 2. (Dow and Downing 2006).

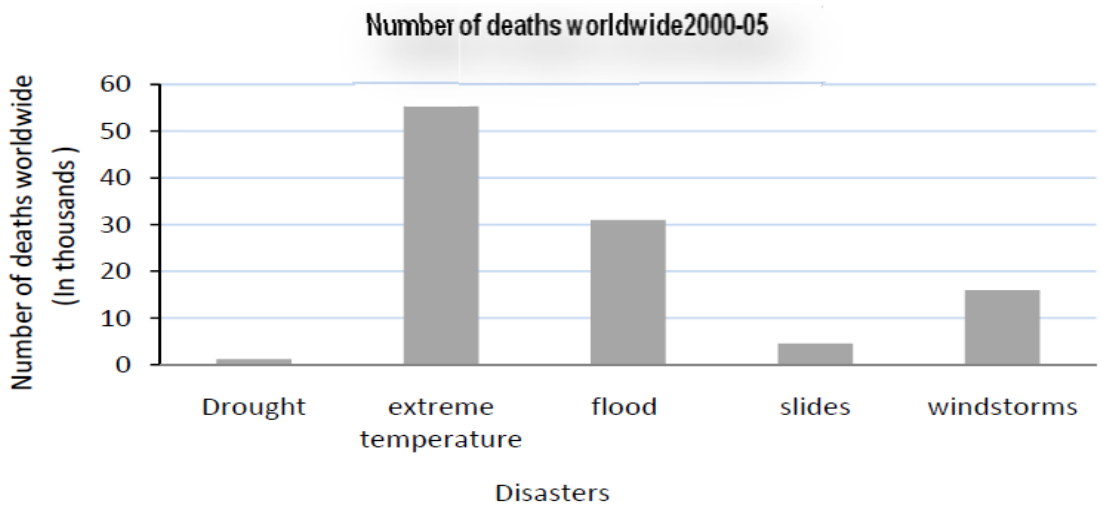

Fig2: No. of human deaths in 5 years time from 2000 to 2005 by different climate related events (Dow and Dowing, 2006)

The following graph shows the increased number of disasters worldwide in recent years. (Graph 3)

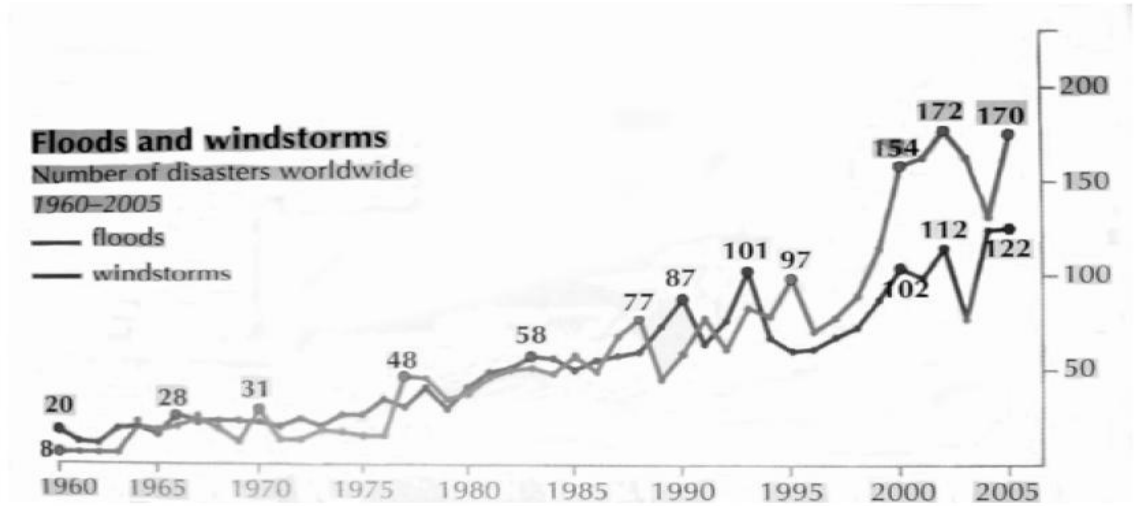

Fig 3: Number of disasters (flood and windstorms) since 1960-2005 worldwide (Dow and Dowing, 2006)

This evidences show that we are vulnerable to changing climate.

Poor people in developing countries are more vulnerable than others (Clark et al. 1998; Mirza 2003; Nicholls et al. 1999; DFID 2004). There is high level of poverty, lack of education, health care and safety. Though everyone is suffering from the impact of extreme climatic events, poor people in the developing countries are most affected. According to IPCC (2001), those communities who live in marginal lands and whose livelihood are highly dependent upon natural resources are most vulnerable to climate change.

Nepal is one of the least developed countries on the basis of criteria like income, human resources and economy etc. It has only USD 210 GNP/capita (Huq et al. 2004). It is also very vulnerable to climate change. Poor people are particularly vulnerable as they have the lowest capacity to deal with the changed context (LI-BIRD, 2009).

This research studies the effects of climate change in local communities. The feelings of local people towards climate change and its disasters and adaptive strategies to cope with climate related disasters are also studied on it. It also analyses the last 30 yrs meteorological data of temperature and precipitation in comparison to the perception of the local people. The study was based mainly on field observations in which house hold survey, group discussion and key informants survey were included.

2. Objectives

The general objective of this proposal is to identify the key sources of physical and social vulnerability in a local community and its adaptation mechanisms.

The specific objectives of this study are.

- To document the current livelihood situation of local people and the extent to which current strategies are able to secure well being in the face of climate stresses and longer term changes.
- To identify the types, magnitude and recurrence interval of climate change based on local people's experience in the study area.
- Compare local perception with the trend of temperature and precipitation as recorded by metro hydrological station.
- Assess the vulnerability and risk in terms of physical and socioeconomic system in the changed context and identify what additional measures are required by adaptation interventions in order to ensure that local community can adapt in the face of a changed climatic context.
- Assess relevant mitigation and adaptation techniques.

2.1 Research questions

- What are the indicators of climate change experienced by local people?

- Do local people have sufficient knowledge of adaptation practices to mitigate the effects of climate change?
- What types of institutional support exist for local farmers, to encourage incorporation of climate change adaptation practices on their farms?
- What are the opportunities and constraints for integration of climate change adaptation measures by local people?
- What kinds of support mechanisms or pre-conditions are needed by local people in order to adapt to and mitigate the effects of climate change?

2.2 Scope and Limitation of the study

The study was carried out at Ramshikharjhala V.D.C. of Kailali district which lies lowland Terai area of Nepal. The scope of this work includes following activities.

Major activities:

- Collection and review of literature and available maps.
- Collection of hydrometeorology data.
- Field observation and field study (household survey, group discussion, key informants survey).
- Digital data base preparation, processing and analysis.
- Preparation of dissertation.

Work is limited to the following activities:

- Only three wards of this V.D.C. have been considered.
- Last 30 yrs single station data has been taken.

2.3 Rational of the study

Nepal is an ideal place to study about climate change impacts on natural as well as socio-economic spheres because of its high diversity in geophysical condition. This study also gives good idea about the intensity and impacts of global change. The first step in this study is collect information about the rainfall and temperature at community level. This study is focused on the perception and knowledge of local people in the community and the adaptive strategies for addressing climate change impacts.

In Nepal, only few community vulnerability studies are done and some national level studies and reports have been published. Micro scale vulnerability assessment is more relevant due to the high diversity in a natural and as well as human system within short spatial variations. Climate change is a major global environmental impact mostly on local level. Therefore, it is vital to study for the formulation of policy and adaptation in the local level. The Terai, low land high temperature region of Nepal, is likely to be susceptible to the impact of climate change and vulnerability. Observed climatic events affect agriculture, property and lives. It hampers people's adaptive capacity and undermines their resilience. In Nepal, different types of adaptive measures have been introduced. For different adaptive measures physical, socioeconomic and institutional factors were considered to achieve desirable outcome of the measure. A local level study is very crucial in order to understand about the local factors that generate vulnerability and shape local adaptation techniques.

3 Literature Review

Climate change refers to the variation in the earth's global climate or in regional climates over time (UNFCCC, 2001). It is related with the terms global warming and green house effect (Silwal, 2009). Because of its geographical and climatic conditions, people in Nepal feel the effect of global warming. In Nepal, people are highly dependent upon natural resources. But there is a lack of adaptation measures to cope with disasters due to climate change which is affecting natural resources directly or indirectly.

Although developed countries have responsibility for global warming, the effect of it is widespread or felt by everyone. So, the entire global communities need to work with unity to solve the great problem (CEN, 2003). The study of the climate change impacts attempt to identify the vulnerability of a system in different climatic conditions. It is necessary to study about climatic change in order to evaluate the vulnerability due to it.

3.1 Climate Change in global Context

According to the United Nations Framework Convention on Climate Change (UNFCCC, 2006), " Climate change refers to the change of climate which is attributed directly or indirectly to human activities that alters the composition of the world's atmosphere and that is in addition to the variability of natural climate observed over the comparable time period." Climate change is the major or overriding environmental issue leading to crisis in economy, health and safety, food production and security.

According to IPCC report (2007), temperature has increased drastically in the 20th century. The current global average temperature is nearly 0.6˚c higher than the temperature of last 100 years (i.e., current temp 15˚c). This increase is attributed to anthropogenic activities. It is also assumed that the global temperature will be increased by1.5˚c to 6.0˚c in the period of 21st century. The global mean temperature will increase by 2.8˚c over the next century with a 3% chance of rising temperature of 6˚c or more. IPCC also predicts that if the temperature will rise of 1-2.5˚c, there will be serious effects on agricultural production, risk of extinction of 20-30% of animal and plant species and spread of climate sensitive diseases. By 2020, 250 million people in Africa would be exposed great risk of water stress. At the end of 20th century, millions of people living in catchment area will face increased risk of floods, drought and water scarcity.

Developing countries have fewer resources to adapt socially, financially and technologically so they are most vulnerable to climate change impacts. Due to the climate change impact, it is difficult for sustainable development of developing countries to achieve the United Nations Millennium Development Goals by 2015 (UN 2007). Developing countries have different individual circumstances so they require a diversity of adaptation measures depending on individual circumstances.

During the last Ice age, atmospheric carbon dioxide concentration was approximately 180 parts per million (ppm) and 280 ppm by the pre-industrial age. Since pre-industrial age, the atmospheric concentration of green house gases reached in its highest record level due to human activities in 1990. Today, the level of carbon dioxide is 380 ppm and rising fast. The concentration of carbon-dioxide equivalent is approximately 430 ppm by adding other green house gases (GHG). If it continues, the IPCC projects that GHG level will rise from 550 to 700ppm carbon-dioxide equivalent by 2050 and 650-1200 ppm carbon-dioxide equivalent by 2100 (Climate change ADB program, Strengthening mitigation and adaptation in Asia and the Pacific, 2007).

3.2 Nepal's climatic features

Nepal is landlocked country situated between India and China. It is located in South Asia at 26˚ - 31˚ north latitude and 80˚ - 89˚ east longitude. It is extended over a length of 885km from east to west and 193km width from North to South. The total area of Nepal is 187,181km^2. Nepal is divided into 5 developmental regions, 14 zones, 75 districts, 58 municipalities and 3912 VDCs. According to CBS, the total population of Nepal is 26.5 millions. The elevation of Nepal ranges from 64m to 8848 m in the highest mountain, i.e., Mount Everest. Nepal covers about 0.1% of the earth's surface but it is rich in biodiversity. Nepal biodiversity strategy (MFSC, 2002) notes that it hosts 118 ecosystem including 35 forest types. According to the Department of Survey (1978), geographically, it can be divided into five ecological region; Terai, Siwalik, middle mountain, high mountain and high Himalaya. Terai region is extended nearly about 800 km from east to west and about 30-40 km from north to south. The climate is humid tropical with more than 25˚c average temperature and elevation is 750m in average. Siwalik has moist subtropical climate with the average temperature 25˚c and the elevation ranges from 700 m to 1500 m. Similarly the middle mountain has temperature with 20˚c average temperature and its elevation varies from 1500to 2700m and the high mountains are cool temperature to sub alpine. High Himalaya ranges from 4,000 to above 8000m. Its climate is alpine with temperature 0˚c to 5˚c.

Nepal has a remarkable climatic variability within a short north-south distance. For the agricultural development and hydrology, precipitation is one of the most important climatic elements. Since Nepal is situated in the Northern limit of the tropics, it has both summer and winter precipitation (Singh 1985). Nepal has remarkable climatic variability conditions which are primarily related to the impressive range of altitudes within a short north south distance. It has different climatic regions; Alpine, cool temperature, warm temperature, subtropical and tropical. The snow lies on around 2500m altitude in winter and 4000m altitude in summer. Rarely, it falls below 1500m altitude (ABTRACO, 2008). The average rainfall is around 1600 mm about 80% of which falls between June to September. The precipitation varies from 6000mm in southern slopes to 250mm in northern central part. The rainy days vary from 24 to 181 in total. The annual sunshine hours vary between 922 to 2820. In winter the minimum temperature is -26˚c where as the maximum temperature in summer is recorded from 25°C to 46°C. There are four season in one year. Each of them consists of three months. They are; winter, spring, summer and autumn season (ABTRACO, 2008). The average temperature of Nepal is increasing at the rate of approximately 0.06°C per year according to the Department of Hydrology and Meteorology. The temperature differences are higher in the winter and less after the summer monsoon begins (Shrestha et al. 1999)

Nepal is responsible for only about 0.25% of total annual emissions of the world's green house gases (Karki, 2007) but it is affected adversely by the effects of global warming. Nowadays, in Nepal, it has been observed that dry period, intense rainfall, flood, landslides, forest fires and glacier retreats are increasing (Shrestha 2007). Nepal is more vulnerable to the climate change because of its limited capacity to cope with hazards associated with the climate change (Kates, 2000).

3.3 Climate change and Vulnerability

According to the UNFCC (2007), climate change is defined as the "Change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere." It also refers to short, medium and long term changes in weather patterns and temperature. These changes include a higher frequency of extreme weather events such as drought and floods, (Christian Aid, 2009, based on the IPCC 4th assessment report, 2007).

Vulnerability describes the susceptibility of a group to the impacts of hazards. It is the degree to which a system is likely to feel harm due to the exposure to the hazards. It is determined by the capacity of a system to anticipate, cope with, resist and recover from the impacts of hazards. Exposure to natural hazards of the community is increasing frequently making it more vulnerable with increasing global change and frequent extreme events (Turner et.al.2003).

According to Book (2003) there are two types of vulnerability they are biophysical and social vulnerability. Biophysical vulnerability is defined in terms of hazards and it is related to outcome of occurrence of hazards or damage incurred by the system where as social vulnerability is defined in terms of independent of hazards, and it is the inherent current state of the system. It is also one of the determinants of biophysical vulnerability.

Vulnerability to climate change is not only the function of geography or dependence on natural resources but also it has economic, social and political dimensions due to which climate change affects different groups (Action aid, 2005)

The IPCC (2001) describes vulnerability as, "the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change including climatic variability and extremes."

Vulnerability is the function of the character, magnitude and rate of climatic variation to which a system is exposed, its sensitivity and adaptive capacity (IPCC, 2001)

3.4 Adaptation Strategies

Adaptation is the process through which societies make themselves able to cope with uncertain future well. Adaptation to climate change entails to reduce the negative effects of climate change and make the appropriate adjustment and change by using the right measures, (UNFCC, 2006). It is also defined as the adjustment in behavior and characteristics of a system that enhance its ability to cope with external stresses. Vulnerability to climate change can be reduced by adaptation. Adaptive capacity is closely related to economic as well as social development but is unevenly distributed across and within societies (IPCC, 2006).

It is very important to link climate vulnerability to socio-economic studies and long term periodic and socioeconomic assessments. Current indigenous knowledge is very important to make policies on coping strategies. There are only two important methods for assessing adaptation options. They are top down and bottom up approaches. Top down approaches includes the use of modeling and scenario analysis which provides the useful background to

make decision. This approach is strong in terms of the biophysical aspects of impacts but unable to represents human interactions and local abilities to adapt. On the other hand the bottom up approach recognizes and builds upon indigenous knowledge and technologies, local coping strategies, local institution and sectors in responding to current climatic variation. From this method, it is easier to incorporate human and economic dimensions of the local communities particularly intersect oral relationship and livelihood condition (UNFCCC, 2007).

Reports, options and ways of reduction of vulnerability to climate change in developing country like Nepal includes IPCC (2001); IPCC (2006); IPCC (2007); World Bank (2005) and DFID (2006). In Nepal, a number of options can reduce the vulnerability to climate change and climate related disasters. Non structural measures are particularly more attractive and they would go a long way towards building capacity for disasters preparedness and the management of water resources. They are generally cheaper than engineering measures. Non structural measures include; Developing and Implementing land use policies, maintaining up to date hazards and maps of vulnerability; training and capacity building for disasters and management of water resources, working with communities to increase public awareness program and promote early warning system, a forestation and deforestation program for reducing risk of flooding and landslides.

Local people have the knowledge and experiences about how to cope with climatic variability and extreme climatic events. They prepare all the necessary things whatever are needed for natural hazards by accumulating through the knowledge and experiences of the past weather patterns. Local coping strategies are very important elements for adaptation planning. Traditional knowledge can also help to provide appropriate, efficient and time tested methods of advising and enabling the adaptation in communities.

According to UNFCCC (2007), farmers have used many traditional techniques in order to adapt climate variability in Asia. Some of the techniques are; intercropping, mixed-cropping, agro–forestry and development of new variety of seed to cope with local climate. There are some useful and conservational strategies for the use of water; terracing surface water and ground water irrigation and diversification to cope with drought. Structural and non-structural measures are used to deal with flood.

The emphasis should be given to sustainable development in order to address the possible impacts of climate change. Adaptation strategies will be more successful if they are identified and developed by local people. Because the local people are likely to be consistent with local

norms, goals, priorities and institutions (Newton et.al. 2005). Institutions and local people involve in mainstreaming as they play the main role to transfer knowledge and to develop policies. Depending upon the vulnerability different techniques of management should be adapted (Ogden and Innes 2008).

4 Methodology

4.1 Research approach

This research has followed climate change vulnerability approach as previously described by several authors (Desanker and Nassef, 2003; Kelly and Adger, 2001; Lim, 2003 as quoted in Sutherland,2004).This research approach is concerned with the collection of the data of any particular area by taking interviews from the local people who are supposed to be the informants. So, I collected all the primary data from the informants through their participation and secondary data from CBS, Hydro- meteorological station and published journal.

In this research physical as well as socioeconomic vulnerability was examined. To evaluate the community vulnerability, a participatory case study method was used. In this method data was collected by taking interviews from participants. This method is useful in understanding the nature of vulnerability of communities to climate related disasters. It leads to the system in questions and examine the conditions of the communities and of various stimuli that gives rise to it's vulnerability and interrelation between them. For the evaluation of extent of vulnerability, the climate change vulnerability approach was used. This approach started with the documentation of the current exposure to climate change of a community. Here exposure denotes both the physical conditions of climatic hazards and its magnitudes. For the documentation of current exposure the local community people were consulted which was based on the personal experience of the respondents. The pattern of establishment, location of assesses and infrastructures in the community were based on field study. The climate change vulnerability approach is as follows.

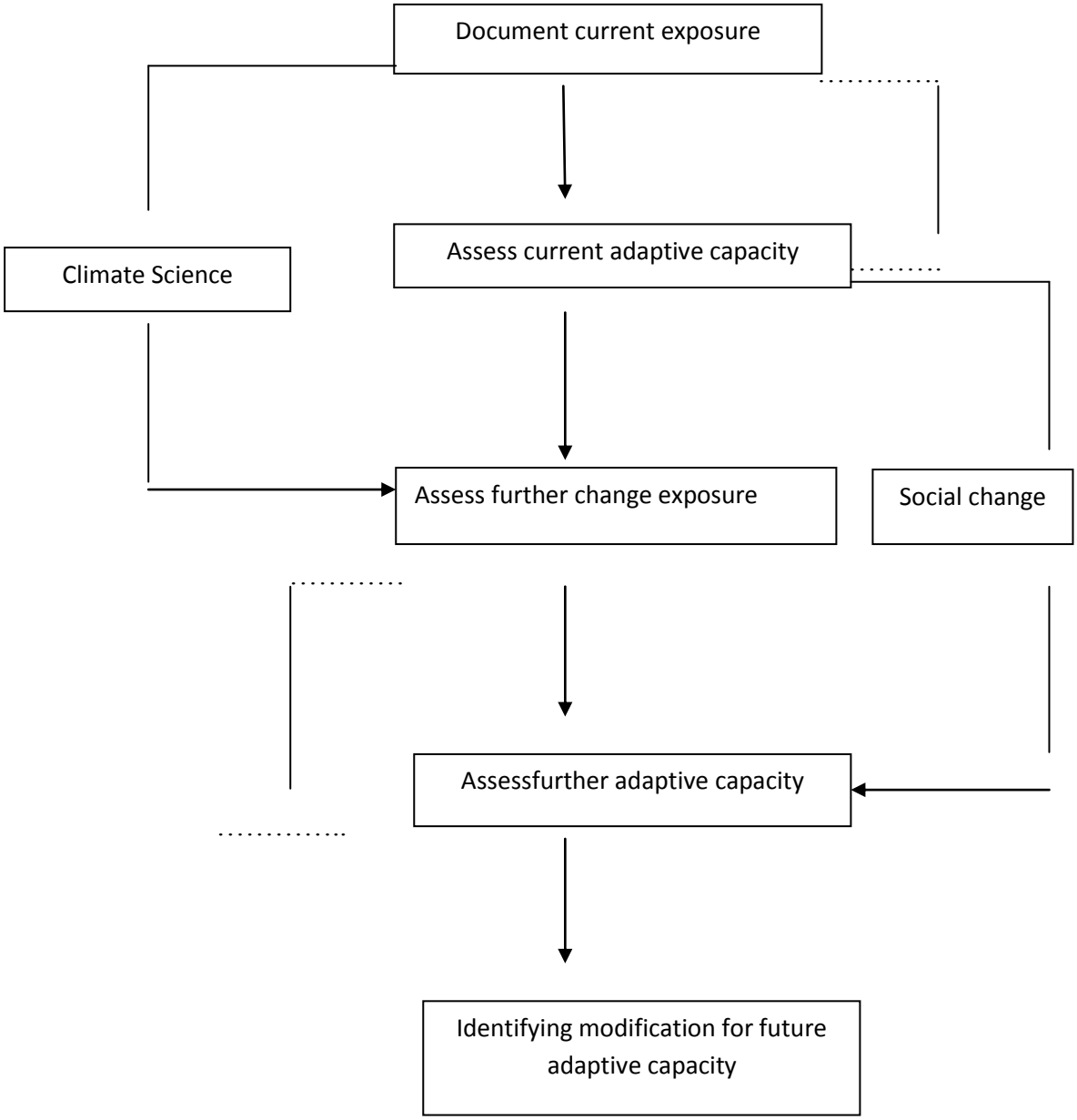

Figure 4. The climate change vulnerability approach. (Desanker and Nassef, 2003; Kelly and Adger, 2001; Lim, 2003 as quoted in (Sutherland, 2004; Kelly and Adger,2001)

Future changes in the climate attributes have been estimated by reviewing the climate science with proper extrapolation.

Different steps involved for this research design were given below.

1. Literature review
2. Problem statement
3. Selection of the area
4. Sampling design

5. Data collection
    a) Primary data.
    b) Secondary data

6. Data analysis
7. Result interpretation
8. Conclusion and Recommendation.

5.2 Data collection

I studied three wards (2, 4 & 7) of Ramshikharjhala V.D.C. of Kailali district lies in the far western region of Nepal. It is 21 kilometers far from the Dhangadhi. Total area of the V.D.C. is 157.95 square kilometer and total population is about 13,560 according to national census 2001. More than 40 percentages of the people in this V.D.C. are Kshetris. The local people of the study area are mostly depended upon agriculture.

Figure 5. Map of showing Kailali district.

Ramshikharjhala V.D.C. lies in Kailai district. Most part of Kailali district lies in Terai belt with varying the altitude ranging from 179m to1957m above sea level. Kailali has a rectangular shape and total area of 2,742 sq.km. Ramshikharjhala V.D.C. is very well-known V.D.C. of Kailali district because the most familiar lake i.e. Ghodaghodi, of the far western region lies on it. It is also attached with highway. The distance between Ramshikharjhala and Dhangadhi (Headquarter of kailali) is 37.8 km. In spite of its popularity it has many environmental problems like landslides, drought, flooding etc. So, it was very important to

take data relating environmental problems of that area. Except that the District Red-cross society of Kailali had also taken the data of that V.D.C. which were related to problems created by flooding on 19 September 2008. According to that, 400 households were affected and 2 people died. So, the selection of that V.D.C. was very interesting.

Most people of that V.D.C. wanted to take any incentives or short term benefit (i.e., money) for giving information because many NGOs and INGOs have been donating money to collect data of that area for enhancement of their profession like agriculture, poultry farming, bee keeping and so on. I was unable to give them such benefit what they expected because I am a student. Therefore, it was difficult to get actual data from them initially. It took a lot of time. I gathered local people, teachers, politicians, respected people of that area and told them about my subject matter. They were convinced and helped me.

4.2.1 Primary Data Collection

The primary data were collected through reconnaissance survey, key informant interview, questionnaire survey, formal and informal discussion, direct observation. I have spent almost 50 days on the field from 1st January to 20th February 2012.

Table1: Types and number of primary data collection

Types of data collection	Number of informants	Period
Reconnaissance survey.		1st Jan to 5th Jan 2012
Household survey	90	6th Jan to 16th Jan 2012
Key information interview.	20	20th Jan to 2nd Feb. 2012
Focus group discussion	16 (four for each group)	5th Feb. to 15th Feb.
Field observation		15th Feb. to 20th Feb.

4.2.1.1 Reconnaissance Survey

This survey was carried out for rapport building and getting a general idea of the field before starting the work. It gave the idea about where, how many interviews as well as location about the field.

4.2.1.2 Key Informant Interview:-

The informal interview was taken by 20 key informants who were model farmers, teachers, local politicians, and other knowledgeable older persons. The interview had focused about the change in climatic pattern, disasters caused by climate change, impacts of climate change and its possible adaptation measures.

4.2.1.3 Household Survey

Totally 90 households within three wards containing 30 in each were selected randomly for the purpose of the household survey. Population and its distribution pattern were studied at the time of reconnaissance survey which helped me for random selection of participants for this survey. All the people of different castes have been living separately. It means different inhabitants are different such as Tharus have their own community; Kshetris have separate and so on. In this survey structured questionnaire was prepared and interview was conducted. In this survey, different aspects of climate change, disaster, water resource, and agricultural production were considered. Other key socio-economic parameters such as income, expenditure and landholding were also considered for household survey. Though selection was random, focus has been given equally to young and old, man and woman, and different castes.

Figure 6 Researcher conducting household survey.

4.2.1.4 Focus group discussion:

The discussion was carried out with four focus groups to get the information about the past and present condition of climate, change in water resources, their economic condition etc. Checklist was prepared for including impacts, trend, mitigation measures on climate and disasters. The people involved in focus group discussion include; teachers, farmers, local NGOs and local politicians. There are four members in each focus group discussion and discussion was carried out in three wards.

Teachers: They are educated people in the society who understand the Climate change and disaster issues. They can disseminate the information to students that spread to the overall community.

Farmers: They are the major group in the society that is facing direct impacts in agricultural production.

Social workers/local politicians: These are the leaders in the society. They listen others view and flow it. They are the medium of any change in the community and can influence the decision.

Local NGO/club: Young people are involved in local NGO and clubs. They gave the information about the current situation of the society and can spread the climate change issues.

4.2.1.5 Field observation:

Field observations were based on climatic hazards and vulnerability issues. Photographs of the area were also taken at the time of observation.

4.2.2 Secondary Data Collection

4.2.2.1 Climatic data.

The climatic data of Tikapur meteorological station were collected to analyze the trends of climatic changes. The monthly station data for 1981 to 2010 were collected including maximum and minimum temperature and precipitation which gave the instrumental measurement of the climate change of this area. Tikapur meteorological station is the nearest station from Ramshikharjhala and distance between them is only 18.2 km. The altitude of Tikapur is 152m above the sea level. It is located at the longitude of 81.11 and latitude of 28.4.

4.2.2.2 Socio economic and other data.

Published data from CBS (Central Bureau of Statistics) was also used to analysis socioeconomic condition of the study area. In the socioeconomic condition, personal, family

and ethnic information as well as education and economic condition of that area were taken. Similarly the data from journal, magazine, symposium, internet paper etc were consulted and relevant data were used.

5. Data processing, analysis and interpretations

5.1 Climatic Analysis

5.1.1 Temperature: The monthly temperature at Tikapur shows that the mean maximum temperature reaches its peak in may where as the minimum is highest in July and mean temperature is highest in June. But the mean maximum, mean minimum and is lowest in January.

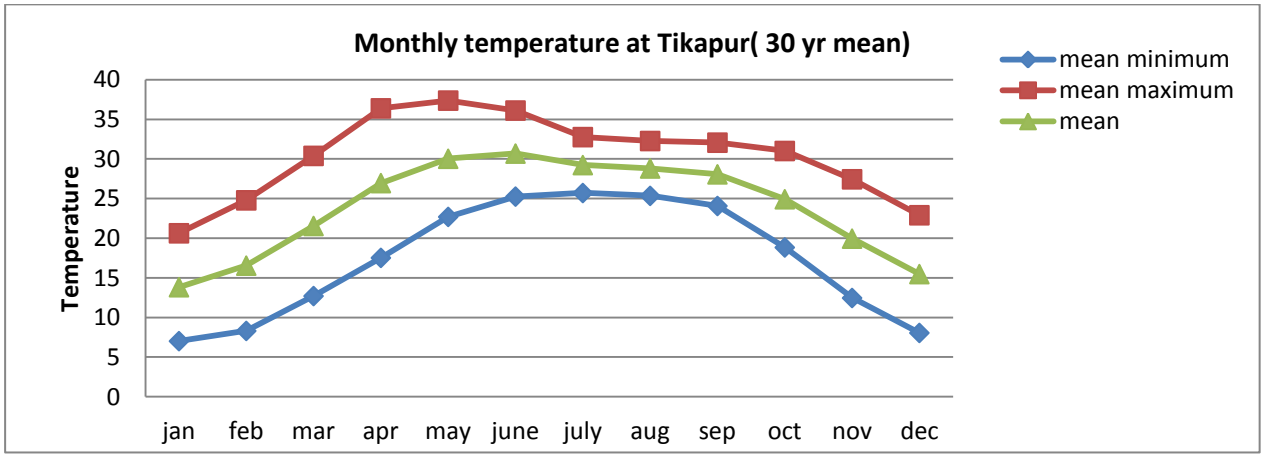

Figure 7: Mean monthly temperature.

According to the IPCC fourth assessment Report (2007), the global warming is unequivocal and the linear trend over the last 50 years is 0.13˚c per decade. Nepal is also observing warming of the system. Based on the records from 1979, the mean temperature of Nepal is increasing at 0.41˚c per decade (Baidhya, 2008). The climatic data of the Tikapur station shows that both the mean maximum and mean minimum temperature are increasing with 0.37˚c and 0.26˚c per decade respectively.

The temperature analysis of 30 years (from 1980 to 2010) shows that the temperature in that area is in increasing trend. In 1980, the maximum temperature at Tikapur was recorded as 31.02˚c and was increased slightly in 2009 i.e. reached at 31.69˚c which was the highest maximum temperature within 30 years. In 1980 the mean minimum temperature was 17.32˚c

which was reached in it's peak in 1998 i.e., 18.88˚c. But it was decreased slightly in 2010 which was 16.25˚c.

The mean maximum temperature of the hottest months April and June was of 38.8˚c and 35.4˚crespectively in 1980 which was increased slightly in 2010 and reached at 40˚c and 38.7˚c respectively but temperature of May was slightly decreased in 2010 in comparison to 1980. Similarly the mean maximum temperature of the coldest months; December and February was increased and reached at 23.7˚c and 25.7˚c in 2010 which was 22.9˚c and 25.4˚c respectively in 1980 where as that temperature of January was decreased at 17.4˚c in 2010 in comparison to 1980 i.e., 21.2˚c.

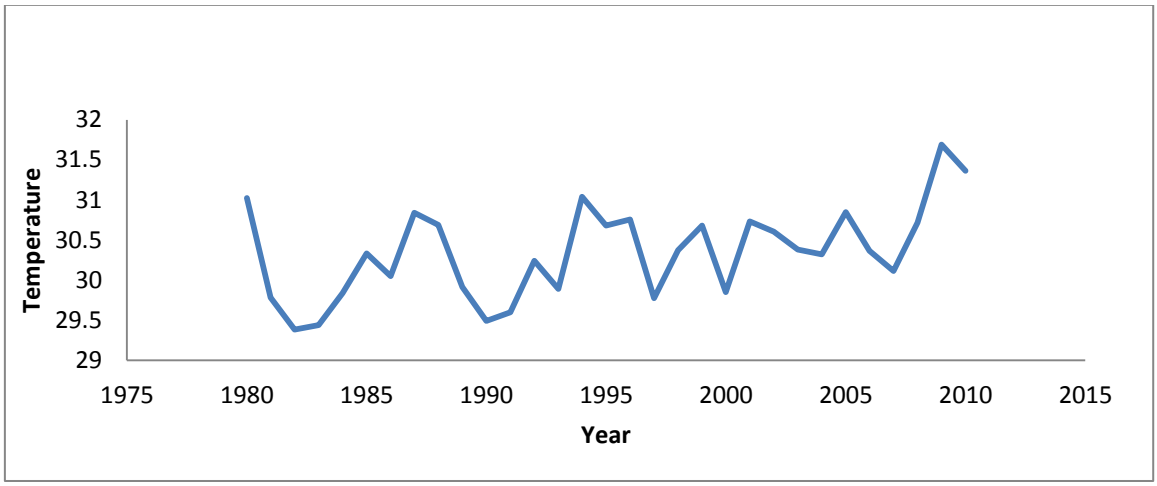

Figure 8: Variation of mean maximum temperature with year

There is a fluctuation of maximum temperature which shows increasing trend.

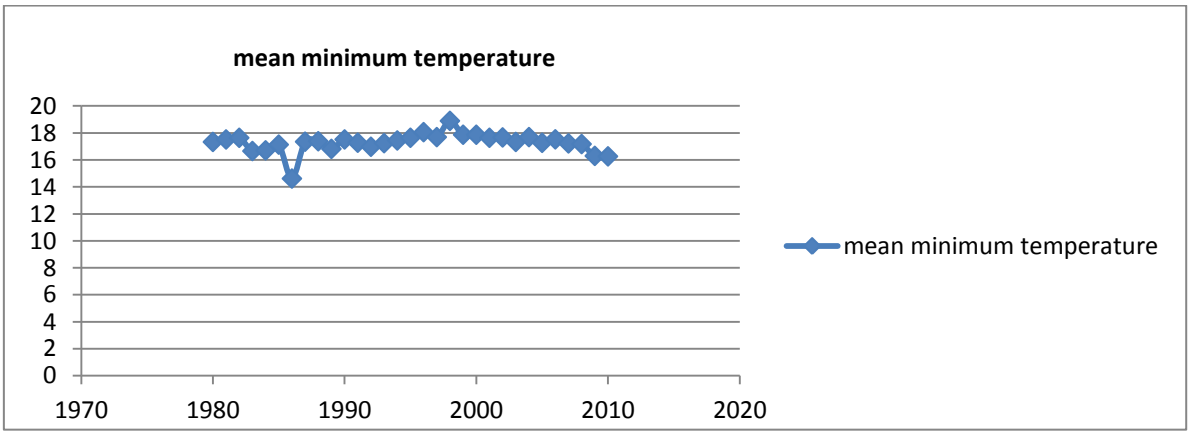

Figure 9: Variation of mean minimum temperature with year

The graph shows that there is no clear trend of mean minimum temperature.

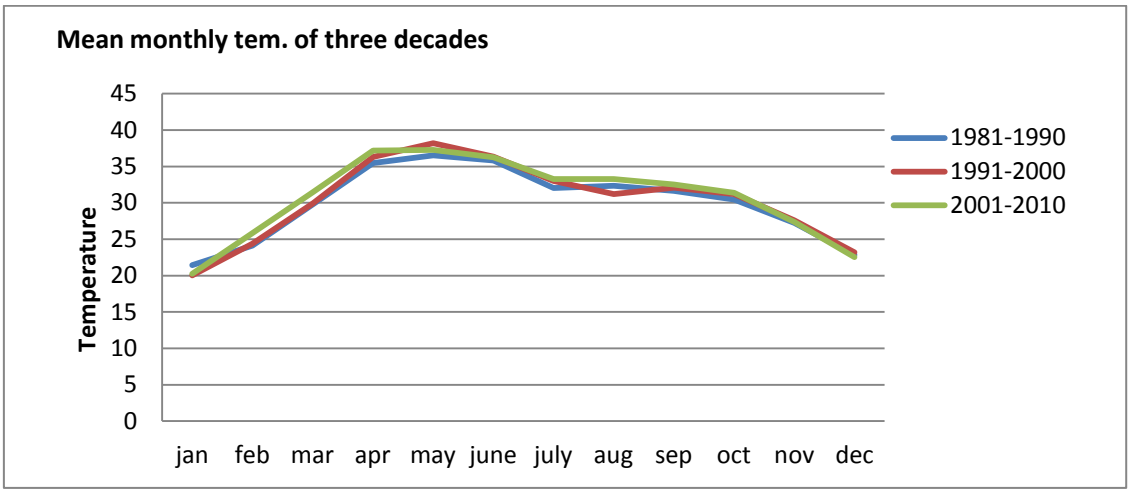

Figure 10. Mean monthly temperature of three decades from 1981-2010.

Mean monthly temperature shows there is no high fluctuation in three decades.

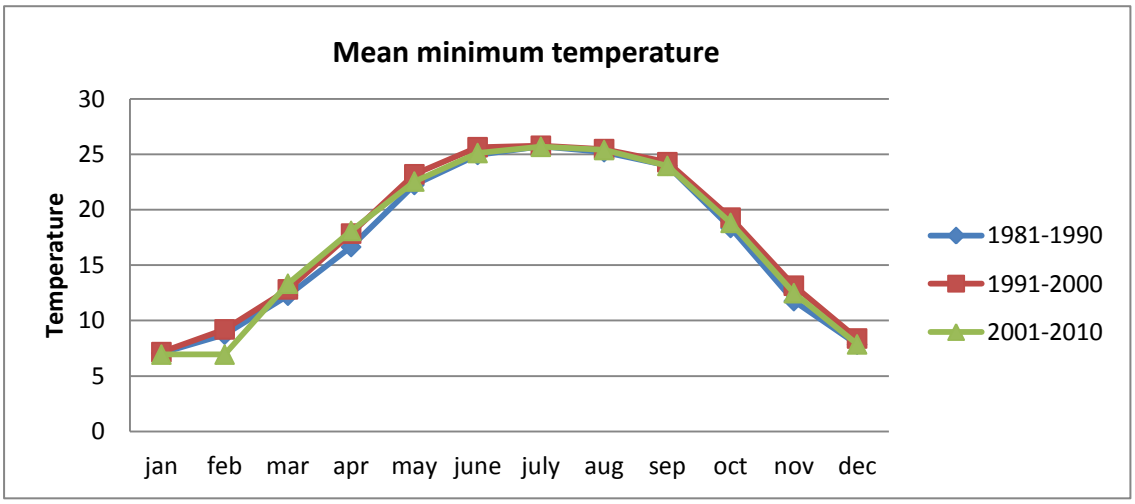

Figure 11: Mean minimum temperature (1981-2010)

Mean maximum temperature has increasing trend but mean minimum temperature remains almost similar during recorded decades.

5.1.2. Rainfall

The mean annual rainfall of 30 years of the Tikapur Meteorological station is 1727mm. The average monthly rainfall shows that November is the driest month with 3.94mm of average rainfall. It is 497mm in July which is the wettest month. June, July, August, September are the months of monsoon season which contributes about 80% of the total annual rainfall. These months are also known as highly sensitive months to the weather disasters. Pre-monsoon (march-may) contributes about 8%, Post-monsoon (October-November) contributes about 6% and the winter season (December-February) contributes about 6% of total annual rainfall. Winter season is the driest season too.

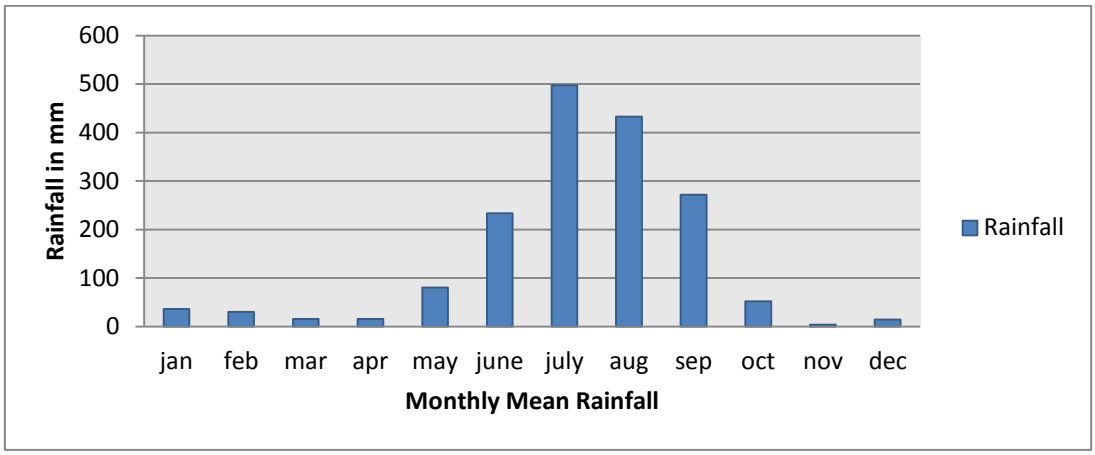

Figure 12: Mean monthly rainfall

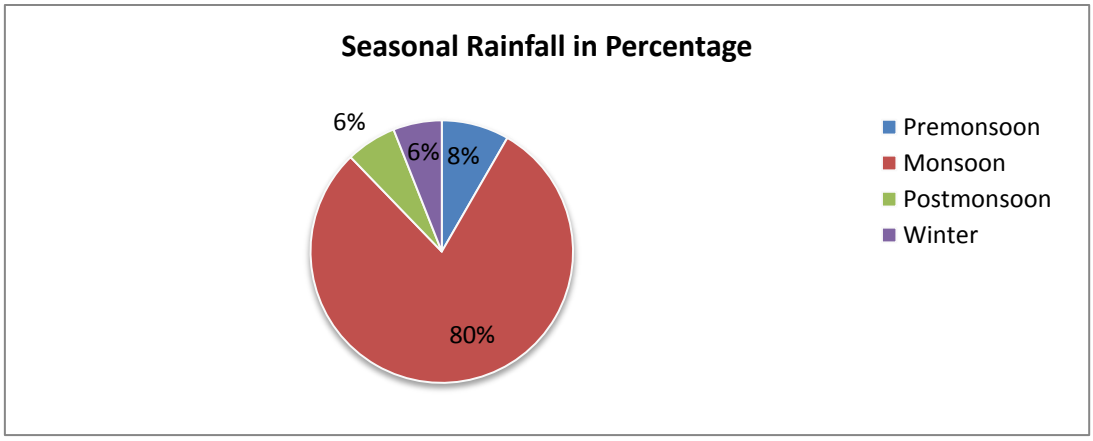

Figure 13: Seasonal rainfall in percentage

The mean monthly rainfalls for three hot months June, July, August show increase. In June, it is increased slightly by 2.8mm in the period of 1981 to 2010. In July, it is increased rapidly by 90.37mm in the period of 1991 to 2010 and in August, the mean rainfall is increased by 41mm in the period of 1981 to 1991. Moreover, the mean monthly rainfall for the two coldest months December and January show gradual decrease. In December, it is decreased by 10.9mm in the period of 1981 to 2000 and 6.7mm in the period of 2000 to 2010 and in January it is decreased by 1.87mm in the period of 1981 to 2000, 10.01mm in the period of 2000 to 2010. But in November, it is increased slightly by 0.17mm in the period of 1981 to 2000 and then decreased by 3.96mm in the period of 2000 to 2010 (table 2)

Table 2: Mean monthly rainfall in three decades.

Month	1981-1990	1991-2000	2000-2010
June	246.09mm	205.85mm	248.89mm
July	588.2mm	406.72mm	497.09mm
August	459.54mm	500.54mm	427.62mm
Nov	5.2m	5.37mm	1.41mm
December	23.83mm	13.74mm	7.04mm
January	40.78mm	38.91mm	28.9m

The total amount of rainfall from July to September is 43074mm in the period of 30 years and it is 7507 mm from October to June within the same period. The value of rainfall in 30 years is highest in 2007 from the months of July to September which is 1961.9 mm. But in remaining months, it is highest in 1983 i.e., 489.3 mm.

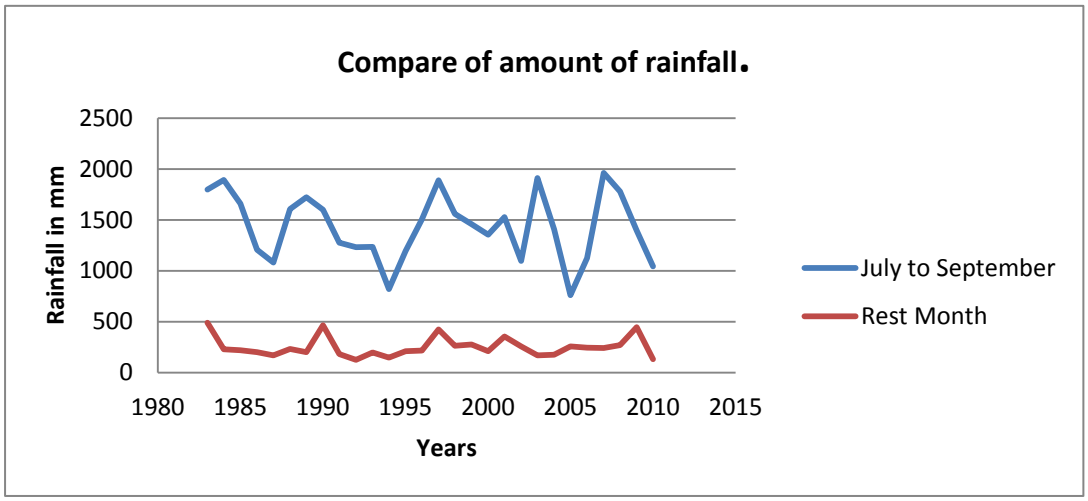

Figure 14: Total amount of rainfall from July to September and October to June (1981-2010).

The high fluctuation on the rainfall indicates the increasing uncertainty in the dry season rainfall in Tikapur which affects greatly on agriculture production. The analysis of the seasonal rainfall shows increasing trend in monsoon while decreasing trend in winter which makes the area more prone to water related disasters. Farmers practice a double cropping with rice as a monsoon and wheat as winter crop.

5.2 Personal, family and ethnic information

The information was taken from 90 households of the selected area. Mostly elder people were the respondents. In the ethnic diversity, 44.4% were Brahman and Chhetri, 28.8% Janjati and 23.33% Dalit people.

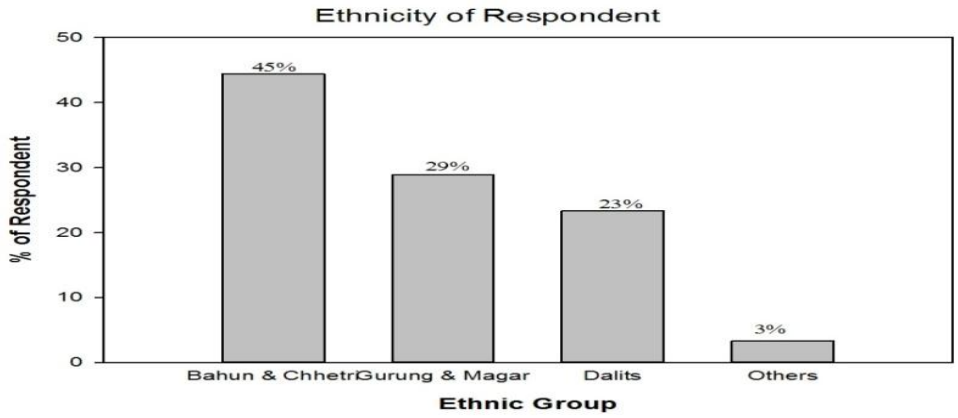

Figure 15: Ethnic composition of study area.

In the survey, the average family size of the area was 5.25 which range from minimum 3 to maximum 9 members in each household.

The male respondents were 52.2% while female were 47.7%. Although survey was focused on perception of people on climate change based on their experience, information was mainly taken from elder people of that area. Furthermore, the literacy rate was very low i.e., most people nearly 57.7% were illiterate, 12.2% were literate, 14.4% were in schooling, 8.8% were of SLC and 6.6% were above SLC.

5.3 Socio-economic context

The study area was a diverse society with different castes like Brahman, Chhetri, Chaudhary, and Dalit. People were involved in job service, business, and agriculture. Mostly they were depending upon agriculture either partially or fully. The total land of that area was used as irrigated land due to which they had grown many crops seasonally and they earned a lot from their crops.

Approximately 20% of households are landless having no land or less than 1 ropani (1 ropani= 0.052ha) of land. They depend upon others land as well as any small business. 36.66% of households are in marginal groups having 1 to 4 ropanis of land. About 18.88% are small farmers having 5 to 10 ropanis of land. The percentage of medium farmer is 20%, having 11 to 20 ropanis of land for farming. Only 4.4% of the families have more than 20 ropanis of land.

Table 4. Average landholding capacity of the community

Landholding (in ropani)	**Percentage of households**
Almost Landless (<1)	20.0
Marginal (1-4)	36.7
Small (5-10)	18.9
Medium (11-20)	20.0
Large(>20)	4.4

5.4 People's perception

5.4.1 People's perception on temperature, precipitation, cloudy days, hailstorm pattern and lightning

According to the majority of the respondents of that area temperature was increasing day by day. To be based on them 72.2% of respondents said that it had increased and 16.6% said it had not changed (fig. 16)

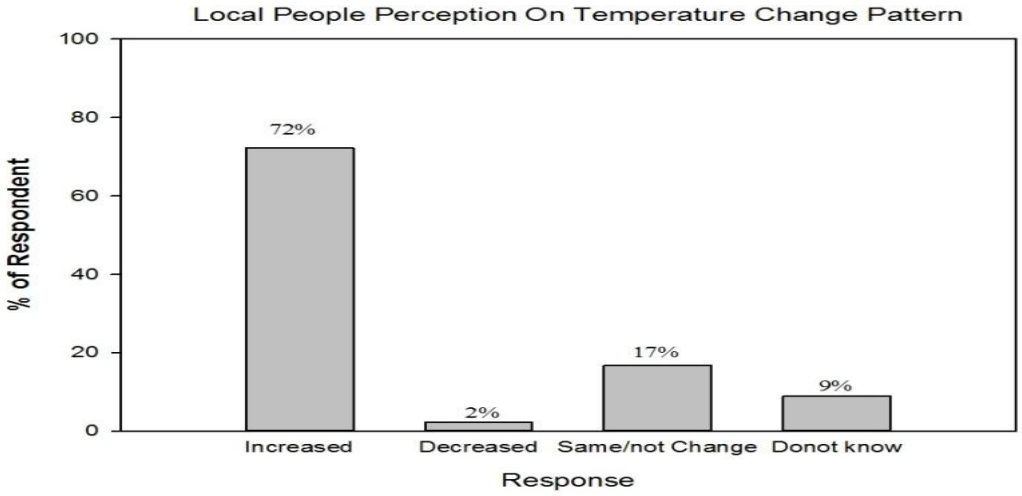

Figure 16: People's perception on temperature change

While respondents were asked about precipitation change including amount of rainfall over the year it was decreasing according to 38.3% and 11.1% of them did not know (fig. 17)

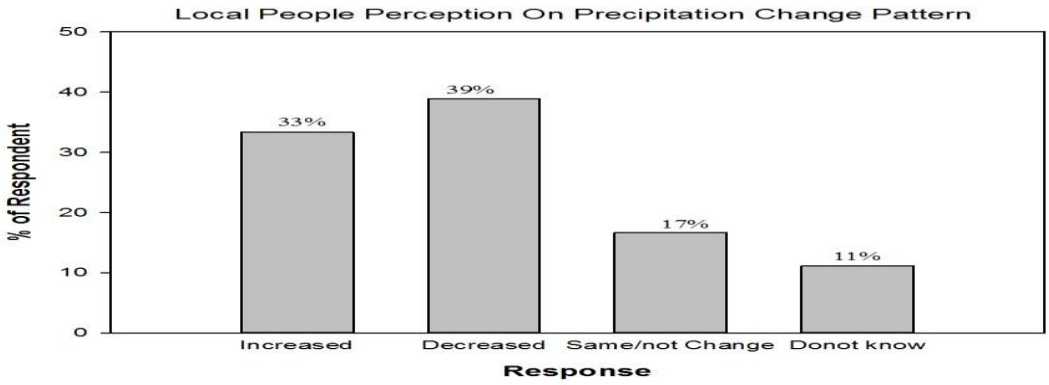

Figure 17: **People's perception on precipitation change pattern.**

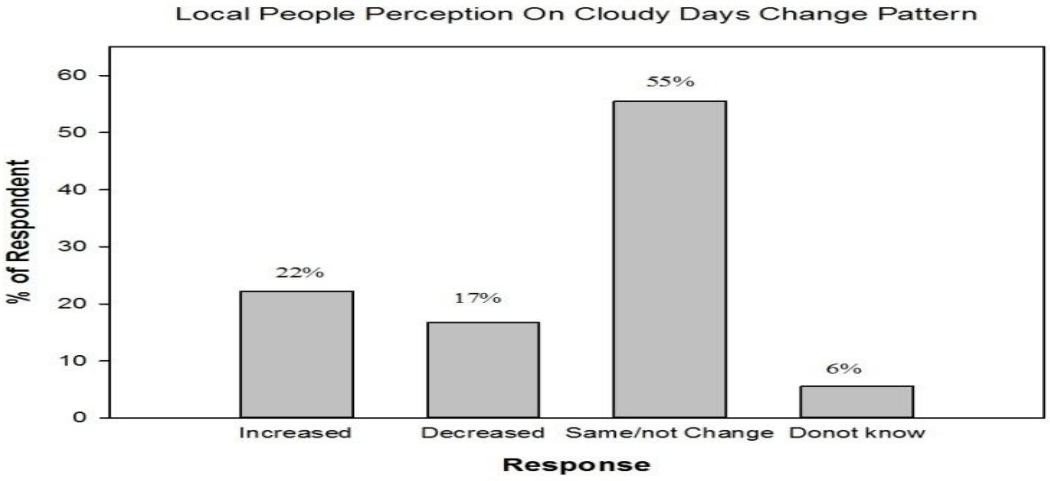

Figure 18: **People's perception on cloudy days change pattern.**

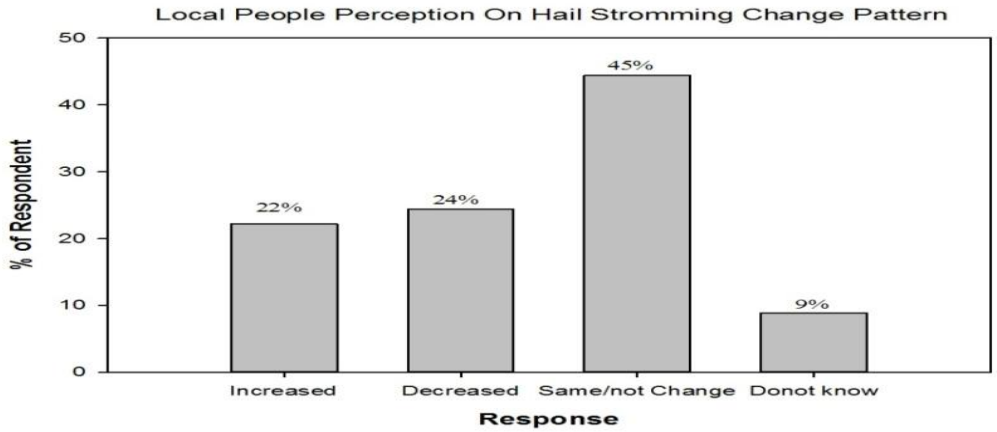

Figure 19: **People's perception on hail storming change pattern**

More than half of the respondents (55.5%) said that they do not experience any change in occurrence of cloudy days (fig 18.). Also, in case of hail storming the answers did not indicate any clear changes.

When respondents were asked about lightning pattern, more than 33% of the respondents said the frequency of occurrence of lightning was increased, 33.3% said it was same year after year while that of 27.2% felt it had decreased and 5.5% did not know about it.

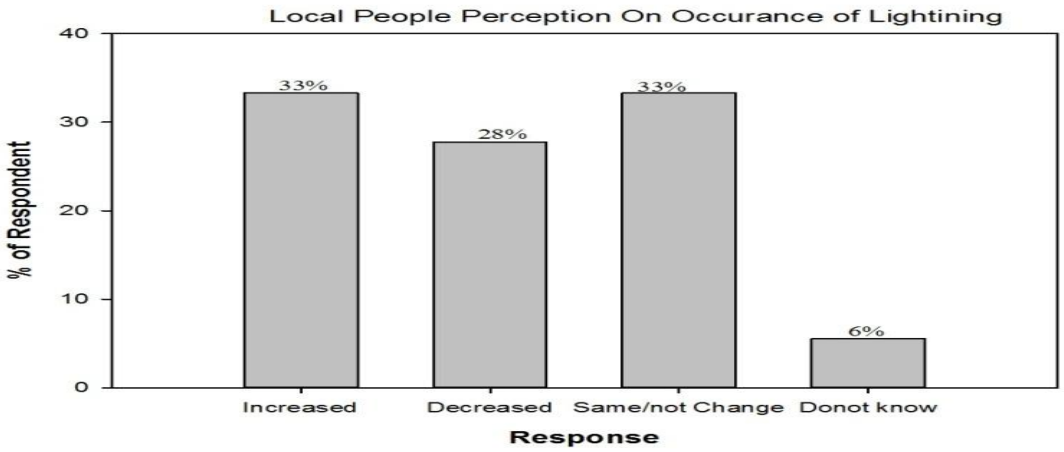

Figure 20: **People's perception on frequency of occurrence of lightning.**

5.4.2 Perception on changing climatic seasons.

5.4.2.1 Summer and winter day's temperature change.

Almost all of the respondents said that days are warmer including extreme heat in summer and fewer cold and frosty days in winter (Fig 21)

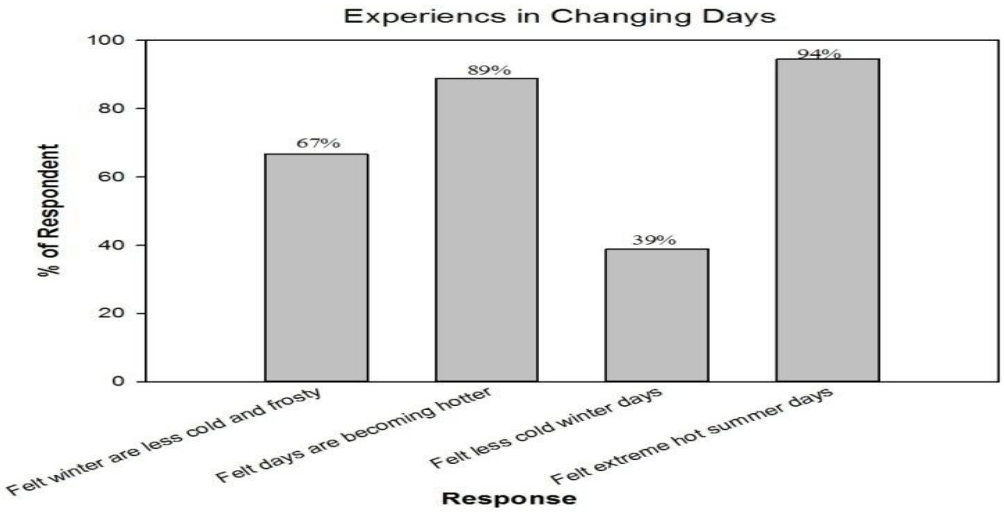

Figure 21: Experience in changing temperature.

5.4.2.2 Temperature seasonal change

Seasonal temperatures have gone up both summer and winter according to the great majority of respondents (fig.22)

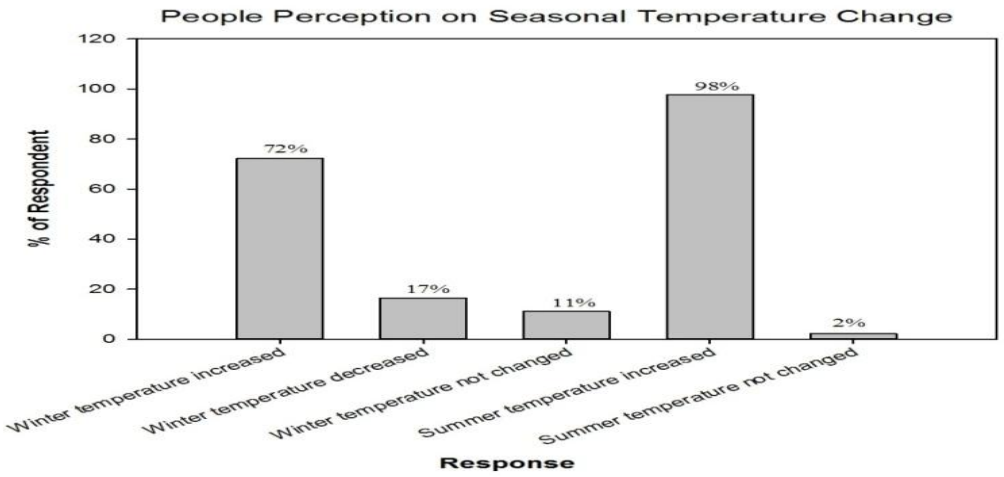

Figure 22: **People's perception on seasonal temperature change.**

5.4.2.3 Rainfall pattern change

Most of respondents said that the unusual rainfall pattern is being more common. Heavy rainfall also increased which caused flooding and affected crops on the fertile land. A few of the respondents felt winter rainfall increased (fig 23).

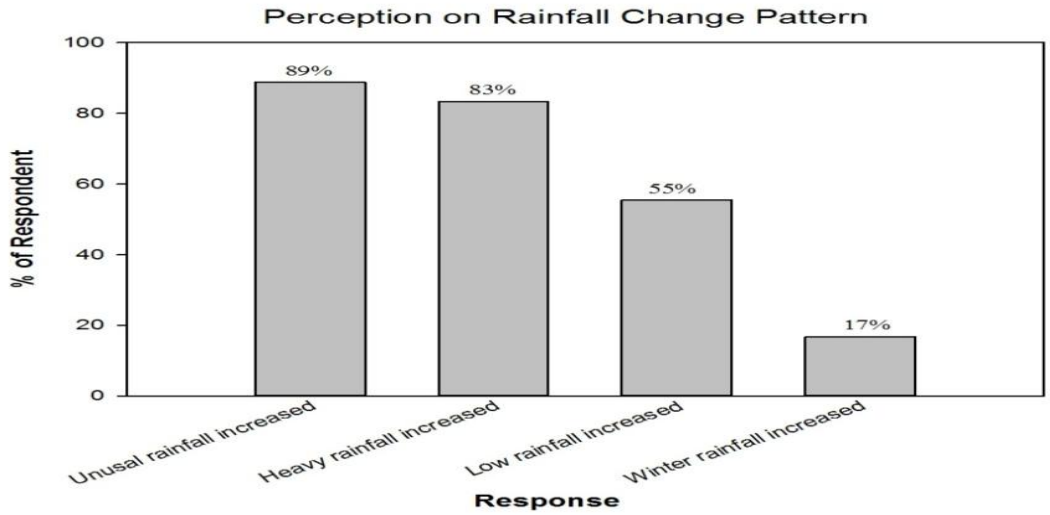

Figure 23: people's perception on rainfall change.

5.4.2.4 Monsoon change pattern

More than half of the respondents said rainfall duration decreased and 44.4%of them said it increased. Above 66% responded that monsoon had started later and a few of them i.e., 22.1% responded it had started earlier (fig.24)

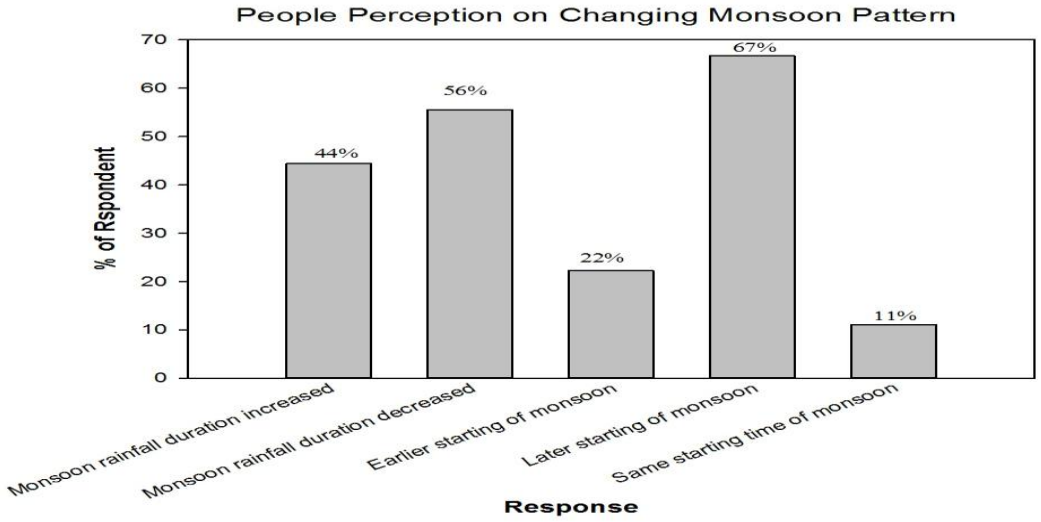

Figure 24: people's perception on changing monsoon pattern.

5.4.3 Climate risk in the area/disasters

5.4.3.1 Disasters rank and cause

The household survey, points to climatic risks as well as disasters of that area including drought, landslides, rainfall, flood and cyclones. This creates great problems in agriculture. The local people responded that one of the greatest problems were natural disaster especially flooding and erosion. Most of the respondents gave flood as a first rank disaster.

More than 72% of the respondents thought that these disasters occurred due to unusual weather events like heavy rainfall. 17.7% of them said that disasters occurred due to the pollution like construction of roads, households etc. A few also mentioned deforestation as a cause.

5.4.3.2 People's perception on disaster events

While more than 90% reported increased frequency of flooding, responses were less clear on questions about landslides, soil erosion, lightning, hailstorm and fires (fig.25).

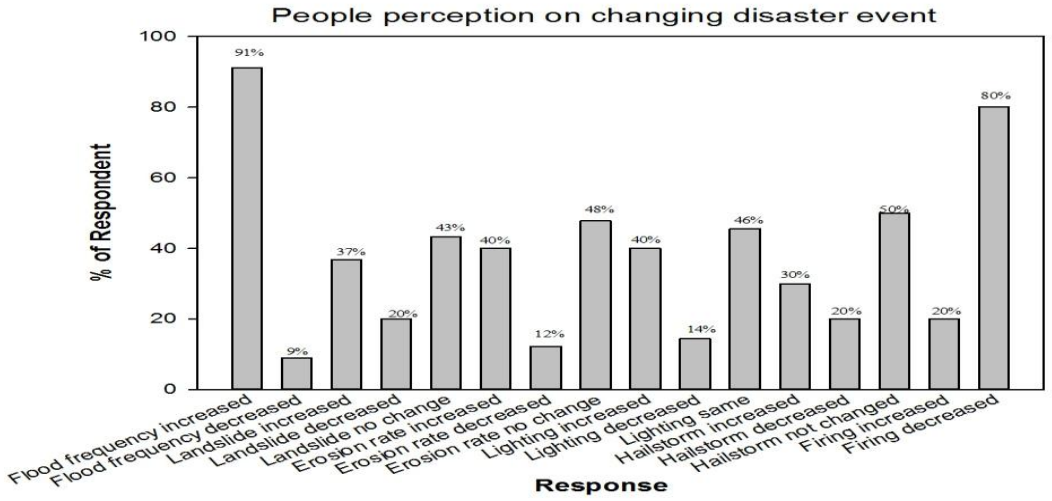

Figure 25: People perception on changing disaster event

5.4.3.3 People's perception on different disasters impacts

It was found that about 84.4% of respondents experienced impact of flood on land and crops. More than half felt its impact on households (HH). 31.1% experienced its impact on water resources. It swept away the water sources creating difficulty in water supply. It also affected the biodiversity.

Similarly, there were great impact of landslides, drought, soil erosion and unusual rainfall on HH, land and crops, water resources and biodiversity too.

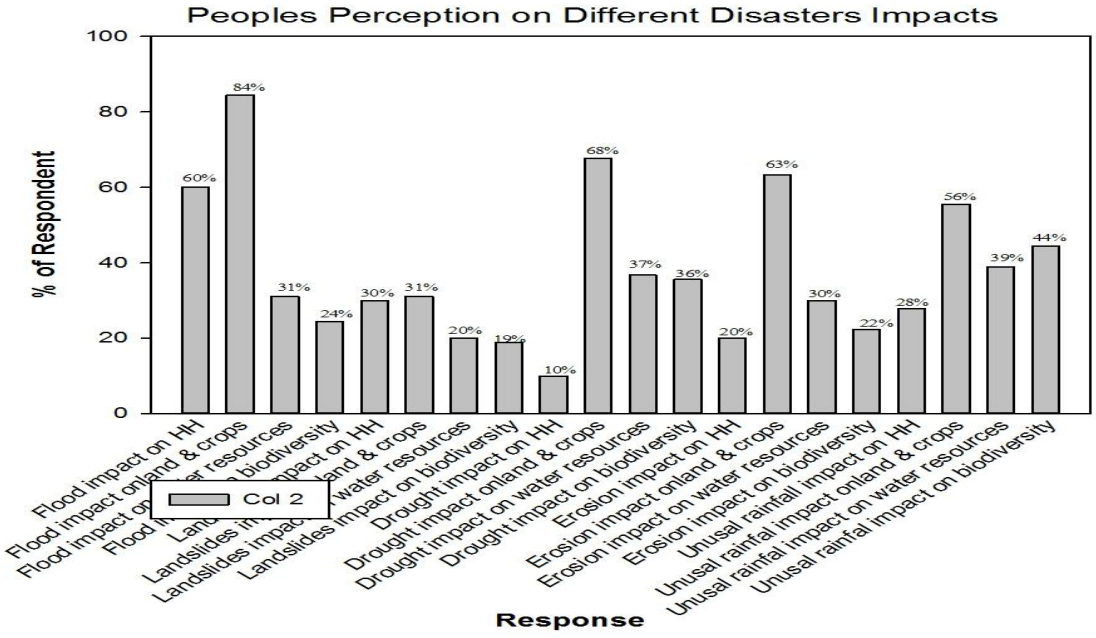

Figure 26: People's perception of disaster events.

5.4.3.4 Adaptation measure in the study area

When question was asked about the use of adaptation measures, more than 95% said "no" meaning they didn't use any adaptation technique like early warning system, knowledge transfer through interactions and trainings etc to cope with disasters. Even there are many political leaders, educated people, many NGOs, INGOs they didn't use any adaptative techniques and awareness programs to protect them from such disasters.

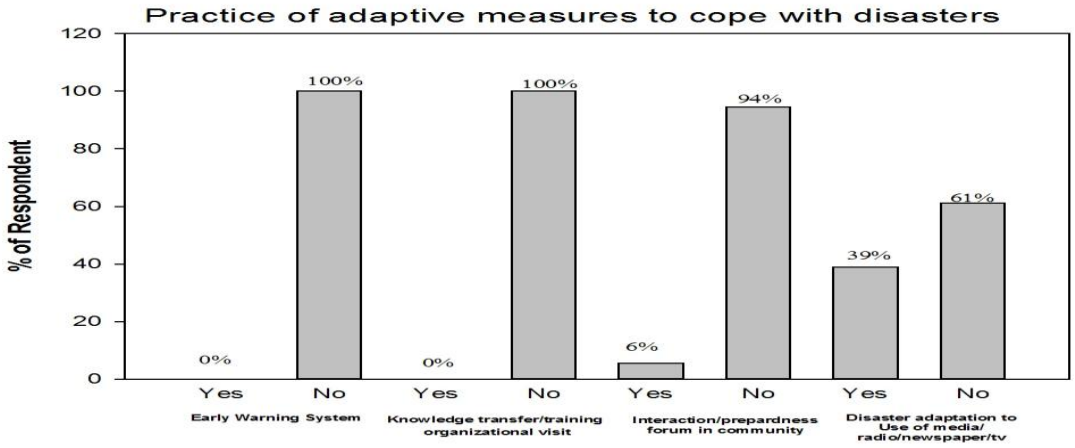

Figure 27: Adaptive measures to cope with disasters.

5.4.4 Agriculture impacts and adaptation

Most of the households of the study area were directly or indirectly dependent upon agriculture. Total land of that area was used as agricultural land. Changing pattern of temperature, precipitation, flooding landslides etc had great impact on agricultural production. Similarly soil erosion and heavy rainfall reduce the soil nutrient content and fertility of soil.

Most of the respondents said the productivity is decreasing in spite of using fertilizers and pesticides. About 50% of the households said the main crops of that area i.e., production of paddy plants, is decreased. Only 15% of them said it is increased but 25% said it is in the same condition neither decreased nor increased.

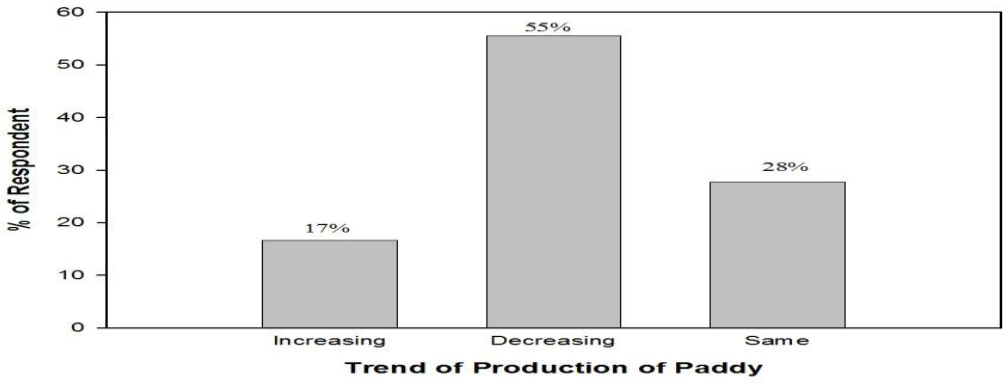

Figure 28: Productivity trend of the paddy plant

The question was asked to them if they had used adaptative measures to reduce the impact of changing climate in agriculture, a few of them had used it. 66.6 % of the respondents used different variety of crops, 22.2% of them started terrace farming, 30 % of them changed the crops, 20 % used rotational irrigation and more than 22 % were used sprinkle irrigation for agriculture.

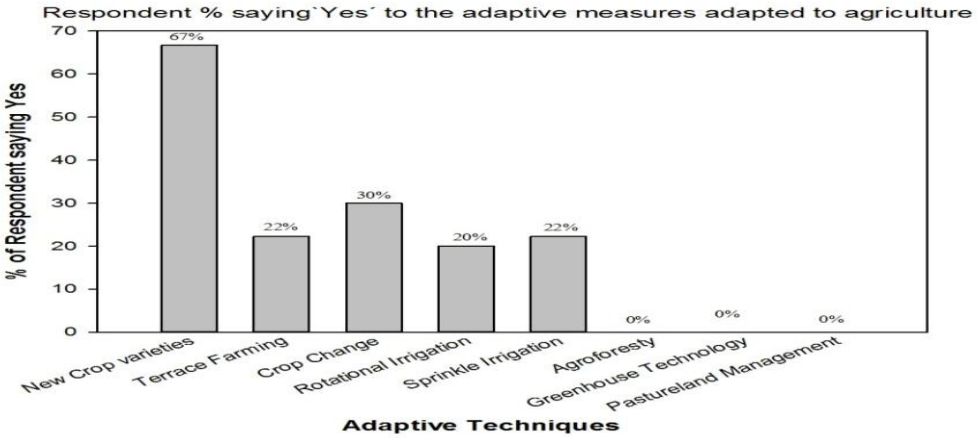

Figure 29: Respondent % saying yes to the adaptive measures in agriculture.

5.4.5 Water resources

There is a direct impact of climate change on the water cycle. Long rainfall, long dry season and abnormal rainfall affected water sources like tap water, well, river and streams that are dried up. Flooding and landslides also occur due to the unusual heavy rainfall. Some of the respondents feel difficulty in accessing drinking water as well as irrigating the land because of dryness caused by long dry season and abnormal rainfall.

57% of the respondents said that there was scarcity of water; it means water quantity in the small river decreased where as only 43% of them said it increased. Scarcity of water in this area is one of the environmental challenges of climate change in water resource.

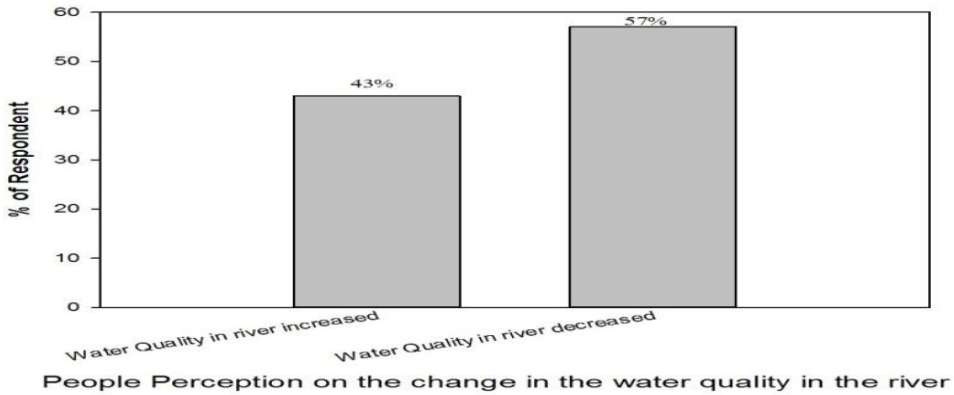

Figure 30: People's perception on the change in the water quantity in the river.

Impacts of disasters on water resource:

From the observation it was found that unusual rainfall, drought, flood and landslides affect greatly on water resource in the study area.

Adaptation during water scarcity: Some respondents didn't use any adaptation measures for scarcity of water. 30% used water wisely that is economizing with available water, 22.2% preserved the water resources and 9 % of them collected it from distance sources.

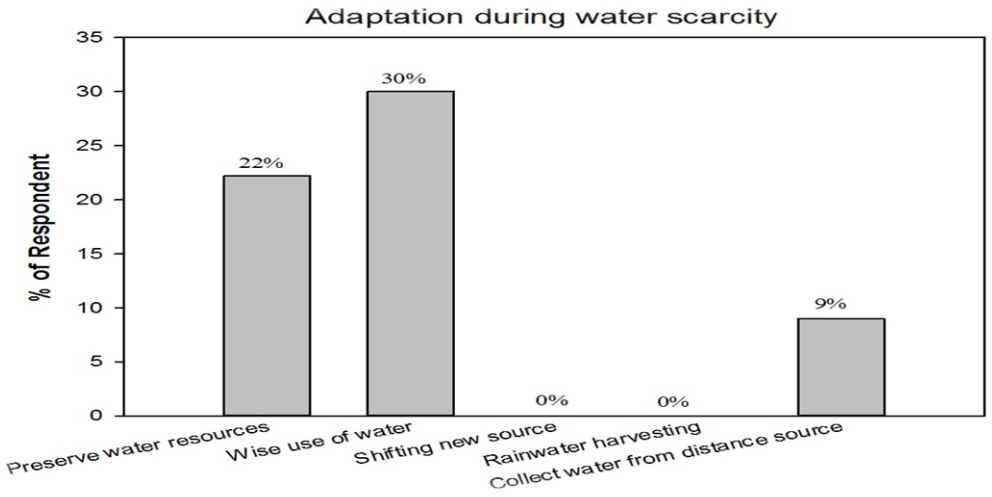

Figure 31: Adaptation to water scarcity.

5.4.6 Drought

Most of the people of that area told that drought affected land, crops and water resources more than households, biodiversity and forest. More than 83% of people experienced the impact of drought on land and crops, 77.7% of them experienced its impact on water resources. It means drought affected land, crops and water resources which are the basic needs for everyone.

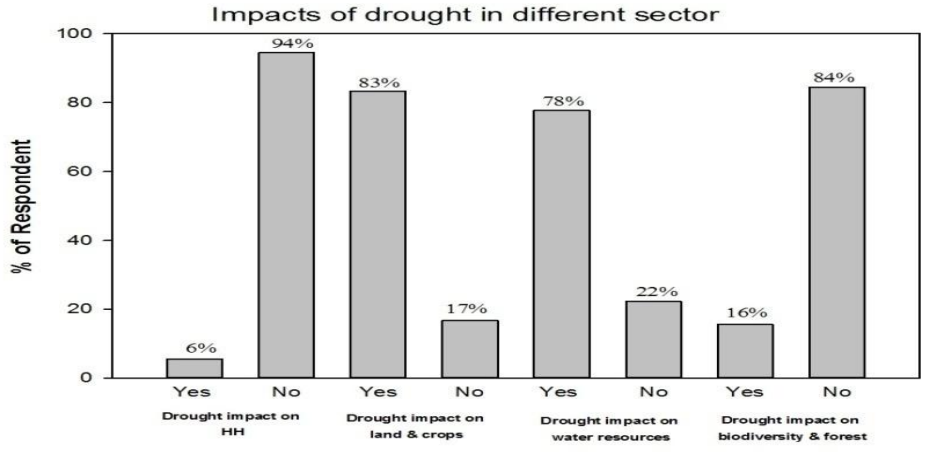

Figure 32: Impacts of drought in different sector.

85% of the respondents didn't use any adaptative techniques to combat these impacts of drought. Only few of them adopted it in rotational irrigation and planting crops which need less water. 9% of the respondents stored the water and 5% of them used it by using method of preservation activities.

Table 5: Percentage of respondent adopting techniques to combat drought effects

Adaptive Techniques	Percent of respondent adopting these techniques (Yes)
Do nothing	85%
Rotational irrigation	30%
Planting crops that needs less water	15%
Water preservation activities	5%
Changing cropping pattern	0%
Rainwater harvesting	0%
Storage of water	9%

5.4.7 Soil erosion

The people of the study area were also faced another great environmental problem created by soil erosion which decreased the productivity of the land. Soil erosion occurs due to the unusual heavy rainfall. Some of the respondents said it has impacted more in fertile land and crops rather than others. 38.8% of them felt its impact on fertile land and crops, a few felt its impact on households, livestock's, water resources, biodiversity and forest. But most of the respondents felt little impact on above factors.

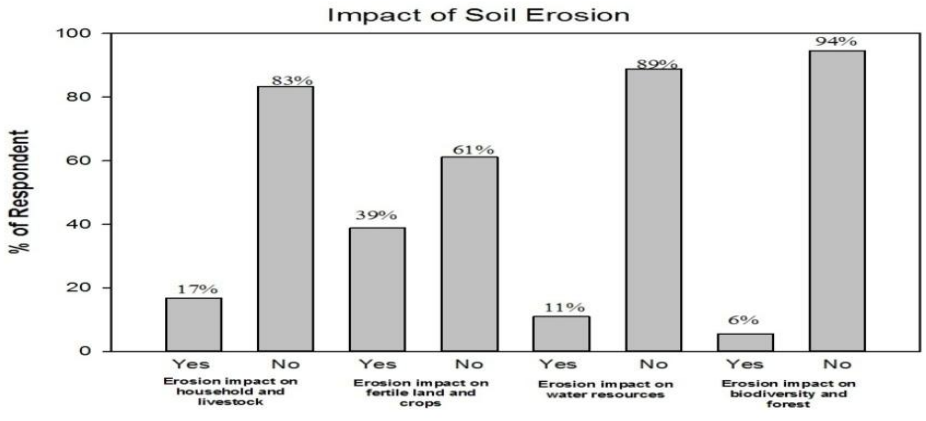

Figure 33: Impacts of soil erosion on different sectors.

None of the respondents adopted any techniques to preserve the soil from erosion. But they needed the plantation and construction of walls to preserve the soil from erosion, for that they were seeking information from NGOs or any clubs or other agencies.

5.5 Adaptative measures and future exposure

5.5.1 Factors for adaptative measures

From the field observation and data analysis, it can be said that the area is greatly vulnerable because of the risk of climate change patterns and disasters. These risks, impacts and adaptative measures have been summarized. From the analysis of climate data and views of more than 90% of the respondents, it is found that temperature, precipitation and other climate change patterns changes in recent years are highly challenging.

Moreover agricultural production is highly affected which is gone down annually, land is being drier, extreme weather events are increased, water resources are dried up and frequency of occurrence of disasters such as flood, landslides, drought etc has been climbed up. The maximum temperature increased beyond the optimum level of crop production so it seems to decrease in production of rice and wheat. Due to these problems people is being poorer and poorer and they are shifting in search of new sources of income and they are migrating from there.

It is impossible to control the impacts of climate change patterns and disasters for the community. At community level, people can only minimize the impacts which are either occurring or going to occur in coming days. The effective implementation programs, sustainable strategy as well as policy are to be managed to cope with these impacts of climate change.

Some governing factors for adaptive measures in the local area are:

Governmental organization: governmental organizations are responsible to provide necessary services to the community during time of disasters and other types of problems. Many district level organizations are agricultural office, irrigation office, forest office, local developmental office are the governmental bodies to work for the climate change and disaster mitigation. They all have given the responsibility during the time of disasters but they haven't done anything yet.

Non-governmental organization

Many NGOs and INGOs are spread highly in Nepal for different purposes. Some of them are working on climate change adaptation. They can provide support to local community but nothing is done by these NGOs in the sector of climate change risk reduction.

Community forum and social networking

There are different types of community forums as well as social networking which are considered major stakeholders. They are working in the field of social services and agriculture. Their inputs are essential not only to overcome the worst impacts but also seek the others technical and financial solutions. Updated technical support to many youth clubs also can help to reduce the risks.

Indigenous knowledge technology and practices for early warning system

In the study area the people will have their traditional system to forecast weather events. They only assume by watching the signs of days. Some villagers are informed by local leader, teachers, educated person about coming weather. But some modernized techniques should be required for early warning. There is not any availability of weather forecasting system. A few of them hear through TVs, radios and others about weather conditions. Many people feel the impact of disaster events, like heavy rainfall and flooding but there is not any early warning system until now. If they are warned and informed timely, they could make preparations.

Technology

Modern technology reduces the bad impacts of disasters in agricultural production as well as others when used wisely. Most of respondents don't know about the technologies such as rain water harvesting, sprinkler irrigation etc. Heavy equipments should be available which helps them to reduce flooding, soil erosion etc through land reclamation. The temperature increases day by day which causes increase in insects and pests. To control them proper technology should be used.

Infrastructures

Infrastructures are also important for adaptative techniques to cope with the impacts of climatic change and disasters. A few of the households are facilitated with certain infrastructures such as irrigation canal, graveled road, constructions of school, health posts etc. Graveled road goes through the villages which helps them to work and travel during the time of heavy rain fall. Similarly, a narrow canal also helps them to irrigate the land during the time of dryness. But they lack the construction of agricultural infrastructures as disposal and treatment of waste water, reservoir and sustainable urban infrastructures such as technology, architectures etc.

Knowledge, Awareness and Communication

To minimize or to control the impacts, it is necessary to share knowledge through communication. Some of the respondents want to share the knowledge through their community. People who are well educated have the knowledge of weather forecasting. From

the field observation it is found that only a few of them are involved in knowledge sharing programs about disasters and climate change. So it is important to participate in every trainings and idea sharing programs about impact of disasters and climate change.

5.5.2 Future exposure

Climatic data and field observation reports predict that the weather related disasters and extreme climatic events like increased temperature; unusual rainfall etc. will create great problems at global, national as well as local level. An indication of future trend and climate change pattern is also noted or indicated by climate science literature with some level of uncertainty. Different measures or techniques adopted to predict, estimates that the average temperature of Nepal will rise in the range of 2 to 4 degree centigrade and magnitude of precipitation also will rise from 150 to 1050mm annually when CO_2 level is doubled. This type of fluctuations in temperature and precipitation will create great problems more to local communities. From the data analysis it is clear that the community has to face many challenges in coming days due to the impacts of climate change and disasters. When households were asked about the risks increased climate change impacts most of them said that they may have to face the bad impacts especially on increased frequency of flooding and agricultural production.

6 Conclusions

Ramshikharjhala lies in the far western Terai region of Nepal in Kailali district. Total area of this V.D.C. is 157.95 square km and population 13,560. Agricultural is the main sources of income except that some people are involved in other private and governmental job services. This area is characterized by low human development indicators such as education, health infrastructures.

Tikapur Hydro meteorological data from 1981-2010 were analyzed. Data analysis indicated some visible changes in the climatic variables in recent years. Mean maximum and minimum temperature are increasing which are 0.37˚c and 0.26˚c per decade respectively. Average monthly rainfall shows that November is the driest month with 3.94 mm of average rainfall where as it is 497.32 in July which is wettest month. The high fluctuation on the rainfall indicates the increasing uncertainty in the dry season rainfall which affects agricultural production. The analysis of the seasonal rainfall shows increasing trend in monsoon while decreasing trend in winter which makes the area more prone to water related disasters.

Most people say that temperature is increasing but there was a mixed view about the perception changing pattern. 38.38% of respondents experienced it was decreased while 33.33% said increased. Almost all of them agreed that there was unusual rainfall pattern. These changes in rainfall pattern are very significant for the community people because most of them depend upon agriculture.

The study area is vulnerable to natural disasters. 91.1% of respondents felt the increased frequency of flooding, 36.6% said that disaster events as landslide also increased. Similarly, 40% of them felt the disaster events as soil erosion of that area increased. More than 72% of respondents thought that this disaster occurred due to the unusual weather events like heavy rainfall. 17.7% of them said that disasters occurred due to pollution like construction of roads, households etc. similarly disasters occurred due to the deforestation which causes the global warming problems according to 5.5% of respondents. Most of the respondents agreed that lightning and hailstorm occurrence frequency is increased in recent years.

About 55% of the respondents said the productivity is decreasing day by day in spite of using fertilizer, increased care, and use of new varieties of crops. Most of the respondents said that uncertain and unusual climatic events are responsible for negative impacts in the field of agriculture.

Adaptation capacity is very poor in that area. Some peoples are using local coping strategies but there was no any institutional support so community is at high level of vulnerability

without well institutionalized coping mechanism. So community level vulnerability will be high in coming years. About 72% respondent feared that the temperature will rise more in coming years and most of respondents said that the risk of extreme rainfall pattern will increase and agricultural production will decrease. So they are worrying about their future. Hence some factors that enhance the adaptive capacity includes common social forum, awareness and communication, institutional and infra-structures, training and advocacy, modernization and practice of indigenous knowledge.

Detailed study is required for the predictions of impacts which could be helpful in formulation of new policy. This new policy must be elaborated from local to regional level.

7 Recommendations

Some measures are needed to minimize the impact of climate change in the community. They will be helpful to mitigate and adapt the climate change impacts not only in research area but also other parts of the country. As prevention is better than cure, it is better to invest earlier rather than disasters have occurred.

Some of the recommendations are as follows:

In the developing country like Nepal where most of the people are innocent, communities' forums and social networking are very essential. They can bring strong dynamic force to cope with changing scenario. Discussions with the communities show the importance of agriculture extension services and use and implementations of the adaptive measures in the agriculture. The people in the community should be provided with the facility of irrigation not depending only on the traditional method of irrigation but also can be done with water collection dams and reservoir or rainwater harvesting method.

The emphasis should be given to sustainable development in order to address the possible impacts of climate change. It is recommended that some of the new projects should be established in the area to train local people about climate change induced vulnerability and coping mechanisms. Community should have to change the livelihood practices to minimize the risks of climate change impacts in coming days. It is very important to introduce with different income generating activities which helps them to enhance the economic status. Local training, further research and assessments are also needed.

Local community should be aware of the induced impacts of climate change. Different hazards should be mapped and safety measures should be taken to reduce these hazards in that

area. Some of the impacts or risks created by climate related extreme events must be backed by awareness building around the community.

Proper maintenance of the early warning system and preparedness should be built up to save lives and properties.

For the management of food related disasters, preparedness improving climate information applications through work with the agricultural office, water resource managers, meteorological office and other users should be very useful. Rescue units should also be established.

Modern technologies should be used to reduce the bad impacts of disasters in agricultural production as well as others. Some of the technologies as rainwater harvesting, sprinkler irrigation, terrace farming will be helpful for good production in agriculture.

The temperature is increasing day by day which causes increase of pests and insects, to control them proper technology should be used.

Heavy equipment should be available which will help people to reduce flooding, soil erosion etc through land reclamation. It is necessary to link climate vulnerability to socioeconomic studies and long term periodic and socioeconomic assessments. Current indigenous knowledge is very important to make policies on coping strategies.

Non-structural measures such as; developing measures and implementing land use/zoning policies, maintaining up to date hazards and maps of vulnerability, training and capacity building for disasters and management of water resources, working with community to increase public awareness program and promote early warning systems and evacuation plans, afforestation program for reducing risks of flooding and landslides should be used which are particularly more attractive and they would go a long way towards building capacity for disaster preparedness and water resource management. Traditional knowledge can also help to provide appropriate efficient and time tested methods of advising and enabling the adaptation in communities.

Integration among the different institutions, NGOs, INGOs is essential. Their update is essential not only to overcome the worst impacts but also seek the other technical and financial support to cope with disasters. Many youth clubs can also help them to reduce the risks. These should be the facilities of different types of Medias such as TV, Radios, FMs and others to gain the knowledge about weather forecasting system.

Thus following activities are recommended to perform for minimizing the risks of climate change impacts in local communities. These activities include awareness programmes, water

preservation, and distribution of climate information, economy generating activities, land use and land use mapping, strengthening of infrastructures and disasters preparedness at community level.

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Annexe 1. Rainfall (mm) in Tikapur

year/month	jan	feb	mar	apr	may	june	july	aug	sep	oct	nov	dec
1981	86	3.6	15.7	24	110.1	273.7	920.4	DNA	328.4	0	0	0
1982	77.4	11.8	23.2	8.8	85.9	382.3	324.1	493.2	257.4	36.6	3.4	20.5
1983	40	9.4	4.5	50.8	94.9	189.4	344.4	598.9	664.4	262.9	0	26.8
1984	103	24.2	14.2	4.3	56.1	483.3	1046.7	117	246.6	12.4	0	15.6
1985	1.6	0	0	5.2	38.1	156.3	357.4	672.2	473.8	159.8	0	14
1986	3.6	31.1	1.1	41	49.9	175.5	427.9	262.6	340.1	28.4	29.4	16.7
1987	15.2	29.6	0	26.1	80.7	49.1	576.8	376.3	78.7	9.5	0	9
1988	0	5.6	32.2	34	70	297.1	563.5	671.2	74.1	34.1	0	55.9
1989	81	16	8.8	0	27.2	246.5	622.3	518.2	336.4	39.9	14.4	12.3
1990	0	134.8	33.6	0.3	259.9	207.7	698.5	426.3	268	13.5	0	21.8
1991	10.3	36.3	28.8	3.4	52.1	155.4	470.5	379.2	270.1	0	4.8	45.7
1992	24.5	14.8	0	0	50.1	163.1	282	631.2	155.3	31.2	5.2	0
1993	28.6	18	47	DNA	104.7	298.1	178.3	545.8	213.3	0	0	0
1994	9.8	94.1	1.4	DNA	40.5	187.6	266.8	359.9	7	0	0	0
1995	80	35.9	7.9	0.5	67	204.7	351.3	438.3	201.2	17.7	2.4	0
1996	36.5	88.2	7.7	6.1	2	199.9	519.9	508.2	278.4	76	0	0
1997	145.9	0.8	1	43.2	28.3	80	779.8	594.1	434.6	41.8	30.6	132.9
1998	7.4	18.4	58	22.8	19.1	81.6	483	639.5	354.6	124	15.1	0
1999	29.2	0	1.2	0	125.6	209.3	451.2	528.9	269.5	117.7	0	3
2000	16.9	44.5	8.5	40.6	99.4	478.8	284.4	380.3	210.5	0	0	0
2001	8.8	4.5	3.6	0	261.5	377.6	574.7	393.2	180.6	73.1	0.4	1.5
2002	76.1	43.6	0	31	63.3	134.6	262.5	572.3	127.2	3.1	5	33.8
2003	67.3	66.5	6.5	3.1	22.3	466.7	508.9	377	558	0	1	3.5
2004	22.7	8.8	0	20	99.4	295.9	354.2	250.8	508.2	23.3	0	0
2005	87.3	39.7	53	12	31.3	90.9	414.2	DNA	254.7	30.1	0	4.3
2006	0	0	38.8	12.7	145.8	232.6	302.5	424.9	163.8	29.7	0	17.9
2007	0	78.7	72.8	29.2	59.1	159.9	1025.6	508	268.4	3	0	0

2008	21.5	0	0	59	124.8	486.8	451.4	361.8	477.5	62.9	0	0
2009	0	9.5	14.9	1.8	89.1	123.7	583.2	531.5	156.1	320.7	6.7	1.5
2010	5.3	40.8	0	0	61.2	120.2	493.3	429.1	DNA	20.1	0	2.4

Annex 2: Maximum temperature (˚C) at Tikapur

year/month	jan	feb	mar	apr	may	june	july	aug	sep	oct	nov	dec
1980	22.5	25.3	30.3	38.8	39.1	35.4	32.4	32.3	32.2	31.2	28.6	24.2
1981	21.2	25.4	29.2	34.6	35.8	36.9	31.2	32.1	31.5	30.5	26.1	22.9
1982	22	22.1	27.5	34.5	36	34.2	33.8	32.7	31.6	30.3	25.9	22
1983	19.2	23.3	29.5	32.7	34.9	37.3	33.5	32.3	30.8	30.2	27.6	22
1984	20.6	22.7	30.5	36.7	38	32.2	31.2	33.2	31.4	31.3	27.3	23
1985	22.2	24.7	32.7	37.3	38	37.3	31.2	32.1	30.6	28.4	26.8	22.7
1986	22	24	30.7	35.2	36.3	37.3	31.8	32.5	31.3	29.6	27	22.9
1987	21.8	26	30.9	35.9	36.7	39.2	32.7	32.1	32.5	30.7	27.9	23.7
1988	23.1	26.3	29.6	36.6	37.3	34.9	31.9	31.7	32.5	31.4	28.5	24.5
1989	20.5	23.7	30	36.4	38.3	33.8	31.9	32.2	31.9	31.5	27.1	21.7
1990	21.5	22.9	27.3	34.8	33.8	35.2	31.3	32.6	32.4	30.6	28.1	23.4
1991	21.1	26.6	30	35.5	38.9	35.5	33.7	22	31.8	31.4	26.1	22.6
1992	20.8	22.3	30.7	37.5	36.8	36.7	33.3	32.1	32.3	30.1	27.5	22.8
1993	18.4	25.6	27.9	35.3	36.9	34.7	32.7	32.1	31.3	31.7	27.6	24.5
1994	22.3	23.8	30.9	36.6	39.1	37.1	33.7	32.2	32.7	31.9	28.1	24.1
1995	20.3	24.4	29.5	37	39	36.9	32.8	32.3	32	32	28.2	23.8
1996	20.9	24.3	30.6	36.8	40.5	35.6	32.6	32.2	32.3	30.6	28.1	24.6
1997	20.8	23.9	29.5	33.3	38.7	38.2	33.4	32.8	32.3	29.7	26	18.7
1998	17.6	24.3	27.2	34.8	39	39.8	32.9	32	32.9	31.9	28.7	23.4
1999	19.3	25.8	32.5	39.5	36.9	35.2	32.4	32.1	31.6	30.9	28.2	23.8
2000	19	22.7	30.5	36.8	36.1	33.6	32.5	32.1	31.6	31.9	27.7	23.7
2001	20	26.9	32.2	38.1	35.6	33.3	33.4	33.8	33.7	32.1	28.4	21.3
2002	22.1	25	30.9	35.3	36	36.2	34.7	32.9	31.6	31.4	28.2	23

2003	18.6	27.8	29.5	37.4	38.8	36.2	33.5	33	31	31.1	26.8	20.9
2004	18.6	25	32.6	36.9	37	34.3	32.8	33.7	32.3	30.6	27	23.1
2005	20.5	24.3	31	36.6	38.4	40	31.1	34.5	33.1	30.7	27	23
2006	21.2	28.3	32.2	35.8	35.5	34.9	33.4	32.2	32.5	31.1	26.2	21.1
2007	20.7	23.9	28.4	35.8	37	36.2	32.4	32.9	32.2	31.4	27.8	22.7
2008	21.6	24.4	32	37.3	37.5	33.5	32.8	33.2	33.2	31.6	27.8	23.7
2009	22	27.2	32.7	38.5	38.1	39.5	35.1	33.2	33	31.3	26.9	22.8
2010	17.4	25.7	33.4	40	38.7	38.7	33.7	33.5	DNA	32.5	27.7	23.7

Annex 3: Minimum temperature (˚C) at Tikapur

year/month	Jan	feb	mar	apr	may	june	july	aug	sep	oct	nov	dec
1980	6.3	8.9	10.2	17.7	23.9	25.7	25.6	25.4	24.1	19	12	9.1
1981	8.2	9.9	13.9	18.5	23.1	24.3	25.7	25.4	24.3	17.9	12.6	6.3
1982	8.4	10.8	10.8	14	20.5	25.1	27.6	26.6	25.3	DNA	DNA	7.2
1983	6.9	7.3	12	16.4	21.9	23.4	25.7	25.5	24.1	19	11.6	6
1984	5	7.8	12.7	17.6	23.4	24.9	24.9	25.8	23	17.9	10.2	7.2
1985	6.9	6.8	11.3	17.5	22.8	25.9	25	25.6	23.5	19.1	11.6	9.5
1986	6.3	8.5	12.3	16.6	21.6	DNA	DNA	21.8	21.1	16.2	12.9	8.8
1987	7.8	10.1	12.5	16.4	20.4	26.3	25.5	25.2	24.7	19.4	11.8	8
1988	6.4	8.8	12.2	18.2	23.7	23.9	26.1	25.5	24.7	18.8	11	9.2
1989	7	7.2	11.7	14.5	22.8	25.1	25.8	25	24.1	18.9	11.6	8
1990	7.7	10.2	13.1	16.7	22.2	25.7	25.1	25.6	24.9	18.1	12.6	8.2
1991	6	9.2	13.9	17.2	23.3	25.7	25.7	25.7	23.9	17.9	10.8	7.9
1992	7	7.9	11.8	16.3	21.5	24.8	25.5	25.5	23.9	18.9	12.8	7.7
1993	7	10.3	9.8	18.6	23.3	24.7	25.7	25	24	18.2	12.6	7.6
1994	6.3	8.1	13.3	17.4	24	26.3	26.2	25.7	23.8	17.9	12.1	8.1
1995	7	9.4	12.4	15.8	22.1	26.8	25.6	25.1	24.7	20.3	13.4	9
1996	8	10.3	15.3	17.9	22.3	25.8	26.2	25.6	24.2	20.5	13.1	7.4
1997	6.4	8.7	13.4	18.6	21.7	25.6	25.7	25.9	24.6	18.2	13.4	10

1998	8.2	10.2	13	19.5	25.5	26.7	26.2	25.6	25	21.9	15.6	9.2
1999	7.9	10.2	12.3	18.4	23.6	24.6	25.2	25.2	24.7	20	13.2	9
2000	7.8	7.8	13	18.8	24.7	25.4	25.7	25.4	24.1	19.1	14.5	8
2001	6.9	6.9	12.5	18.3	23.5	25.5	26.1	25.5	24	20	13.5	8.9
2002	7	7	13.8	18.8	24.2	26	26.2	25.6	23.6	19.1	12.2	8.4
2003	7.1	7.1	13.5	18.3	21.6	24.8	25.7	25.8	24	18.5	12.5	9
2004	8.3	8.3	14.1	19.9	22.7	25	25.4	25.9	24.3	17.7	11.9	8.7
2005	8	8	14.6	16.6	21.2	24.9	25.7	24.9	25	20	11.8	6.4
2006	6.2	6.2	13	18.7	24.2	25.1	26.2	25.7	24.1	19.6	12.7	8.5
2007	5.2	5.2	13.6	19.5	23	25.9	25.3	25.6	24	19.2	12.7	7.4
2008	6.5	6.5	13.6	17.1	22	24.9	25.5	25.4	23.3	18.7	12.9	9.6
2009	7.6	7.6	11.5	16.5	21.8	23.9	24.9	24.3	23.4	16.5	11.1	6.4
2010	6.6	6.6	13.1	17.3	21.3	25.2	25.8	25.2	DNA	18.9	13.5	5.3

Annex 4: Questionnaire For Household Survey.

Household Survey on Community Vulnerabilities & Coping Mechanisms@ Dhangadhi.

HH No.;…….. VDC Name:……

	Interviewer:……..						Date: ……					
	I.	**General Information:**										
	a.	Name:										
	b.	Caste:			c.	gender:	male		female			

d. village : ..... e. ward no:.....

f. educational qualification:.....

II. Family Poster:

S no	name (optional)	relations*	gender	age	Marriatal status	Education	job	remarks
01								
02								
03								
04								
05								
06								
07								
08								
09								
10								

**Relation to respondent (*sharing kitchen*), Marital status*

					Education Level	
Husband/wife	1	Married	1		Illiterate	0
		Unmarried	2			
Son	2					
Daughter	3	Widow	3		Literate	1

	Daughter in law	4	Widower		4	Up to SLC	2					
						IA/+2	3					
	Grandson/daughter	5										
						BA & above	4					
	Others in family	6										

III. Socio-economic (Land, Livestock & Income):

1. Posses own land?

1. yes 2. no

1.1 how did you become landless?

.....

1.2 if not information will you give information on following?

Types of land	Owning others land	Owning Self land	Land given to others	Cost of 1 ropani land

	land well irrigation										
		Depand	on								
		rain water									
	Land in slope										
	Small bushy area										
	forest										

2. How much did you cultivated last year? How much did you sell ?

	Types of culti	Area of cultivable	production	If sold, price	If bought, price	Production cost	
		Land in ropani	In kg				
	Paddy						
	maize						
	millet						
	wheat						
	barley						
	potato						
	phapar						
	mustard						
	soyabean						
	others						

3. why is the change in the production of crops ?

……

4. Change in the production of crops in last 10/20 years ?

Crops&change	paddy		maize		wheat	millet	others	
	before	now	before	now	before now	before	now	before now
area								
(ropani)								
caste(name)								
Fertilizer use								
Use of seeds								
Use of technology								

Irrigated area									
others									

5.What is the annual income of your family?

Source of income		Annual income * 12 month
agriculture	crops	
	cattles	
In the same locality		
Outside the locality but inside country		
abroad		
Tourism and businees		
others		

6 Had the income change in 10/20 years ?

1. yes 2. no

If yes, how?

……

7. What is your yearly income?		
cost		cost (rupees)
Agricultu		workers
		technology
health		
education		
busines		
others		

IV.	**Climate Change:**					
	Changes					
8. have you felt anything in about 20/30 years ? (please √)						

	yes	no	same	Don't know	If yes		
					increasing	decreasing	others

increasing storm

snowfall thunder

cloudy

rainy days

drought

others

9. Have you felt the following ?(√)

- Extreme hot summer days
- Extreme cold winter
- Winter are less cold and frosty
- Days are becoming hotter
- Others (Specify)……..

10. What is the effect of natural disasters in the social life?

 ……..

- ……

11. Impacts and mitigation

Impacts due to change on	Impacts	Mitigation/adaptation/technology adapted	Remarks	
Land uses				
Agriculture				
Forest				
Snow cover area				
Waste land				
Pasture land				
Biodiversity				
Forest				
NTFP				
Agriculture				
Animal				
Birds				
Fish				
Crops				
Crop productivity				
Crop quality				
Crop species				

Crop calendar(Phenology)				
Water resources				
Water availability				
water quality				
Natural disasters				
Flood				
Landslides				
Drought				
Others				
Pest/Diseases and Health				
Tourism				

12 How do you minimize the effects on following?

Impacts on	Adaptation/Technology				√	
Agriculture	Cultivate new species					
	of crops					
	Adoption to agroforesty/Horticulture/crop rotation					
	Change of crops					
	(Drip irrigation)					
	(Rotational irrigation)					
	(Sprinkle Irrigation)					

	(Green house technology)								
	(Pasture management)								
	(Terracing)								
Water resources									
	Collecting rain water								
	(water harvesting through dam)								
	(shifting to new source)								
Disasters(flood/landslides/			(Early warning system)						
	Pre alarmig								
drought etc)									
	(Knowledge transfer/training organizational								
	visit)								
	(Interaction/preparedness forum in								
	community)								
	media								

V. **Disasters:**

- What are the major disaster in your community?(Rank)

    - Landslide
    - Flood
    - Drought
    - Lighting
    - Erosion

    - Hail/wind storms

- Others…….

- What is the reason for the landslide and flood in this region?

  - deforestation 2. Increase in global temperature3. Increased pollution

  4. climate change 5. others……

15. How are you feeling the effect of following factors in last some years?

factors (√)	increase	decrease	same	Don't know	remarks
Flood					
Landslide					
Rate of soil erosion					
Lighting					
Hail/Wind storms					
Firing					
Winter temp					
Summer temp)					
Heavy rainfall					
Low rainfall					

Winter							
rain							
Duration							
low rain							
Unusual							
rain							
monsoon							
Level of river water							

16. Loss due to disasters in last 10 years?

disaster	years	humans	Cattles		Loss of fertile land.		loss of crops	
		(numbers)	No.	money	land	money	crops	amount

flood l.slide drougtstorm

thunder snow fall

17. Effects of the following factors in your community? (Please quantify)

	Loss of household		Fertile land and		Water source	Forest and		

	property		production			wildlife diversity			
(numbers)									
disasters							others		
floods									
landslide									
drought									
Erosion									
unseasonal									
rainfall									
others									

- Any people from this place migrated to other place? If yes, cause of
  - Flood 2. land slide 3. Soil erosion 4. others.....

•Who helped you in from the disaster?(√)

1.	neighbours	2. goverment	
3.	Local organization	4. loan and foreign aids	5. others.....

VI. Awareness/knowledge/institution/Needs for capacity development.

- Are you aware of the system you are using or implementation you are doing in this community to minimize the effects of climate change? (√)

1. Early Warning System

2. Insurance

		3. training and awareness	4. others.....	…….
21. how will you minimize the effect of climate change?				
needs		(Description)	How to implement?	
organization				
Public awareness				
technology				

preawareness

Food safety helping hand safe place

others

22. are you related to any organization?			
		ʒ ʒ	
1. yes	2.	no	

If yes,			
organization		position	objective

VII. Interviewer's comment

……

……

……

Checklist for Focal Group Discussion.

Focal Group Discussion on Community Vulnerabilities & Coping Mechanisms@ dhangadhi.

(Base line survey in different ecological zones)

Village Name:…….

Location (GPS Points): Lat:…… Lon:…….. Elevation:…….

Moderators: Jitendra bikram shahi. Date: ……

Checklist.

Climate Change (temperature):

- **Trend**

- Have this community experienced any changes in temperature in last 30 years? What type of change in Temperature?

- How temperature is changing? (promote by following points)

(Extreme hot summer days, Extreme cold winter, winter are less cold and frosty, Days are becoming hotter, other)

II. Impact/ Adaptation/mitigation

Then what you think are the impacts

(In agriculture, diseases spreading, water resources,…..)

- What, you think, are the consequences of warmer days and seasons?
- Then to escape from such changes, what your community use to do?

Climate Change (Rainfall/snowfall):

- Have you experienced any changes in rainfall/snowfall within last 30 years?
  If yes then,

  What type of change?

  - Rainfall/Snowfall increasing
  - Rainfall/Snowfall is decreasing
  - I don't know

- Do you have any experiences on followings?

  - Unusual rainfall
  - Increasing cloud burst (heavy rainfall at once)
  - Longer rainy season

- Shorter rainfall

- Delayed monsoon starting
- Longer drought
- Decreased winter rainfall
- Increased winter snowfall
- Increased in hailstorm/windstorm

Impacts:

- What, you think, are the consequences of changed rainfall pattern in agriculture? (In Agriculture yield increased/decreased)

- What are the consequences of changed rainfall pattern in Water Resources? (Water availability increased/ decreased, Flood frequency increased/decreased etc)

- What are you doing to cope with these changes in rainfall?

  (Delay cropping, new variety of plantation etc…)

Climate Change (Others):

- Have you noticed any changes in wind pattern in this region?

- Is there any long drought in this area in past years, how long was it , what are the impacts and how you mitigate?

- What about lighting occurring frequency in these days?

- What are the impacts of these changes and how you are mitigating them?

Disasters:

What is the most significant disaster in this community, you think? (Rank)

- Landslide
- Floods
- Droughts
- Lighting
- Erosion
- Hail/wind storms
- Others.....

- What, you think, are the causes of landslide/ flood in the region?

(Deforestation, Global change, increased pollution, abnormal weather events (abnormal rainfall, increased temperature etc)

- Does this community feel any changes on the following in these years?

- What are the losses you have due to disaster (flood, landslide, lighting, drought, hailstorm etc.. within last 10 years ?

Disaster(√)			Increased	Decreased	Not changed	Do not know	Remarks
Flood							
Landslide							
Drought							
Lighting							

Hail/Wind storms						
Firing						
Winter temperature						
Summer temperature						
Heavy rainfall						
Low rainfall						
Winter rainfall						
Duration of rainfall in						
monsoon						
Trend of cloud burst						
Trend of unusual						
rainfall						
Starting time of						
rainfall						
Amount of water level						
in river						

- Which disasters have caused migration of people from the village (If any) ?
- What helped to recover you from disaster?
    - Support from neighbors
    - Support from government organization
    - Support from local NGOs and Red Cross
    - Loan/ Remittance
    - Migration

Annex 5: Figure of field study.