

CHAPTER: ONE

INTRODUCTION

Background of the study

‘Climate change refers to a statically significant variation in either the mean state of climate or variability, persisting for an expanded period typically decade or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic change in composition of the atmosphere’ (UNFCCC 2005: cited in Pielke and Sarawitz 2005: 266pp). Intergovernmental Panel on Climate Change (IPCC 2005), which states that climate change, is ‘any change in climate over the time due to natural variability or as a result of human activity’. In present time the term “climate change” is generally used to refer to the change in our climate, which has been identified as occurring since the beginning of mid 19th century (Bear 2007). The mechanism behind climate change is the increased “greenhouse effects” (WHO 2008). Greenhouse effect is a natural phenomena existing in the earth only. Natural greenhouse system becomes boon to the inhabitants of the earth because by this effect the earth atmosphere traps heat energy from the Sun just like a greenhouse, and supports the life on the earth. Without this heat trapping system, the earth temperature would be about 15⁰C less than the present one. But now this system is heavily disturbed causing serious alteration in the climatic condition which ultimately have multi-faced impact on environmental and human system.

The discourse of climate change is widely being discussed throughout the different disciplines around the world. In the initial time, climate change was only taken as a global environmental problem. But due to its multi-faced impacts, United Nation Security Council in 2007 held its first debate on the implication of climate change for international security. The United Nation also estimated that all but one of its emergency appeals for humanitarian aids that year were climate related. This signifies climate change becoming the social, cultural, economic and environmental trend, problems, issue, tension and challenge. Likewise, similar is the response of European Union in this issue (Crate and Nutall: 2009). Meanwhile, the issue of climate change was increasingly raised in every national and international talks and negotiations. Therefore, climate change is no longer viewed as an environmental issue only, but it

is taken as one of the social, cultural and humanitarian issues. From the social science perspective, the dominant factors shaping climate change are societal in nature, and are equally important aspect of the understanding.

The hazards associated with the climate change such as excessive rainfall, longer drought periods, landslides and floods are increasing in terms of both magnitude, as well as frequency. Such events directly threaten people's livelihood, usually of those who entirely depend upon the nature and live in a fragile ecosystem (SAGUN. 2009). 'The cultural implication [of climate change] could be the disorientation, alienation and loss of the meaning of life that happens when peoples are removed from their environment' (Crate and Nutall 2009: 13).

Changes in climatic pattern such as temperature, rainfall, snowfall have been observed since last few decades in Nepal. The impact of climate change was noticed in five key sectors: water resources, agriculture system, forestry, biodiversity, and human health (Sundmann 2007). Warming seems to be consistent and continuous after the mid 70s. Between 1977 and 1994, average raise in annual temperature was 0.06°C per year (Shrestha *et al.* 1999). Warming was much pronounced in high altitude regions of Nepal such as the middle mountain and the high Himalayas, while warming was significantly lower in Terai and Siwalik regions. Furthermore, warming in the winter was higher as compared to other seasons. According to a recent study, Nepal's temperature is rising by about 0.41°C per decade (Dahal, 2005, Kansakar *et al.* 2004, Sherstha *et al.* 2000). Besides that, in the Himalaya region, temperatures are increasing faster at higher altitudes. The monsoon is also intensifying, with fewer days of more intense rainfall. In addition, the last few years have seen a delay in monsoon onset (Dahal *et al.* 2009).

This research was conducted in the two communities of Chitwan district which represent the two different socio- cultural and ecological settings. Agriculture and livestock are the integral part of the livelihood of people. Farmers of these regions are primarily dependent on the rain-fed agriculture and farmers have already confronted with the climatic changes and its impact on farming system. The change in weather pattern can have both positive and negative impact on the agricultural and livestock system. Thus, this study aims to investigate and compare- how these climatic changes are perceived by locals, how these changes will ultimately impact on the agriculture and livestock system, what kind of coping strategies followed by the local peoples of the respective sites.

Statement of the problem

Natural and human systems of different region respond the change in climate differently according to the geography, social structure and economy of the region (Adger et al, 2006). We can expect this difference in response at regional, national, community and even at individual level. People perceive their environment through culture, and their cognition determines what constitute dangerous climate change, and flexibility will specify limit to the adaptation beyond which community response are no longer able to maintain acceptable social, cultural and economic goals (Carat end Nutall 2008). The experiences and observation of individual throughout their life along with the socio-cultural and environmental condition is responsible for framing the perception about the climate change. Moreover the local people are not only keen observers of the impending climate change rather they have unique flexible adaptive strategies on the basis of their indigenous and traditional knowledge infiltrated from generations to cope with changing climate. Keeping this in the mind, here two study sites at Chitwan district was selected on the basis of different ecological and socio-cultural setting. Therefore the perception of the people on climate change may be different due to the variation in the ecological and socio-cultural setting.

Nepal has already suffered from the hazards associated with the increasing global temperature (6th risk country in the world) for example, glacial retreats, glacial outburst flood (GLOF), long drought, erratic heavy rainfalls, landslide, flood, declining ground water, outbreaks of different vector born disease, which are triggering serious environmental and societal disruptions in spite of its least contributions to greenhouse gas emission (0.025% of global emission) (IPCC 2007). Here the changes in climatic conditions along with the other factors may have affected the livelihood assets of the local people. So it is important to understand how much the changing climatic condition impacted on these assets especially in agriculture and livestock farming, a major way of making living of the people of both the sites. Furthermore the community at different location affected differently through the hazards associated with the changing climate hence the society may develop specific coping and adaptive strategies in the face of change. Based on these assumptions, this study has tried to answer the following research questions:

- 1 How do people understand the climate change?
- 2 What do they consider to be the underlying reasons for such change?

- 3 What are the impacts of climate changes on their agricultural practices and livestock management?
- 4 Do people living in two different sites experiences similar or different impact of climate change?
- 5 What are the adaptive strategies followed by the local communities in the face of such changes?

Objectives

General objectives

Understanding the issue of climate change from local level through comparing the people's perception and their adaptive strategy to cope with the climate change of two communities is the general objective of this study.

Specific objectives

-) To understand the perception of local people on climate change
-) To examine the impact of climate change on agriculture and livestock management practices
-) To analyze the present adaptive strategies of local people
-) To compare the perception, impact and adaptive strategies followed by people of two different communities in response to climate change.

Justification of the study

Till the date the discourse of climate change has got much attention and become the hot topic in every national and international negotiations, debate and seminars. But there are very few researches on climate change from the social science perspectives, especially from the anthropological perspective through out the World and Nepal. This study aims to assess and compare the perceptions of people on climate change, impacts and adaptive capacity of two different communities of Chitwan district. It therefore will be very helpful to understand the issue of the climate change from local perspectives to the researchers, development organizations and organization involved in climate change, adaptation and vulnerability reduction activities.

In addition, this research mainly uses anthropological perspective therefore, it is more crucial to understand the impact of climate change in local level from emic

perspective through community observation knowledge and perception. Hence, this research will be able to create a foundation for ‘Anthropology of Climate Change’ in Nepal, which has recently emerged as a new sub-discipline within anthropology.

Theoretical Framework

Anthropology is the holistic study of people and their society. So no single theoretical perspectives may provide enough understanding on this. Keeping this in the mind the researchers has employed various theoretical approaches in this study. Primarily the study concentrated its focus on the cultural model approach of climate change described by Crate (2008). The concept of cultural model is widely used within anthropology especially in climate change research along with the tools of applied, advocacy oriented and public anthropology, for the emic understanding of people about the effect of global climate change on their world and worldview (Crate 2008:139). Therefore, it is important to know how people as a cultural being relate to, talk about, and frame their perception in the case of weather and climate. Oral history is an important source for understanding adaptive strategies and peoples’ collective understanding of global climate change. In addition the theoretical framework of cognitive anthropology and human ecology also helped to analyze the difference in the perception and adaptive strategies of people.

Moreover, the study also used the sustainable livelihood framework to access vulnerability context, types of livelihood assets affected, total impacts and total capacity available to the local communities to cope with the climate change impacts. The livelihood framework analysis is a tool used in accessing the various livelihood assets of rural communities (Chamber and Conway, 1992)

The Conceptual Model of Study

The generic conceptual model of climate change represents the key elements that shape the perception, impact and adaptation, which will serve in assisting the interpretation of the finding from two different communities’ viz. Hattibang and Kesharbag of Chitwan district. The model is based on the notion that perception is vital parameter to define impacts and specific adaptive capacity. As presented in Figure1.

Figure1. The Conceptual Model shows the perception, impact and adaptation to climate change

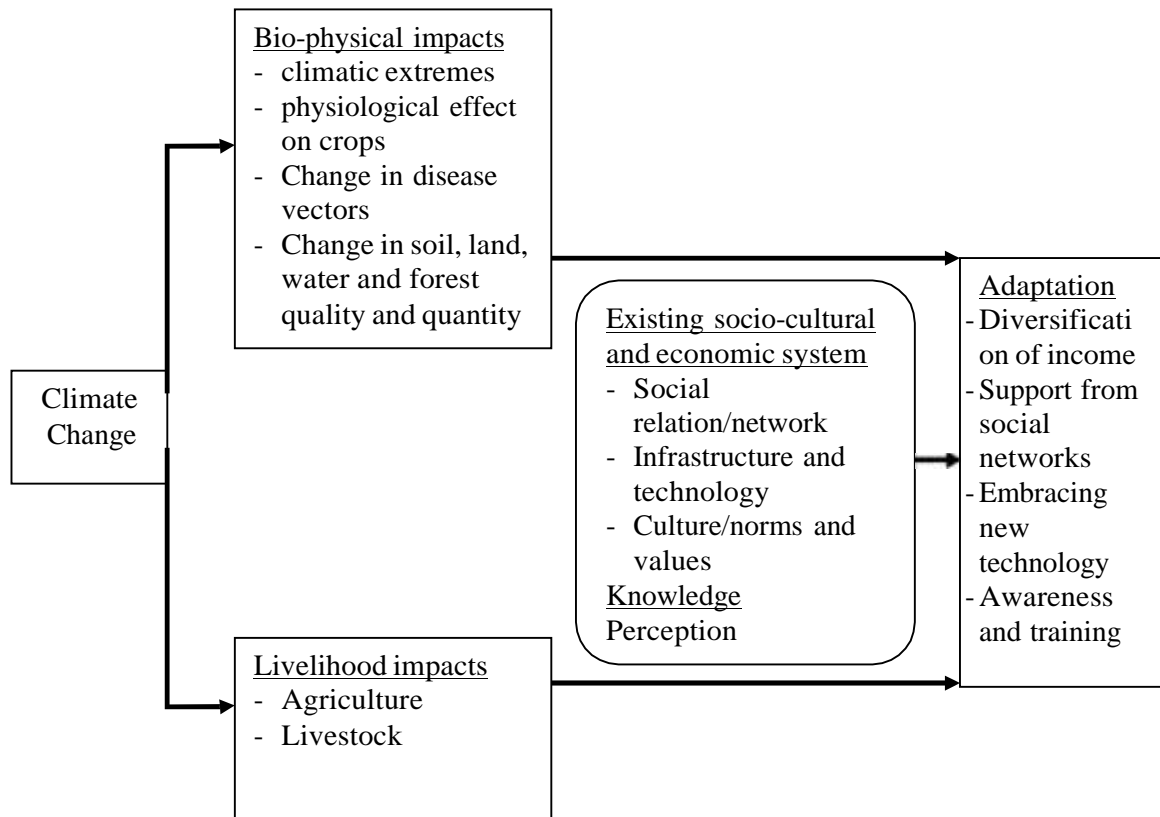


Figure 1 shows that, climate change forms two types of impact: biophysical impacts such as climatic extremes, physiological impact on crops, change in disease vectors, change in land, soil water and forest quality and quantity; and livelihood (socio-economic) impacts especially on agriculture and livestock. The existing socio-cultural and economic system, knowledge system and the perception of the individual determines the nature magnitude intensity and severity of the effect caused by these impacts and also mediates the community or the individual for proper response to these impacts through various coping and adaptive strategies.

Outline of the Thesis

Following this introduction, chapter two incorporates review of literatures and chapter three includes methodological portion of this study. In chapter four, brief introduction of the study site has been given. Discussion on perception on climate change is done in chapter five whereas chapter six includes the finding regarding the impact of climate change on agriculture and livestock, which is followed by coping and adaptive strategies in chapter seven. Finally this study has been concluded in chapter eight.

CHAPTER: TWO

CONCEPTUALIZING THE ISSUE: REVIEW OF LITERATURE

This chapter was grouped on two major sections. First, in the general review, the global and national scenario of climate change, its impact and effects was noted which help to understand the issue of climate change for the research purpose. The second section, the theoretical review on the perception, impact and adaptation will be crucial to understand the research ideas and was important to formulate the particular way of conceptual idea according to the needs of this study.

General Review

The Global Scenario of Climate Change

Talking about the climate change in recent years, the issue of increasing global temperature remains at the centre of concern which is associated with various natural and human induced climatic variations. Natural process such as volcanism, desertification, droughts, floods and forest fires may cause change in atmospheric concentration of gases leading to the modification of climate. On the other hand, human induces climatic variation due to the profit making capitalistic world economy that heavily relies upon the fossils fuel which plays a significant role in emission of greenhouse gases in the atmosphere (Baer 2008). In 2000, 59 percent of greenhouse is contributed by carbon dioxide which is emitted by burning fossils fuel (Baer: 2007 cited in Baer 2008). The increasing concentration of carbon dioxide (CO₂) reaches to 379 parts per million (PPM) in 2003, which was only 280 parts per million (PPM) at the time of the industrial revolution of 18th century i.e. overall 35% increment (IPCC 2005). Similarly, the concentration of methane and nitrous oxide has increased by 148% and 18 % respectively. The atmospheric concentration of carbon dioxide (CO₂) at present is higher than at any point during the last 650,000 years. Such increase in the greenhouse gases consequently causes increase in temperature throughout the globe. In average, the global temperature was increased about 0.6°C to 0.7°C in the 20th century, but the rate is far higher now (IPCC 2007). Scientists now claim that the warming of the climate system is 'unequivocal'. In fact, over the last 100 years, the

earth has warmed by 0.74°C whereas the previous estimation of Third Assessment Reports (TAR) was 0.6°C. The Fourth Assessment Reports (AR4) cites evidences from surface temperature records, lower and mid troposphere temperature records, ocean temperature records, decline of glaciers, snow cover and sea ice and an increase in the sea levels. The AR4 also identifies evidences from continental-scale climate changes including change in winds patterns, precipitation, ocean salinity, sea ice, ice sheets, and extreme weather. The IPCC projects that over the next century, we should expect to see temperature increment between 1°C and 6.3°C, depending upon how much we release greenhouse gases(IPCC 2007).

Climate change is a complex and cross cutting issue. Considering the urgency of the problem, 154 countries expressed their concern over the issue by signing United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in Rio de Janeiro (1992) and pointed out that the level of emission of greenhouse gases in developed countries must be reduced to slow down the process of global warming.

Weather Condition and Climate Change in Nepal

A range of climatic variation from tropics to alpine while going through south to north can be observed in Nepal. There are four seasons: Spring, Autumn, Summer and Winter. The mean annual temperature of the country is 15°C. The maximum temperature generally occurs in May or early June which starts decreasing from October and reaches minimum of the year in December or January. Here, 80% of the total annual rainfall occurs from second week of June to September. The mean annual precipitation is 1800mm. Due to diverse topographical structure; there is great variation in rainfall within the country. The southern slopes of Himalayas receive greater than 5000 mm of precipitation while the north central portion receive relatively very less (SOHAM 2007).

In the Eastern Himalayas the increase in temperature ranges from 0.01°C to 0.06°C per year and annual mean temperature is expected to increase by 2.9°C by the middle of the century (Ebi *et al.* 2007; Shrestha *et al.* 1999; UNEP 2002). This rate of increase in temperature is higher compared to other developing countries. Thus, such warming may have serious impact on lives and livelihoods of local communities in this region. The changes in climatic pattern such as temperature, rainfall, snowfall

have been observed since last few decades. Because of that, impacts were observed in five key sectors namely, water resources, agriculture and livestock, forestry, biodiversity and human health (Sundmann 2007).

Agriculture and Livestock

Nepal is referred to as an agricultural country as it provides livelihood for more than 80% of the population (MOPE 2004; Nayaju *et al.* 2004). According to CBS, 64% of the cultivated land totally depends on monsoon rainfall (CBS 2006), which makes country's agricultural production highly vulnerable to precipitation pattern. If climate change adversely affects the crop production, it will have direct impact on the livelihood of several millions people residing here. The temperature increase is expected to reduce maize and wheat production while climatic variability will pose serious threat leading to famine and death of the poorest at first (PAN 2009). Some estimates suggest that rice production will increase with high precipitation and moderate increase in temperature (NARC 2009). In fruits and vegetable, increase in flowering and decrease in fruiting have been noted (Pradhananga *et al.* 2009). The changes in rainfall can cause devastating effect on crops leading to crop failure and ultimately food scarcity in the region (Regmi & Adhikari 2007a). The overall adverse impacts that can be accounted in agricultural sector has reduced crop production due to change in climatic parameters such as precipitation, temperature, mist and dews and some climate induced risks and disasters such as prolonged drought, erratic rainfall, landslide and soil erosion and disease and pests.

Climate change has also posed serious impact on entire livestock system by reducing the availability of fodder, grazing land, forest, water and causing various physiologic disorders such as thermal stress, problem in maturation and breeding and so on (SAGUN 2009).

Forestry and Biodiversity

Nepal is very rich in biodiversity accounting for 4.5% of the world's mammalian species, over 9.3% of bird species, 2% of reptiles, 6% of butterflies, 2% of flowering plants and climate can support more than 35 forest types (MOPE 2001). It is home to 5833 species of flowering plants, including about 248 species of endemic plant and 700 species of medicinal plants (ibid: 2001). The hazards induced by change in climate such as landslide, drought, and flood and forest fire have threatened the

existence of various plants and animals. For example hotter, drier summers are expected to increase evaporation and generally worsen the severity of fire seasons and increase the risk of forest fires across the Himalayan belt (Dahal *et al.* 2009). Similarly, change in rainfall and temperature would results in plant behavior like early flowering, shift in vegetation line (i.e. expansion of habitat of plants habitat of crops and plant species) and loss of some valuable species and NTFPs. The long drought and erratic rainfall have severely affected the wetlands and wetlands ecosystems (source).

Water Resources

The change in glacier ice and snowmelt impacts water storage and the water yield to downstream areas. The continued glacier retreat will cause two major effects on river system: i) increase in river peak flows which will increase in the quantity of glacio-fluvial sediments transported due to excessive melting, ultimately causing large-scale damage to downstream systems and ii) increase in threats arising from the formation and eventual outburst of high altitude glacial lakes. From 1977 to 2003, the seven Glacier Lake Outburst Floods were recorded with the severe damage to livelihood properties like house, land, bridge, highway, hydro-plant etc. The damage estimation reached over million US dollars (Chaudhary & Aryal 2009). Out of 2323 glacial lakes reported in Nepal, 20 lakes are found potentially dangerous (Brajacharya *et al.* 2007). For example, Khumbu glacier has retreated at the rate of 100m on average per year since 1953.(Shrestha *et al.* 1999). The study of Imja Glacial lake, the second largest glacial lake of Nepal in 2002, revealed that the lake expanded by 28% in last decade (Rai 2007).

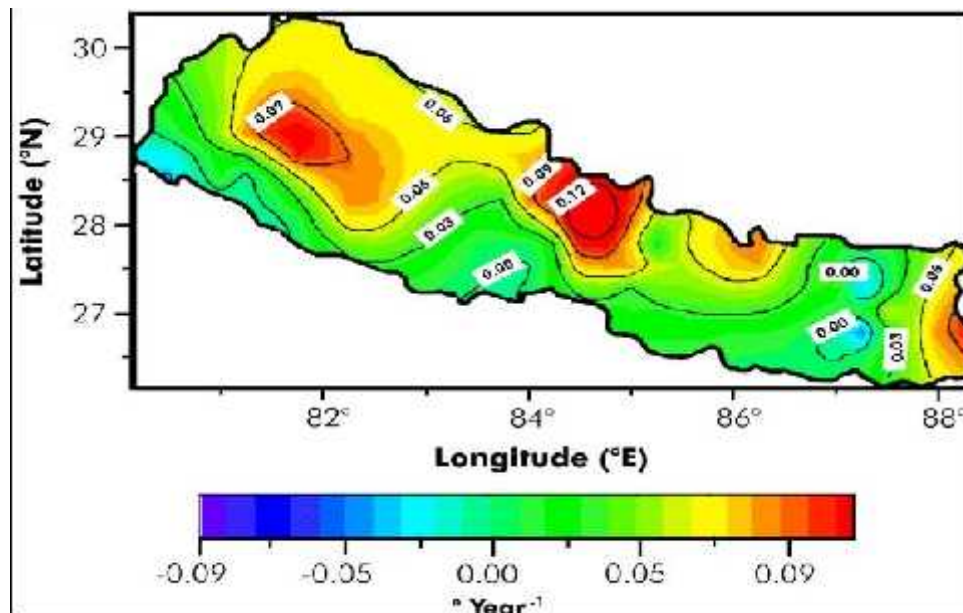
“According to Nepal’s Initial Communication to the Conference Parties of the UNFCCC, almost 20% of the glaciated area above 5000m is likely to be snow and Glacier freezat 1⁰C increase in air temperature” (MOPE 2004; Sundmann 2007). This shows the vulnerability and sensitivity of Himalayas and water resources in Nepal. These natural disasters have effect on plant and animal species composition both up and down streams, thus have significant impact on the ecological system as a whole (Chaudhary and Aryal 2009).

Health

Impact of climate change on health condition is divided into three categories: i) direct impacts from phenomenon such as drought, heat waves and flash floods ii) indirect impacts from climate-induced economic dislocation, conflict, crop failure and associated malnutrition and hunger and iii) indirect impacts due to the spread of infectious diseases because of changing environmental condition (WHO 2005). The increase in temperature increases the risk of expansion of infectious disease vectors like malaria, Kalaazar, Japanese encephalitis, particularly in southern regions of country (Eriksson *et al.*; MOPE 2004). The consequences can be mosquitoes moving to higher altitude, increased incidences of water borne diseases during disaster events, heat stress and heat waves. The exposure of communities to new diseases and spread of insect born diseases is anticipated with global climate change and population below poverty are likely to be hit at first.

The spatial distribution of annual temperature change trend of Nepal, 1977-1984 A.D. was presented in Figure 2. It shows that the change in temperature was different. Therefore the impact related to this may also varied. Though this is based on the temperature data of 1977- 1984, but still important to understand the changing trend of the annual temperature which may exceed its rate at present time.

Figure2. Spatial distribution of annual temperature change trends in Nepal, 1977-1984 (Shrestha et al. 1999)



Theoretical Perspective

Anthropology from its very inception, built an analytical and theoretical tradition. The study of interaction of human population and their surrounding is the fundamental subject matter of human ecology, which mainly focused on the environment, culture and human population (Milton 1997). From the early evolutionists through Steward, Rappaport, Vayda, Wolf, McCay, and others, environmental anthropology, cultural and political ecology have provided the conceptual tools to examine the complex interplay of culture, society, power, and environment (Lahsen 2007). The disturbances in human-environment interaction directly affect the human population and their culture. The issue of climate change directly hits the existing human-environment interaction and is a subject matter of the anthropology. In this context Timothy Finan (2009) argues that anthropology, provides an appropriate lens that allows a sharper focus on how best access adaptation, vulnerability, and resilience and provides both the theoretical concepts and methodological needed to shift the focus on the dynamic interface of natural and human system under change.

The debate on climate change formally entered within anthropology after the Rio conference of 1992 which formally recognized climate change as becoming one of the major challenges faced by the natural and human system in the new millennium. By the late 1990s, there was a talk of 'climate anthropology' as a field (Brown 1999 as cited in Batterbarry 2008). Then after anthropologists were involved in the diverse aspect of climate change research such as the local perception on climate change, climate change knowledge, interaction between the local climatic model and scientific forecast, impact of climate change on the livelihood and culture, coping and adaptive strategy to climate change, community base adaptation and public advocacy oriented issue like fairness, equity and human rights on climate change. The areas of engagement were increasing day by day. In this research I have tried to find out the peoples perception on the change, impact on their vital livelihood strategies (agriculture and livestock) and present adaptive and coping strategies followed by the communities at two different ecological and socio-cultural settings of Chitwan district.

Majority of the studies in climate change have focused either on arctic (Crate 2008, Henshaw 2009,) or on the sub sub-Saharan communities (Hitchcock 2009, Mertz O. et al. 2009). Even within these studies, some of them study about climate change

through local people's experience observation about the ongoing change in their surrounding environment- local perception (Crate 2008, Nutall 2009), while others emphasized on the social construction of impact and coping and adaptive strategies followed by the community in response to such change, and stressed on the importance of empirical studies for the better understanding of the phenomenon through humanistic perspectives (Staruss and Orlove 2003, Roncoli *et al.* 2009).

Local Perception on Climate Change

In the ecological anthropology, perception is the direct knowledge of an individual or groups of their environment in the course of their practical action (Gibson 1979, 1982 as quoted in Ingold 1992). Agreeing with Gibson, Ingold argues that "our immediate perception of the environment is in terms of what it affords for the pursuit of the action in which we are currently engaged". Environment sets the problem, in the form of a challenge; the mind organism embodies the solution in the form of its adaptive response accordingly how it perceives the particular event. The process of perception is also a process of action: we perceive the world as, and because we act in it (Ingold 1992).

People have their own way of classification and understanding of their environment which is embedded in the material and symbolic grounds of their culture through which their cognition was shaped. Local people are not only the witness of climatic event but are the active part of the ecosystem. Their experiences range broadly from erratic weather pattern, ecological variability, biological change and their ill effect on human well being (Crate 2009). However, they were not quite sure whether changes are due to climate change or some other reason. But they believe it might have some association with the changing climate and developed their particular way of dealing with changing climate. Therefore, apart from the holistic approach (global approach) on climate change it is equally important to understand climate change from the "eye and ear" of local people (Staruss and Orlove 2003 cited in Crate and Nutall 2009).

In the context of climate change, the perception of people varies according to where they live and act on a system (Ingold and Kurttila 2000). Even within the same place, different people observed changes in diverse aspect of natural phenomena related to climate, ecosystem and livelihood. The perception of people about climate change varies depending on how they interact with the change. For example, how a fisherman perceives about the changing climate will be different for the farmer living in the

same place. Through perception people classify the impact and risk and developed specific adaptive and coping strategies for combating climatic threats. They have their own perception about climate change and have own creative coping and adaptive strategies in the face of such changes (Chaudhary et al., 2008).

Studies on local perception of climate change around the world have focused on the different aspects of socio-cultural dimension and point out the importance of anthropologist for building community based research model that fosters collaboration between scientist and indigenous people (Henshaw 2009).

Ingold and Kurttila's (2000) study of the perception of weather among the Sami, reveals an almost seamless relationship between the people and their environment. The local people and their environment—experienced through inhabiting particular places—are bound in a mutually constitutive relationship through the simultaneous inscription of a set of meanings in the bodies of the inhabitants and the places they inhabit. Weather is experienced not through the prism of its impact on livelihoods alone, but is refracted through the human multi-sensory apparatus. The study takes a view of the organism and the environment as not two distinct entities with substantial overlap, but as parts of the same continuum and as emergent products of the process of continuous interaction.

Agreeing with Ingold and Kurttila, Vedwan (2006), study about the 'Local Knowledge and Perception of Climate Change among Apple Growers in Northwestern India' focusing on the perception of changes in the amount and timing of snowfall over the last three decades. In his study he tries to present a non-reductionist and nested model of human-environment interaction that explains the perception and knowledge of climate as a function of micro-level livelihood practices, as well as enduring and widely shared cultural notions of risk and vulnerability. Taking analogy from Vedwan, in this study I have used the perception of change in the climatic parameters (precipitation, temperature and mist and dews) over last two decade and more.

Crate (2009) points out the importance of the elder's knowledge while studying the local perception assuming that they are the witness of the ongoing change and have gained valuable information and experience about changing pattern of the climatic regime of their locality during their lifespan which was her pioneering works but still she talks less about the local adaptive strategies followed by the community while talking about the cultural implication of climate change and adaptive option. Differing

with Crate, I have intensively used the elder's knowledge in order to understand perception on change as well as the study about the impact and present coping and adaptive strategies.

Impacts of Climate Change

Climate change is projected on a global scale and is a global phenomenon. The increasing global temperature, the rising sea level, melting of the polar ice caps, retracting of the glaciers, longer drought, heavy erratic rainfall and wind pattern etc., are the some visible evidences of global change in climate system in present time (Regmi and Adhakari 2007b). The impacts associated with climate change have threatened and increased the vulnerability of both, natural (forest, land and water) and human system (health, economy and culture) equally, which ultimately brings the various destruction of the natural and social life.

Anthropologists' nowadays widely use the local and global level perspectives in climate change impact study research (Henshaw 2009, Crate 2009, Smith 2009). They assume that the impacts are socially constructed and vary according to the socio-cultural, political and ecological situation of the region. In this context, Henshaw (2009), analyzed the impact of melting of sea ice among the Inuit of eastern Canadian Artic. She focused on the socio-cultural dimension of such melting from. At local level, she documents the local perception on how melting of sea ice hinders the social mobility like traveling and hunting. Likewise, she talks about vulnerability and ways of coping of the Inuit communities. Documenting the climate change experience, the vulnerability they exposed to and the response they make to such change which serves as a catalyst for Inuit to work at the national and international level. She finally concludes that anthropologist should continue to play in building community based research model that fosters collaboration between scientist and indigenous people.

Likewise Mertz O. et al. (2009). Studied and analyzed the perceptions on climate change and the strategies for coping and adaptation by sedentary farmers in the savanna zone of central Senegal. Households were aware of climate variability and identified wind and occasional excess rainfall as the most destructive climate factors. Households attributed poor livestock health, reduced crop yields and a range of other problems to climate factors, especially wind.

Agriculture and livestock system are the vital livelihood source of the communities which primarily depend upon the natural resource for subsistence. So any change in

the climatic condition directly or indirectly affects the livelihood assets of the communities. Reduce in the crop yield, change in the cropping variety, change in cropping and harvesting time, poor health of livestock, decreasing grazing land and reduce in the productivity of the livestock are the major effect seen in the agriculture and livestock system. Various scholars (Crate2008, Mertz O. et al. 2009 Hitchcock 2009) have studied about the socio-cultural dimension of such impact around the world. In this context, the works of Crate (2009) about the impact on horse herding communities of east Siberia give good example about the impact of such change. Likewise Hitchcock (2009), studies about the San of Kalahari desert region of southern Africa. He discussed how san people they experience the environmental challenge like serious draught, floods, cold spells, hot spells and outbreaks of human and livestock diseases that have affected their livelihood for generations. In Nepal till the date, no anthropological works recorded on the impact of climate change to the livelihood assets but the research from outside the discipline have some important implication in understanding the impact on these system (SUGAN 2009, Gurung and Bhandari 2009).

Adaptive Capacity to Climate Change

Adaptation simply means the adjustment in natural or human system to new or changing environment. Adaptation to climate change refers to an adjustment in behavior that responds to actual or expected climatic stimuli or their effects which moderate their harm or exploits beneficial opportunities (IPCC-TAR2001). Adaptive capacity is determined by the community characteristics such as wealth, equity, political and social stability, access to infrastructure, institutional supports, and social capital. The IPCC working group II identified 228 climate change induce adaptation measure that can be broadly classified under: bearing losses; sharing losses; modifying the threats; preventing the effects; changing the effects; changing use and changing locations. Developing countries have lesser capacity to adapt and are more vulnerable to climate change damages, just as they are to other stresses. The condition is most extreme among the poorest people. Successful adaptation builds on local knowledge, local practices and willingness to act (WHO 2008).

Adaptation has major role in combating unprecedented effect of climate change (Adger et al.2006). The early works on the adaptation basically targeted to identify potential impact of future change using different scientific climate models. But these

models fail to furnish information on regional and local impacts that really forms a basis for catalyzing immediate and practical action in the context level. Natural and human system in different region may respond differently according to the geography, social structure and economy of the region. We can expect this at the regional, national, community and even at the individual level. Therefore, large and centralized adaptation measure may not expose the local realities and hence, might not be able to contribute on vulnerability reduction which is the urgent need impact.

Local people respond the unfavorable environmental condition by modifying the available strategies available for them In this context Smith (2009), studied about the relationship between climate change and population displacement. His focus was on the short and long term migration in response to environmental change. In addition, he concludes migration as one of the important adaptive strategies followed in response to environmental difficulties through out the human history. In addition to this, various scholar have conducted research on the local coping and adaptive strategies which are traditionally developed by the local communities in response to the uncertainties and adaptation to climate change (Vedwan 2006, Ishaya and Abaje 2008, Mertz O. et al.2009, Smith 2009, Lazrus 2009, Ensor and Berger 2009) from various parts of the world.

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

CHAPTER: THREE

MATERIALS AND METHODS

This study basically focused on the local perception, impacts and coping and adaptive strategies followed by the communities to climate change in the two VDCs of Chitwan district. This section concern with the rationale of selecting study sites, unit of study and technique of selecting respondents, data and data collection techniques , data analysis and scope and limitation of the study.

Rationale of Selecting Study Sites

One of the most critical issues of the fieldwork is the selection of the study area (Graner, 1997: 16). The effect of changing climate is experienced almost all over the country with different rates. However, natural and human system in different region may respond differently according to the geography, social structure and economy of the region. We can expect this at the community and even at the individual level. Taking consideration to this, I have selected two VDCs of Chitwan for this research purpose. Even within the short distance it was possible to explore two different ecological and social setting in the research sites having individually separate settings. One of the communities lies in the hilly region while another lies in Tarai region. Moreover, the study sites have primarily depended on the agriculture and livestock for the subsistence. So, it would be easier for the researcher to compare the differences in the perception, impact and adaptive measures followed by the communities in response to the ongoing climatic change.

Unit of the Study and Process of Respondent Selection.

The two communities selected for the purpose study are the broader unit of the study. Due to the nature of my study, I have chosen the elder member of the community purposively. This research focuses on how local people see the changes in climate through different climatic parameters and climate related risk and disaster near their vicinity in order to find out the local peoples perception on climate change and how these variation affects the entire agriculture and livestock system of the community. Finally I have paid attention on how local people cope with such unprecedented

change through various adaptive strategies. So I have paid special attention in selecting the respondents of the study area. For this I have selected the elder members of the community, assuming that they are the witness of the ongoing change and have gained valuable information and experience about changing pattern of the climatic regime of their locality during their lifespan.

Data and Data Collection

I have collected data with the help of widely used qualitative and quantitative methods. Specifically information was collected through interview and observation.

Primary Data

I have elicited necessary data and information on people's perception, impact and adaptation to the ongoing change and socio-cultural characteristics through in-depth interview and observation.

The field work for this research was carried out first in December, 2009 at Kesharbag and in March 2010 at Hattibang. During the last week of March, I had again visited Kesharbag to get some additional information that I felt necessary after I started writing the thesis. I was in regular contact with the local people through telephone also. In the field, I conducted the ethnographic interviews with 37 local people (21 at Kesharbag, Gitanagar and 16 at Hattibang Kaule) at both study areas. Respondent comprises mainly agriculture and livestock farmer along with ex-army man, and teachers. People were asked about change in their social and natural environment during the last 30- 40 years. Subsequently they were asked about what, in their view, explained the changing situation. If they mentioned climate as one of the variables, they were then questioned about the ways in which they perceive change in climatic parameters (temperature, precipitation, mist and dews).

During the course of the interview with the local people, I had primarily taken the reference of some climatic indicator like temperature, precipitation, mist and dew and some climatic risk and disaster like drought, landslide, hailstorms and windstorms, which were happening during their lifetime providing important generalization about the changing situation of climatic regime. One of the goals was to elicit, in open-ended manner information related to way of how people perceive in the local change in climatic condition. I focused on the relatively clear and shared perceptions of climate and associated risks and the subsequent response on the impact of the ongoing

change to the social wellbeing (agriculture and livestock) of the people, which was also the another goal of this study. Finally, after knowing the perception and impact I focused my attention on how people respond to such change through various coping and adaptive strategies. But during this course, I had never used the term climate change in its abstract form, because it might have created dilemma among them.

Observation is a major technique of data collection in anthropology. As a student of anthropology I also used the tool to collect some required qualitative information. Mainly, I observed the techniques and practices of crop and livestock farming in the respective sites. Furthermore I also carefully observed the impact of climatic extremes such as the disease on plants, effect of drought and hailstorm on maize plantation field (see figure 10 and 11 page no 42 and 43 of this thesis). In addition to these I have also observed the present coping and adaptive alternatives of the people for example the weaving of bamboo basket in Hattibang (see figure 14 page no 57) and wheat field and the shallow deep tube well in Kesharbag (see figure 6 page no 32)

Secondary Data

Relevant books and journals, magazine, articles, website, internet research/seminars papers, thesis, reports, government policy and act have been collected and studied. Some have accessed through internet while other have been collected from the relevant libraries.

The socio-demographic information regarding study sites were collected from, Central Bureau of Statistics (CBS) records. Moreover, I have visited the official webpage of Chitwan district for geographic and social data.

The climatic data (Temperature and Rainfall) of Rampur (the nearest climatological station from Kesharbag) and Dhading (the nearest station from Hattibang) over last 40 years (1967-2007) were obtained from Department of Hydrology and Meteorology (DHM).

Data Analysis

The data obtained from the field was further categorized for easy data analysis and interpretation and simple statistics like sum, average and graphs were used for descriptive analysis using MS Excel. Moreover, I have developed various themes from the interviews that have been taken with different individuals and analyzed accordingly. The research has adopted cultural model approach to analyze the

knowledge, beliefs and attitude of different individuals towards change in climatic parameters and climate related risk and disasters. The opinions and experiences of people are quoted in their own words. The real name of the respondent was listed here after taking their permission.

Scope and Limitations

The study was carried out at two different communities of Chitwan district.

The scope of the study includes following major activities:

1. Desk study of the published or unpublished reports, books, Journals, articles on climate change, its impacts, adaptation and local perception to extract secondary information and data.
2. On the basis of literature review to formulate the conceptual model for the study.
3. Field visit in the study area and conduct in depth interview, participation and observation.
4. Interpretation and analysis of result of the study.

Taking into consideration the restrictions of resource, time and extent within this study, the major limitations with the study are:

-) Only a section of the Gitanagar-7 Kesharbag and Kaule-3 Hattibang was taken for study.
-) The research has been conducted through anthropological perspective so the methodology and generalization may not fit on the other approach.
-) The study was focused on accessing local people's perception (especially the elder members), experiences, and adaptive mechanism to climate change. So the validation of these experiences with the scientific data was a major limitation. .
-) Detail physical vulnerability and impact assessment on the basis of the elaborated biophysical, environmental and climatological analysis and modeling was out of scope of this study.

CHAPTER: FOUR

PLACE AND PEOPLE

This study was conducted in socio-culturally and ecologically different two communities of Chitwan district. So this chapter deals with the geography and people of the study sites. It begins with the general information of Chitwan district which is followed by the information about Kaule VDC, Hattibang village, Gitanagar VDC and Kesharbag Village. Personal information of the respondents is placed at the end of particular Village information followed by the photos of respective study sites.

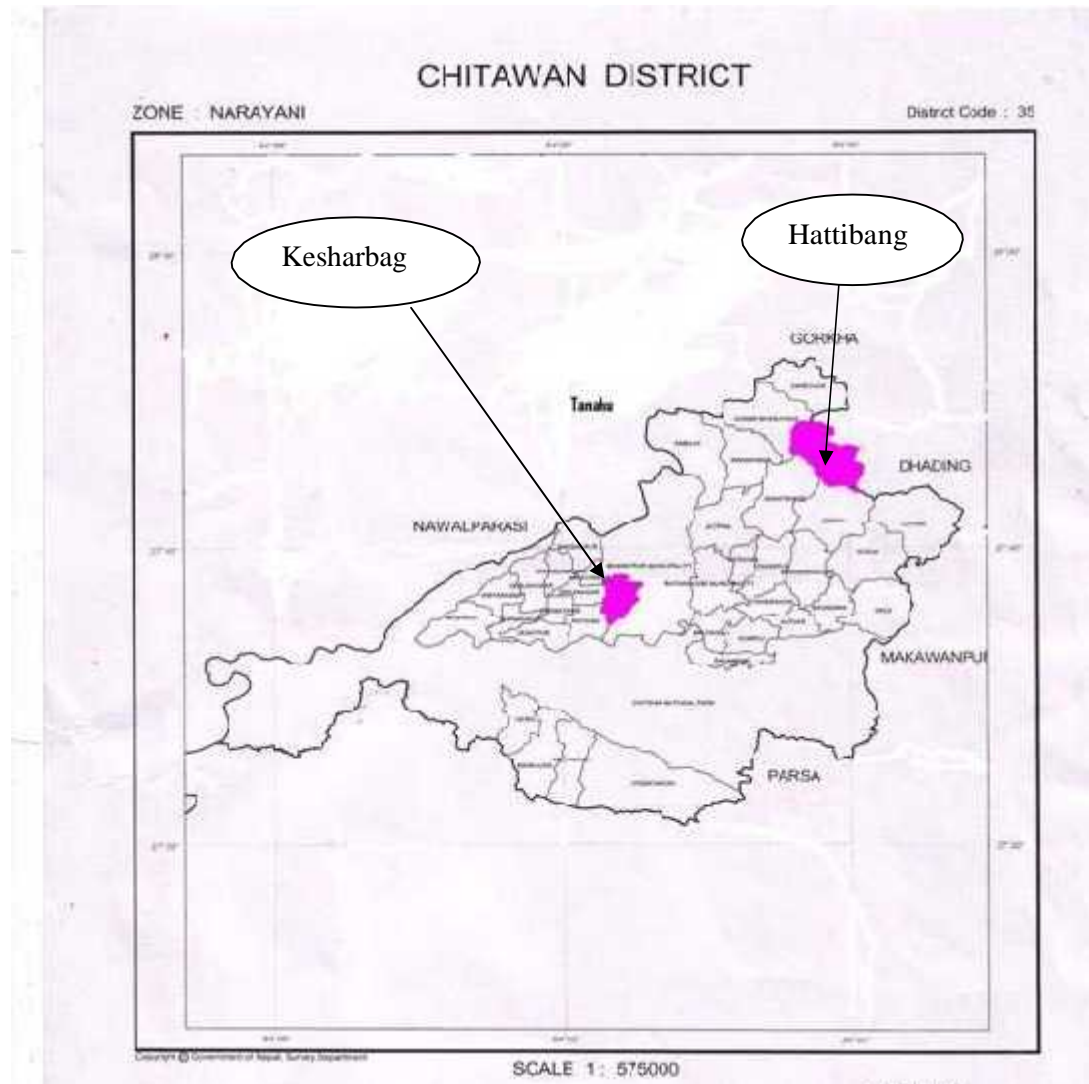
Chitwan District in General

Chitwan district ($83^{\circ} 55''$ - $85^{\circ} 10''$ East Longitude and $27^{\circ} 46''$ North Latitude) is located in the Inner Terai of central Nepal about 146 kilometers southwest of Katmandu. The district covers an area of 2,218 square kilometers. The district demonstrates good altitudinal variation having highest point at 1946 meter and lowest point at about 150 meter from the mean sea level. Therefore, variety of climate is available including tropical, subtropical and moist temperate type. The district has two hill ranges – The Mahabharat hill (2000m) and the Chure hills (900m) which has a wide tract of flat land, called Dun valleys (Inner Terai). This valley has occupied about the three fourth of the District and has average elevation 244 m above the mean Sea level. The annual rainfall is 1900 mm that is quite higher than the national average which is 1800mm. The average maximum temperature ranges between 28° C and 32° C and the minimum temperature between 15° C and 20° C (DHM data 1970-2007).

This district connects both plain, hill region with motor roads and posses vital role in the economy, and as it is linked with almost all parts of the country through the road transportation so is an important transportation centre of the country. The district produces a whole lot of rice, maize, wheat as well as mustard, since it has been recognized as a breadbasket of the country. It is not only agriculturally independent in itself but accumulates a stunning amount to the national production. Within itself, the economy of the Chitwan is highly dependent upon tourism, livestock, poultry and bee farming. Nationally and internationally it is the one of the famous tourist destinations having the homeland of the one horned rhinoceros at Chitwan National park. The

district geographical situation varies from plain to hilly buildings. Chepang are the dominant ethnic group residing in the hills of Chitwan district. Brahmins, Chhetri, Tamang, Gurung Magar, and Tharu communities inhabit in the plain. Due to the agricultural and infrastructural attraction, it seems that no population of no district has been failed to incline to Chitwan for permanent migration, as it has been called the 76th district of Nepal.

Figure3. Map showing the study sites



Kaule VDC

It is located in the Mahabharat range in northeast of Chitwan district. The Shirichuli, Pangshirang and Chaukidada of Mahabharat range separate it from the Chitwan valley. Chandibhanjyang VDC borders it at the west, Shaktikhor VDC and Siddhi VDC to the south and the Jogimara VDC of Dhading District at the east and north. It lies in the catch-up region of Hugdikhol. The elevation ranges from about 650 meter to 1946 meter, which is the highest point of Chitwan district. It is one of the remote VDCs of the district having no connection to the motor road. It takes about 6 hours of walking and 2 hours of bus drive to reach the district headquarter Bharatpur. A small foot trail connects it to Hugdi bazaar of Dhading to the northwest and Shaktikhor bazaar of Chitwan to the south, which was one of the important trade route of Chitwan and Lamjung, Gorkha, Dhading Tanahu and even Katmandu also before the construction of the Mugling-Narayanganj Highway. Uppardanghadi, the headquarters of Chitwan district before 1960, is located in this VDC. Most of the steep slope topography of this VDC is covered by forest, pastureland and cultivated land.

According to the 2001 census, the total population of this VDC was 4691, with 2396 males and 2295 females and 732 household, dominated by the Chepang as it is the homeland of Chepang. In addition to Chepang, other castes like Gurung, Magar, Brahman and Chettri are also settled. The economic condition of this VDC is poor in comparison to the other plain VDCs of Chitwan district due to its steep/slope landscape and lack of infrastructure of the development. Crop farming and livestock keeping are the mainstays of the majority of the people. Climatologically, it is located in the moist temperate climatic zone with relatively less rainfall than the Chitwan valley.

Hattibang Village

Hattibang is located in the south western area of the lower Himalayan foothills, in the lap of Mahabharat range facing towards the northeast direction. Among the nine administrative wards of the Kaule VDC, Hattibang lies in ward no 3. It is in the elevation of 1410m from the mean sea level. Historically, it is the important transit point between Shaktikhor of Chitwan and Hugdi bazaar of Dhading district, which is regarded as the important trade route of that region before the construction of the

Mughling-Narayangraha highway. Sirichuli the highest point of Chitwan district (1946m) lies to the west of the village. This village comprises of about 90 households, majority of them are of Chepang. The Chitwan Chepang Hill Trekking Trail passes through this village and divides it horizontally into two parts. Habitation of Brahmin, Chettri, and Magar is located above the trekking tract while Chepangs live just below it. The houses are colored by red mud (*ratomato*) with zinc-sheet, stone and thatched roof. The cattle shed lies near to the house; cow and goat are the common livestock reared in this village. Almost all the houses possess orange and pear garden.

The majority of the population is dependent on the natural resources and monsoon climate for livelihoods. Crop farming and livestock is mainstay of the majority of the people. In addition, wage labor, off farm employment, providing home stay services, fruit farming and selling of local handicraft like *Doko*, *Dali*, *Kucho*, *Nanglo* to the nearest market are the complementary sources of income generation. Maize, millet and wheat are the major crops produced here. A high school is located in the west corner of the village and a health post nearby. Hattibang khola (bijog khola) a tribute of Hugdi khola flows from the west to east direction from the northern side of the village. A community house is situated in the eastern side of the village. After the Chepang hill trail was introduced for tourist in this village, the facility of home stay has also been open.

Electricity is not available in the village, and is entirely powered by solar energy. Footpaths link home to the service centre (community house, school and health post) and the Chitwan Chepang hill trekking route which passes through the village and connects the village to Shaktikhor to the south and Hugdi bazaar of Dhading district to northwest. During the rainy season, mobility is often temporarily limited by the flash floods in the streams. Piped drinking water is available through community taps for more than 90 percent of the population; water is usually available from 6 am to 6 pm. There is a well stocked natural forest to the western side of the village dominated by *Chilaune*, *katus*, *guras* and other *NTFPS*. People collect fire wood, foliage for fodder and beddings for livestock, and timber for the construction of the house and cattle sheds. Some groups, particularly the Chepangs, largely depend upon the forest for food and income. They collect wild fruits, twigs, tubers and plants for their daily use, and fuel wood for both domestic use and for making various Handicraft goods like *Doko*, *Dali*, *Kucho*, *Nanglo* and sale them to buy groceries and clothing. The environment services provided by the forest are perceived to be important.

Almost all the families in the area were engaged in subsistence agriculture and livestock rearing. Among the total respondents, only 38 (n=16) percent were solely engaged in agriculture. Only 3 respondents' possess irrigated rice fields (khet). Four farmers had been cultivating land owned by others on a crop sharing basis. Only 3 respondents reported that they were able to meet their annual food need from their own production, eight respondents' household have enough food for less than six months. Five had produced food for 6-12 months from their own land. Wage labor, working outside the area, and remittance from the family members are the main other livelihood strategies. Young men like to go out of the village to work. Since young men tend to work outside the village, capacity and responsibility for immediate response to disasters rests mostly on older household heads and women. Among the 16 respondents interviewed, half of them were literate, i.e. able to read and write in Nepali language. Only 1 individual had attended university. Most of the illiterate were women.

Seasonal sickness (common colds, fever, diarrhea) are common. Mild malnutrition is common among children from poor family backgrounds, especially among the children from Chepang community. The average household size was found to be 5.73.

Figure 4. Photo of Hattibang village from southwest direction



(photo by the Researcher)

Figure 5 Photo of Hattibang village from East Direction



(Photo by Parajuli R March 2010, through personal communication)

Gitanagar VDC

Gitanagar lies in the lower plain of Chitwan district in an elevation of 220m from the sea level (chitwanonline.com). It is surrounded by Bharatpur to the north, Saradanagar

and Shivanagar to the west, Patihani to the south and the buffer zone Chitwan National Park to the east. The climate of the area is sub-tropical monsoon. The meteorological records at Rampur station, the nearest station approximately 3 km west shows an annual average maximum temperature between 29⁰ C and 32⁰ C and minimum temperature between 16⁰ and 19⁰ (DHM data 1970-2007). The average annual rainfall of the area for 24 hours was 1995.5 mm (Gurung et al 2009).

According to the 2001 census, the total population of this VDC was 12106 with 5983 males and 6121 females having 2101 household. The habitation in this village was started from 2018 when the government implemented the re-habitation program in Chitwan district. People from various districts came to settle here, so we can find diverse caste groups like Brahman, Chhetri, ethnic groups and Dalits. This VDC is famous for agriculture and livestock farming in the Chitwan and throughout the country also. Paddy, maize, wheat, mustard, lentil and vegetables are the major agricultural products produced here. Cow, buffalo goat and poultry are the major livestock reared in this place.

Kesharbag Village

Kesharbag village lies in the ward no 7 of Gitanagar VDC. It is in the elevation of 220m from the mean sea level. Bish Hazari Lake, one of the important wetlands (Ramshar area of Nepal) lies in the east of the village in the buffer zone of Chitwan national park. Narayangarh- Madi – Thori highway lies in the west of the village. A high school lies in the west of the village. This village comprises of about 250 households. We can find diverse habitation of different caste groups here including Brahmin Chettri, Gurung Gauchan, Parayer, Bishokarma, Kumal and so on. Crop farming and livestock keeping are the main livelihood source of the people. Paddy Maize, Wheat and Mustard are the major crops grown in this place. Cow and goat are the major livestock reared here. In addition to this government service, business, foreign employments are the alternatives source of the income of the people. In the past, this village completely depended upon the seasonal rain for agriculture, but now the situation has quite changed, as people have constructed the shallow tube well for the irrigation purpose.

The commercial cow farming was started when the government formally recognized it as a cow farming pocket area in 2042 BS. The Annapurna Milk Producers Cooperatives, which was established in 2042 and is located in the center of the

village, is one of the leading Dairy of Chitwan district as well as of Nepal. It collects more than 4000 liters of milk per day. Next to the dairy, there is a veterinary office and a private boarding school.

Electricity is available in almost all houses. Gravel road link home to the service centre (Dairy, veterinary, school) and main road. Underground water is the main source of drinking water. Almost all the houses possess at least a well or hand pump set, they are vulnerable to long drought, less rain and even by heavy rainfall. Nowadays people construct deep boring in a community level and seasonal (summer) irrigation channels, which also are similarly affected. There is a well stocked natural forest dominated by *Shorea robusta* (*sal*) to the eastern side of the village which lies in the protected buffer zone of Chitwan National park, where there is no free entrance. People collect fuel wood, foliage for fodder and beddings for livestock, and timber for the construction of the house and cattle sheds when forest was open for 10-15 days two times in a year. Nowadays the dependency of the people on the forest is decreasing in comparison to the past years as they have become less dependent on the forest products such as fire wood, fodder and foliage.

Almost all the families in the area were engaged in subsistence agriculture and livestock rearing. Among the interviewed respondent 57 (n=21) percent were solely engaged in the agriculture. Sixteen respondents' household possess irrigated rice fields (*khet*). Three of them had been cultivating land owned by the other on a crop sharing basis. Only 7 respondents reported that they were able to meet their annual food need from their own production, 4 respondents have enough food for less than six months. Ten respondents household have produced food for 6-12 month from their own land. Livestock farming, wage labor, and remittance from the family members overseas are the main other livelihood. Fifteen individual from the respondents family were working overseas. Young people like to go abroad for work and study. Among the 21 respondent interviewed, 12 of (57 percent) the respondent are literate, able to read and write in Nepali language among them 6 individual have attended university. Most of the illiterate are women. The average household size was found to be 5.31.

Figure 6. Photo of Kesharbag village with shallow deep-tube-well and wheat field.



(March 2010 by researcher)

CHAPTER: FIVE

PERCEPTION ON CLIMATE CHANGE

The main objective of the research was to understand the perception of the local people on climate change. So this chapter basically concern with the perception of the people. In this research perception of climate change is divided into major section. At first the perception of the elder members of the respective communities on the change in the major climatic parameter was noted and tally available meteorological data of the nearest meteorological station. In the second section the perception about climate related risk and disasters on the basis of risk ranking was presented which was important to understand how local people frame their perception on changing climate change on the basis of their lifelong experiences.

Perception on Climatic Parameters

People think that climate has indispensable role in the entire livelihood system of the community. When asked about the change in climate, respondents most often began their response by describing the changed pattern in the local climatic condition particularly with respect to the change in precipitation, temperature and mist and dew pattern during their lifetimes as well as the impact due climatic related risk and disaster. Recollection of memorable events, like the largest disaster and event during the entire course of the time, was the most common method individuals used to discuss the change in the climatic variable. These salient events were almost always recalled and described in conjunction with other meaningful activities and occurrences, typically journeys undertaken, family affairs, and individual life history (Vedwan 2006).

Precipitation

From the interviews with the respondents it has been generalized that the rainfall has decreased in amount and it has also displaced in time. People compare the frequencies and amount of the rainfall they have noticed during the course of their lifetime. Mr Bishnu Prasad Gauchan of 90 years, a local resident of Kesharbag, shares his experience as follows:

“I came here from Myagdi district and continuously living here since 2020 B.S. Enough rainfall (in winter/summer) used to be prevailing in this place. Since 10 years time, the winter rainfall is almost rare whereas the summer monsoon is also uncertain and is decreasing. During my whole life span, I never experienced such a drought as in year 2001. During winter we did not receive enough rain and even the monsoon started late so we faced problem in cropping. Our winter crops almost fail which is the only one means for us to earn cash. In addition, due to the late monsoon, the production of rice was reduced to half in amount. Moreover we also faced similar situation in the year 1969, 1991 and 2006 A.D. and that year many water wells were dried along with the failure of pre-monsoon and monsoon crops.”

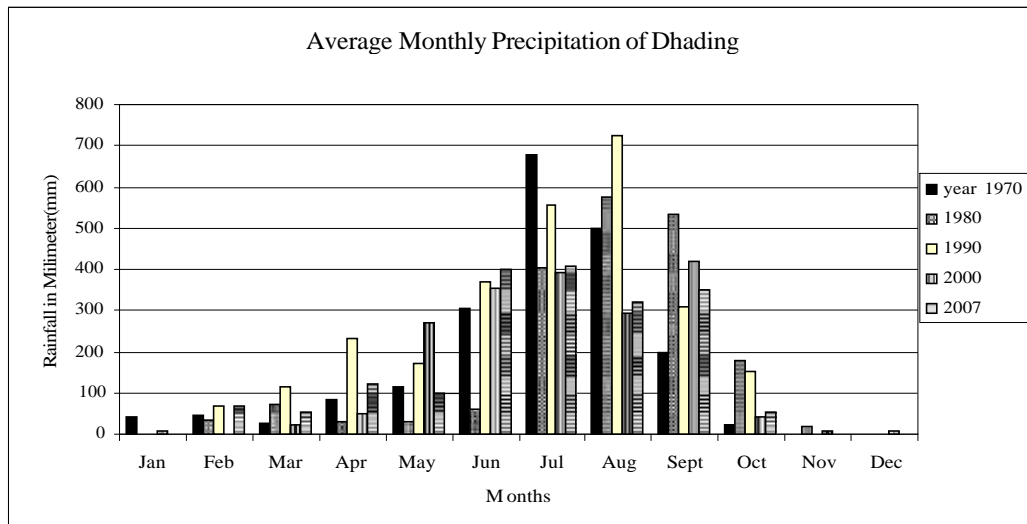
In this context, Mr. Bir Bahadur Praja (Chepang) 83 years old local resident of Hattibang has never heard about the climate change or global warming but he knows something has been going wrong with the rainfall that everyone in the Chitwan hill depends on.

“We either get too much or too little rain these days” he says. “It rains when we want dryness and it’s dry when we want rain. If our crops do not grow, we do not have food, so that means we die. Moreover sources of drinking water were going to vanish forcing our life in deep thrust.”

His reasoning underlines the seriousness of the situation facing all smallholders and marginalized people of the hill region.

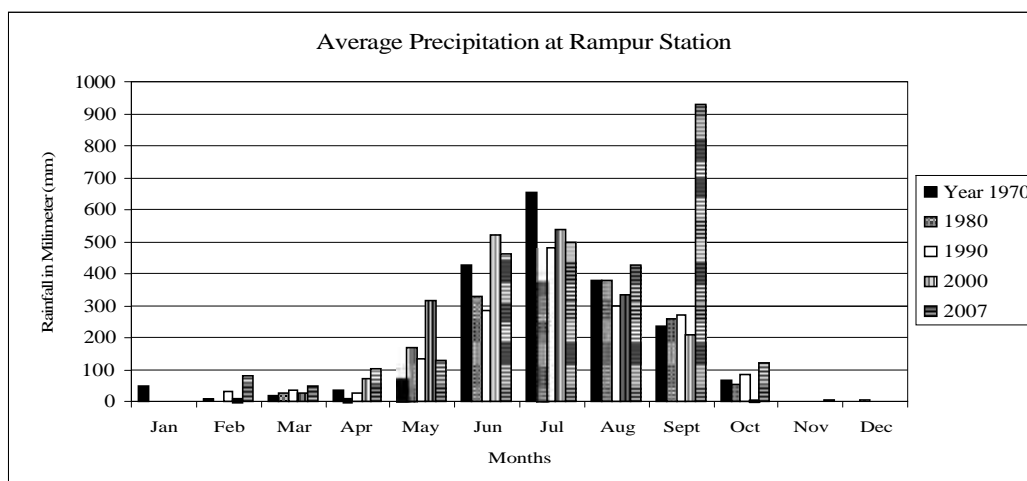
About 67 percent of the informants ($n=37$) felt that the amount of rainfall per month had decreased and 24 percent of them felt that the amount and time of the rainfall has changed. The average monthly precipitation records taken by the department of the Hydrology and Meteorology (DHM) at Rampur and Dhading (the nearest climatological Station from both study areas respectively) show there is significant variation in the timing, frequency and amount of rainfall, that supports perception of the local people.

Figure: 7. The average monthly precipitation of Dhading station (rainfall records 1970-2007, DHM)



The figure 7 shows that in 1970, heavy rainfall started in July and was decreased in coming months. However, in the year 2007, June, July, August and September received almost same amount of rainfall. There was also decrease in the amount of rainfall during July in comparison to the past years, the rice plantation time of local people. Moreover, there was also decrease in rainfall during November, December and January too, which had negative impact on the winter crops.

Figure: 8. The average monthly precipitation of Rampur station (rainfall records 1970-2007, DHM)



Records from Rampur station shows that heavy rainfall which used to take place during June/July has been shifted to September. In addition to this, there has been

decrease in the rain fall during the of winter months (November, December and January). Between these two stations, records from Rampur station show significant change in precipitation pattern.

When talking about decreasing rainfall, for example, local people compare the amounts of rainfall at different time span within their locality as well as other several places to indicate a pattern. They felt that the frequency of rainfall in winter has decreased over time along with the decrease in amount of monsoon rainfall.

Temperature

Like change in the rainfall pattern, people of the study area, the elder people in particular, mentioned that they have noticed a significant change in the temperature regime of their area. Among the two field sites, Hattibang and Kesharbag lies at the altitude of 1400m and 220m respectively from the sea level so there is wide variation in temperature regime. Respondents from both sites claimed that the place is getting warmer in comparison to the past days. According to them the days and night in the winter seasons used to be very chilled in the past. But during recent years, they are experiencing less chilled winter days and nights. Similarly during summer season, the days are becoming hotter. One of the interesting cases happened while I was interviewing Mr. Gambhir Bahadur Rana Magar, the ex-chairperson of Kaule VDC. He was arguing that there is no significant variation in the temperature. His wife Pej Kumari Rana Magar, (55) working in the courtyard explains her observation about the temperature in contrast to him like this;

“This place used to be sufficient cold that we could not avoid quilt (*Sirak*) in the night throughout the year. We used to go to the nearby forest (*Ban*) in order to gather fodder and firewood. The winter mornings were too chilled that working outside house before sunrise was quite difficult. But now, we quit blanket during summer night (*Garmi masa*). In the daytime of summer we feel more heat even staying inside house. Similarly winters are not cold as before. We did not experience the presence of mosquito here; it's been only 5/6 years that they are now playing much around.”

From the above mentioned story it has been clear that local people perceive their change in their environment through what they observe and experience while inhabiting on the particular place during the entire course of the time. In this context Ingold and Kurttila's (2000) argues that the perception of local people about their

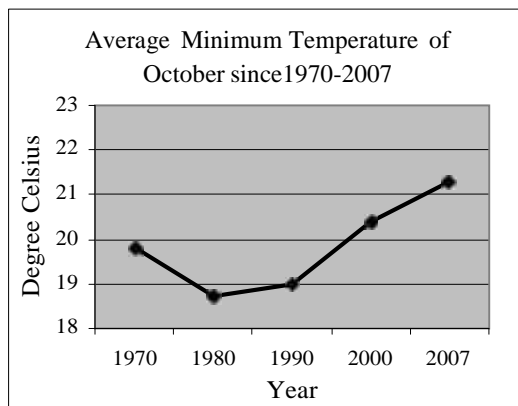
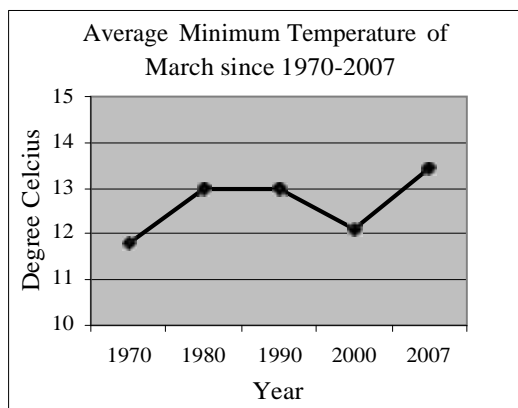
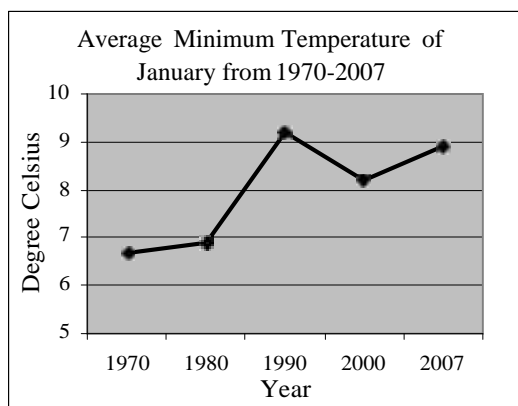
environment—experienced through inhabiting particular places—are bound in a mutually constitutive relationship through the simultaneous inscription of a set of meanings in the bodies of the inhabitants and the places they inhabit. The process of perception is also a process of action: we perceive the world as, and because we act in it. (Ingold1992). In Kesharbag, Sanumaya Khati 55, shared similar experience about the changing climate.

“Generally, in the past the winter season last with the start of March (2nd week of the falgun), but, now days become hotter after the second week of February the (end of the Magh). It creates difficulty in working in the field during the harvesting of Mustard and other winter crops. So since past 10-12 years, we change our working time, we prefer to work in the morning and evening instead of the daytime which we used do in past”

From the above two illustrations it has been clear that people have their own way of understanding about the phenomena happening in their surrounding. They frame their understanding in relation to the activities they have performed during the course of their existence.

The local observation on the temperature is also supported by the average minimum temperature records of the Department of Hydrology and Meteorology, Rampur station. The available data showed a clear increase in mean minimum temperature for the months January (the coldest month of the year), March (the transitional month between winter and summer), and October (the starting month of winter) (see fig 9). If we compare the mean minimum temperature of above mentioned months of year 1970 and 2007, we can see an increase of 2.2⁰C (in January), 1.6⁰C (in March), and 1.5⁰C (in October). This data supports the local perception of being less chilled mornings and nights of those months. From the presented data what we can generalize that there is an increase in mean minimum temperature of winter months.

Figure: 9. Chronological monthly average minimum temperature records of Rampur station (DHM, 1970-2007).



About 80% respondent in Kesharbag felt warmer winter since 20 years, which is further supported by the metrological data presented above figure 9. According to them they experienced pronounced effect of temperature increase on the winter days as the winter mornings and nights getting warmer or less chilled. But in Hattibang more than 93% peoples are experiencing an increase in temperature every year.

Mist and Dews

Like temperature and precipitation, mist has its own role in the climate of any area. While conducting the interviews with the local people of the study area, it became clear that the mist and dew pattern in both of the study area has changed in comparisons to the past. In Kesharbag, local people consider mist and dew to be crucial for the maintenance of proper levels of soil moisture and humidity in the winter season. – essential for the better yielding of the winter crops. They showed their concern about the uncertainty in mist instances. About 52% of respondents felt that the pattern of mist and dew are fluctuating, at the mean time around 42% do not see any significant decrease in mist instances. Rewati Raj Pathak, 93, resident of the Kesharbag Chitwan shares his experience about the mist pattern of this place in this manner:

“During December and January, dense mist used to prevail till 12 of the noon; it was settled down in the form of the dew then after the days remain sunny. Since 10 years, the thick and dense mist that used to recharge soil moisture no longer occurs...insufficient moisture prevents the proper growth and the production of winter crops especially the mustard (Tori). Moreover, the uncertain day long mist with low humidity, continuing 3-4 days causes various fungal diseases to potatoes and mustard (lie) since 10-12 years. So, the use of the pesticide is increasing these days, which makes winter cropping difficult and costly.”

Agreeing with Mr. Pathak, Ramila Sapkota a 38 years old beekeeper of the same place argues,

“Although the density and frequency of the misty days had been reduced, but the mist with low moisture prevail all over the day prevents honeybees going for the nectar collection which lowers the production of honey and ultimately reduces the production of mustard causing problem in the pollination of the flowers.”

The response of people about mist in the Hattibang is somehow different from the people of the Kesharbag. Around 50% of respondent noticed that the pattern of mist was stationary; where as 25% perceived a slight decrease in mist occurrence. Difference in people's perception among these two research site may be because of

the geographical location of the place or due to the lesser impact of the phenomenon to the entire socio-cultural and environmental system.

Perception on Climatic Risk and Disaster

The global and national data clearly indicates an increase in frequency of natural disasters for last few decades. Socioeconomic and environmental losses caused by these natural disasters are increasing. Different analysis revealed that weather/climate (hydro-meteorological) induced disasters are the principal contributors to the present increasing trend of natural disasters (Regmi and adhakari 2007b). Showing conformity to this global trend in the last two decades, Nepal has experienced an increase in the frequency and the severity of weather related disaster particularly heavy rains resulting in floods and riverbank erosion in the Terai, and landslide, soil erosion and debris flow in the mountainous area. Hailstorm, windstorm and long drought are other weather related disasters significantly interfering natural and human system. Such an increase in weather/climate related disasters might be correlated with change in climatic system and human activities.

Local people classify and understand the climate related disaster according to the hazards that affect the existing human environmental relationship and as well to the socio- cultural environment. Since risk is a culturally defined notion (Crate 2008 & 2009). Therefore the perception about the risk is determined through, how it hit the existing system.

During research period local people of both study sites categorized the risk according to the impact affecting them. When respondents were asked to classify the hazards in terms of the severity and risk they are experiencing, in Kesharbag majority of respondent considered drought as one of the most significantly affecting hazards, whereas landslide was recognized in Hattibang (see Table 1). This indicates that these disasters are the most significant and trouble creating hazards of respective community. But in case of Kesharbag landslide was not considered as a risk to the local livelihood. This indicates that different geographical region have different climate induced hazards and the people's perceptions also vary accordingly. Though to some extent geography and place of residence determines the type and intensity of risk, how people perceive also plays significant role in classifying hazard. In Hattibang 12 out of 16 perceive hailstorm as the major threats for them which destroy

their orange and pear garden whereas those who don't have the pear and orange garden were less affected by the same risk.

Table: 1 Respondents classification of the climate related risk

Categories of climatic risk and disaster	Kesharbag (No. of respondent)			Hattibang (No. of respondent)		
	Rank I	Rank II	Rank III	Rank I	Rank II	Rank III
Drought	11	6	4	10	5	1
Landslide/Soil Erosion	N/A	N/A	N/A	14	2	0
Heavy Rain	5	7	4	9	4	1
Hailstorm	2	4	9	12	2	2
Windstorm	3	8	5	12	3	1
Forest Fire	N/A	2	5	8	4	2

(Field Survey: 2009/2010)

During the field study the respondents expressed their grave concern over the increasing frequency of the natural disasters in the village. The majority of them responded that frequency of natural disasters is increasing. According to the elders members of the community not only frequency of these disasters has increased but associated risk and loss have also increased significantly. In Kesharbag 57% of total respondents thinks that there is an increasing trend of occurrence of natural disaster, while 23% were disagreed on this. Similarly, in Hattibang 68% respondent were agreed and 12% did not support the idea.

The natural disaster caused significant damage to the socio-economic and environmental assets of the community. Nearly half of the interviewed respondents have mentioned that the loss of the agriculture land and crops are the major impacts. Other repercussions include economic and social loss in terms of properties, human social – cultural life and animals.

For the rural peoples, agriculture and livestock farming are the major livelihood options. Landslide, soil erosion, erratic rainfall and prolonged drought days are threatening the agricultural systems. On the one hand peoples do not have sufficient landholdings and on the other hand they are out of the new technological advancement for the betterment of farming as well as to minimize the impact of changing environment. Moreover prevalence of adverse conditions during planting, growing and harvesting of agricultural products practiced on available landholding is reducing crop productivity. These all have a cumulative negative impact on their livelihood. As a result of disrupted income sources, losing of lands, properties,

animals and even family members peoples are migrating to new places searching better options. Some have chosen to go abroad in search of high income jobs. This is – in my view – a strategy to cope against present changing environment. Therefore the climatic risk and disaster like drought, landslide, soil erosion, hailstorm and windstorms that were happening during the course of individual's lifetime provides the important generalization about the changing situation of climatic regime and perception of the people and the impact of such unprecedented changes. In addition, it helps to elicit the information on how people observe these phenomena and ultimately help to trace the people's perception on the ongoing climatic events.

Figure: 10. Effect of drought in maize in Hattibang village



(Photo by Parajuli R March 2010, through personal communication).

Figure: 11. Damage by hailstone in the same maize field of Hattibang after three day.



(photo courtesy Rabindra Parajuli March 2010).[®]

[®] These two photographs were taken in same maize field but in two different corners in two different days. First photo (fig 10: taken 4 days earlier to second) shows the desiccating maize siblings and second (fig 11) reflecting the hailstorm destructed siblings. From these two photos we can easily generalize the erratic climatic pattern prevailing on Hattibang.

CHAPTER: SIX

IMPACTS ON AGRICULTURE AND LIVESTOCK

This chapter deals with how the changing climate affects agriculture and livestock management practices system of the communities along with local people's observation and experience.

Agriculture

The agricultural system is highly dependent on the climatic factors (such as rainfall, temperature, humidity, radiation and so on), intrinsic factors (such as soil texture, soil nutrients, soil moisture) and living organism (such as the soil microorganism, pest and animals). Besides these many extrinsic factors such as fertilizers, human labor, pesticides, market, road, and irrigation facility also play vital role. So any change in the agricultural system is the sum total of change in all these factors. Present study is mainly focused on the impact of different climate induced factors in the community and based on local people's perception and researcher's field observations.

More than 90% of the population of both of the research sites directly or indirectly depends on agriculture for livelihood subsistence. They follow traditional cultivation practices that rely on seasonal rain fall. So, any change in climatic factors causes adverse impacts on people's livelihood, thus increasing risk to food insecurity. Thus climate change have direct impact on the economic- wellbeing of the community. The major impact observed by the local people in the research sites are presented in the Table 2.

According to the people of Kesharbag, the unprecedented rainfall pattern (in timing and frequency) severely affected and caused shift in agricultural calendar. Moreover, the increasing temperature and long drought caused reduction in the soil moisture and increased desiccation; causing problem in germination and survival rates after planting crops. Respondents have observed the significant decline in production of the crops over the past 15 years or more. The principal matter of the concern is that the seasonal calendar of both research sites has been changed due to the change in the climatic parameters and increased frequency of disasters. Different types of diseases and the pest outbreaks and fungal diseases to the potato and mustard plant are the main problems faced by the people these days. Although the use of the chemical

fertilizer and pesticide is increasing day by day, the production of all crops is decreasing.

Table: 2. Peoples observation of the impacts on agriculture

(Field Survey, 2009/2010).

Impacts	Peoples Observation by Area	
	Kesharbag	Hattibang
Loss of local variety of crop	Maize (<i>Local Pahalo</i>) Wheat, Rice (<i>Manshara ,Dudhraj, Asnhame Masino, Aapjhutte</i>)	Maize(<i>Local Seto</i>) Wheat,Millet (<i>Dalle Kodo</i>) cucumber
Loss of production of key crops	Maize, Rice and Mustard	Maize and Pepper
Change in cropping pattern due to climate related extremes	Change in cropping calendar (maize and rice plantation) Difficult to grow local crop variety,	Change in cropping calendar (shift in the plantation and harvest of maize because of reduced in number of days to mature)
Paste and disease	Increasing <i>Gabaro</i> disease in Maize), Aphid(<i>Lie</i>) in Mustard and Rice (<i>Rate, Seto Putali</i>)	Increasing more to wheat (<i>Kalo Poke</i>) and Maize
Input of production	Costly due to use of pesticides and chemical fertilizer	Started using pesticide since a couple of years back
Emergence of new crops	Wide use of genetically modified crops especially more on rice and maize	Relatively lower use of genetically modified crops. But start of cropping new cash crops like Beans(<i>Ghyau seemi</i> , hybrid cucumber, new varieties of maize etc.
Fruits and Vegetables	N/A	Started cropping cauliflower, new varieties of pepper as local seemed really vulnerable to present conditions.

Similarly, in Hattibang people believe that the agricultural system is subjecting to various changes in comparison to past. People observed that some varieties of local crops, especially maize (*local Seto*) and millet (*dale kodo*) are about to vanish from the area. The productivity of major crops is declining every year. Several new disease and pest problems are being reported these days. Moreover, production of fruits (orange and pear) is decreasing by both qualitatively and quantitatively. Erratic hailstorm and strong windstorms during the time of flowering and fruiting of these fruits are the major climate induced hazards reducing the net yield hence threatening local economy. In addition, various diseases to the orange plant affecting plant health causing immature ripping of the fruits and even dying out plant.

Change in Production

When the respondents of Hattibang and Kesharbag were asked to express their ideas about the agriculture production within the past 15- 20 years, majority of them in both the study sites were arguing on behalf of changed agricultural production. In Kesharbag, about 52% (n=21) respondent believed that overall agricultural production is decreasing, whereas 29 % argued that the production is increasing and remaining 19 percent didn't express any idea about change in production. The case is slightly different in Hattibang where about 74% (n=16) noticed significant decrease, 13% for increase and 13% noticed no change in agricultural production. The difference between these two sites may be due to the geographical and other social parameters like access of the road, utilization of the technology, knowledge levels which ultimately provide the adaptive capacity of the community. The detail is shown Figure 12.

Figure: 12. Change in agriculture production

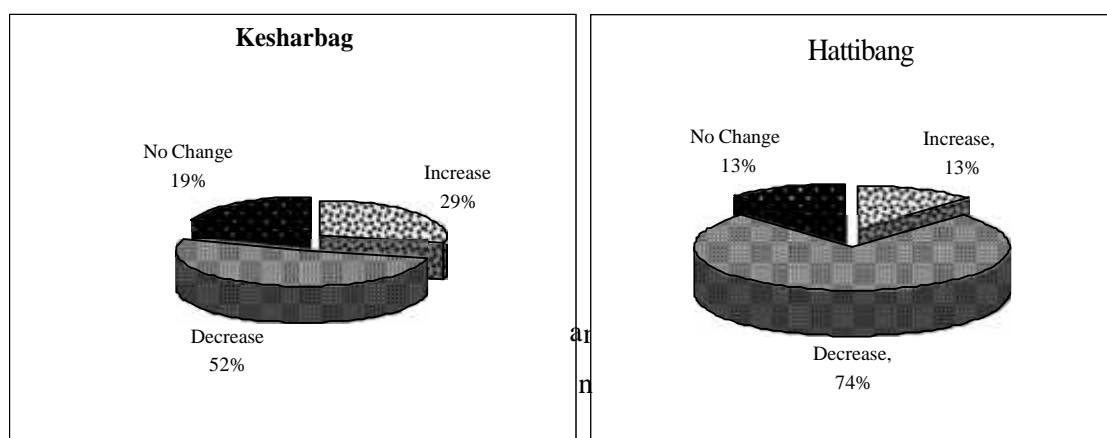
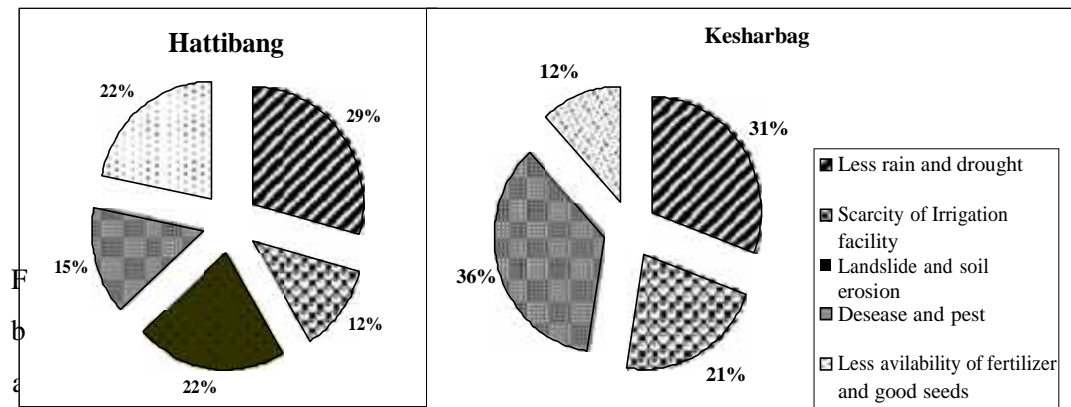


Figure: 13. Cause for reduction in agriculture production



large impact on reduction in the production of both the sites (Hattibang 29% and Kesharbag 31%). But, the case is quite different for landslide and soil erosion. In Hattibang, people consider landslide and soil erosion (22%) as the second largest factor for decline in agriculture production which has no significant role in the Kesharbag. It is mainly due to the geography and landscape of the area where people inhabited.

Likewise, in Hattibang, the case of scarcity of irrigation water contributes the least (12 %) for the reduction in the production. But in Kesharbag, it came to third position (21%) by its contribution for the reduction in agriculture production. This difference can be explained by the variety of crops cultivated there. In Hattibang, maize, millet and wheat are generally cultivated as the major crops which does not need any special irrigation facility, so the rainfall if properly occur, will be sufficient for those crops. But in Kesharbag, paddy is the major food crop which needs more water. Irrigation was directly or indirectly affected by the change in climatic parameters as well as risk and disaster. In addition to climatic factors, various other social and political factors have some important influence to the variation in peoples' perceptions on different place.

According to the respondents, another factor for the reduction in the agricultural production was the outbreaks of various disease and pests. In Hattibang, it comes in fourth position by its contribution (15%) but in Kesharbag it is regarded as the main cause for the loss in the agricultural production (36%). Farmers from Kesharbag notice that the outbreaks of the various new diseases and pests become more problematic since last 10-12 years. The increase in frequencies of disease especially in the rice plant in the summer time causing reduction in crops yields. The common

one is red leaf of rice (*Rate*) and white fly (*Seto putali*). In the winter, it is hard to harvest mustard seeds without using pesticides at least 3-4 times because of the aphids (*Lie*) which were not prevalent before 12-13 years. In addition, the disease *Gabaro*, and *Kalopoke* are also increasing significantly in maize and wheat respectively. People argue that the reason behind such increase in the outbreaks of the diseases were the increasing temperature, change in mist pattern, insufficient rain and excessive use of genetically modified crops which have very low tolerance towards disease.

According to the respondents, next factor for the reduction of the agricultural production was the availability of the good seeds and fertilizer. In Hattibang, it has contributed second largest factor (22%) for the reduction of the crops, whereas in Kesharbag it is considered as the least affecting factor (12%). The access to the road, market, technology, geographical location and ecological setting were the causes for such variation within two places.

Change in Planting and Harvesting Time

The respondents of both studied sites argue that it is being a compulsion to change the planting and harvesting time for many crops especially rice and maize. In Hattibang the respondents argue that planting time of maize was shifted in order to cope with prolonged drought. In the past people usually saw maize in second week of February (first week of the *Falgun*) and used to take almost 7 month for harvesting but now they often cultivate maize on the second week of March (last week of *Falgun*) and it does not take seven months these days to harvest. They also mentioned the use of new variety of maize which can be ready to harvest in 5 months, such variety used to be unsuitable in Hattibang in previous days. People connect the reason for such a significant change in harvesting time and introduction of new variety with an increasing temperature over past 15- 20 years.

According to the people of Kesharbag - who used to plant paddy during the first week of the second week of July (1st week of *Sharwan*), now no longer do so at the usual time, because of the change in monsoon pattern. Even though some farmers who have irrigation facility in their field still plant the paddy in usual time, they need to face severe drought or heavy rain immediately after plantation. Peoples are also facing several problems during the rice harvesting because of off-seasonal and un-timely rainfall – one of the major natural destructors – damaging both grains and straw.

Average rainfall data for the months September and October taken by the Department of Hydrology and Meteorology at Rampur station shows an increasing trend; supporting the people's perception of increasing rainfall during harvesting period. In addition to these climatic variations, there are many other causes for the shift in cropping and harvesting time for example the availability of irrigation facility, use of the genetically modified crop variety, new technological innovations, new agricultural practices and so on.

Change in the Cropping Variety

During the interview, people of Kesharbag argued that some crop variety they used to grow in the past are no longer available. They argued that the traditional, paddy varieties like *Dudhraj*, *Aanpjhutte*, *Ashami masino Manshar* are no longer available. Likewise, the Local *Pahelo* maize is becoming rare. These days, they have started to cultivate improved and genetically modified varieties available in the market. Almost all respondents claimed that they changed their cropping variety because of the decrease in the production of the former crops. According to the farmers, causes behind the changes in crop variety are climatic extremes (change in the climatic parameters and climatic risk and disasters), pest and diseases that directly affect the production. In addition to this, they also noticed some other factors like introduction of new technology and high priced crops.

While in Hattibang people are not experiencing the changes in crop varieties. But the loss of the production of traditional key crops (especially maize and millet) is forcing them to think about changing the cropping variety in near future.

Change in the Harvesting Techniques

Climate change also has direct or indirect impact on the traditional harvesting techniques. It may be due to the change in the planting and harvesting time or the change in the cropping varieties. In Hattibang, the respondents argue that they have faced many difficulties while harvesting maize because of heavy rain-which causes depletion on grain quality hence affecting net yield. Moreover, they faced problems in the storing grains due to various pests and deteriorations. Especially the traditional way for storing maize outside the house (*Makai ko Suuli halne*) - arranging of maize in near the courtyard in hut like fashion - is no longer applicable due to the unpredictable weather and climatic patterns. In case of Kesharbag because of

unfavorable conditions during crop harvesting people are found not being able in properly storing seed needed to plant for next year. To cope with such an adverse effect they now need to be fully dependent on hybrid and improved seed varieties available in the market. This is always pushing them towards the uncertainty of agricultural practice and making more vulnerable.

Change in Cropping Pattern

According to the respondent there has been change in cropping pattern since the past 15-20 years. The change was especially in the variety and choice of crops and vegetables. Finger millet and maize were the two major crops of Hattibang, beside these wheat and mustard were the common crops. Before, leafage mustard, cabbage, turnip, were the main vegetables planted for the home use, but now beans, coriander, bitter gourd, cauliflower and tomato are also equally grown.

In Kesharbag the change is usually seen in the intensity and variety of the crops. According to the respondent they used to cultivate maize, paddy and mustard and lentil in the past but now this cycle no longer exists especially the mustard and lentil in the winter is replaced by the wheat and other commercially important cash crops like carrot, cauliflower, cabbage and radish. Moreover, in the past farmer usually used to cultivate two crops in a year leaving the field fallow in the rest of the month but now people hardly leave the cultivated land fallow rather they grow three or four crops within a year in order to compensate the production loss. In addition to this people usually practice mix cropping pattern (for e.g. Mustard and lentil, Maize and Soyaben/Sweet pea) these days.

When people were asked for the reason behind such a change in the cropping pattern, they were pointing out various causes like increasing climatic extremes (long drought, heavy rain), availability of new varieties of seeds, market demand of some valuable cash crops and so on.

Impact on Livestock

Livestock is an integral component of the farming system in Nepal. It plays a pivotal role in the process of the intensification of Nepalese agriculture. In the hills and mountain it is one of the important adaptive responses of the people to their environment which is generally known as the *mountain specification* of the

livelihoods (Jodha; 1992). Moreover, livestock production is integrated with the production of the staple crops like paddy, maize millet, wheat and pulses as well as fruit and vegetables. Livestock recycles the nutrients on the farm, supply draught power, manure, milk and meat, while crop supply food and fodder. The most common livestock species found in mixed crop farming are cattle, buffalo, and goat. Nearly half of the animal feed comes from the crop residues (Tulachan 2001). Livestock contribute close to 50 % of the household cash income in mountains, 36% in hill, and 20% in the plain (ibid 2001). Availability of fodder, grazing land, forest, water and manpower are the necessary prerequisite for the livestock farming.

Like agriculture, livestock system is also dependent on the natural resource and the local climatic condition. This fact is also supported by Molnar in her study about the four communities of Kham Magar in western hill of Nepal (Molnar 1981). Crop by products like straw and natural products like water, fodder and grass from forest, livestock rearing in pasture land plays important role in livestock farming. Any changes in these systems directly or indirectly pose threats to the livestock system.

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

Besides these various causes for the change in the livestock practices, almost all the respondents of both the study area argue that the change in climatic parameters and climate related risk and disasters have significant impact on the livestock system in their areas. people frequently raise the issue about the change in the productivity of the livestock and changing fodder management practices while talking about the changing climatic parameters and the climate related risk and disasters.

Better environmental condition, good quality of feeds and forage and hygienic sheds along with proper health care of the livestock are the basic elements for the good livestock productivity. The respondents of the both study argue that the overall productivity of the livestock is changing. According to respondents of Hattibang the increasing temperature cause thermal stress to the animal especially for cow and goat causing reduction in the milking capacity, increasing fever and even death of the livestock. Oxen are main source of the power for ploughing, in that hill village the elders' members of the community noticed that the stamina of oxen is decreasing these days in comparison to the past days. They relate it to the loss of hygienic grass in the forest and reduction in grazing land that the livestock used to graze in the past because of long drought, soil erosion and forest fire.

In Kesharbag cow and goat are the major livestock. All animals were stall fed and need plenty of stored feeds. So, livestock rearing is highly associated with the crop farming. Rice straw is the main livestock feed through out the year except June and July. In these two months farmers' feed maize stovers, green grasses grown in paddy fields. They don't get permit to enter into the forest for fodder and foliage collection.

The respondent at Kesharbag felt that the cattle were maturing and breeding earlier than in the past. Previously, cows usually mates only after two years; but now they give birth within two and half years. Similarly goats used to mate only after one whole year; nowadays they mate much earlier (within 8-10 month). Farmers also points out that although the maturation and first breeding time for the cattle is shortened but the overall fertility of the cattle was decreasing due to increase in the duration sterility and miscarriage. There used to be regular breeding and calving season; for example most of cow used to breeds during July to October but now this cycle no longer applicable for them.

Similarly, the appearance of new disease and shift in the timing of the endemic disease is another important problem faced by the local residents. According to the farmers the foot and mouth disease (*Khoret rog*) used to prevail in the summer season; becoming one of the important cause for the reduction of milking capacity of cow and even the loss of animal in the winter since last 4-5 years. One of the members of the co operatives has lost his 4 cow due to the foot and mouth disease. The officials of the milk producing Co- operatives, Annapurna Milk producers co-

operative - one of the leading diaries in Chitwan, used to collect around 4000 liters of milk per day, argues that the amount of milk production is decreasing these days.

Furthermore, the scarcity of the quality fodders also adding to the burden of farmers in animal husbandry. The increasing trend of hybrid paddy plantation, due to the change in climatic condition, reduces the fodder yields. In addition, with the change in the climatic parameters and increase in climatic related risk and disasters, the outbreaks of various new diseases to crop also increased. So, the increasing intensive use of the pesticides these days directly affects fodder hygiene and nutritional quality of the fodder than the local landrace crops.

Local people have various explanations about the cause for the above mentioned change and challenge to the livestock system. But some elder respondents connect it as a consequence of the ongoing increase in the temperature and long drought which they were experiencing in last few decades.

CHAPTER: SEVEN

COPING AND ADAPTIVE STRATEGIES

This chapter deals with the present coping and adaptive strategies followed by the communities which help to increase the adaptive capacity and resilience power of the respective communities in response to natural disaster and calamities especially in climate change. In addition to this the constraint that limits the efficiency and well functioning of coping and adaptive strategies also presented in the latter part of this chapter.

Coping and Adaptive Strategy Followed by the Communities

Adaptation to climate change refers to an adjustment in behavior that responds to actual or expected climatic stimuli or their effects which moderate their harm or

exploits beneficial opportunities (IPCC-Third Assessment Report). The coping and adaptive strategies are the set of the alternatives through which people reduce the adverse effect of climate change on their health and well-being, and take advantage of the opportunities that their climatic environment provides (Ahmed et al. 1999). Through coping and adaptive strategies individual or communities increase their adaptive capacity and resilience to the ongoing change. The alternatives varied according to the physical geography and ecological settings as well as the community characteristics such as wealth, equity, political and social stability, access to infrastructure, institutional supports, and social capital (Adger 2006).

Diversification of Income Source

The availability of diverse opportunity for income source has important role to cope with the environmental change. Once the impact of climate change narrows down the scope of traditional livelihood people seeks alternatives. They give first priority to make the existing livelihood source more resilient. The second priority is to seek alternatives livelihood like income generation from the available resource and opportunities (Gurung and Bhandari 2009). From the field study it is clearly seen that the people have already experiencing the consequences of impact of climate change in

agriculture and livestock system, which is the mainstay of the living. Local people not

only face the hardness of change in their livelihood but also develop specific adaptive and coping strategies for their viable livelihood. The major adaptive and coping strategies followed by the local people of both the study sites are describe below.

Agriculture and Livestock

Agriculture and livestock farming are the main source of income for the majority of the people of both the study sites. The changing climates have caused severe impact on their traditional agriculture and livestock farming practices. Therefore in order to cope with such change people have modified their agriculture and livestock system. In Hattibang currently people change the planting and harvesting time of the maize. Presently they grow beans, cauliflower and cucumber in their kitchen garden, by selling these vegetables they get money which they can use to buy other foodstuffs and necessary groceries. Hattibang seems suitable for the commercial farming of the goat due to the easy availability of the fodder and forage as well as grazing land. Few peoples have already started improved varieties of goat farming.

In Kesharbag the farmers were using genetically modified variety of crops variety especially of rice and maize. They are selecting those varieties which have short growing period but good yield. Furthermore, due to the high prevalence of the disease to mustard and construction of the shallow deep tube-well, people plant improved variety of wheat in their field which has high productivity in comparison to the mustard and lentil that people used to grow in the past. Selling of the milk is one of the important sources of income. People keep high milk yielding breeds of cow like Holistain, Jersey, Hariyana and some local cross variety. In addition to this goat farming, vegetable production and bee keeping also contribute significant amount in the income of the people.

Formal and Informal Loan

According to the local people of the study sites, loan play important role for the maintenance of their livelihoods. In Hattibang people take informal loans from the local money lenders or friends or relatives. Majority of peoples have a culture to return the loans and work sincerely on their investments. Generally people takes loans either for business, or to go abroad for jobs or for cultural ceremonies like marriage, funeral. No formal loan system is practiced in this area except some co-operatives and women groups' (Aama Samuha) local NGO has started micro finance and micro

credits schemes. House wives are organized in groups and through this small investment are done in income generation activities, especially on goat and poultry farming, establishment of the shop and so on. Housewives are motivated and encouraged to save money which can be useful during the needy time.

The respondents of Kesharbag argue that they prefer the loan from formal banking and finance and Co-operatives Company which they primarily use for purchase of new cow, new agricultural crops and starting of business such as groceries shop. The loan from bank and finance takes minimum rate of interest which they can pay in installment. The loan from formal sector mainly used for foreign employment and for some cultural ceremonies like marriage, death rituals. They usually take the loan from relatives and neighbors. The farmers group (cow farmers group) and mothers group (Amma Samuha) contributes significant amount of loan especially in the agriculture and livestock related sectors which ultimately reduce the borrowing money from banks and local money lenders.

From the study of the formal and informal loan system of the both the study sites it can be concluded that the resilience and adaptive capacity of the local people is increasing by this system which ultimately use in the post disaster recovery process and preparedness to the disasters.

The Local Cottage Industry

The product of local cottage industry like *Doko*, *Nanglo*, *Kucho Dali* and *Theki* are the traditionally followed important source of income for the people of Hattibang especially for Chepang people. They made such product from the locally available bamboo and *Githedar*, *Shadan* (tree species use for making *Theki*) and exchange it either with money or grains in the market. Moreover chapang people also involved in the trade of fruits and oil of Nepalese butter tree (*Chiury*).

Figure 14. The Chepang men working on bamboo art.



Photo by Parajuli, R. march 2010 through personal communication.

Off-farm Employment

During the interviews with the respondents it indicated that the majority of the male members of each family have migrated in search of work to nearby local towns and cities as well as to other districts and foreign countries.

The people of the Hattibang especially the Chepang usually travel to the nearby towns and cities like Shaktikhor, Kholeshimal, Tandi, Narayangarh, Mugling, Hugdi and Malekhu and even to Katmandu for wage labor and selling their handicraft goods like *Doko*, *Nanglo*, *Dali*, *Kuchho*, and the *Chiury* fruits (Nepalese butter fruits). Some of them travel to Nainital of India during their off farm time as a labor and return back their home after 4-6 month usually in the cropping time. In contrast, the other groups like Brahmin Chettri, Gurung and Magar usually travel to Katmandu, Malaysia and Gulf country in search of the employment.

In case of Kesharbag, people rarely go to the nearby towns and cities for labor. But the frequency of foreign employment is quiet higher than that of Hattibang. At least one members of majority of the respondent are in foreign country like Malaysia and Gulf countries, USA and UK.

The goods and cash generated through these employments help the local population from post-disaster recovery and preparedness to the natural disasters and calamities

which are caused due to climate change or other processes. Hence, helps in increasing the adaptive capacities and resilience of the people.

New Infrastructure and Technology

The facilities of physical infrastructure and technologies like road, irrigation system, hospital, communication, electricity, new cropping techniques, pest management system have important role in the well functioning of the agrarian based economy, hence increasing the adaptive capacity and resilience of the people from the unprecedented effect of the disasters. In both the study sites the access and distributions of physical infrastructural facilities are differing.

The facilities of physical infrastructure and technologies are not enough in Hattibang. The community is not connected with the motorable road. Walking is the popular mode of transportation for this area. In the rainy season the mobility of the people is hindered by the landslide and flood. There are some new innovations in the infrastructural facility in the village such as the hill trekking track, telephone, solar panel, health post, drinking water, school, landslide controlling wall to provide minimum necessary services for the villagers. Moreover, most of the villagers are optimistic on the gravel motorable road that link them to the Prithivi Highway - one of the important Highways of Nepal - at Hugdibazzar of Dhading district, which is just started to construct.

In contrast with Hattibang, Kesharbag have got good facility of the physical infrastructure like, motor road, telephone, electricity, irrigation facility, health post, village agriculture and veterinary office, Dairy, School. These infrastructural facilities have increased the adaptive capacity of the local people providing possible alternatives. For example after the Construction of shallow deep tube-well farmers easily grow off seasonal vegetable and irrigates their winter crops, especially wheat and paddy (April) and other various cash crops like beans, mushroom and fish. Similarly, the motor road increases their access to the market. The dairy provides good value for their produced milk.

Social Networks

Social networks are the glue between many of the elements of adaptation hence itself is an important adaptive strategy for any kind of disaster and calamities. It is visualized as a web of connections' that link diverse individuals and institutions,

either directly or via other actors. The actors are interdependent, and through their relationship they create opportunities for resource and information exchange, and form the social, economic and political structures that defines how they as individuals or groups may act (Ensor and Berger; 2009: 21). It is an important form of social capital that built on trust and reciprocity, such that positive behavior is expected and replicated by the members of the network, while destructive behavior can lead to the breakdown of the relationships. This form of social capital can therefore be weak and fragile, and often situated in institutions that have formal rules of behavior (ibid: 21) but has great significance to adaptive capacity and resilience. The social network defines the access to and distribution of material as well as non-material resource. In our country, where formal loss sharing mechanism like insurance and government's compensation are less effective, the social networks and institutional supports plays a crucial role for increasing the adaptive capacity and resilience of the community in the face of change. The social networks may be vertical (between communities and government) or horizontal (between individual to individual and individual and communities to communities).

In Hattibang people take supports from neighbors and relatives whenever they need. The social structure in this community is based on the belief in helping each other during the need as in the case of most of village of Nepal. The sense of social binding and mutual assistance is strong in this community. According to the respondents the neighbors and villagers are the first to provide moral support and financial assistance irrespective to their caste, class and ethnicity. During disasters and hard time society and neighbors forget any rivalry and conflict, if any exist, and come forward to help needy ones. There are many incidents in Hattibang to prove it. The members of the community talk together and share their problems and knowledge to the other members. Most of the activities like, seed selection, plantation, harvesting, and selection of alternative source of income were primarily through the discussion with the neighbor and villagers and the decision were made according to the local weather and climatic prediction and the past experience. They share labor power with neighbor during cropping and harvesting time. This type of social network and co-operation plays crucial role for their adaptive capacity and resilience to the negative impact of the ongoing change. In addition to this another factor that strengthens the adaptive capacity and resilience to the disasters and calamities to people of Hattibang, is the support from relatives. The moral, and financial supports from the relatives

plays crucial role for maintaining the livelihood. Although the support provided them was not enough and sufficient to recover all the lost and pains but it gave great encouragement to start new way.

Respondent from Kesharbag argues that the strong social structure and co-operation exist in the past had been changing in these days, along, with the increasing trend of the urbanization and other social, economic and political factor like education, availability of cash, technological development and so on. In Kesharbag the share labor practice during the plantation, harvesting time almost disappears. People use the wage from other village and even from India came to the village during plantation and harvesting. Individual generally use his own rationality as well the suggestion from the agriculture office for the selection, plantation and harvesting of the crops and livestock farming. Some families have taken the financial supports from their relative (mainly used in the purchase of cow goat cultural ceremonies), starting of new business within or outside the village, for foreign employment and education to the children.

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

Awareness and Training

Though, the sense of consciousness and getting vocational trainings do not directly relate to the environmental issues, it plays an important role in building up the capacity of local people to adopt in adverse condition. In Hattibang the training on home-stay tourism, training on tourist and nature guide with the technical support from District Development Office / Sustainable Tourism Development section, Nepal Tourism Board and UNDP/TRPAP program has taken place. At the local level people formed a group named Siraichuli Homestay Management Group which works for

providing facilities and services for the internal and foreign tourists that financially assists the locals in some instance. The awareness program on forest and environmental conservation to the school children will be helpful in increasing future adaptive capacity towards natural disasters.

In Kesharbag, the program on women empowerment by The Asia Foundation, PACT Nepal and other governmental and non-governmental organizations are helping in various sectors of social improvement like; training and organizing local women in goat-farming network (gifting kid nanny goat to others after reproduction) which help to gather income for the local women. In addition to this, training on livestock keeping, bee keeping, vegetable farming, fodder and shade management, paste and disease management by District Agriculture Office and other national government and non-government office helped to enhance the capacity of local people. Similarly, the awareness program on health and sanitation, bio-gas generation and education helps to strengthen people's capacity somehow.

Constraints to Coping and Adaptive Strategies

All the above mentioned adaptive strategies are not designed in direct response of climate change but they may play crucial role in minimizing the risk and hazards of ongoing climate change. From this research, I have documented following constraints from the both communities that hinder the adaptive capacity and resilience.

The Land and Landscape

This is one of the visible constraints for the people of the Hattibang because of the steep and terraced landscape, which is more prone to landslide and soil erosion. In addition to this the fertility of such land is also low in comparison to the plain. Moreover, it is hard to develop physical infrastructure that directly hinders in the delivery of services and facilities in the needy time.

Increasing Population and Land Fragmentation

Specially, in the case of Kesharbag, the increasing population is causing direct pressure in agricultural land which is the main source of livelihood and income of the local people. The growing urbanization in the village is rapidly fragmenting the fertile agricultural land is turning into residential areas. If these problems prevail in the existing condition, it may cause low adaptive capacity and resilience to the climate

related risks and disasters. In Hattibang, this type of problem is very low in comparison to Kesharbag.

The Availability of Manpower

It is one of the most noticeable constraints faced by the people of the both the communities. The outgoing of efficient manpower especially the young male for different reasons like, employment, education, and so on is causing shortage of manpower for the agricultural and livestock farming.

Better Infrastructure and Facilities

The sufficient infrastructure and facilities is regarded as one of the crucial means to adopt in climatic change. In the case if Hattibang there are very few infrastructures (roads, engineering structure to control flood, debris flow, landslide and erosion) and services available in local source and even governmental concern is rarely found in the issue of ongoing change. Though in Kesharbag, the availability of infrastructures and facilities seems relatively more, even this is not sufficient for proper adaptation.

Low Level of Knowledge on Modern Adaptive Strategies

In both study areas, the perceived hindrances to adoption of modern technique as adaptation strategies of climate change include lack of improved seeds, lack of access to water for irrigation, lack of knowledge on modern adaptation methods, lack of information on weather incidence and lack of money to acquire modern techniques all influences the drive towards adapting to climate change.

CHAPTER: EIGHT

CONCLUSIONS

The main objectives of the research was to understand the perception of the local people on climate change and examine the impact of such change on agriculture and livestock management practices among the people of two different ecological and social settings, i.e. Hattibang and Kesharbag of Chitwan District. Moreover the research also attempted to analyze the present adaptive strategies of the local people which ultimately increase their adaptive capacity and resilience in the face of change. The concept of cultural model is widely used within anthropology especially in climate change research along with the tools of applied, advocacy oriented and public anthropology, for the emic understanding of people about the effect of global climate change on their world and worldview. Hence I have primarily employed this approach to understand the perception, impact and adaptive strategies followed by the two different communities of Chitwan districts at different geographical and ecological settings. Moreover, the framework of the cognitive anthropology and human ecology also helped to compare and analyze the difference in the perception about change in climatic variables and climate related risk and disasters, their impact on agriculture and livestock management practices and present coping and adaptive strategies followed by the people in their respective surroundings. Furthermore, the study also used the sustainable livelihood framework to access the climate change impacts on agriculture and livestock system of the both of the studied communities.

I have attempted to understand the perception of the people on climate change through the change in the climate related parameters such as precipitation, temperature, and mist and dews and climate related extremes and disasters such as the long drought, heavy rainfall, landslide and soil erosion, windstorms and hailstorms. These are considered as having important direct or indirect impact on the agriculture and livestock system of the communities of Hattibang and Kesharbag. I have compared the local observations with the available meteorological data. Finally I have analyzed the present adaptive and coping strategies followed by the communities. After going through this I have reached in following conclusion.

From this study it was clear that climate change in these areas was occurring. The communities are already experiencing the change in temperature, precipitation and

mist and dews patterns since past 15-20 years. This was supported by a number of indicators such as decrease in rainfall, shifting of monsoon, warmer winters, increased rainfall intensity within short duration, long draught, landslides, soil erosion and outbreaks of pests and diseases. The available meteorological data from Rampur (the nearest meteorological station from Kesharbag) and Dhading (the nearest meteorological station from Hattibang) also support the above findings. The impact of such change in climatic condition is seen in the present and may cause severe impact on the livelihood of the communities especially on agriculture and livestock in future. Though the people of both communities had not heard the term 'climate change', they were quite aware of the phenomena. They had felt significant change in climatic parameters such as temperature, precipitation, mist and dews through out their life experiences over the period. The perception on climatic risk and disasters depend on how it hits them, existing socio-cultural and economic system and ecological setting they are residing in. For example, people of Hattibang perceive landslide and soil erosion as a major risk but this was not true for the people of Kesharbag. It is because landslide and soil erosion are major risks of the hill area which is not found in plain. In this context, Ingold and Kurtile (2000) argue that the perception of the people about the environment and environmental risks depend on where they live and how they act on the system. In addition to this, the perception also varies from individual to individual within same geographical and social settings. Therefore the climatic risk and disasters like drought, landslide, soil erosion, hailstorm, windstorms that were happening during the course of individual's lifetime provide the important generalization about the changing situation of climatic regime and perception of the people and the impact of such unprecedented change. In addition, it helps to elicit the information on how people observe these phenomena and ultimately help to trace the people's perception on the ongoing climatic events.

The change in climate patterns (temperature, precipitation and mist and dews), and the destruction of the natural resource base leads to the unpredictable and erratic rainfall pattern, warmer temperature, diminishing pasture and water availability, frequency of drought, hailstorms and windstorms pose threat to the livelihood strategy of Kesharbag and Hattibang communities. The decrease in production, change in crop variety, change in planting/harvesting time, change in cropping patterns are the major change in the agricultural system of both the communities. Similarly the livestock system also suffer from various problems that are co-related with the climatic

variability and extremes, like early maturation and breeding of livestock, increase in the duration of sterility after first breeding and miscarriage, the incidence of various new disease, reduction in the quality and the quantity of fodder and forage which ultimately reduces the productivity of livestock. The intensity and frequency differ in respective communities. This is due to the variation on geographical and socio-cultural settings of the communities. Hence, it can be concluded that the impact of change differ according to the geographical and socio-cultural settings which is also pointed by Adger et al (2006)

The local people of Kesharbag and Hattibang are practicing various means to cope with the above mentioned adverse impacts but these are not enough to accommodate all those consequences. Communities have diversified their income source from various measures like agriculture and livestock, formal and informal loans, local cottage industry and off farm employment which help to generate cash that can be used in the needy time. In addition to this, the social network such as the relatives' supports, neighbors' supports and helps increase the resilience power of both communities. So from this study it can be concluded that the existing adaptive strategies followed by the communities are not designed to the direct response of climate change but plays important role for increasing adaptive capacity of the communities. Some factors like land and landscape, population pressure and land fragmentation, lack of manpower, lack of infrastructure and facilities and lack of knowledge on modern adaptive strategies are hindering the existing adaptive strategies.

Further Research Suggestions

From the study, some issues raised by the community members like the occurrence of diseases to the plants and livestock, decrease in productivity of agriculture and livestock farming in relation to climate change need more intensive and interdisciplinary research and investigations.

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Particularities		Kesharbag	Hattibang	Total
Average Household Size		5.31	5.73	
Sex	Male	14	11	25
	Female	7	5	12
Age group (* two respondents don't know their age group)	<40	2	2	4
	40-50	3	3	6
	50-60	10	6	16
	60-70	3	1	4
	>70	3	2	5
Educational status	Illiterate	9	7	16
	Literate	6	8	14
	Higher Education	6	1	7
Food sufficiency	<6months	4	8	12
	6-12 months	10	5	15
	>12 months	7	3	10
Occupation	Farming only	12	6	18
	Business(Tea shops and Hotels)	1	5	6
	Job(Teaching, technician)	4	2	6
	Labor	1	2	3
	Others	3	1	4
Caste group	Brahmin/Cheetri	17	5	22
	Chapang		8	8
	Gurung	1		1
	Gauchan	1		1
	Magar		3	3
	Pariyar	2		2
Total number of the respondents		21	16	37

Appendix I: General overview of respondents

Appendix II: Respondents Observation on the Climatic Parameters

(A) Gitanagar-7, Kesharbag

S.N	Name of the Respondents	Age	Sex	occupation	Perception on Climatic Parameters		
					Rain	Temp	Frost
1	Bal Bahadur Pariyar	58	M	Labor	-	+	*
2	Bishnu Parasad Gauchan	93	M	Farmer	-	+	*
3	Bishnu Prasad Sharma	61	M	Business man	-	+	=
4	Buddhi Prasad Poudel	63	M	Ex-Teacher	_*	+	-
5	Dev Raj Poudel	38	M	Diary-Personnel	-	+	-
6	Ganga Dhungana	65	F	Housewife	-	=	*
7	Ghana Shyam Chhapagain	50	M	Farmer	_*	+	-
8	Harimaya Khati	51	F	Housewife	-	+	*
9	Jit Bahadur	48	M	Hotel owner	-	=	-
10	Keshab Raj sharma	42	M	Teacher	_*	+	*
11	Laxmi Pariyar	51	F	Housewife	-	+	-
12	Lok Bahadur Gurung	58	M	Farmer	_*	+	*
13	Purna Bahadur Basnet	51	M	Farmer	=	=	*
14	Purna Prasad Parsai	55	M	Teacher	_*	+	-
15	Prakash Khand	50	M	Ex-teacher	-	+	*
16	Rawati Raj Pathak	93	M	Farmer	-	-	-
17	Ramila Sapkota	38	F	Beekeepers	_*	+	*
18	Saraswoti Parhak	75	F	Housewife	-	+	-
19	Sanumaya Khati	55	F	Housewife	-	+	*
20	Tek Nath Timilshina	51	M	Dairy-personnel	_*	+	*
21	Sunita poudel	49	F	Housewife	-	+	-

(Source : Field Survey 2009)

Note: (-) Decrease, (+) Increase, (*) Uncertain, (-*) Decrease and Uncertain, (=) Stationary.

(B) Kaule-3, Hattibang

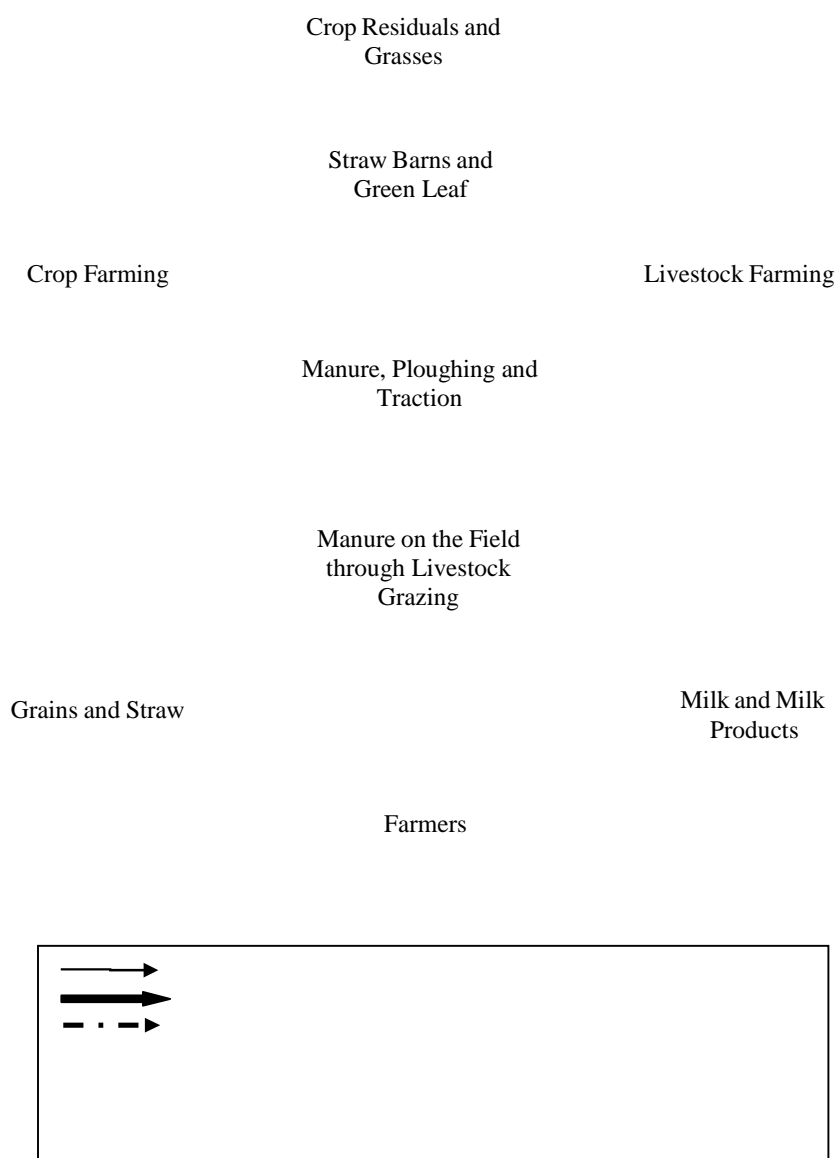
	Name of the Respondents	Age	Sex	occupation	Perception on Climatic Parameters		
					Rain	Temp	Frost

1	Bir B. Parja (Chapang)	85	M	Farmer	-	+	=
2	Chandra Singh Parja	83	M	Builder	=	+	-
3	Dhung B. Rana Magar	50	M	Farmer	-	+	-
4	Dil B. Chapang	N/A	M	Farmer	-	+	=
5	Gambhir B. Rana Magar	64	M	Farmer	-*	=	+
6	Govinda Prasad Bhushal	35	M	Teacher	-*	+	=
7	Hom Raj Puri	54	M	Farmer	-	+	=
8	Jagadish Puri	38	M	School-assist	-	+	+
9	Nawaraj Chapang	42	M	Farmer	=	+	+
10	Man Kumari Chapang	45	F	Housewife	-	+	=
11	Page Kumari Rana Magar	55	F	Housewife	-	+	+
12	Phul maya Chapang	53	M	Housewife	-	+	=
13	Purna Prasad Acharya	46	F	Farmer	-	+	-
14	Shri Maya Chapang	N/A	F	Housewife	-	+	-
15	Shanti Puri	51	F	Housewife	-	+	=
16	Som B. Chapang	52	M	Farmer	-	+	=

(Source : Field Survey 2010)

Note: (-) Decrease, (+) Increase, (*) Uncertain, (-*) Decrease and Uncertain, (=) Stationary.

Appendix III: The Integrated Agriculture and Livestock Farming in the Study Sites



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Thank You!