Local Peoples’ Perceptions on Climate Change, Its Impacts and Adaptation Measures in Mid-Mountain Region of Nepal

(A Case study from Kaski District)

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Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Bachelor of Science in Forestry

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Citation:

LETTER OF ACCEPTANCE

The thesis attached hereto, entitled “Local Peoples’ Perceptions on Climate Change, Its Impacts and Adaptation Measures in Mid-Mountain Region of Nepal (A Case study from Kaski District)” prepared and submitted by Yubraj Bhusal in the partial fulfilment of the requirements for the degree of Bachelor of Science in Forestry is hereby accepted.

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Declaration

Me Yubraj Bhusal declare to the senate of the Institute of Forestry, Pokhara that thesis is a product of my own research work and all other sources of materials are duly acknowledged. This work has not been submitted for any academic degree to any university. My principle advisor has been Krishna Raj Tiwari, Ph. D. at the institute of forestry, Pokhara, Nepal.

........................................
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Yubraj Bhusal
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBO</td>
<td>Community Based Organisation</td>
</tr>
<tr>
<td>CBS</td>
<td>Central Bureau of Statistics</td>
</tr>
<tr>
<td>CFUC</td>
<td>Community Forest User Committee</td>
</tr>
<tr>
<td>CFUG</td>
<td>Community Forest Users’ Group</td>
</tr>
<tr>
<td>ComForM</td>
<td>Community Based Forest and Tree Management in the Himalaya</td>
</tr>
<tr>
<td>DAI</td>
<td>Dangerous Anthropogenic Interference</td>
</tr>
<tr>
<td>DWIDP</td>
<td>Department of Water Induced Disaster Prevention</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agricultural Organisation of the United Nations</td>
</tr>
<tr>
<td>G0N</td>
<td>Government of Nepal</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>ICIMOD</td>
<td>International Center for Integrated Mountain Development</td>
</tr>
<tr>
<td>IoF</td>
<td>Institute of Forestry</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel for Climate Change</td>
</tr>
<tr>
<td>mm</td>
<td>millimetre</td>
</tr>
<tr>
<td>MS</td>
<td>Microsoft</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
</tr>
<tr>
<td>RECOFTC</td>
<td>Regional Community Forestry Training Center</td>
</tr>
<tr>
<td>SAGUN</td>
<td>Strengthened Actions for Governance in Utilization of Natural Resources</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nations’ Framework Conference on Climate Change</td>
</tr>
<tr>
<td>VDC</td>
<td>Village Development Committee</td>
</tr>
<tr>
<td>WMO</td>
<td>World Meteorological Organisation</td>
</tr>
</tbody>
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Abstract

This research was carried out in Lumle and Ghandruk VDC of Kaski district. The study examines how farmer’s perceptions regarding climate change correspond with temperature and rainfall data recorded at meteorological station in Lumle and documents local adaptation responses to the impacts of climate change, and it's variability. Total 113 respondents were randomly interviewed by making transect walk ranging from 1000 m to 2300 m from mean sea level.

Linear trend line of averaged mean temperature during period 1978 – 2007 showed that temperature has risen by 0.9 °C and rainfall is characterized by large inter-annual variability with substantial decrease in the amount over the years from 2002 to 2006. The analysis shows that 90% respondents perceive the temperature has increased and 97% said they are experiencing unpredictable rainfall patterns since last 10 years.

Additionally, more than 50% respondents explored that late start of monsoon, incidents of drought has increased, hail storm occurs abnormally, wind flow pattern is getting warmer, decreasing water sources, changes in flowering and fruiting time, invasion of new weeds like Ageratina adenophora and Ageratum sps., and reduction of some indigenous plants like Artemisia indica.

Study found some adaptation measures such as forest protection, utilization of marginal lands by planting trees and grasses, crop diversifications in their farming practices. However, poor and marginalized groups were unaware regarding climate change impacts and adaptation measures. Thus, these measures were found to be event specific based on local knowledge and innovations, and not actually to cope with the impacts of climate change.

Key Words: Climate change, Impact, Adaptation, Temperature, Rainfall, Farmer, Perception
Chapter One: Introduction

1.1 Background

There is a worldwide consensus that global warming is a real, rapidly advancing and widespread threat facing humanity this century. Scientists have presented evidence and tested models to substantiate this truly alarming fact (Chaudhary & Aryal, 2009). Available data show that air temperature near the earth surface rose by 0.74 °C from 1906 to 2005 and scientists estimated it could be increased as much as 6.4 °C on average during the 21st century (IPCC, 2007). Temperature observations in Nepal from 1977 to 1994 showed a general warming trend and increased in average annual temperature was 0.06 °C (Shrestha et al., 1999). Climate change scenarios for Nepal showed considerable convergence on continued warming, with country averaged mean temperature increases of 1.2 °C and 3 °C projected by 2050 and 2100 (Shrestha et al., 1999). Past emissions are estimated to involve some unavoidable warming (about a further 0.6°C by the end of the century relative to 1980-1999) even if atmospheric greenhouse gas concentrations remain at 2000 levels (IPCC, 2007).

Observations of regional and seasonal variation at different part of the country resulted high rainfall regions and seasons are recording increases in precipitation and becoming wetter, whereas low rainfall regions and seasons are recording decreases in precipitation and becoming drier (GON, 2004). The changed intensity and amount of monsoon rains positively correlate with the increase in water-induced disasters like floods and landslides (Ministry of Home, quoted in DWIDP, 2006). The water springs in the mid-hills of Nepal have been drying up in the recent past (Gurung & Bhandari, 2009).

FAO (2007) & Jianchu et al, (2007) reported that as climatic patterns change, so also do the spatial distribution of agro-ecological zones, habitats, distribution patterns of plant diseases and pests which can have significant impacts on agriculture and food production. FAO (2005) has predicted that in developing countries, 11 percent of arable land would be affected by climate change, including a reduction of cereal production in up to 65 countries, about 16 percent of agricultural Gross Domestic Product (GDP). The increase in temperature has both negative and positive impact on agriculture as IPCC (2007) has projected that the potential food production to increase with increase in local average temperature over a range of 1 to 3 °C, but above this it is projected to decrease.
1.2 Importance of the Study

It is increasingly argued that many climate change studies, whilst effective in alerting policymakers to the possible effects of climate change, have had limited usefulness in providing local-scale guidance on adaptation, and that the climate change community should learn from experiences gained in food security and natural hazards studies (Richard, 2004). The analysis begins with the recognition that vulnerability exists today, vulnerability that will not disappear on its own and may indeed be growing, and with the desire to make active interventions to reduce the vulnerability (Richard, 2004). The scientific knowledge on impacts of climate change is increasing all the time, as are practical experiences in responding to adaptation needs. This knowledge needs to be exploited. In Nepal lack of research and credible evidence on the impacts of climate change is a major challenge. There is limited understanding on such basic issues as the nature and scale of impacts of climate change on forests governance and livelihood aspect including the carbon sequestration levels of various forest ecosystem types (Ojha et al., 2008). As in other regions of the world, climatic and ecological changes caused by global warming have resulted in several negative consequences for people’s health, the economy and livelihoods in Nepal (Eriksson, 2006).

Agriculture - the mainstay of rural food and economy that accounts for about 96% of the total water use in the country - suffers a lot from erratic weather patterns such as heat stress, longer dry seasons and uncertain rainfall, since 64% of the cultivated area fully depends on monsoon rainfall (CBS, 2006). Declined yield due to unfavorable weather and climate will lead to vulnerability in the form of food insecurity, hunger and shorter life expectancies (Ebi et al., 2007). There are some impacts for which adaptation is the only available and appropriate response (IPCC 2007). In response to climate change, the prospects of bringing new land under cultivation by clearing the vegetation have also threatened biodiversity conservation in high altitude areas through habitat destruction, degradation, fragmentation and loss. Important habitats will be displaced by croplands (Gurung & Bhandari, 2009).

Nepal demonstrates diverse geo-physical and climatic conditions within relatively small areas. It is, therefore, an ideal place to study climate change impacts on natural and socio-economic spheres. Such a study would contribute towards a better understanding of the intensity and impacts of global changes. The first step in such a study would be to start monitoring rainfall and temperatures at the community level. Studies on perceptions, local knowledge, and adaptive strategies at the household and community levels, as well as lessons learned, can provide the
basis for concepts and methods of assessing climate change impacts, vulnerability, and adaptation on livelihood of the local people.

In this context the present research seeks to investigate impacts of climate change on agriculture and adaptation activities carried out by the local people. Based on the case of the local peoples of Lumle and Ghandruk VDC, this report intends to capture the extent of local peoples’ awareness and perceptions of climate variability and change and the types of adjustments they have made in their farming practices in response to these change.

1.3 Objectives

The general objective of this research is to expand understanding of local peoples’ experience of climate variability and responses made to overcome impacts of climate change.

Specific objectives:

- To understand the local peoples’ perceptions towards climate variability.
- To verify the peoples’ perceptions by analysing 30 years data of temperature and precipitation.
- To find out the major impacts of changing climate in local peoples’ view.
- To document how local peoples are adapting to changing climate to maintain their livelihoods.

Chapter Two: Defining Terminology

2.1 Climate Change:

United Nation Framework Convention on Climate Change (UNFCCC) has defined climate change as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

For this research purpose definition given by Intergovernmental Panel for Climate Change (IPCC) has been used, which defines climate change as a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.
2.2 Perception:

As Ban and Hawkins (2000) define ‘perception’, it is the process by which we receive information or stimuli from our environment and transform it into psychological awareness. It is interesting to see that people infer about a certain situation or phenomenon differently using the same or different sets of information. Knowledge, interest, culture and many other social processes that shape the behaviour of an actor who uses the information and tries to influence that particular situation or phenomenon (RECOFTC 2001, Cited by Banjade, 2003). Saarinen (1976) talks about perception as an extremely complex concept and confines ‘social perception’ which is concerned with the effects of social and cultural factors on cognitive structuring of our physical and structural environment. This varies with the individual’s past experiences and present sets or attitudes acting through values, needs, memories, moods, social circumstances, and expectations (Saarinen, 1976, Cited by Banjade, 2003).

2.3 Impacts:

“The effects of climate change on natural and human systems” (IPCC, 2007). Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts:

- Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation.
- Residual impacts: the impacts of climate change that would occur after adaptation.

2.4 Adaptation:

“Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects” (IPCC, 2007). Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned.

Adaptation is the adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderated harm or exploits beneficial opportunities (UNFCCC, 2009, cited by SAGUN, 2009).
2.5 Adaptive capacities:

“Is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007).”

There are individuals and groups within all societies that have insufficient capacity to adapt to climate change. The capacity to adapt is dynamic and influenced by economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology (IPCC, 2007).

2.6 Vulnerability:

“Vulnerability to climate change is the degree to which geophysical, biological and socio-economic system are susceptible to, and unable to cope with, adverse impacts of climate change, including climate variability and extremes” (IPCC, 2007). Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.” The term “vulnerability” may therefore refer to the vulnerable system itself, the impact to this system, or the mechanism causing these impacts. Based on a number of criteria in the literature (i.e., magnitude, timing, persistence/reversibility, potential for adaptation, distributional aspects, likelihood and ‘importance’ of the impacts, some of these vulnerabilities might be identified as ‘key’. Key impacts and resultant key vulnerabilities are found in many social, economic, biological and geophysical systems.

The identification of potential key vulnerabilities is intended to provide guidance to decision-makers for identifying levels and rates of climate change that may be associated with ‘dangerous anthropogenic interference’ (DAI) with the climate system, in the terminology of the United Nations’ Framework Convention on Climate Change (UNFCCC). Ultimately, the determination of DAI cannot be based on scientific arguments alone, but involves other judgments informed by the state of scientific knowledge. Key vulnerabilities may be linked to systemic thresholds where non-linear processes cause a system to shift from one major state to another. Other key vulnerabilities can be associated with “normative thresholds” defined by stakeholders of decision-makers (IPCC 2007).
3.1 Research Approach

Main approach used for data collection for this study is exploratory, where the gathering data is through observing people, actions and situations and exploring the individuals’ attitudes, preferences or behaviors in informational issues of this research. The research follows qualitative as well as quantitative methods of information collection and analysis.

3.2 Site Selection

This study was carried out in Lumle and Ghandruk Village Development Committee (VDC) of Kaski District of Western Nepal. VDC is the lowest political and administrative unit. This site was selected according to the following criteria:

- Meteorological station is available for the measurements of temperature and precipitation.
- High Rainfall area of the Nepal.
- Accessible and near from Highway.
- Representing high variation in altitudinal ranges and.

3.3 Unit of Analysis

Unit of analysis for this research purpose is basically residents within the VDCs. Resident here is a person inhabiting within the political boundary of VDC for more than 10 years.

3.4 Data Collection

This study was conducted through the analysis of 30 years data of temperature and rainfall from local meteorological station, field observation, Personal interview, key informants interview as well as consultation with research and academic institutions and other institutional and individual information sources.

3.4.1 Reconnaissance survey

A weeklong initial field visit was carried out. The main objective of that visit was to become familiar with the study area such as geographical situation and social structure. It helped to identify socio-economic and bio-physical conditions of community. Similarly, with the frequent
visits to the study area, cozy environment was created to come closer and work with local people.

3.4.2 Personal Interviews

In-depth interviews and structured questionnaire survey were executed in the research site selected by making transect walk. For this purpose respondents were selected considering various socioeconomic factors and altitudinal zones.

3.4.2.1 Sampling Technique used to select respondents

In this research, total of 113 interviewees were selected. Those respondents were selected from each category of people including all gender, ethnicity, education, economic class and geographic location. The detail characteristics of the VDC inhabitants were collected from the respective VDC offices and Ghandruk Unit Conservation Office of Annapurna Conservation Area Project. Respondents selected with following ‘ad hoc’ and ‘snow ball’ sampling techniques were first examined according to caste/ethnicity, economic class, gender, education and social position and then sought for other interviewees where representation from certain categories were realized insufficient.

Snowball sampling: “Snowball” sampling technique was used to follow the pattern of phenomenon and to understand the relationship of social processes, communal adaptations and information exchange about climate change. This snow balling is appropriate for determining the actor who become the source of information if situation is dependent on other social factors. In case of selecting the respondents of specific or ‘unique’ characters (for example, some specific forest users, some people holding some position in CBOs, NGOs or person from some specific location or ethnic community) were found out by asking previous respondents or to anybody at crossroad bearing information of people with sought characteristics.

Ad hoc sampling: Initial interviewees were selected on ad hoc basis without considering other criteria. Researcher took opportunities of any places and occasion to find an interviewee provided he or she would agree to be interviewed and provide the time for it. Especially during resting places (Chautaris), corners of main meeting places, teashops, fields were taken as opportunities to interview people from different background. Most of the respondents were selected in these ways.
3.4.2.2 In-depth Interviews

In in-depth interviews, interviewees were provided with the semi-structured and open ended questions. The interviewers seek to encourage free and open responses, and there may be a trade-off between comprehensive coverage of topics and in-depth exploration of a more limited set of questions. In-depth interviews also encourage capturing of respondents’ perceptions in their own words, a very desirable strategy in qualitative data collection (Frechtling et al., 1997). A list of simple questions was prepared prior to the actual fieldwork. In-depth Interviews was conducted by making transect walk to gather the household information, attitude of local peoples’ toward climate change, their knowledge and experiences regarding climate variability, impacts and adapting activities, and perception of different stakeholders. Full attention was given to collect the data from individuals from mix methods, i.e., in a single interview two way communication (discussion on a issue of relevance), direct question answers, exploring history of ethnicity and family whom the respondents belong, pebble distribution for rankings, social mapping of some events and settings was done subsequently to assure that information provided from same person could be checked in itself.

3.4.3 Key informant interview

Additional information was gathered from government staffs, NGO staff, CBO staff, local school teachers, CFUC members, local leaders and this information was used to cross check with respondents’ views.

3.4.4 Secondary data collection

30 years monthly meteorological data of temperature and precipitation (as suggested by WMO) of Lumle agro-meteorological station was purchased from Department of Hydrology and Meteorology, Kathmandu. Other Secondary data was collected through review of literature available in the form of journals, articles, thesis, reports, publications, web sites.

3.5 Data analysis

To assess local peoples’ perceptions of climate change and variability, researcher first look at how climate data recorded at meteorological stations evolved (trends and variability) and how Farmers perceived these changes. Tests were undertaken for linear trend in annual means and seasonal means of temperature, and total annual and seasonal rainfall at the Lumle Station. Descriptive statistics based on summary counts of the questionnaire structure are used to provide insights into producers’ perceptions of climate change and variability. In the literature several studies have undergone the same type of analysis. For example, Vedwan and Rhoades (2001) examine how apple farmers in the western Himalayans of India
perceive climate change. This is done by comparing the locally idealized traditional weather cycle with climate change as perceived by the farmers of the region using snowfall and rainfall data to measure the accuracy of perceptions. Hageback *et. al.* (2005) assess small-scale farmers’ perceptions of climate change in the Danagou watershed in China by comparing the local precipitation and temperature data trend with the responses given by farmers to the question “Do you feel any changed in the weather now compared to 20 years?” They conclude that farmers’ perceptions of climate variability correspond with the climatic data records.

The data was processed and analysed using computer software packages such as MS Excel 2007 and SPSS 16 (Statistical Package for Social Science). Descriptive statistics was used for simplistic presentation.
Chapter Four: Study Area

Figure 1: Study area

The study area lies in the north-west of Kaski district, Nepal.
Chapter Five: Results and Discussion

5.1 Comparison between local peoples’ perceptions of changes in temperature and rainfall and meteorological stations’ data

5.1.1 Temperature change

The result revealed that 92 percent of the local people interviewed perceived long-term changes in temperature. While, most of them (90 percent) perceive the temperature has been increased. Only 2 percent noticed the contrary, a decrease in temperature.

![Bar chart showing local peoples’ perceptions of change in temperature.](image)

**Figure 2: Local peoples’ perceptions of change in temperature.**

The statistical record of temperature data from the Lumle between 1978 and 2007 showed an increasing trend, with the increased mostly in the winter. During the period of 30 years, the temperature has raised around 1.0°C (Table 1). Though this warming trend is in line with the average annual temperature increase calculated by Shrestha *et. al.* (1999), it is more than global average increase given by IPCC (2007). Figure 2 shows the change in average temperature of the area, which gives a clear picture of the warming trend in the area. The average temperature (16.5°C) for the period 2002-2007 is 0.9°C more than (15.6°C) that of period 1978-82.

The analysis showed that local peoples’ perceptions appear to be in accordance with the statistical record in the region.
Figure 3: Trend of Temperature data for the Lumle: 1978-2007

Figure 4: Average Temperature for 5 year periods (°C)

Table 1: Analysis of temperature data from 1978 to 2007

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Yearly</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (°C)</td>
<td>15.97</td>
<td>17.68</td>
<td>12.14</td>
</tr>
<tr>
<td>Standard deviation (°C)</td>
<td>0.46</td>
<td>0.6</td>
<td>0.46</td>
</tr>
<tr>
<td>Maximum average temperature (°C)</td>
<td>16.95</td>
<td>18.94</td>
<td>13.68</td>
</tr>
<tr>
<td>Minimum average temperature (°C)</td>
<td>15.03</td>
<td>16.63</td>
<td>10.69</td>
</tr>
<tr>
<td>Trend (°C/year or season)</td>
<td>0.03</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Total change calculated from the trend (°C/30 years)*</td>
<td>0.97</td>
<td>0.71</td>
<td>1.13</td>
</tr>
</tbody>
</table>

*Total change is the difference between the trend line value of the last and first year.

# Months (March to June)

^ Months (October to February)
5.1.2 Precipitation Changes

97 percent of the respondents observed an unpredictable rainfall patterns over the past 10 years, and 3 percent noticed a predictable and constant rainfall patterns. Almost 72 percent of the respondents said that the incidents of drought has been increasing and link it with the untimely and unusual rainfall patterns over the past few years. Key informants also shared their experience that in recent year (2009) there was less or no rainfall in the monsoon season.

**Figure 5: Drought occurrences Perception of local people**

**Figure 6: Rainfall Pattern perception local people**
The recorded data on rainfall from 1979 to 2007 showed about 69 percent of the rainfall occurred during Monsoon. Pre-monsoon (Jan-May) rainfall trend doesn’t show great variations, but during the last few years of the study (2003 to 2006) there was a substantial decreased in the amount of rainfall especially in monsoon (Figures 7 & 8). And again in 2007 this rainfall trend was found to be increased. These strongly indicate that local peoples in such scenario couldn’t predict the usual rainfall pattern.

![Figure 7: Trend of Rainfall data for the Lumle: 1979-2007](image)

**Table 2 Analysis of Rainfall data from 1979 to 2007**

<table>
<thead>
<tr>
<th>Rainfall (mm)</th>
<th>yearly</th>
<th>Pre-Monsoon</th>
<th>Monsoon</th>
<th>Rest Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (mm)</td>
<td>5443.86</td>
<td>580.06</td>
<td>3724.12</td>
<td>1139.69</td>
</tr>
<tr>
<td>Percentage of yearly total</td>
<td>10.6</td>
<td>68.4</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Standard deviation (mm)</td>
<td>624.67</td>
<td>130.59</td>
<td>515.11</td>
<td>315.27</td>
</tr>
<tr>
<td>Minimum Rainfall (mm)</td>
<td>3945.6</td>
<td>352.7</td>
<td>2751.9</td>
<td>684.2</td>
</tr>
<tr>
<td>Maximum Rainfall (mm)</td>
<td>6561.4</td>
<td>870.3</td>
<td>4979.7</td>
<td>1814.4</td>
</tr>
<tr>
<td>Trend (mm/year or season)</td>
<td>30.42</td>
<td>7.45</td>
<td>10.46</td>
<td>12.51</td>
</tr>
<tr>
<td>Total change calculated from the trend (mm/29 years)*</td>
<td>852.46</td>
<td>208.71</td>
<td>292.88</td>
<td>360.17</td>
</tr>
</tbody>
</table>

*Total change is the difference between the trend line value of the last and first year.
5.2 Local peoples’ perceptions on changing climate and major impacts

Local people shared some experiences of climatic conditions, ecosystem function & process, and biological system. But most of the respondents were not aware about climate change instead they understand only rainfall and warming system. Moreover, respondents were totally unaware about changing climate and its impacts. Thus the responses given below were of respondents’ views and which needs further verification to conclude that these were due to the impact of climate change.

Local peoples’ past experience showed increasing warming days, erratic rainfall patterns, ecological variability, biological change and their adverse effects on human beings. More than 50% respondents said that warming days are increasing, rainfall pattern is unpredictable, seasons are changing, incidents of drought is increasing, hail storm occurs abnormally, wind pattern is getting warmer, decreasing water sources, wind storm is getting stronger, changes in flowering and fruiting time, invasion of new plant species and reduction of some indigenous plants (Table 3). Some elder person observed the less frost in recent years, which also indicates the warmer nights as explained by IPCC (2007).

Many respondents reported that forests, grasslands and agricultural ecosystems in the study area are in critical condition. Local People revealed that different plant species were flowering and
fruiting irregularly: *Naspati* and Apple flowering in all the seasons, *Aru* ripen in Jestha instead of Ashad, *Painu* flowered in Kartik (one month earlier), early fruiting of *Kafal, Robus elipticus*. In agriculture system they are observing some unusual phenomena: Fast maturity of Maize and Rice, new types of pests, short stalk of rice and wheat.

**Table 3 Local Perception on various Climate change Related Changes in their Locality***

<table>
<thead>
<tr>
<th>Major areas of impact</th>
<th>Responses</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>Don't know (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climatic conditions</strong></td>
<td>warming days are increasing</td>
<td>90</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Rainfall Pattern is unpredictable</td>
<td>97</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Seasons are changing</td>
<td>86</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td><strong>Ecosystem function and process</strong></td>
<td>Incidents of Drought is increasing</td>
<td>72</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Regular interval of snow fall</td>
<td>38</td>
<td>47</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>hail storm occur beyond autumn and spring season</td>
<td>52</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Wind pattern is getting warmer</td>
<td>70</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Wind storm is getting stronger</td>
<td>55</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Flooding in your field</td>
<td>21</td>
<td>71</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Water source and availability is increasing</td>
<td>12</td>
<td>81</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Extinct/ shifting plant species</td>
<td>57</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Frequencies of fire are increasing</td>
<td>45</td>
<td>56</td>
<td>9</td>
</tr>
<tr>
<td><strong>Biological systems</strong></td>
<td>Changes in flowering and fruiting time</td>
<td>50</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Changes of fruit/crop ripening</td>
<td>51</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>New diseases in Agriculture crops</td>
<td>74</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>New plant species seen</td>
<td>85</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Behavioral changes in livestock</td>
<td>23</td>
<td>48</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Change in Fish species in rivers</td>
<td>39</td>
<td>19</td>
<td>42</td>
</tr>
</tbody>
</table>

*Framework of this table is based on Chaudhary and Aryal, 2009.*

[Responses given above were of respondents’ views and which needs further verification to conclude that these were due to the impact of climate change.]

Local peoples’ responses and verification in the field provided evident of invasive species like *Ageratum sps* (*Nilgandhe*, which is not edible for livestock), *Ageratina adenophora* (*kalo Banmara*), *Chromolaena odorata* (*Seto Banmara*) and these weeds are taken as a major causes of declining cereal production, grass coverage and reduction of perennial local herbs. At the same time, the common herbs of the area, such as *Ageratum conyzoids* (*setogandhe*, which is edible for livestock), *Titepat, Buki flower, Salla Jhar* are disappearing/decreasing from the area. Some respondent also shared experience that *Okhar and Bakaino* is regenerating in higher altitudes than that of their usual distribution, but it needs further verification to be proved. During field observation *Kalo Banmara* was observed at the elevation above 1600 m, as
observed by Lamichhane & Awasthi, 2009, and key informants said that it is spreading in higher altitudes yearly and *Chiple kira* (once abundantly found, now not seen since 4-5 years in that area i.e. 1600m altitude), which can be correlated with the warming trend in the study area. Scientific communities believe that changes in temperature and rainfall are creating favourable environments for pests, diseases and invasive species to emerge, spread and encroach on agriculture and forestlands (SAGUN, 2009).

Agriculture was the mainstay in the study area. Most people follow traditional cultivation practices that rely on seasonal rain water. Erratic rainfall patterns and hailstorm contributing to soil erosion, soil fertility loss, and crop damage are having an adverse impact on livelihoods of most of these communities, thus increasing risk to food security. Though drinking water is increasing due to availability of water storage tanks and water pipes, Local people said that they are facing more drought periods resulting decrease in natural springs and irrigation water. This may affects agriculture, and subsequently food security.

### 5.3 Adaptation measures

At the study site, there were some local coping and adaptation strategies adopted in response to observed risks and hazards related to climate and non-climatic factors. Most of the coping activities were found to be event specific based on local knowledge and innovations, because most of the respondents were not aware about actual impacts of climate changes. The study found that traditionally local people has managed forest very well which is the good indication of coping with the impacts of climate changes. This may be the reason that there was no big landslide. Majority of these local farmers were practicing vegetable farming instead of cereal crops as crop diversification as well as to earn more income than cereal crops. Optimum utilization of marginal lands by planting fodder trees, fruit trees, and other grasses also observed.

Lumle Agriculture Research Centre, present in the study area, has provided some employments and benefits to the local peoples especially for farmers, by providing extension services, trainings, quality seeds and varieties of races, soil testing etc. Changes of local seed to improved seed of vegetables as well as cereal crops has resulted loss of local races. This practice may vulnerable for crop failure in the context of climate change.

Moreover, communities have many groups such as Mothers’ group, Youth Club, Conservation area Management Committee, Vegetable farmer’s group responsible for community level works
such as awareness raising, cleaning and fund collection. These local groups can be potential institutions to community as well as local level adaptation measures in the future.

There is trend of changing varieties of crops and not protection of local races of crops, which is bad adaptation. On the basis of these results it can be said that Local people are only experiencing some changing climatic patterns, but they are not facing serious effects due to climate changes so there is not any structured strategy solely focusing to adaptation. It may be due to the lack of working organizations which can explain all the causes and consequences of climate change to the villagers.
Chapter Six: Conclusions and Ways Forward

The statistical analysis of temperature data from 1978-2007 in the Lumle showed a linear trend of increasing around 1°C, with the increase mostly in the winter period. Over the 30 years examined, rainfall is characterized by large inter annual variability with a substantial decrease in the amount of rainfall over the final four years of the data. However, there is a noticeable, long-running trend of increasing rainfall. Similar response reported by local people on climate variability is in line with climatic data records. Indeed, Local people in the Lumle & Ghandruk VDC of Kaski district were able to recognize that temperatures have increased and there has been a fluctuation in the volume of rainfall. People with access to extension services are likely to perceive changes in the climate because extension services provide information about climate and weather. Impacts were observed contributing to loss of species and local landraces, declining productivity and yield, outbreak of diseases and pests, rapid encroachment by invasive species, and emergence of human diseases.

Local knowledge, practices and innovations are important elements for community-based coping and adaptation mechanisms. There were few examples of adaptation strategies in agriculture such as change in cropping patterns, choice of crops, and improvement in the system. Other areas (forestry, livestock) had relatively less innovations and practices to deal with climate risks and hazards. There was limited awareness, knowledge and capacity at local level to understand climate change scenarios, address issues, and conduct long-term planning. Coping strategies and adaptation mechanism were limited at the study site.

Government policies should therefore ensure that farmers have access to affordable credit to increase their ability and flexibility to change production strategies in response to the forecasted climate conditions. Because access to water for irrigation increases the resilience of farmers to climate variability, irrigation investment needs should be reconsidered to allow farmers increased water control to counteract adverse impacts from climate variability and change. Furthermore, government should improve off-farm income-earning opportunities. There is urgent need to undertake the steps towards awareness increasing programs regarding future unavoidable impacts of climate change and strategies to cope with it.

The more specific studies on the sectorial basis considering gender, ethnicity and economic conditions of peoples is urgent to validate and document the actual coping strategies to respond to unavoidable impacts of changing climate.
References


