Communities Challenging Climate Change

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(Case studies from Nepal : communities' understanding and adaptation for climate change)

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Design
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First Edition 2010

Printed at
Jagadamba Printing Press, Hattiban

Publisher
Community Radio Support Center (CRSC)/ Nepal Forum of Environmental Journalists (NEFEJ) with Support from Free Voice, THE NETHERLANDS.
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ISBN:- 978-9937-2-2252-5

PREFACE

Nepal Forum of Environmental Journalists is a pioneer institution of Nepal working in proximity to the community especially awareness raising in Environment and Sustainable development. Besides these activities NFEFJ covered in environmental awareness, urban environment, forestry and biodiversity and tourism etc. CRSC has been promoting, enabling, facilitating community radio movement in Nepal. CRSC/NEFEJ initiated a new area Climate Change through community participation. Innovation conceived in the group of CRSC especially the coordinator triggered an idea of launching a project "Communities Challenging Climate Change". The concept was to observe, document the activities adapted by local communities to face the climate change impact at local level. Free Voice Netherlands and Nationale Postcode Loterij-NPL cooperation remained instrumental for the project as CRSC/NEFEJ and FV/NPL are working hands in hands for CCCC.

Transparent screening was made after receiving formal applications from the participating organizations. Expert support was availed during the screening process. Five organizations Batabaran Sanrakshan tatha Bikas Manch (Environmental Conservation and Development Forum), Taplejung district east Nepal high mountain;.Janasewa Samaj Nepal (Public Service Society Nepal), Khotang district east Nepal Hill; Banyajantu Batabaran Sanrakshan Manch (Wildlife and Environment Conservation Forum) in Kavre district, central Nepal Hill; Gramin Jagaran Tatha Ekikrit Bikash Sangh (Rural Awareness and Development Association), Baglung district. mid western hill Nepal; Society for Creative Women (SfCW), a Kailali district, far western tarai (flatland) Nepal , participated different activities as part of the project focusing on the linkages of communities to climate change. Field level information collection was not so easy as bridging up of the technical jargon and layman understanding gap needed especial communication skill. CRSC/NEFEJ schooling helped the field workers to extract the understandings of communities. Findings of the study were aired by the partner radio stations. Eco-club members especially the primary and secondary level students designed school-community linking activities to raise awareness on climate change and document climate change related activities in their neighbourhood. Their motivation was really appreciative as they designed their yearly activities, spared own contribution to ensure success of those activities, distributed prizes to the best performers.

Project Managers of Taplejung, Kabhre, Kailali put their best efforts to bring the site spe-

cific results through orientation program, collecting field based data and producing quality research report. Khotang and Baglung team also attempted from their level.

Present book is neither a scientific publication, nor a journalist's column, rather should be understood as a communities realization on climate, translated by professionals with scientific background - a readers note. This is the start of CRSC/NEFEJ, a case study from Nepalese communities. If it could contribute in the adaptation process for the communities in an interface of changing climate, the attempt will be considered meaningful.

Madan Koirala,PhD
Professor of Environmental Science

FOREWORD

Climate change is a raging issue today. While Nepal, of course, has not contributed to the menace, it is a victim nonetheless. Reports have come up with instances of the farming communities facing adverse impact in Nepal too.

Unpredictable rain pattern and equally surprising rise and fall in temperatures have been reported. Of course, conclusive scientific evidence may still said to be missing. But that does not in any way rule out facing adverse impact.

Meanwhile there is a need to raise awareness among the general public by way of relating global warming and resultant climate change so that the concerned section of population grow aware on the issue and think of mitigating their lot.

But that can be possible only after they know the problems are real before they can be explained the solution in what could be a positive contribution towards mitigating efforts whereby communities combat climate change.

That incidentally was undertaken by Community Radio Support Center (CRSC) under Nepal Forum of Environmental Journalists (NEFEJ) under which it implemented five pilot project areas aimed at assessing the local impact of global warming by going back to communities.

The aim of the project was to examine the outcome when community radio and local NGOs undertake joint actions to enhance understanding of the communities on complex issue like climate change and also adapt to the adverse impact.

The studies conducted by five local Non-Governmental Organizations (NGOs) and equal number of community radio stations in the respective project areas come in the form of a baseline on the local impact of global climate change and how best to cope with changing climatic conditions. The content which appear in this publication suggest that farming communities are feeling the adverse impact of climate change.

The importance of the publication lies in the fact that it will be of use to organizations working in the area of climate change and adaptation and policymakers alike. We are confident that it will be useful for researchers to base their studies on.

We would like to thank Prof. Madan Koirala, PhD and Ranjana Bhatta for putting in conscientious work to produce this valuable publication. Thanks also go to partner organizations and concerned community radio stations for the role played by them, respectively. We are grateful to Nationale Postecode Loterij- NPL and Free Voice, the Netherlands for their generous support and facilitation in this regard.
Thank you !

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ACKNOWLEDGEMENTS

We express our sincere gratitude to everyone who contributed from their level to make possible publication this book as an incremental activity of us. We render special thanks to:

- Prof. Madan Koirala, PhD and Member, Climate Change Council of Nepal for internalizing the concept, and orient the activities towards an output as a book.

- Ms. Ranjana Bhatta, who assisted the lead author, translated the collected information in a scientific format.

- Mr.Bhairab Risal, Senior Journalist, and Journalist D L Bhandari for always motivating the authors and project team.

- Dr. Mukesh K. Chalise, for participating in the initial stage of the project.

- Mr. Nimesh Regmi and Mr. Nagendra Lamsal for valuable inputs and Rabin Sayami for the design.

- Chandra Prakash Bhattarai, Bikash Rai, Krishna Chandra Acharya, Kiran Paudyal, Shakuntala Bhatta, the key personnel of the 5 partner organizations. Til Kumari Menyangbo, Rajan Humagain, Devraj Joshi for active participation in the field. Students of the eco-club deserve special appreciation for their active participation during the training and the whole year of activity.

Finally, very special thanks are reserved for Jacqueline Eckhardt-Gerritsen, Victor Joseph and Amis Boesma of Free Voice, The Netherlands; and NPL without whose crucial support and encouragement the document would not at all have come out in this form.

Raghu Mainali
Coordinator,
Community Radio Support Centre/NEFEJ
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Acronyms and Abbreviations

ADB:	Asian Development Bank
BAU:	Business as Usual
BLS:	Brown Leaf Spot Disease
CCCC:	Communities Challenging Climate Change
CCAG:	Climate Change Aware Group
CDM:	Clean Development Mechanism
COP:	Conference of Party
CMP:	Conference of Parties serving as the Meeting of the Parties of KP
CRSC:	Community Radio Support Center
DHM:	Department of Hydrology and Meteorology
FV:	Free Voice
GHG:	Greenhouse Gas
GLOFs:	Glacial Lake Outburst Flood
GoN:	Government of Nepal
ICIMOD:	International Center for Integrated Mountain Development
INGOs:	International Non Governmental Organizations
INC:	Initial National Communication
IPCC:	Intergovernmental Panel on Climate Change
IUCN:	International Union for Conservation of Nature
KP	Kyoto Protocol
LI-BIRD:	Local Initiative for Biodiversity in Research and Development
LWF:	Lutheran World Federation
MoPE:	Ministry of Population and Environment
NAPA:	National Adaptation Program of Action
NPL:	Nationale Postcode Loterij
NEFEJ:	Nepal Forum of Environmental Journalists
NGOs:	Non Governmental Organizations
OECD:	Organization for Economic Co-operation and Development
PRA:	Participatory Rural Appraisal
PPCR:	Pilot Program for Climate Resilience
SfCW:	Society for Creative Women
UNFCCC:	United Nations Framework Convention on Climate Change
VDC:	Village Development Committee
WWF:	World Wildlife fund

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Chapter I

INTRODUCTION

Climate change has become an above-the-fold issue in the last few years, garnering wider attention beyond the world of climate scientists and environmental policymakers. Climate change is the major, overriding environmental issue of our time, and the single greatest challenge facing environmental regulators. It is a growing crisis with economic, health and safety, food production, security, and other dimensions. Climate change in Intergovernmental Panel on Climate Change (IPCC) usage refers to 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. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to 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. The impact of global warming is already being felt by the most vulnerable-the world's poorest people and countries.

The physical consequences of climate change include change in precipitation patterns, sea level rise (amplified by storm surges), more intense and perhaps frequent extreme weather events, increased prevalence of vector-borne diseases and perhaps catastrophic events, such as reversal of the Glacial Lake Outburst Flood (GLOFs). The potential economic consequences include productivity changes in agriculture and other climate-sensitive sectors, damage to coastal areas, stresses on health and water systems, changes in trading patterns and international investment flows, financial market disruption (and innovation), increased vulnerability to sudden adverse shocks, and altered migration patterns all with potential implications for external stability.

The problems of climate change emerged with the beginning of industrial era. Atmospheric CO_2 concentration was approximately180 parts per million (ppm) during the last ice age. It was 280 ppm by the pre-industrial era. This difference of 100 ppm translated into a 4°C mean temperature rise. Since pre-industrial era, the atmospheric concentration of green house gases increased due to human activities reaching their highest record level in the 1990s. An increasing rate of warming has particularly taken place over the last 25 years, and 11 of the 12 warmest years on record have occurred in the past 12 years. Today, CO_2 level is 380 ppm and rising fast. Adding in other GHGs, it is approximately 430 ppm of carbon dioxide equivalent (CO_2e). If current trends continue, the IPCC projects that GHG levels will rise to 550–700 ppm CO2e by 2050 and 650–1200 ppm CO2e by 2100. (Climate Change ADB program, Strengthening Mitigation and Adaptation in Asia and the Pacific, 2007). With the planet already in a warm period, any increase in temperatures of more than 2ºC over preindustrial levels is predicted to have devastating impacts on people's lives, economic infrastructures, and natural environments. The Intergovernmental Panel on Climate Change (IPCC, 2007) projects that under current policies ("business as usual," BAU)—the global mean temperature will increase over the next century by 2.8°C, with a 3 percent chance of rising 6°C or more. Even with a temperature rise of 1– 2.5°C the IPCC predict serious effects including reduced crop yields in tropical areas leading to increased risk of hunger, spread of climate sensitive diseases such as malaria, and an increased risk of extinction

of 20 – 30 per cent of all plant and animal species. By 2020, up to 250 million people in Africa could be exposed to greater risk of water stress. Over the course of this century, millions of people living in the catchment areas of the Himalayas and Andes face increased risk of floods as glaciers retreat followed by drought and water scarcity.

While climate change will affect everyone, it is expected to have a disproportionate effect on those living in poverty in developing countries. Developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt: socially, technologically and financially. Climate change is anticipated to have far reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN 2007). Over the next decades, it is predicted that billions of people, particularly those in developing countries, face shortages of water and food and greater risks to health and life as a result of climate change. Developing countries have very different individual circumstances and the specific impacts of climate change on a country depend on the climate it experiences as well as its geographical, social, cultural, economic and political situations. As a result, countries require a diversity of adaptation measures very much depending on individual circumstances.

Adaptation to climate change

Adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions. Adaptation is a process through which societies make themselves better able to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on climate change but also on the type of development path that is pursued. Thus adaptation should be implemented in the context of national and global sustainable development efforts. Local coping strategies and traditional knowledge need to be used in synergy with government and local interventions. The choice of adaptation interventions depends on national circumstances. To enable workable and effective adaptation measures, ministries and governments, as well as institutions and non-government organizations, must consider integrating climate change in their planning and budgeting in all levels of decision making.

Increasing scientific capacity by improving access to climate data, development of modelling capabilities, and having mechanisms in place to process and disseminate the data for users, helps promote awareness of potential climate change impacts. It also equips nations with climate information necessary for national impact assessments, and adaptation and development planning hence increasing their capacity to adapt. The preparedness for current climate variability is essential for limiting the chaos and costs that ensue from existing climate impacts. Extreme events are often the driver for adaptation efforts because impacts are visible and the damage can be economically devastating. Preparedness and adaptation for existing extremes is likely to increase resilience to changes in mean climate conditions.

Chapter II

CLIMATE CHANGE IN NEPAL

Nepal has a remarkable climatic variability due to its impressive range of altitudes within its short north-south distance and the presence of the high Himalayan range in its north. Nepal's greenhouse gas (GHG) contribution to the atmosphere is not significant in global terms but the impacts of climate change in the country's economy and local livelihoods are significant. Based on available data it is found that the average warming in annual temperature between 1977 and 2000 was 0.06 ^{o}C/yr (Shrestha et al, 1999). The warming is found to be more pronounced in the higher altitude regions of Nepal such as middle-mountain and Himalaya, while the warming is significantly lower in Terai and Siwalik regions. Further, warming in the winter is more pronounced compared to other season. The maximum temperatures are increasing faster than the minimum temperatures indicating a widening temperature range. There are a decreasing number of rainy days and increasing numbers of higher intensities rainfall events. The projected change in temperature above the baseline average is 1.2^{o}C for 2030, 1.7^{o}C for 2050 and 3.0^{o}C for 2100 (OECD 2003). Studies conducted in Dhaulagiri, Langtang, Khumbu, Shorong, and Kanchanjunga regions of Nepal suggested that the majority of glaciers are undergoing rapid deglaciation. The rate of retreat of these glaciers range from several meters to as high as 20 m/year (Fujita and Kadota 2001, Fujita et al. 1997, Kadota et al. 2001). Nepal comprises about 2315 glacier lakes of varies sizes, with the total area of 75 sq. km. (ICIMOD, 2001). The rapid rate of snowmelt in high Himalayas is expected to create and or expand glacial lakes as well as increase river water flows initially. The potential increase in disasters from glacial lake outburst floods (GLOFs) is perhaps the most relevant climate change related threat for many parts of Nepal (Raut, 2006).Agriculture, biodiversity and health sectors are also adversely affected by climate change in Nepal. Nepal is agriculture based country where about 80% of people depend on agriculture and the agriculture system of most area is rainfall dependent. The agriculture sector of Nepal is severely hit by change in hydrological cycle. Nepal's First National Communication Report identifies both positive and negative impacts of climate change on agriculture (MoPE, 2004). It has been suggested at 4^{0}C temperature and 20% precipitation rise, there could be marginal yield increase rice; between 0.09 to 7.5% and beyond that yield will continue to decline. However, temperature rise has mixed reaction in the case of wheat as the actual yield of wheat has increased in western region with the rise of temperature and decline in other regions. Similarly, temperature rise has negative affect to maize yield as it is found to decrease with increase in temperature. With warming of higher altitudes, it has been predicted that there may be an increased range of lower altitude disease vectors such as mosquitoes and consequent increase in the spread of malaria, Kalaazar and Japanese encephalitis in such regions.

People's concern and institutions working

There is no longer a regular monsoon for Dilmaya in Taplejung to plant rice, also the uprooting time of mustard from the field has been changed for Phuldevi in Dhangadhi. Guava in Kiran's orchard in Baglung didn't ripe in time this year rather it was having insects during the ripening period. People are raising question about the change they are experiencing in their livelihood. 'Lekh, gaon, besi' practice for chopping firewood, shifting the 'goth'

to kharka and parma for weeding the wheat seem changing compared the usual time a decade back to the older farmers. This change is experienced by many of the communities in Nepal. They have their own way of taking it.

Nepal joined the climate change movement through submitting the Initial National Communication (INC) document as a party of United Nations Framework Convention on Climate Change (UNFCCC) in July 2004. Ratified Kyoto Protocol in 2005 and designated Ministry of Environment as Designated National Authority for Clean Development Mechanism (CDM). There is a Climate Change Network representing government, NGOs, academicians, and donor agencies working. National Climate Change policy (2009) has been formulated by the government and other climate change policies are either formulated or underway. A high level Climate Change Council under the chairmanship of Prime Minister has been formulated. A National Committee for the preparation COP 15/CMP 5 has been set up and ready to fuction. Nepal organized South Asian Regional Conference on Climate Change 'Kathmandu to Copenhagen' which came up with common stance among the countries of the region. It also formulated a consortium of the donor countries for climate change. A regional conference of youth was also organized. National Adaptation Program of Action (NAPA) is under preparation. There are sectoral implementation programs for strengthening capacity for managing climate change and environment. Preparation of Second National Communication is underway. Technology needs assessment Project is ready to initiate. Nepal is participating in the pilot program for Climate Resilience (PPCR, funded by the ADB and World Bank) and Cool Earth program (funded by the Government of Japan).

At ministry level various ministries are working in cross-cutting areas. Ministry of Environment is the focal ministry, Department of Hydrology and Meteorology is keeping up the regular hydrology meteorology data at different stations across the country. DHM is also monitoring a number of glaciers for melting and retreating parameters in eastern and central Nepal. Ministry of Environment has proposed to set up a Climate Change Division under its organogram as a functioning entity. There are sectoral programs in Ministry of Forests and Soil Conservation, Agriculture, Health, Local Government, Education, Housing and Urban Planning, Social Welfare etc.

Tribhuvan University and Kathmandu University in collaboration with partners are conducting specific research at temporal and spatial dimensions especially on Land Use Land Cover Change, flooding, agriculture change, habitat of specific animals, aerosol deposition in the atmosphere etc.

At I/NGO level ICIMOD has specific programs covering climate change in monitoring and impact at socio-economic cultural level. There are programs comparable at biosphere level considering Nepal's Kanchenjunga and Shey Phoksundo as case studies. IUCN Nepal has awareness raising programmes on Climate change at Churia hills Ilam, Tinjure Milke Jaljale in eastern Himalaya. WWF Nepal has a separate unit on Climate change helping in

capacity building to GoN and monitoring programme as well. LI-BIRD is running farmer level program on Climate Change. Lutheran World Federation (LWF), Practical Action, Action Aid, OXFAM also have specific program considering Climate Change.

Nepal Forum of Environmental Journalists (NEFEJ)/ Community Radio Support Center (CRSC) is launching case studies at 5 different parts of the country covering Mountain, Hills and Tarai ecological zones and covering east to far west Nepal. It is working with the communities with local NGOs and local Community Radios to enhance the impact of the study.

Chapter III

STUDY AREA

Nepal is a land-locked country located in South Asia between India and China, at 28^0 north latitude and 84^0east longitude. Elevations of the country vary from about 80 meters above mean sea level in the southern plain area (the Terai plain) to 8,848 meters (Mount Everest). It has a very diverse environment, resulting from its impressive topography and extreme spatial climatic variation from a tropical to arctic climate with a span of about 200 kilometers. The east-west length of the country is about 800 km, roughly parallel to the Himalayan axis, and the average north-south width is 140 km. Nepal covers about 0.1 percent of the earth's surface but it hosts rich biodiversity. Nepal Biodiversity Strategy (MFSC, 2002) notes that Nepal hosts 118 ecosystems, including 35 forest types. The geography of Nepal can be divided into five ecological regions according to the Department of Survey (1978) as Terai, Siwalik, Middle Mountain, High Mountain and high Himalaya. Terai is the northern part of Indo-Gangetic plain and extends nearly 800 km from east to west and about 30-40 km from north to south. The average elevation is below 750 m, including Terai region, Bhavar Terai and Inner Terai. The climate is humid tropical with average temperature more than 25^0C. The elevation in the Siwalik ranges from 700 to 1,500 m. The climate is moist subtropical climate with average temperature 25^0C. The elevation of Middle Mountain, also known as Mahabharat range, varies from 1,500 to 2,700 m. The climate of this region is temperate with average temperature 20^0C. High Mountains range from 2,200 to 4,000 m. The climate is cool temperate to sub alpine. High Himalaya Ranges from 4,000 to above 8,000 m dominate the High Himalaya. The climate is alpine and the snowline lies at 5,000 m in the east and at 4,000 m in the west. The temperature ranges from 0 to 5^0C. The area lying to the north of the main Himalayan range is the Trans-Himalayan region, which restricts the entry of monsoon moisture and therefore the region has a dry desert-like climate. The remarkable climatic variability conditions in Nepal are primarily related to the impressive range of altitudes within a short north-south distance of the country. Precipitation is the most important climatic element for agricultural development and hydrology. Being located in the northern limit of the tropics, Nepal gets both summer and winter precipitation (Singh 1985).

The study was conducted in five districts of Nepal Taplejung, Khotang, Baglung, Kavre and Kailali covering all the ecological regions.

- **Taplejung** district is North Eastern part of the country and the geographical location is 27^0 21'N and 87^0 40'E. The total area of the district is 3646 Km^2 with total population 134,698 and most of the population is involved in agriculture. Total eight Village Development Committees (VDCs) Tapethok, Linkhim, Sikaicha, Phawakhola, Tiringe, Phurumba, Hangdeva and Phungling were selected for study. The elevation of these areas ranges from 1200 to 3794 m. The demography of Tapethok VDC is 1,545, Linkhim is 2,281, Sikaicha is 2,503, Phawakhola is 1,457 and that of Tiringe is 2,003. Similarly the demography of Phurumba, Hangdeva and Phungling is 2,605, 3,763 and 11,912 respectively. The total number of households in the district is 24,764. The study area covers siwalik range, middle Mountain and high Himalayan range.
- **Khotang** is situated in eastern region of Nepal covering an area of 1591 Km2

with total population 42,866. Jalapa, Nunthala, Patheka, Kharmi, Ainselukharka, Hauchour, Nerpa and Diktel VDCs were taken for study area. The total population of Nunthala, Patheka and Kharmi is 1,792, 4,374 and 4,064 respectively. Similarly the total population of Ainselukharka, Hauchour, Nerpa is 3,457, 2,250 and 3,456 respectively and the total households in the districts are 42,866.

- **Kavre** is a hilly district situated in central part of the country with altitudinal range 300 to 3018m. The demography of the district is 385,672. Two VDCs Dhunkharka and Bhakundebesi were taken for the study area.
- **Baglung** district is western part of the country and the geographical location is 28^0 85' N and 82^0 45'. The study areas cover the Siwalik as well as middle mountain range. Altogether three VDCs Narayansthan, paiyunpata and Bhakunde were taken for study. The demography of Narayansthan, paiyunpata and Bhakunde is 3,495, 5,603 and 4,033 respectively. The total number of households in the district is 53,565.
- **Kailali** is the terai region and situated in far western region of the country. The total population of district is 616,697 with total households 94,430. Total three VDCs were taken as the study area, Baliya, Chaumala and Godawari. These VDCs contribute population of 31,851, 18,691 and 13,733 respectively to the district.

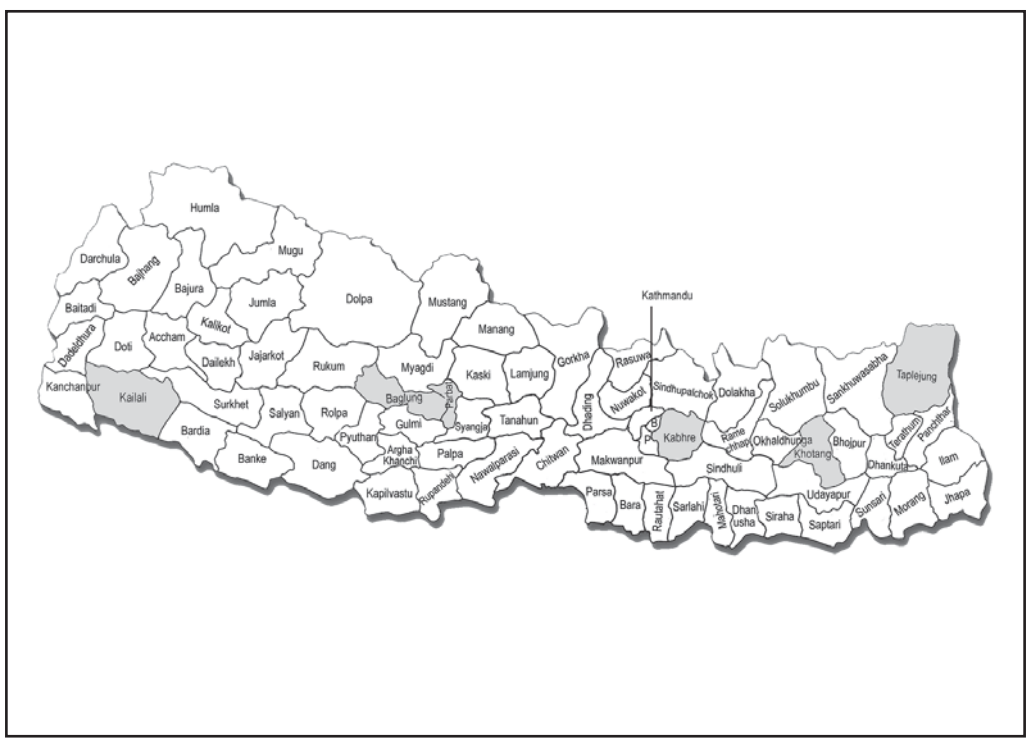

***Fig1**: Location of study area*

Chapter IV

METHODOLOGY

4.1 Project genesis and management

Community Radio Support Centre's Grant Committee (headed by Bhairab Risal and Member Secretary Coordinator Mr. Raghu Mainali and NEFEJ Executive Director Mr. Om Khadka) identified its 5 partner NGOs and community radio stations based upon a pre defined criteria through rigorous screening process in five different districts with representative ecological zones of the country in 2008. This venture is supported by Free Voice and NPL The Netherlands.

4.2 Area selection

The entire process of area selection started with the institution of an experts' panel. Communities with vulnerability from climate change perspective were the criteria for selecting the sites in terms of ecological zones also covering the administrative regions. Mountain, hills and plains were the ecological zones considered. Similarly, eastern, central, mid-western and far western were the administrative regions covered under purposive sampling. Despite the political instability, socio-economic transition, bandh and unexpected strikes selection of project site was done. Livelihood and hardship of the local community with the natural landscape was also kept in consideration.

For the specific project sites of the specific ecological zone possible parameters were suggested to the local team to collect the information. The followings were the key parameters suggested by the team of experts to local project teams.

- **Taplejung district:**
  - Sudden change in the trend pattern of temperature and rainfall.
  - Change pattern in the qualitative and quantitative yield of vegetation types in community forests.
  - Change in flowering time of rhododendron and other key flowering plants.
  - Changes by drought, heavy rainfall, reduced rainfall, hailstorm and snowfall and impact on farming.
  - Changes brought about by climate change in the fertility of the soil and its impact on agronomic yield.

- **Khotang district:**
  - Change in temperature and rainfall patterns.
  - Change in the vegetation types of forest ecosystems (community) and its measurable biomass (qualitative and quantitative yield).
  - Changes in the yield of rice, maize, wheat and local strain of millet.
  - Changes brought about by climate change in major crops especially mustard, flowers, fruits and oilseeds.

- **Kavre district:**
  - Change in the pattern of of temperature and rainfall.

- Change in the qualitative and quantitative yield demonstrated by community forests.
- Change in yield pattern of mustard, flowers, fruits and other oilseeds due to the possible impact of climate.
- Changes in the yield of rice, maize, wheat and local strain of millet.
- Changes by climate change in the fertility of the soil and its impact on due to agronomic yield as well as local economy.

- **Baglung district**
  - Change in major meteorological parameter such as sudden rise and fall in temperature and rainfall.
  - Change in forest biomass yield (qualitative and quantitative) local community forest only.
  - Changes brought about by climate change in mustard, flowers, fruits and other oilseeds.
  - Changes brought about in the yield of rice, maize, wheat and local strain of millet.
  - Changes brought about by climate change in the fertility of the soil and its economic impact

- **Kailali district**
  - Changes in the nature of rainfall, nature of flood, natural forest deforestation and their impact.
  - Flash floods arising from isolated showers.
  - Change in relative humidity, temperature and nature of drought and their impact.
  - Changes brought about by climate change in oilseeds, pulses and other cash crops.
  - Changes in the yield of rice, maize and wheat.

4.3 Call for proposals

The CRSC announced for project proposals outlining the format from local NGOs by running advertisements on local community radio stations to conduct the program through local initiatives. The call was run for a month and prospective NGOs requested to submit proposals either at the community radio station in their district or at CRSC Secretariat in Kathmandu.

The supplied format of the proposal included the following contents:
Title, Introduction, Profile of the organization, why the grant has been sought, Objectives, Project activities and areas, Expected output, Budget, Partners and other sponsors if applicable, Annex (audit report of the last three years/ last three years' activities undertaken and budget spent/ organizational profile/registration documents and statute of the organization, year when last election was held, rise in membership, letter from the executive committee, etc)

4.4 NGO and Radio selection

4.4.1 NGO selection and Grant

The CRSC Grant Committee awarded the grant to the following NGOs operating in respective districts. The CRSC Grant Committee selected the five project areas based on the suggestion of the experts.

- Batabaran Sanrakshan tatha Bikas Manch (Environmental Conservation and Development Forum), an NGO operating in Taplejung. Taplejung is a mountainous district in the eastern part of the country.
- Janasewa Samaj Nepal (Public Service Society Nepal), an NGO operating in remote Khotang district of east Nepal and known for its hilly environment.
- Banyajantu Batabaran Sanrakshan Manch (Wildlife and Environment Conservation Forum) in Kavre, a region which is known for its own geographical setting and ecosystem and farming practices, with main crop being potato. It is located in central hill region of the country.
- Gramin Jagaran Tatha Ekikrit Bikash Sangh (Rural Awareness and Development Association), an NGO based in Baglung district. Located in mid western hilly region of the country.
- Society for Creative Women (SfCW), a Kailali based NGO run by women. The region where the NGO operates is known for its tropical climate and rich agriculture. Far western geographical and administrative region, a flatland and terai.

4.4.2 Selection of Radio

The CRSC team selected the five community radio as media partner to disseminate the activities about "Communities Challenging Climate Change" operated by local NGO in respective project districts. The CRSC team has selected those community radios in respective project site area which has wider ownership in community and content of program are more community oriented to the target group. Each community radio stations produced half an hour program related to climate change and broadcast it in weekly basis. Selected community radio stations in project site area are as follows:

1. The activity performed by an NGO Environmental Conservation and Development Forum in Taplejung district was disseminated by Radio Tamor.
2. The activity performed by an NGO Public Service Society Nepal in Khotang was disseminated by Radio Rupakot.
3. The activity performed by an NGO Wildlife and Environment Conservation Forum in Kavre district was disseminated by Radio Namobuddha.
4. The activity performed by an NGO Rural Awareness and Development Association in Baglung district was disseminated by Baglung F.M.
5. The activity performed by an NGO Society for Creative Women in Kailali district was disseminated by Tikapur F.M.

4.5 Training to NGO and Radio partners

The CRSC organized training workshop in five project site area targeting to the partner NGO and radio representatives to understand the issues of climate change and its affects in different sector at community level such as in agriculture, rainfall pattern, water resources and melting of glacier and Himalayas etc. The training has helped to understand the issues of climate change globally and locally to the participants. The training has helped the partner NGO to perform the research activities in local level to find out the affects of climate change in project site area. It also helps to partner radio to understand the issues of climate change and to disseminate it in local perspectives to inform the local community.

The CRSC conducted 5 orientation training workshops for implementing partners on how to implement the climate change related project being implemented by them. The areas of training comprised process of pre-testing and testing of questionnaire in the field, data collection, data processing and report writing.

Moreover, the training ran into how to conduct interaction programs with the local stakeholders to bring out the climate change related issues through PRA exercises and other tools and methodology.

The training was conducted by CRSC expert team. The team of experts followed the planned activities of the concerned NGOs beginning with the finalization of questionnaires. The team traveled to Kailali, Kavre, Khotang, Taplejung and Baglung district. In many of the sites grant committee representative also participated in the training workshop.

4.6 Awareness, adaptation and mitigation activities

For awareness raising, adaptation and mitigation activities, the local NGOs carried out activities through a whole year cycle. Detailed activities carried out in respective districts are as follows:

4.6.1 Taplejung district

Batabaran Sanrakshan Tatha Bikas Manch (Environmental Conservation and Development Forum) and Radio Tamor, a community radio based in the district, implemented the project activities in a coordinated manner. While the NGO conducted field based project activities, experience, and findings, the radio disseminated the same through weekly radio programs. The field activities comprised building database that shows changes in rainfall, temperature, snowfall and frost going back to the last ten years. Other activities comprised identifying effect of climate change on the flowering time of rhododendron, and other vegetations. Disappearance of specific vegetations over time, outbreak of pests affecting agriculture and duration of the year they hit and effect of human behavior on climate.

Based on the database, 8 Village Development Committee (VDC) level awareness generating seminars with the participation of 240 local people were conducted. One orientation workshop that lasted for 3 days was conducted at the district headquarter Phungling, where participants from local NGOs, headmasters and teachers, forestry personnel, agriculture personnel participated. The number of participants was 30. Two more reflection seminars were organized at the district level. Lastly, 8 eco-clubs were formed in 8 schools which have a total of 99 school students as its members. Eco-clubs conducted program at village level. Eco-club activities were a minimum of four for each VDCS covering four seasons of the year. For the duration of fifty two weeks half-an-hour radio programs was aired by Radio Tamor on different local issues of climate change.

4.6.2 Khotang district

Janasewa Samaj Nepal (Public Service Society Nepal), and Radio Rupakot, a community radio based in the district, implemented the project activities jointly. While the NGO conducted field based project activities, experience, and findings, the radio disseminated the same through weekly radio programs.

The field activities comprised building database on changes in rainfall, temperature, snowfall and frost going back to the last ten year.

Further activities comprised identifying effect of climate change on lifestyle and vegetation, outbreak of new pests which are affecting farming and duration of the year and effect of climate change on human lifestyle.

Based on the database, 8 Village Development Committee (VDC) level awareness generating seminars with the participation of 240 local people were conducted. One orientation workshop was conducted at the district level with the number of participants at 30. Two more reflection seminars were organized at the district level. Training was conducted with the participation of 72 lead farmers. Lastly demonstration farming activity was carried out in 8 VDCs on wheat, rice, and maize and potato cultivation.

This was backed up by 52 weekly half-an-hour radio programs on Radio Rupakot and which were devoted fully to the issues related to climate change.

4.6.3 Kavre district

Banyajantu Batabaran Sanrakshan Manch (Wildlife and Environment Conservation Forum) in Kavre, and Radio Namobuddha, a community radio based in the district, implemented the project activities jointly. While the NGO conducted field-based project activities, experience gathering, and compiling findings, the radio disseminated the same through weekly radio programs.

The field activities comprised database on changes in rainfall, temperature, drought and dew on time series basis for the last ten years.

Further activities carried out in Bhakundebesi and Dhunkhark. The areas which have not have had any rainfall for the last four years comprised identifying effects which have led to fall in maize, rice and vegetable yield, extreme weather condition, drying up of water springs, disappearing herbs and pests which have come along with climate change.
Based on the database, 5 Village Development Committee (VDC) level awareness generating seminars with the participation of 260 local people were conducted. One orientation workshop was conducted at the district level with the number of participants at 32. Two more reflection seminars were organized at the district level. Moreover 30 local people formed awareness groups in 4 different areas. Lastly, two rounds of quiz contest on the issue of climate change were conducted with the participation of local schools and local Non-Governmental Organizations (NGOs).

This was backed up by 52 weekly half-an-hour radio programs Radio Namobuddha and which were devoted fully to the issues related to climate change.

4.6.4 Baglung district

Gramin Jagaran Tatha Ekikrit Bikash Sangh (Rural Awareness and Integrated Development Association), an NGO based in Baglung district, and Radio Baglung, a community radio based in the district, implemented the project activities jointly. The NGO conducted field-based project activities, experience gathering, and compiling findings, the radio disseminated the material through weekly radio programs.

The field activities comprised database on changes in rainfall, temperature, change in yield pattern of the previous available years.

Further activities carried out comprised identifying effects which have led to the flowering time of mainly rhododendron and similar other local vegetation, change in duration when trees shed leaves, disappearance and appearance of medicinal herbs, arrival of new pests which are affecting crops and changes induced by human on climate.

Based on the database, 6 Village Development Committee (VDC) level awareness generating seminars with the participation of 300 local people were conducted. One orientation workshop was conducted at the district level with the number of participants at 30. Four reflection / review seminars were hosted with the participation of 82 participants. Moreover 10 eco- clubs were formed with the membership of 175 school students.

This was backed up by 52 weekly half-an-hour radio programs Radio Baglung and which were devoted fully to the issues related to climate change.

4.6.5 Kailali district

Society for Creative Women (SfCW), a Kailali based NGO run by women and Radio Tikapur, a community radio based in the district, implemented the project activities in a

coordinated way. While the NGO conducted field-based project activities, experience gathering, and compiling findings, the radio disseminated the material through weekly radio programs.

The field activities comprised building database on changes in rainfall, temperature, dew, drought and flood of the previous 5 years.

Further activities carried out comprised identifying effects of climate change which have led to changes in the yield of mustard, sunflower, paddy, wheat and maize with the corresponding changes in the harvesting time apart from changes in the harvesting time of the local indigenous Tharu potato and vegetables and effect of rising temperature on local medicinal herbs and green leafy vegetables. Further activity comprised changes catching up with human activity and river system.

Based on the database, 6 Village Development Committee (VDC) level awareness generating seminars with the participation of 308 local people were conducted. One orientation workshop was conducted at the district level with the number of participants at 28. Six eco-clubs were formed with 447 members comprising local school as members. Moreover 10 eco- clubs were formed with the membership of 175 school students.

This was backed up by 52 weekly half-an-hour radio programs produced and broadcast by Radio Tikapur and which were devoted fully to the issues related to climate change.

4.7 Field Methods

Participatory Rural Appraisal (PRA) and household questionnaires survey method were adopted for collecting the data. For questionnaire survey random sampling of household was done and a set of questionnaires was prepared for household survey. Face to face interviews made it easier to clear any ambiguity respondents had about questions.

In Taplejung and Baglung group discussion was used as the main method to grab information data. A series of group discussion were organized in all 8 VDCs. People with age group 40 or more were participated in group discussion. Mostly open ended questions were used to promote explanations and opinions.

In Khotang, Kavre, and Kailali household survey as well as group discussion were followed. In Khotang about 400 households 50 from each eight VDCs were surveyed. Some 8 VDCs were selected in such that these VDCs represent the whole geography of the district. A purposive sampling method was used considering the people above 60 years have more knowledge regarding information on climate change. From each ward of each VDC 5 households were sampled and 5 more from higher altitude of same VDCs were selected. Similarly, secondary data were collected from Koshi basin field office, Rupakot community radio, meteorological department of Koshi basin field office, Department of

Meteorological, Kathmandu.

In Kavre random sampling of household based on the age and sex was followed. About 60 households were selected from Dhungkharka and Bhakundebesi. Similarly, focus group discussion, key informants interview, interaction with representatives from government line agencies, experiences sharing in some aspects of climate change and agriculture was carried out to generate information. The secondary data were obtained from District Agriculture District Office, Kavre, Department of Meteorological Science and other relevant papers published by some other organizations.

In Kailali main data collection techniques are interviews based, group discussions and observations. Household survey and PRA methods were adopted. About150 households from each three VDCs were surveyed and the households were sampled on the basis of economic status and socially excluded groups. The research team conducted household interviews with people regarding the present and past conditions of agricultural products like maize, paddy, mustard and sunflower seeds, sugarcane, the rise and decrease in the level of rainfall, water, temperatures and condition of medicinal herbs and the fishes in the ponds. Besides this, three focus group discussions were conducted at the VDC level, three focus group discussions were conducted with the students of eco-clubs and one district level focus group discussion was carried out with participants from three VDCs and various governmental and non-governmental organizations. Along with these, three essay competitions were carried out in one school of each of three VDCs.

Chapter V

COMMUNITIES CHALLENGING CLIMATE CHANGE

Present findings are synopsis of observation of community response towards climate change. It was reported from Taplejung and Khotang of eastern mountain, Kabhre of central hill, Baglung of mid western hill and Kailali of far western plain. The common features observed in climate change by the community were change in temperature and rainfall patterns, change in distribution range of vegetations, change of flowering and fruiting time of locally grown crops and other plants, change in availability of water and water resources and effects on agricultural practices.

5.1 Case study in Taplejung

To study climate change effects the area was divided into three parts on altitudinal basis. The data represent Siwalik, middle Mountain and high Mountains regions

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1) Siwalik or Lower region (up to 1200m)
2) Middle region (1200 to 2100m)
3) Higher region (2100 to 3794m)

Regarding the peoples' perception on climate change, it was found that local people were worried about climate change and its effects. Commonly concerned subjects among local people were climate change, poverty, loss of biodiversity, natural disasters and social conflicts. Out of total respondents (n= 120), 21% showed high concern on climate change, 21.5% on poverty, 20% on natural disasters and 20% on social conflicts. However, few people, about 17.5% had showed their concern on biodiversity loss. More effects have been observed in the higher altitude. The effects of climate change have been noticed by local people as shown below.

i) **Change in dew fall time**
The time of falling dew and frost was found to be changed. According to the respondents, before 2063 B.S (2006) dew and frost started to fall in September/October and ended in February/March. But after that it started from October/November and ended in January/February.

ii) **Alteration in snowfall time**
More than 80% of respondents agreed that the snow fall time had been changed. Before 2006 snow started to fall from October/November and remained till April/May. But these days the time of snow fall has been postponed and ended within 10-15 days. Moreover, the snow melts so early in comparison to past.

iii) **Scarcity of water**
Along the Pathibhara Temple area the water was being supplied through Net Water Techniques (fog collection) in which fog is the main source of water.

Water that is condensed from the fog is collected. This water fulfilled the water need for 7 months in recent 2 years, the availability of water has been declined, mainly due to low amount of fog. The intensity and duration of fog has been declined. Similarly, the water level in the sources like well, river and tributaries was also found declined.

iv) **Increase in temperature**

Majority of people (>80%) reported that there is increase in temperature in recent years. Due to rise in temperature the availability of grasses in higher altitude has been increased. These days herders take their livestock to higher altitude and spend more time as the snow fall time has also changed. Generally, herders used to keep their Goth (temporary shed to keep livestock in higher elevation) from May/June to August/September. But since last 2 years, they used keep Goth from April/May to October.

5.1.1 Temperature and rainfall pattern

About 15 years data from 1994 on temperature and rainfall was collected from meteorological station. The yearly average temperature was fluctuating. However, the 5 years time interval data showed that there was continuous increase in average temperature. From 1994 to 1999 the average maximum temperature was 20.72 ^{0}C. From 1999 to 2004 the average maximum temperature was 21.06 ^{0}C and that of from 2004 to 2008 was 21.56^{0}C. Similarly, the minimum average temperature was also found to be increased in each five years interval as shown in table

Table 1: Five years average temperature from 1994 to 2008

Year	average max temp (^{0}C)	average min temp (^{0}C)	Cumulative rainfall (mm)
1994-1999	20.72	11.66	2070
1999-2004	21.06	11.61	2089.6
2004-2008	21.56	12.14	1901.82

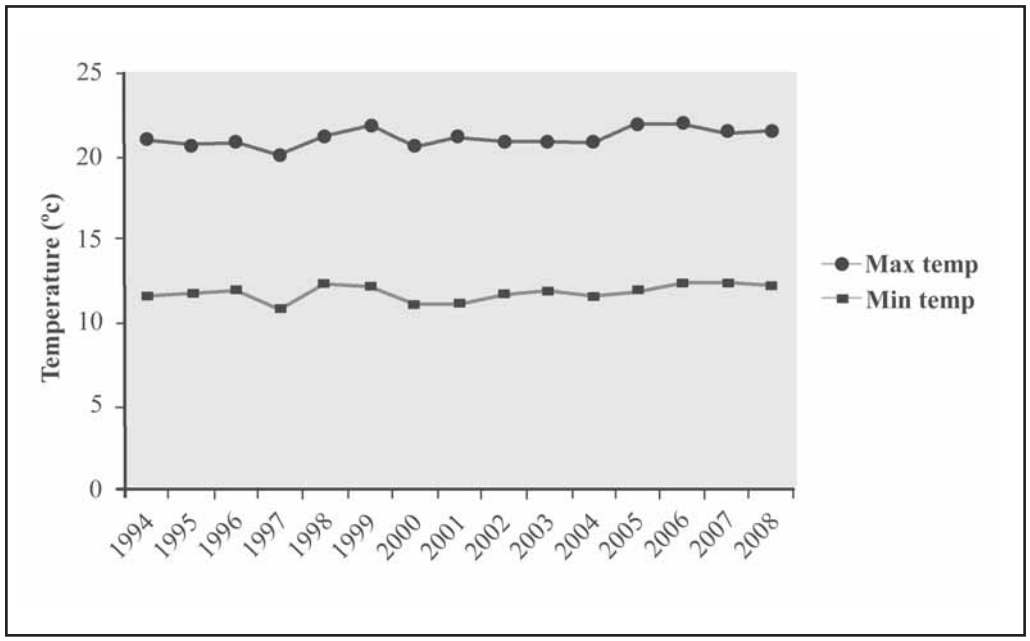

Fig 2: *Average maximum and minimum yearly temperature from 1994 to 2008.*

The yearly rainfall data showed that there was great fluctuation showing erratic in yearly rainfall with maximum in 2003 (2505 mm) (Fig 3). In average five years time interval there was decreased amount of rainfall.

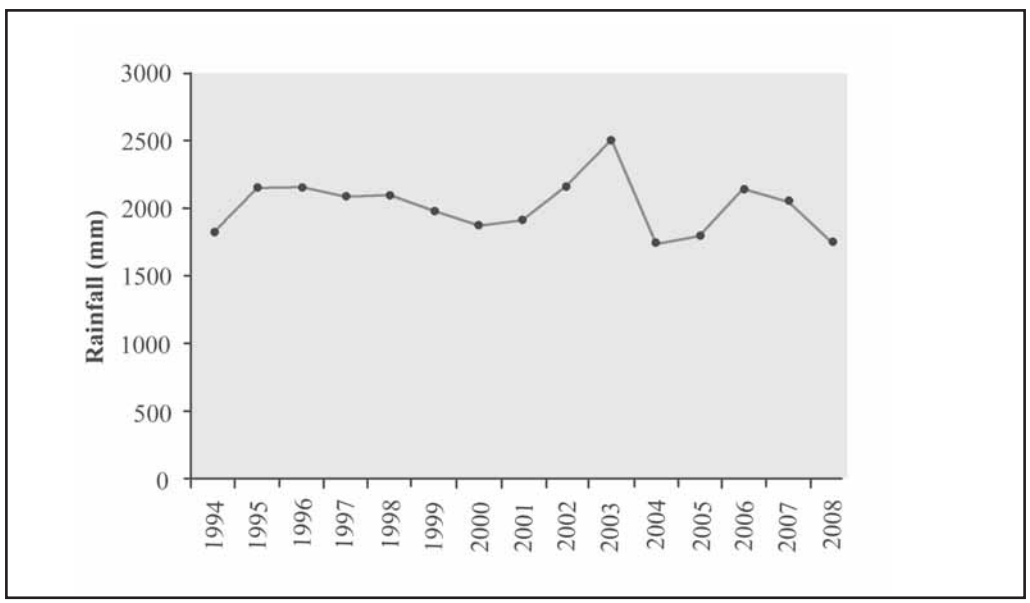

Fig 3: *Average yearly rainfall in mm from 1994 to 2008*

5.1.2 Observed changes in distribution of vegetation

There was no change in distribution of vegetation in different altitudinal range. Most of all plant species had been distributed in the same range as they found before. The altitudinal shift was found with two plant species only *Alnus nepalensis* (Uttis) and *Macaranga indica* (Malato). The distribution of *Alnus nepalensis* (uttis) has shifted below than its previous range at lower region of phungling VDC. Similarly, the altitudinal range of *Macaranga indica* has shifted above the previous range at lower region of phungling VDC . The distribution range of different plants is shown in the table 2.

Table 2: Change in distribution of vegetation in observed VDCs

Main vegetation	Phungling			Hangdeva			Phurumba			Linkhim			Tapethok			Phawakhola			Tiringe			Sikaicha		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Lower region																								
Fodder species																								
Litsea monopelata	*			*			*			*			*			*			*			*		
Newaro	*			*			*			*			*			*			*			*		
Ficus semicordata	*			*			*			*			*			*			*			*		
Ficus lacor	*			*			*			*			*			*			*			*		
Artocarpus lakoocha	*			*			*			*			*			*			*			*		
Melia azederach	*			*			*			*			*			*			*			*		
Bauhinia (Tanki)	*			*			*			*			*			*			*			*		
Bauhinia purpurea	*			*			*			*			*			*			*			*		
Wood species																								
Shorea robusta	*			*																				
Murraya paniculata	*			*			*			*			*			*			*			*		
Bombax ceiba	*			*			*			*			*									*		
Alnus nepalensis		*		*			*			*			*									*		
Castanopsis indica	*			*			*			*			*			*			*			*		

Main vegetation	Phungling			Hangdeva			Phurumba			Linkhim			Tapethok			Phawakhola			Tiringe			Sikaicha		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Lower region																								
Chilaune	*			*			*			*			*									*		
Pinus roxburghii	*			*			*			*			*			*			*			*		
Albizia julibrissin	*			*			*			*			*			*			*			*		
Albizia procera	*			*			*			*			*			*			*			*		
Juglans regia	*			*			*			*			*			*			*			*		
Macaranga indica			*	*			*			*			*			*			*			*		
Medicinal plants																								
Zanthoxylum acanthopodia	*			*			*			*			*						*			*		
Viscum album	*			*			*			*			*						*			*		
Stephania japonica	*			*			*			*									*			*		
phyllanthus emblica	*			*			*			*			*						*			*		
Artemisia indica	*			*			*			*						*			*			*		
Eupatorium adenophorum	*			*			*			*			*			*			*			*		

Main vegetation	Phungling			Hangdeva			Phurumba			Linkhim			Tapethok			Phawakhola			Tiringe			Sikaicha		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Astilbe rivularis	*			*			*			*			*						*			*		
Tinospora cordifolia	*			*			*			*			*			*			*			*		
Middle region																								
Fodder and Wood species																								
Dudhilo	*			*			*			*			*			*			*			*		
Ficus auriculata	*			*			*			*			*			*			*			*		
Saurauia napaulensis	*			*			*			*			*			*			*			*		
Bambusa arundinacea	*			*			*						*			*			*			*		
Chilaune	*			*			*			*			*			*			*			*		
Alnus nepalensis	*			*			*			*			*			*			*			*		
Rhododendron	*			*			*			*			*			*			*			*		
Castanopsis spp	*			*			*			*			*			*			*			*		
Pinus spp (Gobre salla)	*			*			*			*			*			*			*			*		
Juglans regia	*			*			*			*			*			*			*			*		
Angeri	*			*			*			*			*			*			*			*		
Daphne bholua	*			*			*			*			*			*			*			*		

Main vegetation	Phungling			Hangdeva			Phurumba			Linkhim			Tapethok			Phawakhola			Tiringe			Sikaicha		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Medicinal plants																								
Zanthoxylum oxphyllum	*			*			*			*			*			*			*			*		
Stephania japonica	*			*			*			*			*			*			*			*		
Ban mula	*			*			*			*			*			*			*			*		
Acorus calamus	*			*			*			*			*			*			*			*		
Swertia chiraita	*			*			*			*			*			*			*			*		
Higher region																								
Saurauia napaulensis				*			*			*			*			*			*			*		
Ficus auriculata				*			*			*			*			*			*			*		
Persea odoratissima				*			*			*			*			*			*			*		
Castanopsis spp	*			*			*			*			*			*			*			*		
Chap				*			*			*			*			*			*			*		
Rhododendron	*			*			*			*			*			*			*			*		
Rhododendron barbatum							*			*			*			*			*			*		
Quercus lantana							*			*			*											
Betula utilis							*			*			*			*								

Main vegetation	Phungling			Hangdeva			Phurumba			Linkhim			Tapethok			Phawakhola			Tiringe			Sikaicha		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Pinus spp (Gobre salla)							*			*			*			*			*			*		
Laut salla													*											
Dhupi salla										*			*			*			*			*		
Thamnocalamus spathiflorus							*			*			*			*			*			*		
Medicinal plants																								
Chimphin	*			*			*			*			*			*			*			*		
Astilbe rivularis	*			*			*			*			*			*			*			*		
Zanthoxylum oxyphyllum	*			*			*			*			*			*			*			*		
Berjenia ciliata	*			*			*			*			*			*			*			*		
Swertia chiraita	*			*			*			*			*			*			*			*		
Sun thankne	*			*			*			*			*			*			*			*		

Note: 1= same as previous range, 2= below the previous range, 3= above the previous range

5.1.3 Flowering and fruiting time of the different crops and plants

Study on flowering and fruiting time of different types of plants as well as crops showed that there was no clear change in flowering and fruiting time. However, farmers reported that the harvest time of some crops like maize, barley and wheat is shifting earlier at middle region (1200 to 2100) mainly due to increase in temperature. On the other hand, there was clear observation of change in flowering time of *Rhododendron barbatum* (Dudhe chimal). Generally the flowering time of the species is 2nd week of July but from last 2 years, the flowering time had shifted one month before (June).

Table 3: Observation on flowering and harvest time of different plant species and crops

Plants	Flowering Time	Changes in flowering time			Changes in harvest time		
		Early	Late	No change	Early	Late	No change
Paddy	Sept/Oct			*			*
Maize	May/June			*			*
Wheat	March/April			*			*
Barley	March/April			*			*
Millet	Sept/Oct			*			*
Soybean	August/Sept			*			*
Philunge Niger	Jan/Feb			*			*
Mango	Jan/Fe			*			*
Katahar Jack Fruit	Jan/Feb			*			*
Lemon	Jan/Feb			*			*
Orange	Jan/Feb			*			*
Aru plum	Jan/Feb			*			*
Naspati pear	Dec/Jan			*			*

Plants	Flowering Time	Changes in flowering time			Changes in harvest time		
		Early	Late	No change	Early	Late	No change
Bombaxceiba	Dec/Jan			*			*
Kadam	March/April			*			*
Shorea robusta	Jan/Feb			*			*
Schima wallichi	Octr/Nov			*			*
Alnus nepalensis	Jan/Feb			*			*
Prunusspp	April/May			*			*
Castanopsis spp	April/May			*			*
Michelia spp	April/May			*			*
Raspberry	Jan/Feb			*			*
Chutro	Jan/Feb			*			*
Bauhinia spp	Oct/Nov			*			*
Bauhinia purpurea	March/April			*			*
Ficus spp	Feb/Mar/April			*			*
Nimaro	Feb/Mar/April			*			*

5.1.4 Changes in availability of water and water resources

The phenomena of climate change seem more evident on water resources. It was studied on the basis of present water availability these days in the area compared to 15 years back. Study showed that there was significant decline in availability of water (Table 4). Out of total water resources available (N=335) in the area, about 32.23% had same water level as that of 15 years ago. Similarly, in 54.32% of water resources water level was found to be declined and in 13.42% it was declined drastically.

Table 4: Current level of water in different resources

water sources	Phungling			Hangdeva			Phurumba			Linkhim			Phawakhola			Tiringe		
	Level of Water																	
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Marshy area with water throughout the year	6	9	0	8	10	1	3	12	1	1	4	6	10	13	0	3	4	0
Water well	2	13	2	10	9	2	11	7	0	3	8	5	11	13	2	6	9	4
Ponds and lake	3	2	0	1	0	3	0	5	0	4	0	4	0	3	8	0	2	1
River and Tributaries	5	6	2	3	15	1	4	13	0	6	5	0	8	11	2	0	9	1
Total	**16**	**30**	**4**	**22**	**34**	**7**	**18**	**37**	**1**	**14**	**17**	**15**	**29**	**40**	**12**	**9**	**24**	**6**

note: A= same as 15 years ago, B= slight decline, C= drastic decline

Three types of water resources had been identified in the study area viz: a) marshy area, b) well, ponds and lake, and c) river tributaries. Phawakhola consists of highest number of water resources out of which about 36.25% did not show any change in water level compared to 15 years back. The highest numbers of water resources that were severely hit by dryness were found in Limkhim where 33.33% had significantly lost water level. The main cause of water decline is rise in temperature level, less precipitation and long term dryness in the area. Decreased availability of water even had led to increase in social conflicts and people had to devote more time to fetch water.

5.1.5 Effects on agricultural practices

Agriculture is mostly affected by change in climatic pattern. According to farmers the production of cereal crops has been declined. Due to long term dryness and untimely rain fall, agricultural practices have been adversely affected. A cash crop big cardamom (*Amomum subulatum*) was found to be highly affected by the dryness. The plant and flower became dried due to lessen supply of water resulting in decline of yield. Cardamom is the important economic source of farmers in Taplejung. With low and irregular rainfall, the amount of

water in the rivers, ponds and lakes was found to be declined. This directly affected the irrigation system and increased social conflict between farmers. Most of the respondents reported that prevalence of disease, pest and weeds had increased since 2- 3 years. Maize was found highly affected by pest and disease in all VDCs while paddy was highly affected in Phungling and Hangdeva and less affected in other VDCs. Millet was found to be less affected crops in all VDCs. Similarly, Cardamom was highly affected by pest and disease in all eight VDCs. The details of pest occurrence and their effects are shown in table 5.

Table 5: Prevalence of pests on crops in different VDCs

Main crops	Pests	Effects in different VDCs							
		Phungling	Hangdeva	Phurumba	Linkhim	Tapethok	Phawakhola	Tiringe	Sikaicha
Maize	Ghun, Gabaro, Khumre	Highly	Highly	Highly	Highly	Highly	Highly	Highly	Highly
Paddy	Pat beruwa, Patero	Highly	Highly	Highly	Moderate	Moderate	Moderate	Highly	Highly
Millet	Sindure, Patera, Lahi	-	-	-	Highly	Moderate	-	Less	-
Wheat	…….	Less	-	less	-	Highly	less	-	Highly
Soybean	Kage kira	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Mustard	Lahi, Green larva kira	Moderate	Moderate	-	Highly	Moderate	Moderate	Moderate	Moderate
Cauliflower	Lahi	Moderate	Moderate	Highly	-	-	-	-	-
Potato	Ants	Highly	Highly	Highly	Highly	Highly	Highly	Highly	Highly
Alachi	Caterpillar, Gabaro	Highly	Highly	Highly	Highly	Highly	Highly	Highly	Highly

Similarly, Daduwa was the major crop disease which affected maize, paddy, wheat and potato (Table 6). It was prevalent in most of the area. Cardamom, paddy and maize were mostly affected crops.

Table 6: Occurrence of disease crops in different VDCs

Main crops	Diseases	Effects in different VDCs							
		Phungling	Hangdeva	Phurumba	Linkhim	Tapethok	Phawakhola	Tiringe	Sikaicha
Maize	Daduwa, ranke,	Highly	Highly	Highly	Moderate	Moderate	-	moderate	Highly
Paddy	Daduwa	Highly	Highly	Highly	Highly	-	Moderate	Moderate	Moderate
Wheat	Daduwa, ranke,kalopoke		Highly	Highly	-	-	Highly	Highly	--
Mustard	Dropping of flower	-	-	-	Moderate	-	-	-	-
Cauliflower	Root rotten	Moderate	-	Highly	-	-	-	-	-
Potato	Daduwa, fungus	Highly	Highly	-	Highly	-	-	-	Highly
Alachi	Phrke chirke, bulb rotten	Highly	Highly	Highly	Highly	Highly	Highly	Highly	Highly
Millet	Lack of grains,	-	-	-	-	Moderate	Moderate	-	-

5.2 Case study of Khotang

5.2.1 Temperature and rainfall pattern

Analyzing 20 years temperature data, the maximum average temperature was between 20.1 ^{0}C to 23 ^{0}C. The data showed that there was gradual increase in temperature from 1990 to 2008. The temperature was increased by 1.2 ^{0}C from 1995 to 1996. From 1990 to 2003 there was continuous increase in average temperature and slightly declined for 2004 and for 2005. But from 2006 onward the temperature was continuously increased. The highest temperature was 25.6 ^{0}C in 2009. Similarly, the minimum average temperature range was found between 11.8 ^{0}C to 13.6^{0}C as shown in Fig 4. It was found that the temperature continuously increased in every five years time interval. In first five years the temperature was 20.64^{0}C, in second five years the temperature was 22.28^{0}C. The temperature was 23 ^{0}C in fourth five years time interval which showed the increase in temperature by 2.36^{0}C as shown in fig 5.

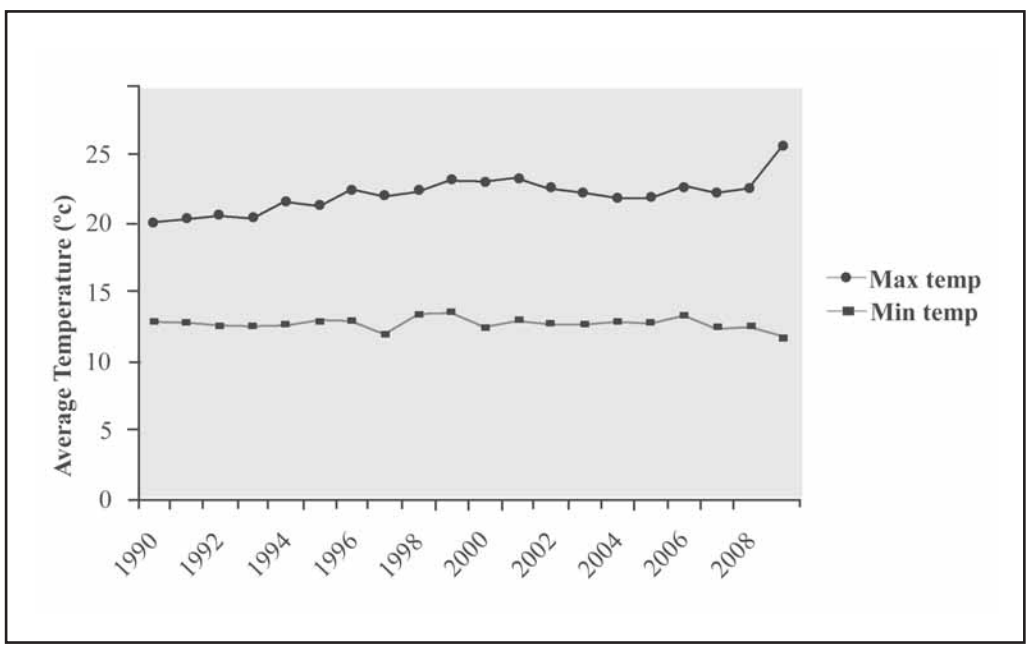

Fig 4: *Average maximum and minimum yearly temperature from 1990 to 2009*

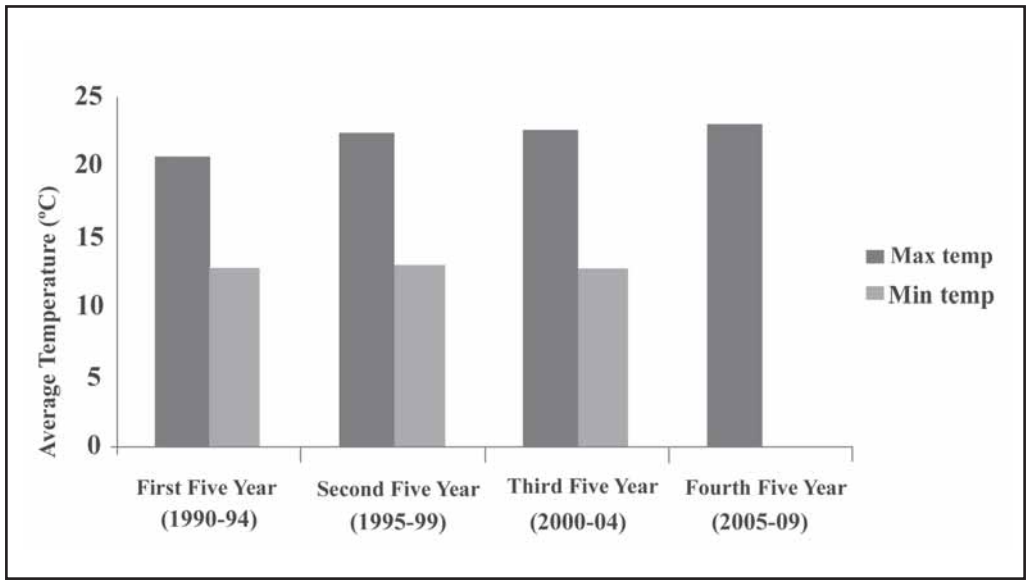

Fig 5: *Five years time interval average temperature from 1990 to 2009*

The data showed that there was drastic decline in annual rainfall in last 20 years (fig 6). The annual average rainfall in 1990 was 2037.80 mm and it was decreased to 1704.30 mm by 1994. The average rainfall decreased to 1465.90 mm by 2000. The average annual rainfall was 713.2 mm in 2009. The average rainfall decreased by 1324.60 mm from 1990 to 2009.

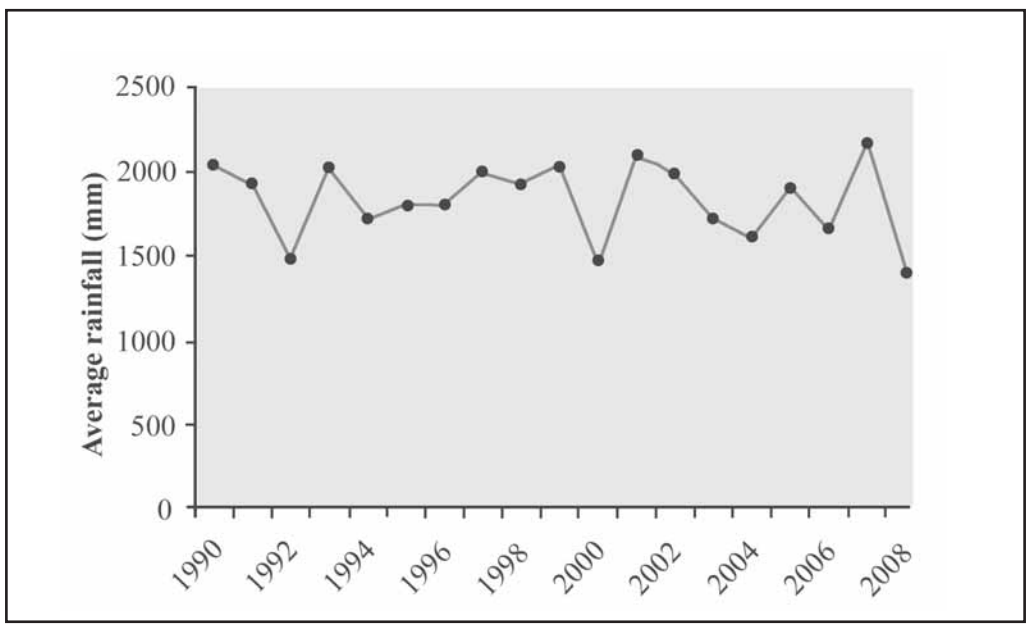

Fig 6: *Average yearly rainfall (mm) from 1990 to 2009*

5.2.2 Observed changes in vegetation

It had been found that the distribution and availability of more than 66 plants including medicinal was changed. Some of the species had shifted their distribution range while in the other hand some species were decreased in number. Abundance of more than 18 medicinal plants was found to be decreased since last 10 years. These days apples are growing in relatively lower altitude. Similarly, Uttis (*Alnus nepalensis*) was found in lower altitude and Nibhara had shifted in higher altitude. Respondents reported that one orchid species *Navabeli* and two medicinal plants famful and panchkane had extinct from the region (Table 7).

Table 7: Observed changes in vegetation in the study area

Observed Changes	Vegetation
Decrease in number	Prunus cerasoides (Painyu), Ficus neriifolia, Akle mane, Rubia manjith, Costus speciosus, Hadjoda, Patmeru, Ghoge chap, Chari amilo, Persea odoratissima, Nanak, Bikhuma, Beljam, Elephantopus seaber, Lot salla, Daphne sureil, Ambule, Anthocephalus chinensis, Quercus glauca, Alangium salviifolium, Callicarpa macrophyla, Garuga pinnata, phytolacca acinosa. **Medicinal plants:** Cassia fistula, Terminalia chebula, Bergenia siliata, Chiraito (Swertia chiraita), Ban jimbu, Plumbago zeylanica, Jugemala, Bauhinia vahlii, Coccinia spp, kalopati, Antidesma bunius, Juglans regia, Acorus calamus, Chiuri, Asparagus racemosus, Centella acetic, Phyllanthus emblica, Kagate.
Distribution range	Apple, Ulnus nepalensis, Nibhara,
Extinct species	Navabeli sunakhari, Famfal, Dillenia indica

5.2.3 Flowering and fruiting time of the different plants

Respondents reported that the flowering and fruiting time in some of the plants had been shifted earlier and nobody reported about late flowering and fruiting of the plants. About 54.5% of respondents reported the early fruiting and flowering of 32 plant species as shown in table 8. Similarly, 36.5% reported that there was no change in time schedule of flowering and fruiting of plants and remained 9% did not know about this.

Table 8: Observation of flowering and fruiting time of different plants

Plants	Changes in flowering time		Changes in harvest time	
	Early	Late	Early	Late
Nibuwa	*		*	
Naspati	*		*	
Guava	*		*	
Rubus elipticus	*		*	
Sisnu	*		*	
Lichi	*		*	
Mango	*		*	
Bans ko tama	*		*	
Aaru	*		*	
Lemon	*		*	
Orange	*		*	
Banana	*		*	
Bauhinia purpurea	*		*	
Myrica indica	*		*	
Mandre	*		*	
Castanopsis indica (Katus)	*		*	
Aalcha	*		*	
Prunus cerasoides	*		*	
Arubakhada	*		*	

Plants	Changes in flowering time		Changes in harvest time	
	Early	Late	Early	Late
Ghangharu	*		*	
Mulberry	*		*	
Godawari	*		*	
Rhodorodendron	*		*	
Magnolia campbelii	*		*	
Malingo	*		*	
Makhamali	*		*	
Marigold flower	*		*	
Apple	*		*	
Bhogate	*		*	
Junar	*		*	
Goruphul	*		*	
Katahar	*		*	

5.2.4 Changes in availability of water and water resources

The availability of water in different resources was studied on the basis of last 20 years. Out of total, about 182 water sources including ponds, lakes, rivers and tributaries had lost their water volume. About 75% were dried and in remaining 25% the water level had been decreased drastically (Table 9).

Table 9: Water sources that had lost the water level in last 20 years

Study area	Number of source	Responses
Jalapa	37	Long term dryness, less precipitation and deforestation
Nunthala	19	Long term dryness, less precipitation, landslide and deforestation
Patheka	21	Long term dryness, less precipitation and landslide
Kharmi	16	Long term dryness and less precipitation
Ainselukharka	28	Dryness, less precipitation and landslide
Hauchaur	19	Long term dryness, less precipitation, landslide, deforestation and earthquake
Nerpa	27	Landslide, long term dryness and earthquake
Diktel	15	Landslide, Deforestation
Total	**182**	

Most of the respondents (>80%) in all VDCs reported that the major causes responsible to decline in water sources are less precipitation, deforestation, landslide and earthquake. Jalapa was found to be most affected area where the highest numbers of water sources got dried.

5.2.5 Effects on agriculture system

Paddy, maize, wheat and potato are the main crops in Khotang. Results showed that these crops were highly affected by dryness, disease and pests. The intensity of disease and pests was increased resulting reduced productivity. About 94.5% of respondents reported for reduced production of paddy, maize, potato and wheat. Various kinds of disease on the crops had been shown in table 10.

Table 10: Details of various diseases on different crops

Crops	Species	Planting period	Main Diseases	Stage of Crops	Remarks
Maize	Sano Seti, Thulo Seti, Paheli Sano, Paheli Thulo,Khukhure, Thulo chyapte, Makwanpure, Satiya, Ganesh-1	Februay-April	Guva Khane	Sapling	
			Sete lagne	After fruiting	
			Sukauro	After fruiting	
			Decay at bottom	After fruiting	
			Ankhle	Fruiting	
			Kali poke	After fruiting	
			Sarange, pahele, Dadhuwa	After fruiting	Most harmful
Potato	Pothra, Khumbule Bhotange, pangkadhle, Kholome, Sikkime, TPSBaksile	January-Frbruary	Khumla	Graining time	
			Plant decay	After Graining	
			Maruwa	After Graining	
			Ageru	After Graining	
Wheat	Mandane, Bhangere, Bhote, Bikase, Nepale, Dholekhe, Nerpali, Americane, Junge	October-December	Sindure	Before Fruiting	While no rain
			Sukauro	Before Fruiting	
			Kalipoke	After Fruiting	
			Seto Kira	Flowering	
Paddy	Marshi, Tauli, Makwanpure, Malingi, Saprali, Laldhoj, Phapare, Chundamarsi, Solmali, Dhanase, Thapachine, Taichin, Himali, Lakali takmare	June-July	Pahele	Sapling	
			Maruwa	Seedling	
			Beruwa	Fruiting	
			Chirke	Fruiting	
			Husse lagne	After Fruiting	
			Khumre	After Fruiting	
			Ankhli	After Fruiting	
			Kalipoke	After Fruiting	Newly Seen

Highest percentage of respondents reported that alteration in climate pattern adversely affected on paddy crop followed by maize, wheat and potato. Cause of high intensity of diseases was spread off from other areas. About 20% of respondents reported that use of chemical fertilizers highly affect on maize.

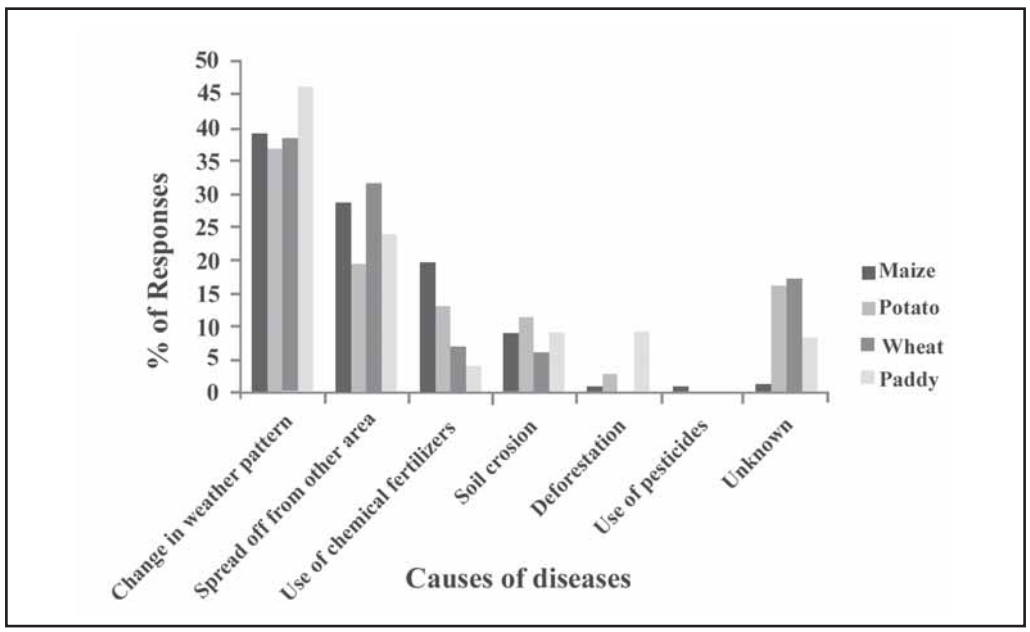

Fig 6a: *Causes of disease in different crops*

Out of total respondents, 68.75% reported that they didn't change the planting time of crops while 31.25% reported they had changed the planting time. During late monsoon, the planting date was delayed by 15 to 1 month which results reduced crop yield.

5.2.6 Changes in snow fall and dew time since last 10 years

The time and intensity of snowfall, frost and dew was found to be changed. The intensity and frequency of snowfall, frost and dew was gradually decreasing since last 10 years. In between 2000 to 2008, the snow fall was gradually decreased, mostly in high altitude and there was no snow fall in 2008 at all.

Similarly, result showed that there was significant change in rainfall pattern. The intensity of rainfall was found to be decreased gradually from 1999. There was drastic change in winter monsoon. From 1999 to 2004 winter monsoon started from December to April. But from 2004 onward it was scanty and irregular. Moreover, the time of monsoon arrival had been shifted by 2 to 3 months later. About 41% of responses were in favour of less rainfall in current years while 39% of respondents reported about the drastic change in arrival of monsoon. The details of responses regarding the status of rainfall are shown in figure 7.

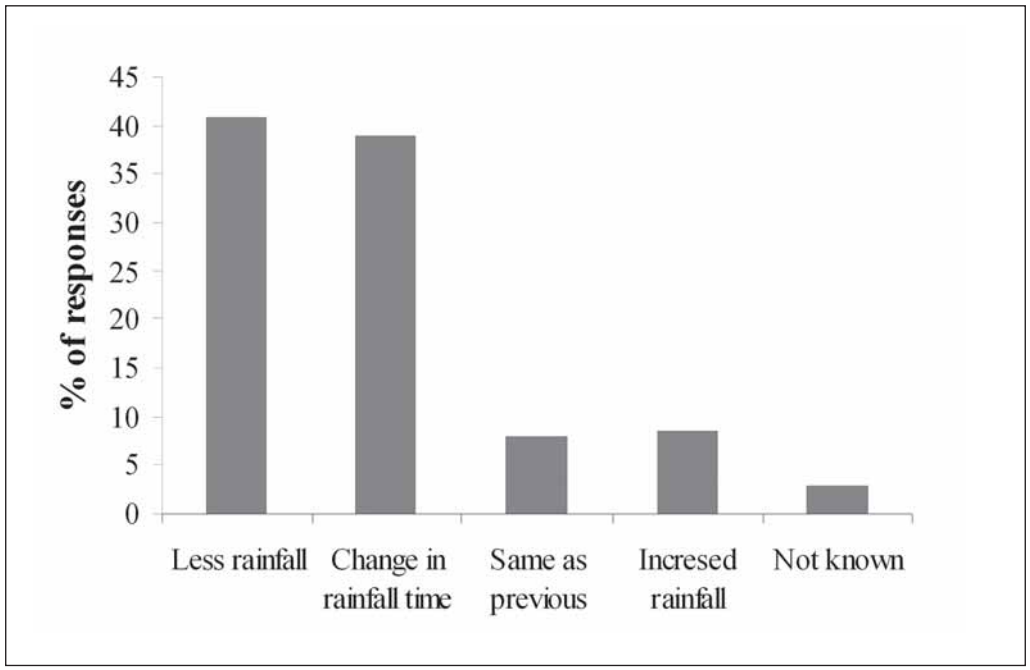

Fig 7: *Current status of rainfall compared to last 10 years*

The change in climatic parameters in between 10 years was measured by 5 dichotomous statements. It was found that majority of respondents (73.5%) agreed with increase in temperature. However, higher percentage of respondents was disagreed with change in time of frost and dew fall. Similarly, majority of respondents (69%) were agreed with drastic decline in snowfall intensity (Table 11).

Table 11: Change in climatic parameters in between 10 years of time period

Statements	Agree	Disagree	Don't know
The time of frost and dew fall has been changed	30.5	48.5	21.5
There is less amount of dew and frost	77	5	18
There is increased in temperature	73.5	6	20.5
The time of snowfall has been postponed	53	23	24
The amount of snowfall has declined	69	24	25

5.3 Case study from Kavre

5.3.1 Temperature and rainfall pattern

The average maximum temperature was found more or less stable from 1998 to 2007. However there was slight variation in annual minimum temperature. The highest maximum temperature was 29.37 ^{0}C in 1998. From 1999, the temperature was in the range of 28 ^{0}C except in 2005. There was no significant increase in temperature within 10 years time period.

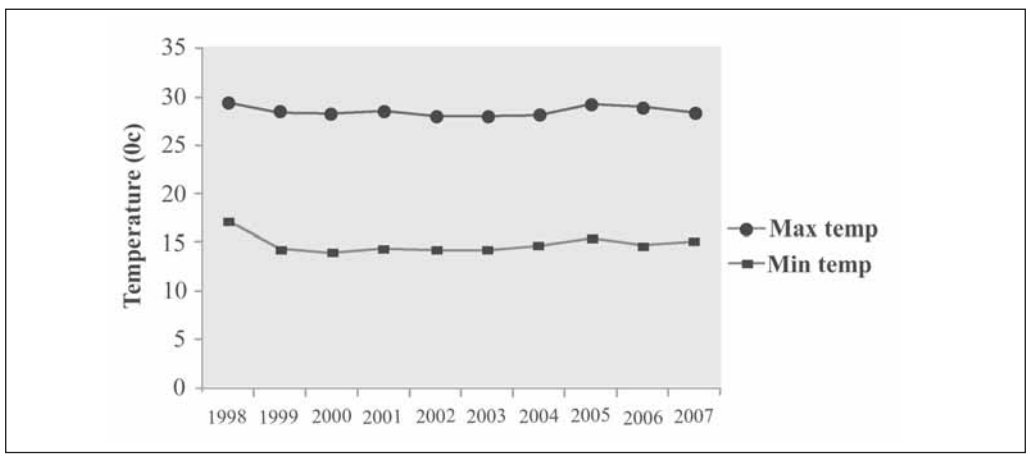

Fig 8: *Average annual minimum and maximum temperature*

There was great fluctuation in the average annual rainfall showing erratic pattern. In 1998, the average rainfall was 121.95 mm. In 1999 it was as increased by 17.71mm which was highest rainfall in 10 years time interval. The lowest average rainfall was 80.7 mm in 2005 as shown in fig 9.

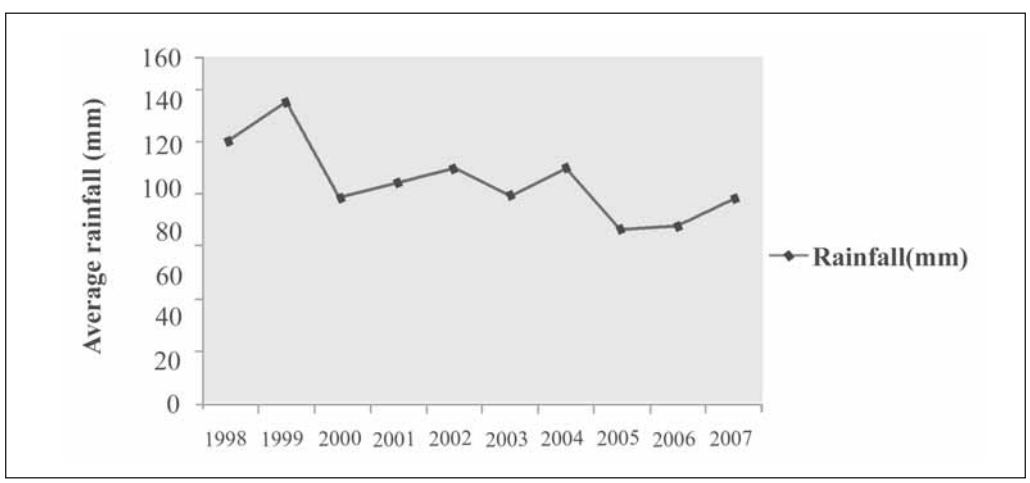

Fig 9: *Average annual rainfall in mm*

5.3.2 Change in cropping system and agro- biodiversity

Dhungkharka has maize based cropping system whereas Bhakundebesi has rice based cropping system. Potato and rapeseed were also important crops. It was found that new improved variety of cereals & vegetables had been introduced in the cropping system. Moreover, more productive hybrid and improved varieties replaced the indigenous seeds and crop varieties Farmers had experienced change in their agro-ecology. Many plants, animals that were found previously in the areas were not seen these days as shown in the table below (Table 12).

Table 12: Trend of increase and decrease of plants and animals in the study area

Types	Decreasing in number	Less seen at present	Increased and newly seen
Plants	Sal, Chiuri, Kafal, Pani Amala, Ainselu, Chutro Jamun, Kalo, Haledo, Katus, Archal, Lokta	Gunjar Ganu, Banj, Dumri, Padmachalnu, Gol Kankri, Latte, Junel, Nimtel, Gahat, Masyang Machaino, Katike simi, Jatamasi, Koiral	Seto banmara, Juane Jhar, Ghode Dubo, Ainjeru, Sitaram Jhar, chari amilo Khanyo
Animals and Birds	Spotted Tiger, bat, Subicharo, Gauthali (swallow Bird), Titra, Earthworm	karyang kurung, SalakTodke, SamrangecharoWolf	Lokharke, snakes, Lampuchhre, Rats kalo bandel, red Monkey
Disease and Insects			Red ant and late blight in potato, Termites, Aphids and bugs, Smut of onion knotWeevils in storestem gallBrown Leaf spot of maize

Local people had experienced appearence of new species in their environment with disappearence of old ones. Some notorious plants like Eupatorium & *Cynodon dactylon* became common in Bhakundebesi Area. There was increased in diseases and pests prevalence. The major diseases in the area were gray leaf spot in maize, late blight in potato and smut in cereals. Cabbage butterfly is the most serious insect pest in Cole crops. The

white colored moth is common on storage. Recently, aphids are creating huge problems to the farmers damaging many crops & vegetables. Farm animals were being suffered from Diarrhea (goat), fever & Foot and Mouth Diseases.

Farmers had experienced drastic change in the agro-biodiversity in the area. Local varieties of many crops had been extinct. It was found that all local germ plasm of local potato and soybeans (Kailo Bhatmas) have been extinct from Kavre and many new varieties were introduced with changing Agro-ecology & farming situation. The variability in climatic parameters forced farmers to adopt new practices and find new varieties to sustain in the changing environment. Data showed that majority of respondents (91.67%) reported that they had changed planting time of rice. Similarly, about 61.67% of respondents reported that the planting time of maize had been changed. About 45% of respondents changed the planting time of rice in Dhungkharka where as it was 46.67% in Bhakundebesi. Likewise, in case of wheat, about 30% changed the planting time in Dhungkharka and 31.67% in Bhakundebesi. About 16.67% reported about the change in flowering time of fruits, out of which 6.67% were from Dhungkharka. and 10% were from Bhakundebesi.

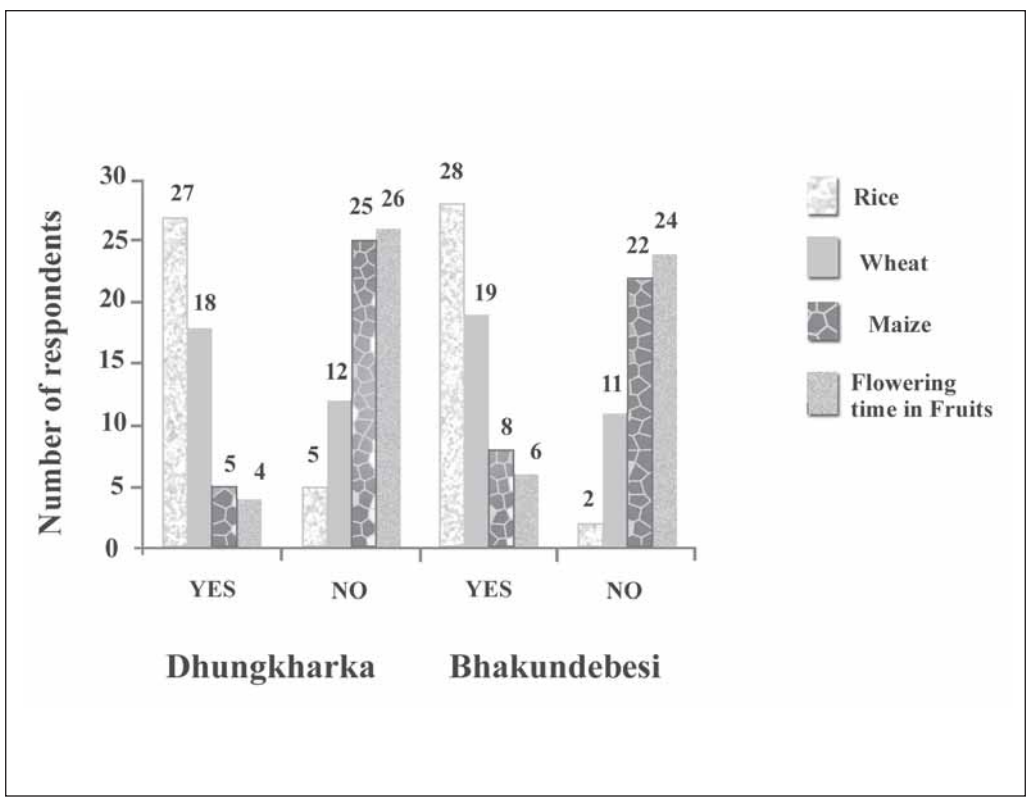

***Fig 10**: Change in crop planting time and flowering time in fruits.*

Previously, rice was planted in June but now the planting time has shifted to August. In 2008, most of rice field in Bhakundebesi remained uncultivated and in 2009 the planting of rice was done only in last of Shrawan to Bhadra 1st (August) due to delay in monsoon. The planting time of maize was also delayed by 3 weeks due to change in rainfall. Farmers of Bhakundebesi selected short season rice varieties to maintain the planting time of wheat as if planting time of wheat is delayed, the yield become significantly reduced. The flowering of rhododendron species was found to be shifted by one to two month before (mid January in place of March). Similarly, Kafal *(Myrica spp)* was ripened earlier with changed in color and hardness. Respondents reported that the fruits of Raspberry (*Rubus ellipticus*) were less juicy with less moisture.

5.3.3 Change in Climatic Variables in the Study area

About 97% of the respondents reported that there was changed in climatic variables temperature, rainfall pattern, duration, density and number of thunder storms. More than 85% of respondents argued that there was some change in annual temperature. On the other hand 98% of respondents reported that the summer become warmer and 8% of the respondents reported for more cold winters than in the past. Some 86% experienced extremely high temperature during summer and only 12% experienced there was moderate rise in summer temperature.

All respondents reported that there was change in rainfall pattern. About 66.18% of respondents reported high intensity of rain in short period of time during rainy season. At the same time, 71.15% reported less rainfall in long period of time during winter season as shown in fig 11.

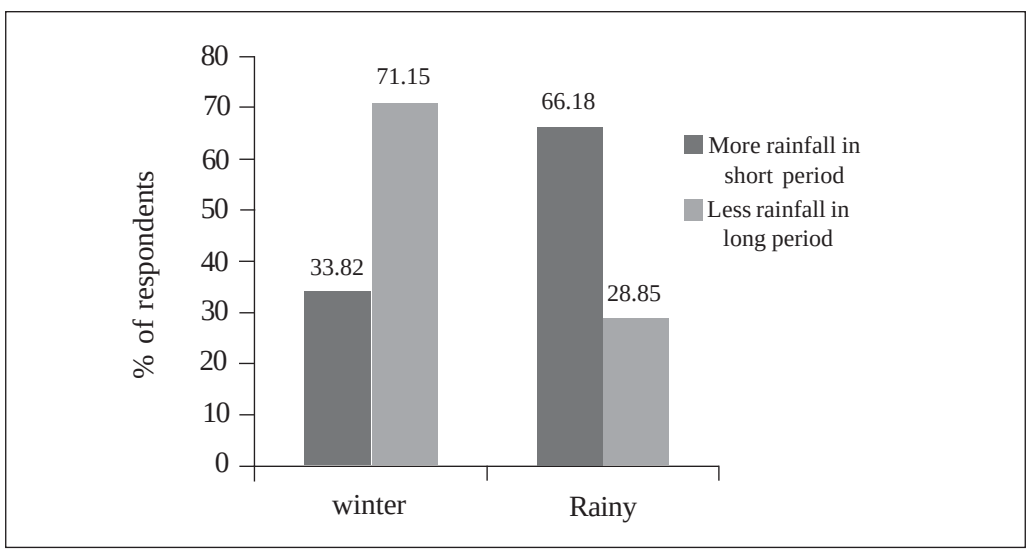

Fig 11: *Responses regarding rainfall pattern*

The productivity trend of rice, wheat and maize in last 10 years showed that there was decrease in productivity. According to the respondents there was high productivity of rice in 1998 and 2002. Higher production of rice in 1998 and 2002 was associated with sufficient rainfall in these years. Rainfall was higher in 1998 and 2002 in Kavre district. However, rainfall was erratic and fluctuating and it is in declining trend after 2002 and the productivity of all crops was below the level of past years as well.

5.3.4 Climate Change and adaptation in agricultural activities

People relying on subsistence agriculture reported the decreased productivity of Maize in Dhungkharka due to incidence of Gray leaf spot disease. Increasing risk of landslides in Dhungkharka and soil erosion in Bhakundebesi caused farming system vulnerable. More than 78% of respondents believe that Climate Change is the responsible factor for such change in agriculture. They also introduced new crops in rotation as an alternative strategy to adopt changing climate. It was found that more than 88% of farmers in study area followed crop rotation since many years ago. More than 50% of farmers in kavre had changed crops in rotation in order to adopt new climatic conditions especially less water availability. Farmers changed their cropping system from rice-wheat-maize to rice-vegetable-maize/potato. They introduced vegetables like tomato, cauliflower, cabbage, potato etc in place of cereals for better income.

5.3.5 Pilot test and Public Awareness

5.3.5.1 Varietals Demonstration Trial in Maize

The project also carried out the action based research in maize taking 3 varieties: Ganesh, Deuti and Local with three different sowing times. This trial was performed to test the prevalence rate of Brown Leaf Spot Disease (BLS) by altering sowing time. First planting was done one month before normal planting time (May/June), second planting was 15 days before normal planting and third planting was at normal planting time.

The observation was made on disease occurrence and yield performance. Early planting of Ganesh is less susceptible to BLS followed by Deuti and local variety is highly susceptible. Early planting of all three varieties showed better result and disease occurrence was found lower. The incidence of BLS was more in higher altitude within same variety as compared to lower altitude. Ganesh is a short duration variety so that tasseling stage precedes the conducive environment of BLS. So, if the farmers continue normal planting then tasseling stage coincide with damp weather and transmission of BLS pathogen is faster. So, farmers practiced early planting of maize.

5.3.5.2 Varietals Demonstration Trial in Rice

This study had also designed to study appropriate planting date as per the trend of monsoon. But during the project time the monsoon was so late that we could conduct only one

planting. Bhakundebesi area is suffering from draught since last five years and by 2009 Bhakundebesi receives very late and less rain and planting of rice was delayed by two weeks. It had been expected that late planting of rice will reduce rice yield by 35-40% in this area.

5.3.5.3 Public Awareness

During the course of study we found awareness level about climate change in community level was very low. Formation of climate change Aware Group (CCAG) in study area had gear up the awareness in chain reaction order. Four CCAG were formed with total of 30 members. Similarly, Village Level Interaction Program covered about 300 individuals. Likewise, our coordination with Radio Namobuddha is the main achievement in awareness sector. Weekly program on climate change and transmission of project activities through radio covered the farmers of its transmission area. Interactions on different level including district governmental officials have created positive influence as well as informative discussion.

5.4 Case study from Baglung

The study area was divided in to three regions based on the altitude representing Siwalik region, middle Mountain and high Mountains. The lower region with elevation 600 to 1000 m represents Terai as well as Siwalik range. The middle region with elevation 1000 to 1800m represents Siwalik range as well as Mahabharat range. The higher region represents Mahabharat range and High Mountains with elevation 1800 to 2900 m.

Three groups in every three VDCs were created and total 9 groups were formed for series of discussion. The mostly concerned subjects among local people were decrease in agricultural production, increase in natural disasters and increase in temperature. About 57% were found to be worried on decrease in agricultural production and 51% on increase in disaster events like drought, landslides and floods. Similarly, 54% of people put the increase in temperature as the most concerned and debatable subjects. About 39% had showed their concern on biodiversity loss where as few people (24%) showed their concern on climate change. According to people the effects of climate change had been clearly noticed from 2006. The effects of climate change have been noticed by local people as below:

5.4.1 Temperature and rainfall pattern

About 10 years data of temperature and rainfall from 1998 to 2007 was analyzed. The result showed that there was fluctuation in average annual temperature. From 1998 to 1999 maximum temperature was increased by 0.11^0C where as it was increased by 1.03^0C in 2000. The maximum temperature was 29.8^0C in 2001.Between 9 years i.e., from 1998 to 2006 the maximum temperature was increased by 0.53^0C. The maximum temperature decreased by 0.79^0C from 2006 to 2007. Similarly, the minimum temperature was increased by 0.66^0C in between 9 years. However, there was great fluctuation along the time as shown in fig 12 below. The highest minimum temperature was 21.04^0C in 2004.

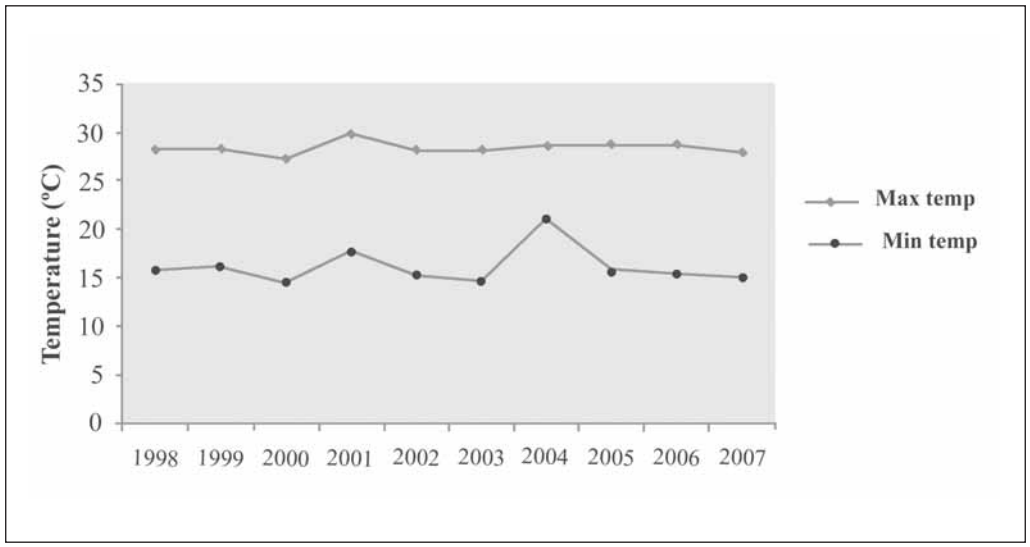

Fig 12: *Annual average maximum and minimum temperature*

Data showed that there was decreased in amount of rainfall. There was declining trend except in the years 2000 and 2003, however the difference of increased rainfall was very little at this time. From 1998 to 2006 the average rainfall was decreased by 45.58mm with great fluctuation along the years. By 2007, average rainfall increased by 54.15mm with compared to 2006.

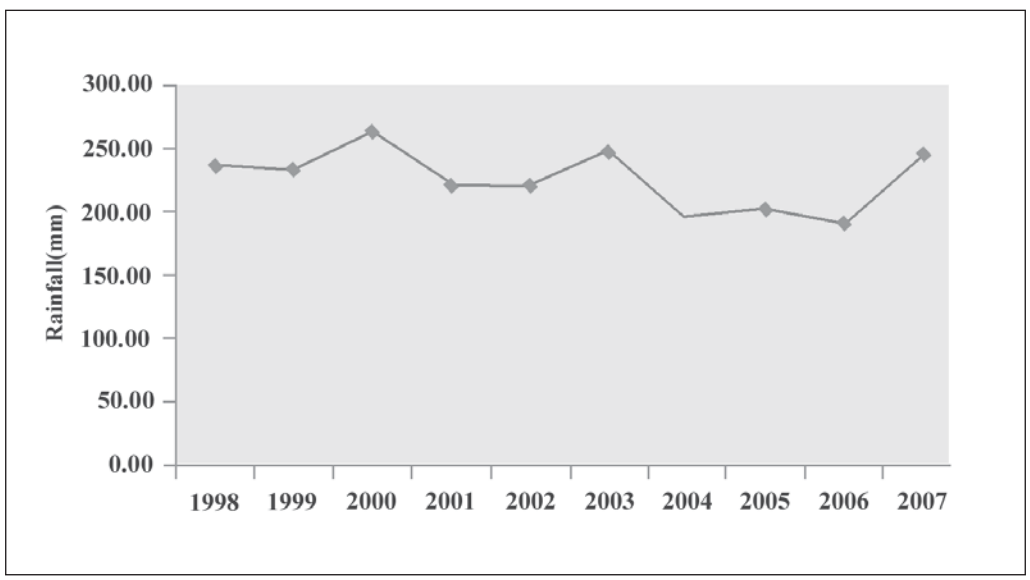

Fig 13: *Annual rainfall in mm of Baglung districts*

5.4.1.1 Change in dew fall time

It was found that the time of falling dew and frost had been changed. According to the participants, before 2063 B.S. (2006) dew and frost started to fall in September and ended in March. But after 2063 B.S. it started to fall from October/November and ended in January/February.

5.4.1.2 Change in snowfall time

The intensity and time of snowfall had been decreased significantly. Before 2063 B.S. (2006), snow started to fall from October/November and remained till April/May. But now days the time of snow fall has been postponed. Most of the participants reported that there is no noticeable snow fall from 2006.

5.4.1.3 Change in flowering time of the plants

The flowering time of some plants had been found to be changed. The flowering time of rhodorodendron, orange and prunus had been shifted earlier. Generally, the flowering time of rhodorodendron is June/July but now the time of flowering shift to one month earlier and started to flower in April/May.

5.4.1.4 Scarcity of water

The decrease in volume of water in ponds, lakes and water level of ground well was observed. There was significant decrease of water volume in Bhakunde pond, an important pond of the district, in 2008 due to drought.

5.4.1.5 Increase in temperature

Majority of people (>80%) said that there is increase in temperature in recent years. Due to rise in temperature the availability of grasses in higher altitude has been increased.

5.4.2 Observed changes in distribution of vegetation

The altitudinal distribution of some of the plant species was found to be changed. In lower region (600 to 1000 m) of the study area, *Ficus lacor* (Khabro) and *Juglans regia* (Okhar) were found above than previous range. The medicinal plants Satuwa was also shifted above the previous range. Similarly, in the middle region (1000 to 1800 m) Dhudhilo and *Bambusa arundinacea* (Bhalubans) were also found above the previous range. However, these species were found to be shifted in Narayanthan VDC only. There was no change in distribution range of vegetation in higher range. The distribution range of different plant species is shown in the table 10 below.

Table 13: Distribution of different plant species in the study area

Main vegetation	Narayanthan			Payyupata			Bhakunde		
	1#	2#	3#	1	2	3	1	2	3
Lower region									
Fodder species									
Litsea monopelata	*			*			*		
Ficus semicordata	*			*			*		
Ficus lacor	*			*			*		
Artocarpus lakoocha	*		*				*		
Melia azederach	*			*			*		
Bauhinia purpurea	*			*			*		
Wood species									
Shorea robusta	*			*					
Murraya paniculata	*			*			*		
Bombax ceiba	*			*			*		
Castanopsis indica	*			*			*		
Schima wallichii	*			*			*		
Pinus roxburghii	*			*			*		
Juglans regia	*					*			*
Medicinal plants									
Zanthoxylum acanthopodia	*			*			*		
Satuwa	*			*					*
Stephania japonica	*			*			*		

Main vegetation	Narayanthan			Payyupata			Bhakunde		
	1#	2#	3#	1	2	3	1	2	3
Phyllanthus emblica	*			*			*		
Artemisia indica	*			*			*		
Eupatorium adenophorum	*			*			*		
Astilbe rivularis	*			*			*		
Tinospora cordifolia	*			*			*		
Middle region									
Fodder and Wood species									
Dudhilo	*					*	*		
Bambusa arundinacea	*					*	*		
Schima wallichii	*			*			*		
Alnus nepalensis	*			*			*		
Rhododendron	*			*			*		
Castanopsis spp	*			*			*		
Pinus spp (Gobre salla)	*			*			*		
Juglans regia	*			*			*		
Angeri	*			*			*		
Daphne bholua	*			*			*		
Medicinal plants									
Zanthoxylum oxyphyllum	*			*			*		
Stephania japonica	*			*			*		

Main vegetation	Narayanthan			Payyupata			Bhakunde		
	1#	2#	3#	1	2	3	1	2	3
Ban mula	*			*			*		
Acorus calamus	*			*			*		
Swertia chiraita	*			*			*		
Higher region									
Persea odoratissima				*			*		
Castanopsis spp	*			*			*		
Magnolia campbelli				*			*		
Rhododendron	*			*			*		
Rhododendron barbatum							*		
Quercus lantana							*		
Betula utilis	*			*			*		
Pinus spp (Gobre salla)	*			*			*		
Laut salla	*			*			*		
Dhupi salla	*			*			*		
Thamnocalamus spathiflorus							*		
Medicinal plants									
Zanthoxylum oxyphyllum	*			*			*		
Zanthoxylum oxyphyllum	*			*			*		
Berjenia ciliata	*			*			*		
Swertia chiraita	*			*			*		
Satuwa	*			*			*		

1# = same as previous range, 2# = below the previous range, 3# = above the previous range

5.4.3 Flowering and fruiting time of the different crops and plants

The study showed that there was no change in flowering and harvest time of most of the plants and crops as shown in Table 14. There was change in flowering time of few species only. It had been found that Payyu and Rhodorodendron flower earlier. The flowering time of Payyu was shifted by 2 months earlier.

Table 14: Changes in flowering and harvest time of plants and crops

Plants	Flowering time	Changes in flowering time			Changes in harvest time		
		Early	Late	No change	Early	Late	No change
Paddy	Sep / Oct			*			*
Maize	May / June			*			*
Wheat	March / April			*			*
Barley	March / April			*			*
Millet	Sep / Oct			*			*
Soybean	August / Sep			*			*
Mango	Jan / Feb			*			*
Katahar	Jan / Feb			*			*
Lemon	Jan / Feb			*			*
Orange	Jan / Feb			*			*
Aru	Jan / Feb			*			*
Pyrus comminis	Jan / Feb			*			*
Bombax ceiba	Dec / Jan			*			*
Kadam	Dec / Jan			*			*
Shorea robusta	March / April			*			*
Schima wallichii	Jan / Feb			*			*
Alnus nepalensis	Oct / Nov			*			*
Prunus cerasoides	Jan / Feb			*			*
Rhodorodendron	April / May			*			*
Castanopsis species	April / May			*			*
Magnolia campbelli	April / May			*			*
Rubus ellipticus	Jan / Feb			*			*
Berberis asiatica	Jan / Feb			*			*
Bauhinia purpurea	Oct / Nov			*			*
Bauhinia purpurea	March / April			*			*

5.4.4 Changes in availability of water and water resources

The effects of change in climatic pattern on water resources were studied on the basis of water availability in last 10 years ago (Table 15). The study showed that out of total water resources available (N=108) in the area, only 19.44% hold water level same as 10 years ago. In 38.88% of water resources, the water level was declined slightly where as in 41.66% the water level was declined drastically in comparison to 10 years ago.

Table 15: Changes in availability of water and water resources

Water resources	Narayansthan			Payyupata			Bhakunde		
Marshy area with water throughout the year	1	3	3	2	2	5	2	6	8
Water well	0	2	1	1	4	6	3	4	5
Ponds and lake	0	1	0	0	6	8	4	1	3
River and Tributaries	0	4	2	2	4	2	6	5	2
Total	1	10	6	5	16	21	15	16	18

Three types of water resources had been identified in the study area, marshy area, well, ponds and lake, and river tributaries with total number 108. Bhakunde consists of highest number (N= 49) of water resources out of which 30.61% hold water level same as 10 years ago. In 32.65% of sources the water level was steady declined where as 36.74% of resources had lost water level drastically. In Bhakunde there were highest number of sources that retained water level same as 10 years ago. Payyupata was severely hit by dryness where about 50% of resources had lost water level drastically and only 12% had water level same as 10 years ago. There was increase in social conflicts due to less availability of water. As a result of increase in dryness and less availability of water, there was increase in forest fire.

5.4.5 Effects on agricultural practices

The agricultural sector was mostly affected by untimely rainfall with less intensity. Due to irregular and less rainfall, the planting and harvest date of the crops had been changed resulting less production. Most of the respondents (>80%) reported that the production of maize, paddy and potato had been declined due to long term dryness. Similarly, the frequency of diseases pests and weeds had been found to be increased.

Table 16: Prevalence of pests on different crops in different VDCs

Main crops	Pests	Effects in different VDCs		
		Narayansthan	Payyupata	Bhakunde
Maize	Ghun, Gabaro, Khumre	Highly	Highly	Highly
Paddy	Pat beruwa, Patero	Highly	Highly	Highly
Millet	Patera, Lahi	Moderate	-	-
Wheat	Sindure	Less	-	less
Soybean	Kage kira	Moderate	Moderate	Moderate
Mustard	Lahi, Green larva kira	Moderate	Moderate	-
Cauliflower	Lahi	Moderate	Moderate	Highly
Orange	Gabaro	Moderate	Highly	Highly
Potato	Ants, Dadhuwa	Highly	Highly	Highly
Alachi	Caterpillar, Gabaro	Highly	Highly	Highly

Maize was highly affected by pests Ghun, Gabaro, Khumre in all the study area where as paddy was found to be highly affected by patero, and patberuwa in all three VDCs. Potato and Cardamom were also found to be highly affected by pests and insects in all the area. However, soyabean, millet and mustard were less affected crops by pests.

Regarding the prevalence of diseases, maize and paddy were highly affected in all three VDCs. Daduwa was found as most common disease in maize, paddy and wheat. A cash crop cardamom was also highly affected by disease in the study area as shown in the table below.

Table 17: Prevalence of disease on different crops in different VDCs

Main crops	Diseases	Effects in different VDCs		
		Narayansthan	Payyupata	Bhakunde
Maize	Daduwa, ranke,	Highly	Highly	Highly
Paddy	Daduwa	Highly	Highly	Highly
Wheat	Daduwa, ranke, kalopoke	Highly	Highly	-
Cabbage	Root rotten	Moderate	-	Highly
Potato	Daduwa, fungus	Moderate	Highly	-
Alachi	Phurke chirke, bulb rotten	Highly	Highly	Highly
Millet	Lack of grains	Moderate	Moderate	-

5.5 Case study from Kailali

5.5.1 Temperature and rainfall pattern

The data showed that the average annual temperature was continuously increased. From 2004 to 2009 the average annual maximum temperature ranges from 30.28^{0}C to 34.75^{0}C. From 2004 to 2009 the temperature was increased by 4.47^{0}C which is very high in comparison to national increase rate. Similarly, the average minimum temperature was also increased continuously ranging from 17.88^{0}C to 23.7^{0}C.

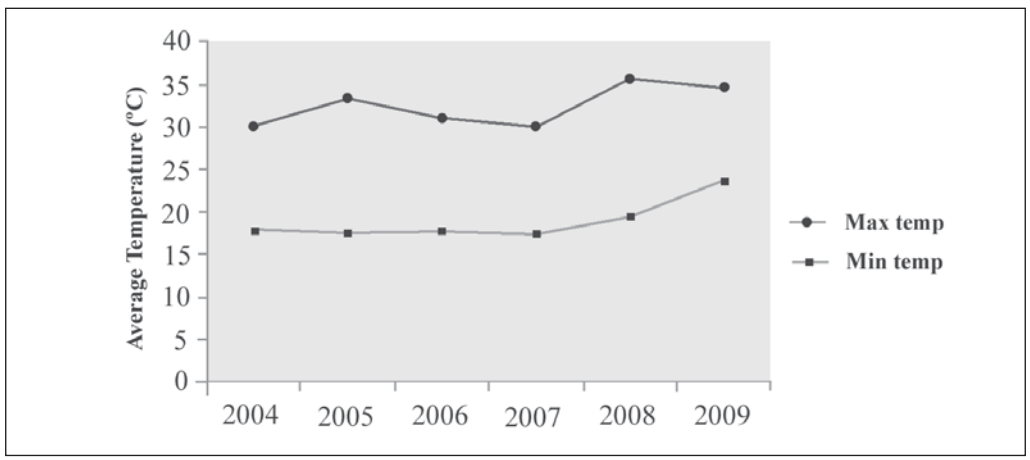

Fig 14: *Average maximum and minimum yearly temperature from 2004 to 2009*

The data showed that there was erratic rainfall from 2004 to 2008. However, the average annual rainfall was found to be increased. The highest average annual rainfall was 178.83mm in 2008. The data was not complete for 2009 and only up to June.

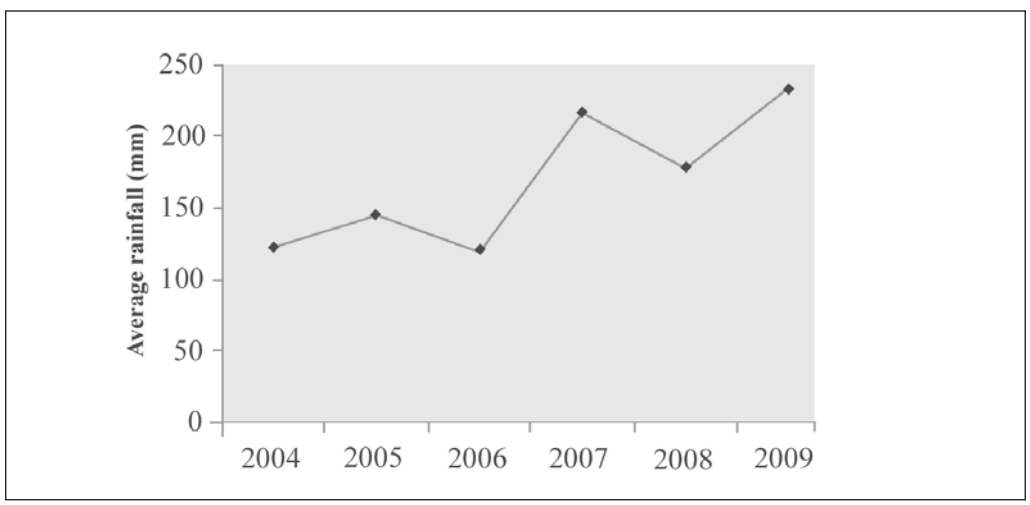

Fig 15: *Average yearly rainfall (mm) from 2004 to 2009*

5.5.2 Observed change in agriculture system

The production of most of the crops was found decreased. Mustard and sunflower were highly affected. About 74% of respondents reported the decrease in production of mustard from last 4-5 years where only 5.11% reported increased production of mustard as shown in fig. Likewise, 18.22% had no idea about this and 2.67% reported no change in production. Respondents reported that the main causes of decrease in production were lack of water for irrigation, untimely rainfall, increase in intensity of pests and diseases, breaking of the tradition of cultivating maize where mustard seeds were planted and no use of organic fertilizers.

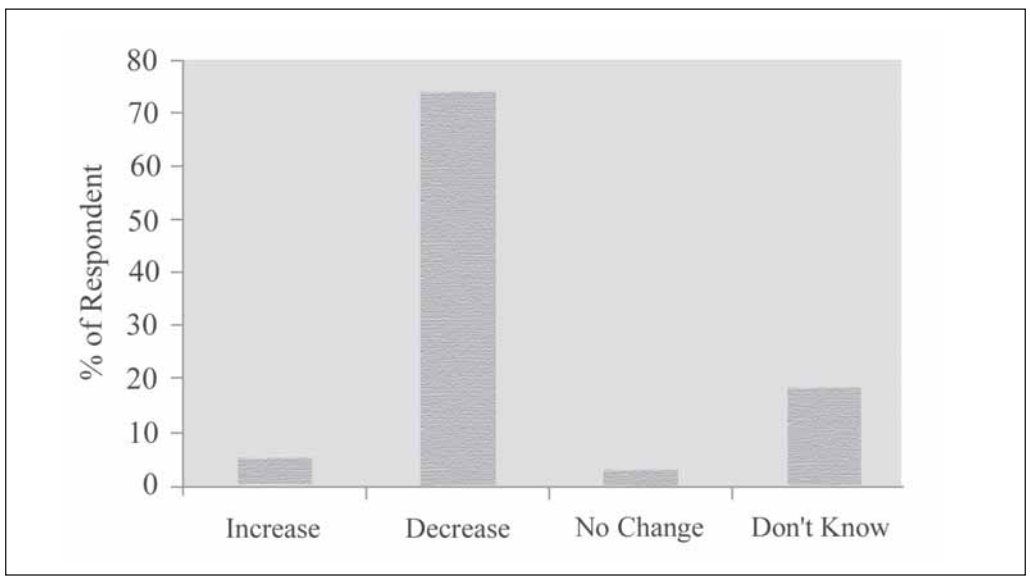

***Fig 16**: Percentage of respondents based on the age groups*

With decreasing production, the quality of mustard was also degraded. Majority of respondents reported (62.9%, N=450) that the quality of oil seed became degraded as comparing to 10 years. About 12.4% reported the quality of oil seeds normal i.e., no change in quality as shown in fig.

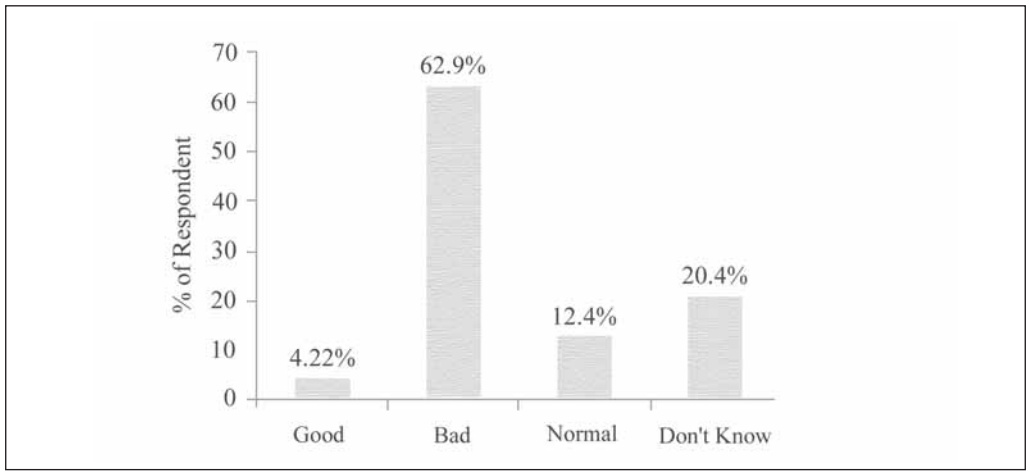

Fig 17: *Quality of mustard in compare to 10 years ago*

Since sunflower was cultivated by only few numbers of farmers, most of the respondents were unfamiliar about the crop. Only 8.44% (N=38) of respondents reported about the sunflower crop. About 28.95% reported the decreased production of sunflower where as 42.11% reported that there was increased production of sunflower. Some 28.95% accounted the normal production i.e. no change in production. Similarly, 3.33% accounted about increased quality of sunflower seeds where as 15.56% reported decreased quality of oil seeds and rest of respondents had no idea. The indigenous potato called 'Tharu aaloo' is the major vegetable of the native Tharu community. But now the production of indigenous potato has been declined drastically. About 90% of respondents provided the information regarding the indigenous potato. Out of total respondents, 6.4% reported that there was increase in production of indigenous potato where as majority of respondents (53.8%) accounted for decreased in production of potato. The details of responses are shown in fig below.

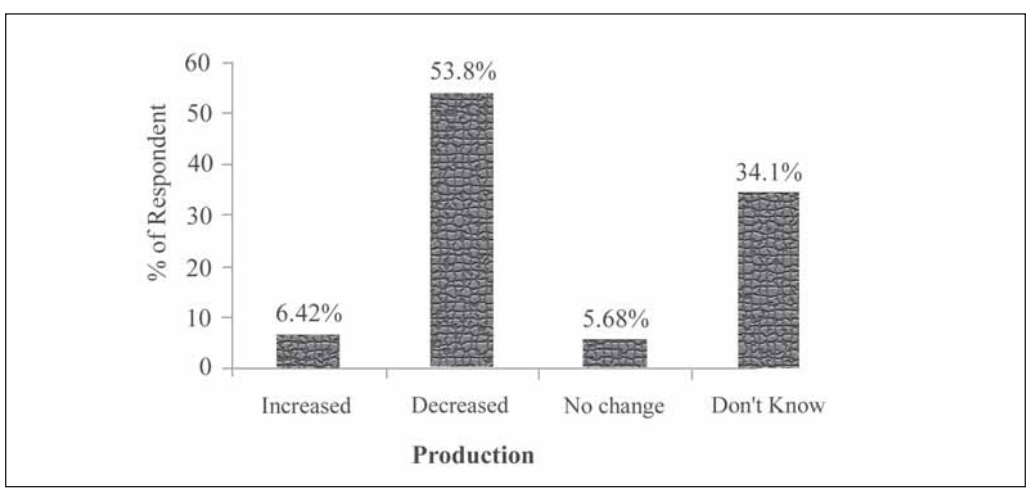

Fig 18: *Peoples' response in production pattern of specific crops*

The planting and harvest time of potato was found to be shifted by 1 month later. Previously, potato was planted in September to first week of October and harvested in February to first week of March but planting time had been shifted to last week of October to November and harvested in Last week of March to April. According to respondents, the production was declined mainly due to untimely rainfall, dense fog in winter season and increase in paddy cultivation instead of potato in the feild. About 36.73% of respondents reported that the planting and harvest time of potato was changed where as 23.46% accounted for no change. Some 39.81% of respondents did not bear any idea. The production of paddy, wheat and maize was also found as decreased. About 47% of respondents reported decreased in the production of paddy, wheat and maize and only 10% reported increased production of these crops. The main causes of declining production were more dependency on rain water and untimely rainfall, increased pests and diseases intensity and lack of organic fertilizers. Majority of respondents (74.44%) reported that there was increased in the intensity of pest and disease on the crops and very few people (3.78%) agreed with decrease in prevalence of pests and diseases as shown in fig.

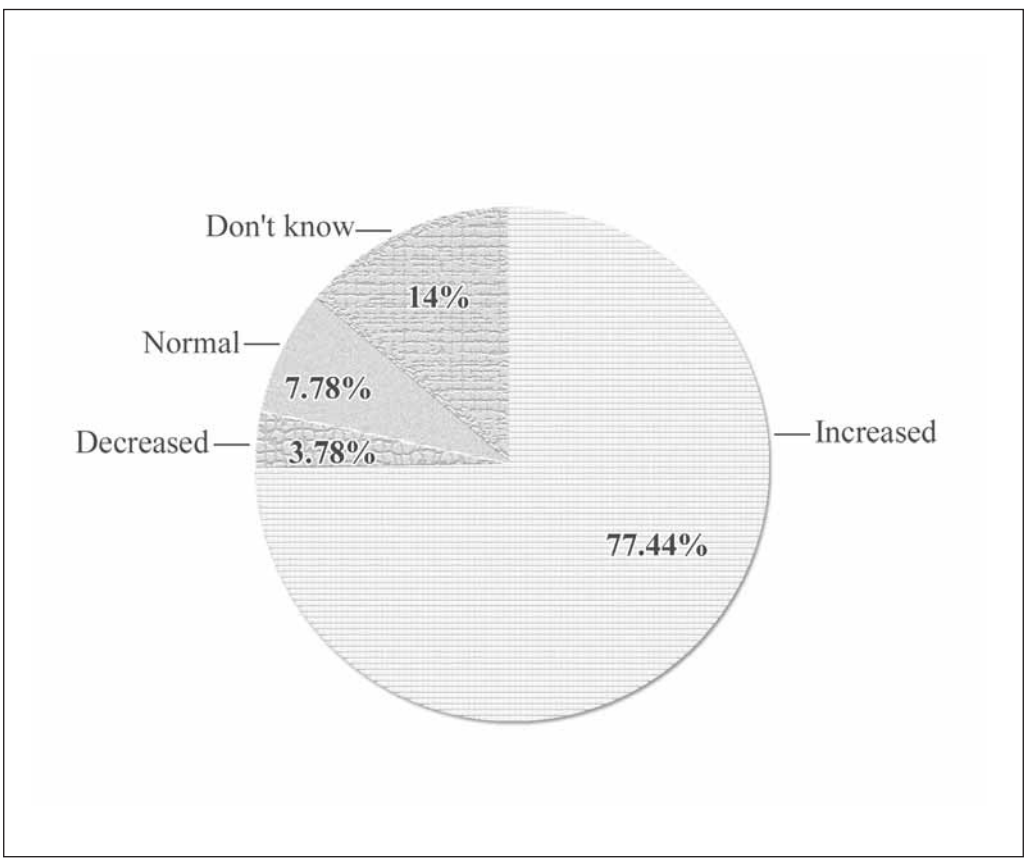

Fig 19: *Intensity of pests and diseases on different crops in the study area*

5.5.3 Observed changes in climatic parameters

Changes in climatic parameters like temperature, rainfall, fog and dew time was found in Kailali district as well. The duration and intensity of fog and dew fall was found to be changed. The number of days with cold wave had been increased and sunny days were decreased. The cold wave in winter affected agriculture as well as social life system. Majority of respondents (56.2%) accounted that the intensity of fog and dew at morning and evening time was decreased with compared to 7-8 years ago. The percentage of responses regarding intensity of fog increased and similar to that of 7-8 years ago was found nearly same as shown in fig. However, respondents most of all respondents reported that the cold wave in winter had been increased.

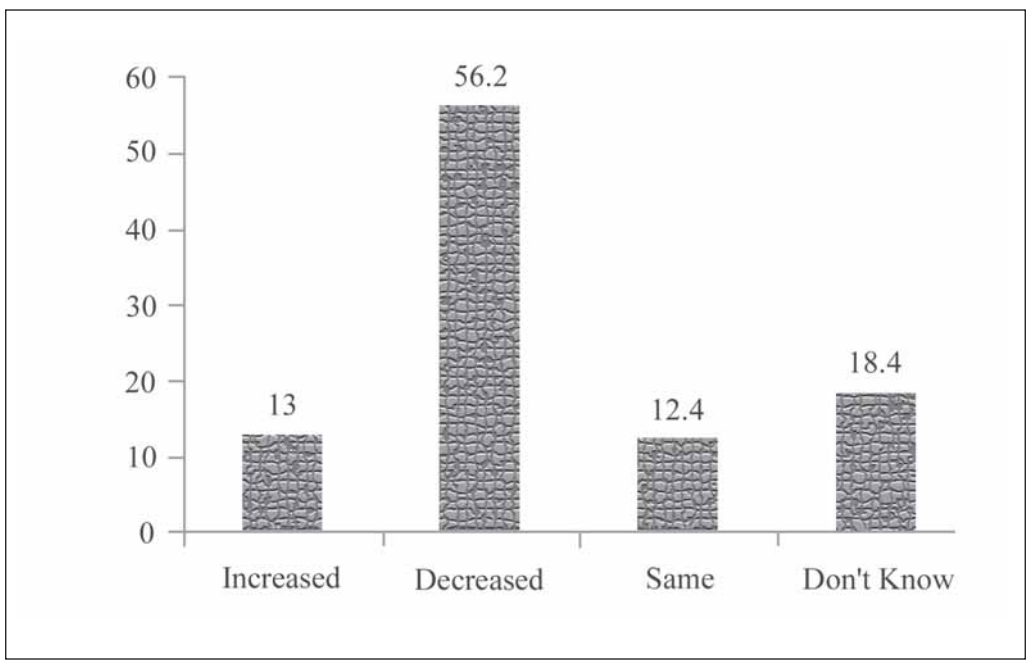

Fig 20: *Responses on intensity of fog in the study area*

Majority of respondents agreed with rise in annual temperature. About 58.9% (N=265) of people reported that the annual temperature was increased with compared to 5 years ago. Only 9.1% reported decrease in annual temperature and 32% of them did not care the temperature. Likewise, majority of people supported that there was erratic and untimely monsoon. About 80.69% of respondents reported the rainfall was irregular with high intensity in short period. Only 0.23% reported that the rainfall was regular within a normal time and 19.08% did not have any idea about this. In 2009, there was no significant amount of rain during the monsoon (June to September) but there was heavy rainfall in October.

5.5.4 Changes in water availability

Ground water is the main source of water in terai region. Tube well and hand pump are the source of drinking water in the area. Majority of people, about 76.4% were agreed with decrease in level of ground water and few people about 0.44% reported increase in water level of ground water. At the same time, 4.67% of people said that there was no change in water level where as 18.4% did not know about this. The main causes of decline were less rainfall, long term dryness and heavy extraction of ground water for irrigation purpose. Out of total agricultural land only 30 to 40% is supported by irrigation system. Rest of the land is dependent on either ground water or monsoon. With increasing irregular and less intensity of rain, more ground water was extracted. The level of water in river and rivulets was also found to be decreased. About 78.9% of people reported that the level of water in river and rivulets had been decreased where as only 2.67% reported increased in water level of river and rivulets. However, about 18.4% did not know about this.

5.5.5 Increase and disease in parasites

Due to rise in temperature, intensity of parasitic diseases was increased. The population of parasites especially mosquito was increased significantly. Now the mosquitoes used to be seen in winter as well. Majority of respondents (80.9%) reported that there was increased in population of mosquitoes in summer season as shown in fig.

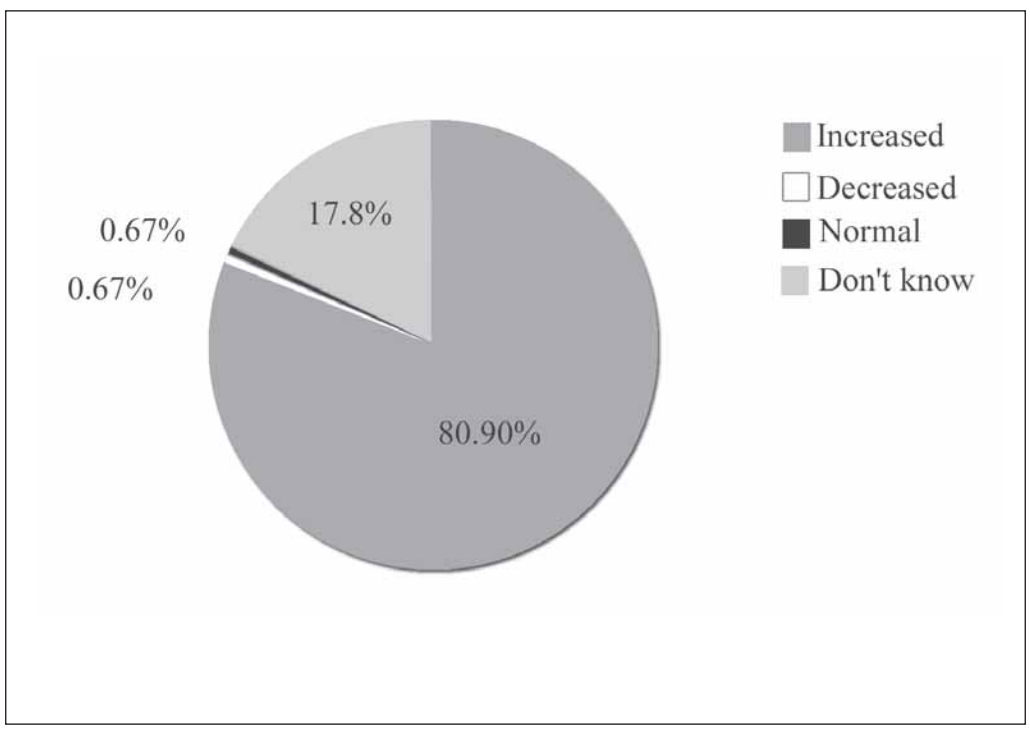

Fig 21: *Responses regarding the population of mosquitoes in the study area*

Likewise, 67.11% had reported that the mosquitoes were increased in winter season. Due to increase in mosquito population, intensity of diseases like malaria and encephalitis were increased.

5.6 Awareness and adaptation through radio

The five community radio stations and NGO had worked in coordinated approach to implement the project. The project activities conducted by NGO and findings are disseminated by community radio relating to local issues. Community radio has disseminated the messages on effects of Climate Change through locally adaptation process. It makes the community people and local stakeholder such as Federation of Community Forest Users Nepal, Dolphin Conservation Centre and other local NGO's working in forest, environment and sustainable development sector and local government bodies to aware and understand the issues of climate change in local perspectives. While disseminating the activities of project through community radio, in wider range people are informed and internalized the issues of climate change. In the experience of partner NGO's local people are making discussions and taking interest about climate change and adaptation process in local level. Disseminating the concept and activities performed by NGO in project sites through community radio makes the NGO transparent as well.

The radio programs are focusing and given space to- i) news of events around the project sites and specific project activities; ii) interview of the members of implementing NGO, local farmer, community people, other stakeholder and government bodies related to forest and environment sector. iii) Changes seen by local people and farmer in agriculture and rainfall pattern, melting of Himalayas and glacier etc iv) Reducing local impact of climate change though mitigation and adaptation process (vi) Global impact of climate change and its affects in agriculture, forest, environment, water resources, human health, fertility of soil, tourism, development, global warming, glacier, Himalayas and other sector in local level (vii) Experience of senior citizens about the changes they have seen in rainfall pattern, agriculture pattern and other sector (viii) National and global information about the concept and activities of climate change.

Thus, with the community radio program the awareness level of local people was found to be increased. These programs help to broaden the knowledge of local people on climate change. Initially climate change was new thing for people but now climate change becomes a debatable topic among the local people. As a result of radio programs, participation of local people was found to be increased in seminars, workshops and eco clubs. The most fruitful contribution of collaboration with community radio is local communities became aware about climate change and got information on mitigation and adaptation to climate change.

Chapter VI

CONCLUSION AND RECOMMENDATION

Climate change has been a topic of common understandings for communities now. Be the people of mountains, hills and plains either urban or rural. The concern is on how to adapt with the change. Many countries have already formulated the national plan of adaptation to the change. Nepal is still working to prepare the adaptation plan. Communities have a way long practice to adapt with the change, either with the untimely snowfall or to the flood in the plain, long hours of fog during the fruiting and seeding period of their crops or outburst of pests due to the change in temperature. This informal knowledge is not documented in any texts. Change of paddy field into cardamom orchards by the farmers in Taplejung is realized by them how the water charge system or hydrological cycle is changed in the local ecosystem. Shift of ecosystem services (water, oxygen, shade etc.) is realized and understood by them and they are adapting with the climate change at local level. Sporadic studies in different ecological zones, administrative regions linking with the communities capacities to adapt/combat climate change are examples of "Communities challenging climate change". Nepalese Communities are an example of those knowledge stocks.

With the glacial melt in the Himalayas, food insecurity caused out due to the prolonged period of drought and floods in the plains of Kailali and Koshi or the landslide in mountains of eastern Nepal have drawn attention of Communities Radio Support Center (CRSC). Realizing the media role and responsibility to bring the issues upfront to the communities "Communities challenging climate change" was an attempt to observe in Nepalese communities. Above five case studies done in Taplejung, Khotang, Kabhre, Baglung and Kailali districts of Nepal covering mountain, hills and plain ecological belt conducted by local NGOS involving local communities and disseminating the findings by local communities radio, CRSC has opened the avenue to debate the issue in local community. It is simply a start and long ways is to go ahead in bringing communities together to observe the climate change, adapt and mitigate the negative impacts. CRSC welcomes the association of all partners to work in the issues in future days.

From the study, It can be conclude that there is marked variation in two important climatic parameters, temperature and rainfall. In all the areas, rainfall was found as erratic with less amount of total rainfall. Similarly, there is increase in average temperature as well. Taplejung experienced increase in temperature by 0.4^0c in 14 years where as in khotang, temperature rise was 2.9^0c within 19 yrs. The condition is more hares in Kailali where temperature increased by 4.47^0c in short period of time (only 5 years).

The effects of climate change is being increasing in Nepal which is supported by the results observed in distribution of vegetation, crop productivity, diseases & Pests prevalence and decrease in water resources.

Some of plant species like *Rhododendron barbatum* shifted their range of distribution. Production of major crops, rice wheat has been declined mostly in Kavre due to lack of

water availability diseases & pests. Cash crop cardamom suffered highly. There was drastic decline in water resources in Taplejung & Khotang.

Since climate change and its impacts are evident in the study areas apapation strategies at community level need to be devised to respond the imports at the earliest possible time.

Recommendation

A token support provided by CRSC to observe the climate change in five districts of Nepal has come up with representative findings such as change in flowering season of marigold (photoperiodism) in Taplejung, flooding/drought and its relationship with the agronomic yield in Kailali. Local partners seem enthusiastic with the finding. Further study can suggest possible adaptation strategies. In a historical juncture, while Nepal is still drafting National Adaptation Program of Action (NAPA), and the high level Climate Change Council is still defining its activities, donors are interested to include climate change and adaptation in most of the activities, such studies involving communities challenging climate change need greater attention.

In a period when responsible media is helping in strengthening of the capacity of society, issues such as climate change can facilitate the livelihood, local economy and well being of people at the long run. Further studies to document indigenous knowledge for adaptation to changing climate at local level and replicate the knowledge in other parts of the world is the demand of time in fact.

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ANNEXES

ANNEX 1: Average temperature and rainfall patterns of project areas

Table 1. Average temperature and rainfall data from Taplejung

Year	Maxtemp (0C)	Min temp (0C)	Rainfall (mm)
1994	21	11.5	1834.9
1995	20.64	11.78	2159
1996	20.82	11.88	2160.7
1997	20	10.85	2094.4
1998	21.18	12.31	2101
1999	21.86	12.16	1983.7
2000	20.55	11.15	1874.1
2001	21.11	11.16	1912.4
2002	20.93	11.72	2172.8
2003	20.85	11.86	2505
2004	20.91	11.65	1746.3
2005	21.87	11.92	1795.3
2006	22	12.47	2146.8
2007	21.45	12.4	2055

Table 2. Average temperature and rainfall data from Khotang

Year	Maxtemp (0C)	Min temp (0C)	Rainfall (mm)
1990	20.1	12.9	2037.8
1991	20.4	12.8	1934.2
1992	20.6	12.6	1485.7
1993	20.5	12.6	2040.3
1994	21.6	12.7	1704.3
1995	21.3	12.9	1802.7
1996	22.5	12.9	1802.7
1997	22	12	2006.9
1998	22.4	13.4	1925
1999	23.2	13.6	2026.5
2000	23	12.5	1465.9
2001	23.3	13	2093.5
2002	22.6	12.7	1984.7
2003	22.2	12.7	1720.6
2004	21.9	12.9	1618.9
2005	21.9	12.8	1900.8
2006	22.7	13.3	1654
2007	22.2	12.5	2171.3
2008	22.6	12.6	1405
2009	25.6	11.8	713.2

Table 3. Average temperature and rainfall data from Baglung

Year	Maxtemp	Min temp	Rainfall
1998	28.33	15.84	236.68
1999	28.44	16.21	233.52
2000	27.3	14.68	263.49
2001	29.8	17.74	220.90
2002	28.2	15.39	219.78
2003	28.37	14.75	246.88
2004	28.65	21.04	195.60
2005	28.79	15.77	202.88
2006	28.86	15.51	191.09
2007	28.07	15.18	245.24

Table 4. Average temperature and rainfall data from Kailali

Year	Maxtemp (°C)	Min temp (°C)	Rainfall (mm)
2004	30.28	17.88	123.07
2005	33.46	17.63	145.38
2006	31.08	17.86	121.43
2007	30.36	17.49	216.3
2008	35.81	19.51	178.83
2009	34.75	23.7	233.02

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