



Impacts of Climate Change: VOICES OF THE PEOPLE



Impacts of Climate Change : **VOICES OF THE PEOPLE**



BASED ON FIELD OBSERVATIONS, INFORMATION AND INTERACTIONS
WITH THE COMMUNITIES IN NEPAL

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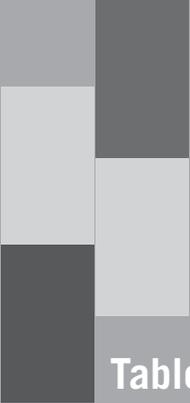


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Message from the Country Director

Nepal has nearly zero per cent contribution to Green House Gas (GHG) emissions on a global scale but the effects of climate change has already affected the bio-physical and socioeconomic sectors of Nepal. The effects are anticipated to become more adverse as Nepal is a highly vulnerable country due to high trend of temperature change, disturbances in monsoon rainfall, poor socioeconomic condition and fragile geology to impacts of climate change. Therefore adaptation to climate change is a priority for Nepal. However, specific impacts and their projections are imperative to understand for effective adaptation measures.

This publication is a step towards understanding the impacts of climate change and their nature on the ground. Twenty different sites across the country were visited to interact with the communities and appraise their perception to climate change, its impacts, and share their response activities. During the visits, the communities shared their perception to climate change and its impacts in their livelihoods. The perceptions and impacts are specific to different ecological zones. In order to help the community level adaptation, diverse interventions are required for different agro climatic zones which demands significant efforts, resources and coordination across the sectors. I hope the information presented in this publication will help in understanding the impacts of climate change that are already experienced and perceived by poor communities despite their zero contribution in causing the current global climate change.

This report is an outcome of information collected in 2007/08 by Gehendra Gurung, Kamala Gurung and Saraswoti Shrestha and in 2008/09 by a team of experts comprising of Dhiraj Pradhananga, Jagadishwor Karmacharya and Amrita Subedi from Small Earth Nepal. My sincere thanks to the study team.

Last but not the least, thanks to Mr. Gehendra Bahadur Gurung, Team Leader of Reducing Vulnerability Programme for conceptualising and materialising the study, Upendra Shrestha, Fundraising and Communications Manager and Shradha Giri, Communications Officer from Practical Action Nepal Office for rigorously working on language and structure of the report and bringing physically to this shape.

Achyut Luitel
Country Director

Abbreviations

BS	Bikram Sambat (Era)
DDC	District Development Committee
DHM	Department of Hydrology and Meteorology
DiSCO	District Soil Conservation Office
FGD	Focus Group Discussion
GHG	Green House Gas
GLOF	Glacier Lake Outburst Flood
GCS	
HIV/AIDS	Human Immuno Virus/Acquired Immunodeficiency Syndromes
ICIMOD	International Centre for Integrated Mountain Development
IITM	Indian Institute of Tropical Meteorology
mas:	metre above sea level
NPRs	Nepalese Rupees
PRA	Participatory Rural Appraisal
PRECIS	Providing Regional Climates for Impacts Studies
SEN	Small Earth Nepal
SOHAM	Society of Hydrologists and Meteorologists
UNDP	United Nations Development Programme
VDC	Village Development Committee

Nepali nomenclature equivalent

1. Aijeru - *Loranthus falcatus* (Sc), Strap flower (eng)
 2. Babiyo - *Ischaemum angustifolium* (Sc)
 3. Banjh - *Quercus leucotricophoria* (Sc)
 4. Banmara - *Lantana camera* (Sc), Lantana (eng)
 5. Bhangeri - *Passer domesticus* (Sc), House Sparrow (eng)
 6. Bwanso - *Canis lupus* (Sc), Wolf (Eng)
 7. Chachari - *Zoothera Sps* (Sc), Thrush (Eng)
 8. Chepare - *Certhia Sps* (Sc), Tree creeper (Eng)
 9. Chilaune - *Schima wallichii* (Sc) needlewood (Eng)
 10. Chuletro - *Brassaiaopsis hainla* (Sc) Seto chuletro tree (Eng)
 11. Danfe - *Lophoporous impeyanus* (Sc), Daphne(Eng)
 12. Dhikur - *Streptopelia chinensis* (Sc), spotted dove (eng)
 13. Falat - *Quercus glauca* (Sc), Ring cupped oak (eng)
 14. Gurans - Rhododendron
 15. Jureli - *Pycnonotus jocolus* (Sc), Red vented bubbul (Eng)
 16. Kalij - *Lophura leucomelanos* (Sc), pheasant(Eng)
 17. Kal Chaude - *Myophonus caeruleus* (Sc), Blue whistling thrush (Eng)
 18. Katus - *Quercus tribuloides*(Sc), hill chestnuts(Eng)
 19. Kharbari - Grassland
 20. Khasru - *Quercus semicarpifolia* (Sc), English oak (Eng)
 21. Lato Koseira - *Asia flammeus* (Sc), short-Eared owl (Eng)
 22. Rakchan - *Daphnephylum himalayanses* (check)
 23. Ranichara - *Percrocotus flammeus* (Sc), Scarlet minivet (Eng)
 24. Sal - *Shorea robusta* (tree found in the Southern Asia, source of hardwood timber), Sal tree (Eng)
 25. Siru - Imperate cylindrical L.
 26. Theuwa - *Coracias benghalensis* (Sc), Indian Roller (Eng)
- (Sc = scientific name and Eng = English name)

1. Introduction

Practical Action Nepal Office conducted studies on community perception to climate change and its impacts in 2007/08 and 2008/09. The studies were conducted following a participatory approach to understand communities' experience on change in local climate and its impacts on their livelihoods and local environment. This report compiles the outcomes of the studies which brings out the communities' perceptions and concerns in respect to climate change, and provides basis for adaptation planning.

2. Methodology

Participatory Rural Appraisal (PRA) tools, such as Focus Group Discussion (FGD), historic timelines, seasonal calendars, key informant survey and transact walk were the main tools used to conduct the study. The study sites were selected based on the climate data of Department of Hydrology and Meteorology (DHM) covering the period 1976 to 2005. The identified sites based on the analysis of meteorological data represented high trends of temperature and precipitation.

The 2008/09 sites were selected based on the District Soil Conservation Office (DiSCO) priority watershed in the districts. The DiSCO has prioritised the watershed on the basis of intensity of landslides and flashfloods problem faced by the local communities.

Table 1: Selected sites for 2007/08 study

Name of village	VDC	District	Approx. Attitude (m asl)	Latitude (approx)	Longitude (approx)	Criteria for selecting
Depalgaun	Depalgaun	Jumla	2450	29° 15' 50"	82° 12' 40"	Annual rainfall decreasing
Kalena	Kalena	Doti	1500	29° 16' 52"	80° 58' 30"	Annual temperature decreasing
Tikapur	Tikapur	Kailali	150	28° 30' 00"	81° 10' 00"	Annual rainfall slightly decreasing
Khalanga	Khalanga	Salyan	1500	28° 25' 00"	82° 12' 00"	Annual rainfall slightly decreasing
Semaran		Rupandehi	120	27° 30' 00"	83° 15' 00"	Annual rainfall decreasing
Lumle	Lumle	Kaski	1700	28° 15' 00"	83° 50' 00"	Annual rainfall increasing
Khudi	Khudi	Lamjung	850	28° 17' 00"	84° 22' 00"	Annual temperature increasing
Pragatinagar	Pragatinagar	Nawalparasi	150	27° 40' 00"	84° 11' 15"	Annual rainfall increasing
Ramche	Ramche	Rasuwa	2000	28° 02' 30"	85° 12' 30"	Pre-monsoon and monsoon temperature decreasing
Jibjibe	Jibjibe	Rasuwa		27° 58' 30"	85° 14' 00"	Pre-monsoon and monsoon temperature decreasing
Khanigaun	Nilkantha	Dhading	1023	27° 52' 10"	84° 52' 10"	Annual rainfall decreasing
Jhule		Dolakha	2000			Annual rainfall decreasing
Bhimphendi	Bhimphendi	Makawanpur		27° 35' 00"	85° 08' 00"	Annual rainfall increasing
Khadbari	Khadbari	Sankhuwasabha	1038	27° 20' 00"	87° 15' 00"	Annual temperature decreasing

Table 2: Selected sites for 2008/09 study

Study site	VDC	District
Um Khola Watershed	Chandannath and Mahat Gaun	Jumla
Salya Khola-Godare Khola Watershed	Kalena and Khatiwada	Doti
Kanda Nadi Watershed	Thapapur	Kailali
Lower Phalagu sub-basin	Dhaibung and Bhorle	Rasuwa
Kalleri-Kampur sub-basin	Kalleri and Kampur	Dhading
Boudha Khola Watershed	Gaidakot and Ratanpur	Nawalparasi

For observation please refer Map 1: Map of Nepal, indicating the districts of study - page 38

3. Observed climate and future climate scenario

The observed climate trend is based on a report produced by Practical Action Nepal Office with support from SOHAM Nepal in 2007/08. Similarly, the future scenarios are based on a study conducted by SEN in 2008/09 with support from Practical Action Nepal Office.

3.1. Observed temperature trend over Nepal

The annual mean temperature over Nepal increased steadily at a linear rate of 0.4° C per decade from 1975 to 2005 (APN 2007). ICIMOD (2007) stated, the temperature rise in Nepal was within a range of 0.2-0.6° C per decade between 1951 and 2001 particularly during autumn and winter. Warming trend is high in the mountains and hills compared to tarai. The trend of mean maximum temperature ranged from 0.068 - 0.128° C per year in most of the middle mountain and Himalayan regions while the same ranged below 0.038° C per annum in tarai and plain (Shrestha et al 1999). The annual mean temperature trend over Nepal ranged from -0.04 to 0.06° C in far western, 0.02 to 0.04° C in mid western, 0.02 to 0.08° C in western, -0.04 to 0.08° C in central and -.06 to 0.09° C in eastern region during the period 1976 - 2005 showing a range of variations in the temperature trend (Practical Action 2009). The variations in trends from one study to another also depend on the range of years and the number and locations of the meteorological stations considered in the analysis. Nevertheless, the temperature trends in Nepal are high when compared to the global average temperature rise of 0.74° C in the last 100 years (1906 to 2005) and 0.13° C per decade in the last 50 years (1956 to 2005) (IPCC 2007).

Baidya et al (2008) found a general increasing trend in the extreme temperature events with a consistent higher magnitude in the mountains than in the plains. The study has reflected that both days and nights are becoming warmer with less frequent cold days and cold nights.

3.2. Community perception on warming

The local people have experienced rise in temperature with hotter days, longer summer and shorter winter seasons. These perceptions were backed by the data provided by the meteorological stations which showed increasing trend in temperature. Comparing the experience of the communities during the past 25 years proves that the summer season has increased by up to three months (Annex B) starting early and ending late. People from Dhading District have felt the elongation of summer season significantly and people from Salyan District have felt the shortening of winter season when compared to other districts visited. The increase in summer season is also expressed in terms of decrease in the length of winter season by up to 2.5 months compared in the past. Some communities noted summer season starting early whereas some noted summer lasting longer, both indicating increase in the length of summer season.

On the contrary, communities from Dolakha have

for observation please refer map 2: annual mean temperature trend over nepal from 1976 to 2005 in oc/year- page 38

felt that winter season has increased by about five weeks and frost months have increased by one month indicating increase in the length of winter season. The local people have their own indicators to verify such changes in temperature. The community perceptions related to temperature are generally found to be consistent with the trend recorded in the near by weather stations.

People in Dolakha also mentioned there is drop in temperature for the past three years as they are using blankets during summer (*Jesth-Asadh*) and are wearing warmer clothes too. The decrease in temperature is also indicated by longer seed germination time. Three years ago, potato seeds (tubers) used to sprout in one month after plantation (end of *Mangsir* to end of) but now it takes nearly one and half months (end of *Mangsir* to second week of *Magh*). Similar impacts have also been noticed on wheat and garlic germination and sprouting.

In Khalanga of Salyan District, local people have perceived increase in temperature since last 25 years mainly because the top of the high hills in the area has not received any snow since 1983, earlier which was frequent in the winter. Similarly, Nawalparasi and Rupandehi Districts also reported increase in temperature in the last 10 years

In Rasuwa, temperature has increased significantly since last 6-7 years. According to the local people, working in the field during the summer has become difficult due to hotter days. But they are happy with the warm temperature as this has led to increase in the length of the growing season in this usually cold village.

In Makawanpur, local people responded that they have not experienced any change in temperature. But one participant mentioned that the temperature in the higher altitude has decreased since 2050 BS (1993). In his experience, the maize seeds used to germinate in 15 days from sowing, but now the same variety of maize takes 22 days to germinate which is attributed to decrease in temperature.

The communities of Sankhuwasabha have perceived summer becoming hotter and the winter becoming cooler since the last eight years with occurrences of fog during winter. Similarly during summer, they are using mosquito nets due to the increase in mosquito population which was not alike ten years ago. People also reported difficulty working under the sun during *Baisakh–Jesth* due to increase in summer temperature.

3.3. Observed precipitation trend over Nepal

There is no significant change in annual and monsoon precipitation in Nepal (APN 2007, Shrestha et al. 2000). However, a clear decreasing trend has been seen in the number of annual rainy days during the last four decades (APN 2007). A significant variability on annual and decadal time scale was noted in the rainfall record from 1959 to 1994 (Shrestha et al. 2000).

Changes in precipitation are occurring in amount, intensity, frequency and form over the locations in Nepal. The average annual precipitation trend ranged from -10 to 20 mm in the eastern region, -40 to 20 mm in the central region, -30 to 40 mm in the western region, -20 to 10 mm in the mid western region and -10 to 20 mm in the far western region between 1976 to 2005 (Practical Action 2009). The precipitation shows a high variability spatially, seasonally and the forms it occurs.

The precipitation shows an increasing trend in extreme events in most of the stations examined (from 1961 to 2006). However, a systematic difference is not observed in extreme precipitation trend between hills and low land - southern plains of tarai. The study (Practical Action 2009) also suggested complex processes in precipitation extremities indicating that more weather related extreme events like floods and landslides could be expected in the future.

(For observation please refer Map 3: Annual rainfall trend of Nepal from 1976 to 2005 in mm/year - page 38)

3.4. Community perception on change in precipitation

The local communities have observed the form of precipitation has changed from snow to rain in the high mountains where temperature is in increasing trend with more hails in the middle mountains, less dews in some parts of tarai. There are deviations on the dates of precipitation from the ones that used to occur in the past. Duration of drought has increased. The nature of rainfall has also changed from more little rain over a several days to more intensive rain within few days or hours. The following paragraphs provide the community observations on precipitation from different parts of the country.

Jumla

Local people have experienced decrease in the amount of annual snowfall in the last 5-6 years. Jumla used to receive around 3-4 feet deep snow fall every year which usually melted only after a week. But now, Jumla receives little snow which usually melts in a day. In 2007, the area received almost no snowfall with only few inches in the high altitude. Due to the decrease in snowfall the small glaciers have diminished in size which feed water into streams resulting into reduction in water resources and leading to decline in productivity and winter crops yield.

Besides the decrease in snowfall, there is a decrease in the occurrence of frost and increase in hail incidences. Moreover, there is an increase of intensive rainfall that leads to increasing occurrence of flash floods, soil erosion and landslides. The increase in events of hail and uncertainty of rainfall has adversely affected the crop production.

Doti

People in Doti stated having snowfall on the high hills in the past, but now expressed that the snowfall has significantly decreased since 2054 BS (1997). Regular annual rainfall has decreased from 2056 BS (1999). Community considered rainy season from first week of *Baisakh* to second week of *Bhadra* (second week of April-end of August), but now the rainy season is from *Jesth-Bhadra* (15 May-15 September). The onset of monsoon rainfall is irregular varying from second week of *Jesth* (1 June) to *Asadh* (15 June) or *Shrawan* (15 July) with rainfall decreasing since 2060-63 BS (2003).

Salyan

Twenty-five years ago, the rivers of Salyan were difficult to cross because of high discharge due to heavy rainfall during monsoon. Today, the rivers are easily crossable even during the peak monsoon



Photo 1: Even in the month of January there is no snow on the high mountains

season (July-August). Some of the houses in Salyan would receive water sprouts earlier but today there is no such evidence due to which decrease in amount of rainfall is linked.

Kailali

For the past seven years Kailali has been receiving less rainfall every year. Local people have also reported changes in the wind behaviour as in the past, windstorms used to occur during the months of *Chaitra-Baisakh* (March-May), now it is unpredictable and occurs at any time of the year.

Rasuwa

Local residents in Rasuwa reported decreasing of winter rainfalls where as they use to receive 5-7 times winter showers during the month of *Magh* (January). The amount of snowfall has decreased; as a result winter water scarcity has increased. Similarly, people in Rasuwa have also experienced decrease in dews with increase in fog. One of the participants said, "Annual rainfall has decreased, but rainfalls during monsoon and heavy rain in short duration have increased." Another participant reported strong lightening during monsoon every year since 2059 BS and increase in landslides every year from 2060 BS. Rasuwa used to receive rainfall from *Baisakh* (15 May) until four years back, now it is delayed until *Jesth* (15 June) changing the rainfall pattern.

Kaski

Irregular and late monsoon rainfall has been perceived for the past 10 years. The usual rainfall season used to be *Jesth-Bhadra* (from third week of May to second week of September) which has changed now. Besides, incidences of hailstorms and its sizes have significantly increased.

Lamjung

High hill tops in Khudi village barely receive any snowfall these days which was a phenomenon in the past. There is a significant decrease in the amount of rainfall from past ten years and it has become much severe from past five years.

Dhading

People in Dhading used to receive 6-7 days of uninterrupted rainfall during monsoon but are now experiencing heavy rainfall in short periods. Increase in sporadic rainfall has caused unequal distribution of rainwater causing some places to become dry pocket areas and some with high level of rainwater.

Dolakha

People from Dolakha shared their experiences of receiving less annual rainfall since past five years. Earlier, the monsoon season in Dolakha was from *Jesth-Bhadra* (15 June-15 September), now it has become



Photo 2: Upper boundary of winter fog shifted upward

irregular disturbing the paddy transplantation activity especially in *Shrawan* (July). The winter rainfall used to occur during *Magh-Phalgun* (February), now it has also been disrupted. Sometimes the month of *Kartik* (October-November) receives heavy rainfall destroying the paddies at its harvesting stage. There is an increase in hail which usually occurred during *Baisakh* and *Jesth* (April-May), now it occurs at any month but in smaller size. There is a perception that the events of hail have increased, but there is a decrease in snowfall events.

Makawanpur

People in Makawanpur have experienced an increase in intensive rainfall events with decrease in total annual precipitation.

Nawalparasi

In Nawalparasi, rainfall has decreased from the past four years. Local people experienced droughts in 2061-63 (2004-2006) where as they are experiencing high rainfall in 2064 (2007). Winter rain used to occur during *Poush-Magh* (December-February), but it has now decreased since the past ten years. There is an increase in lightening and events of larger hailstorms with rough surface.

Rupandehi

In Rupandehi, local people have experienced the timing of rainy season is becoming erratic since 2054 BS (1997). In the past, rainy season used to start from *Jesth-Asadh* (June-July), but now the onset has delayed until the third week of *Asadh* (last week of July). Moreover, there is a decrease in total annual rainfall.

Sankhuwasabha

Communities in Sankhuwasabha have been experiencing change in the months of rainy season. Ten years ago, the rainy season was *Baisakh-Bhadra* (15 April-15 September), but now it is from *Baisakh* to *Ashwin* (from 15 April-15 October). Similarly, the winter rain used to occur for 7-15 days continuously but now it only lasts for one or two days. Local people have also experienced a decrease in number of rainy days but increase in the

total amount of rainfall (per event per year).

3.5. Climate scenarios over Nepal

Under different emission scenarios, the general circulation models project increase in mean annual temperature in Nepal. It is projected that by 2060s the temperature will be increased by 1.3 - 3.8° C, and 1.8 - 5.8° C by 2090s with inter model spread of 1.5 - 2° C by 2090s under any one emissions scenario (UNDP 2007). The (GCS) model also projects increase in the frequency of hot days (11-28 per cent) and nights (18-28 per cent), and considerable decrease in the frequency of cold days and cold nights.

Output from the PRECIS model run at IITM over South Asia and adjacent area has projected warming all over Nepal with a mean annual temperature rise from 3.4 to 5.2° C by 2100 (SEN 2009). Warming in high rate is projected over mountainous regions and relatively lower rate over middle mountains with intermediate rise in tarai belt. The analysis shows that the temperature will rise by 4.2° C on average over Nepal by the end of 21st century compared to the base period (1961-1990).

(For observation please refer Map 4: Mean temperature scenario over Nepal by 2100 based on PRECIS Model (from SEN 2009) page 39)

UNDP (2007) has projected increase in mean annual rainfall over Nepal (-14mm to 59mm per month) which is largely due to increase in monsoon rainfall. In the model ensemble June, July and August (JJA) rainfall is projected to change by -36mm to +224mm per month by 2090s with largest increase in eastern *tarai* and largest decrease in far west Nepal.

SEN (2008) has projected increase in mean annual rainfall by the end of this century by varying amount (0-40 per cent) from the base period (1961-1990) over various parts of Nepal except over the mountainous parts of Gorkha and southern parts of Banke and Bardia. In these areas of Gorkha, Banke and Bardia it is projected to decrease the rainfall from marginally up to by -5 per cent. Over central and western Himalaya in Nepal, the rainfall is projected to increase slightly (up to 10 per cent). In eastern

hilly region of Nepal, it is projected to increase by up to 20 per cent whereas in tarai belt and adjoining mid mountains in central and western Nepal, up to 30 per cent increase is projected. At few areas (grids), projected increase is as high as 40 per cent above the baseline rainfall. Overall, Nepal's average rainfall is projected to increase by 15.5 per cent by 2100.

It is noteworthy that complex topography brings local variations in precipitation which is likely to be large

and may vary from the regional trend (Christensen et al. 2007). By and large, model projection of temperature is generally robust and most models project similar future trends, but there is a high level of uncertainty in projection of precipitation.

(For observation please refer Map 4: Mean temperature scenario over Nepal by 2100 based on PRECIS Model (from SEN 2009) page 39)

4. Impacts of climate change

The first impacts of climate change are on biophysical resources and physical assets, that lead to impacts on the socioeconomic sectors. The impacts are through change in temperature or through deviation in usual precipitation or through the combination of both. Other climatic factors such as changes in wind, frost, hailstorms and forms of precipitation are also gradually showing impacts. Following table shows the nature of impacts of climate change observed from the field:

Table 3: Nature of climate change impacts

Climate change	Primary impacts	Secondary impacts	Tertiary impacts
Increase in GHG concentration in the atmosphere			
Decrease in air temperature	Shorter growing season	Crops cannot properly mature	Decrease in crop production
Increase in air temperature	Glacier and snow melting faster than accumulation	Water scarcity for irrigation and drinking Drying up of spring water Potential disaster from GLOF Increase in forest area in higher altitude zone	Crop failure due to irrigation problem Problem of water for various uses (drinking, water, etc) Forest and pasture encroachment in higher altitude zones Damage to local infrastructure by associated hazards
	Increase in insect and pests, and vectors of diseases for crops, animals and human beings especially shifting towards higher elevations	Increase in crops and livestock diseases Increase in human diseases	Decreasing crops and livestock production and productivity Increase in cost of crops and livestock production Human death due to diseases to which local people are not immunised Increase in cost of health care Pests and diseases affect forest biodiversity
	Desiccation of soil moisture	Drought to crops and plants Drying of water springs Dropping down of ground water table	Difficult to plow field Crops and livestock production and productivity decline Growth of natural resources like grass adversely affected Cost increases to access the ground water and other resources
	Heat stress on crops and animals	Decreasing productivity of crops, livestock and poultry	Cost increases for crops and livestock production Poor people with limited resources are the one most affected
	Increase in growing season	New land brought under cultivation in higher elevation/cold regions Number of crops in a plot per year increase	Mix cropping is possible in higher elevations leading to more crops in a year Increase in agriculture production and productivity in higher altitude Threaten to deplete forest and biodiversity in higher altitude because of extension of agriculture over new areas and upward shifting Livestock affected and the pasture/forest land is brought under cultivation

Climate change	Primary impacts	Secondary impacts	Tertiary impacts
Deviation in nature of precipitation	No rainfall when there is need	No rain water for crop irrigation	Crops cannot be grown on the right time Crop sown on time gets failed because of drought
		No ground water recharging	Drying of springs leading to water scarcity for irrigation and drinking Drop in ground water table
		Chances of increase in fire hazards	Increase events of fires (forest and personal properties)
	Off-seasonal rainfalls	Damage to crops Water induced disaster as the communities are not prepared during off-seasons	Crop production decreases because crops are damaged at growing and harvesting stages by too much of water Risk for possible disaster as people are not prepared during off-seasons
	Increase in intensive rainfall	Increase in intensified soil erosion	Soil fertility declines leading to decrease in agriculture productivity per unit area Decrease in area of productive agricultural land Decline in soil fertility adversely affects natural resources like forest
		Intensity and frequency of landslides, floods and flashfloods increase	Productive land on hills are washed away Productive lands in foothills and plains are damaged by debris, sedimentation and flood Loss of standing crops and livestock Personal and community infrastructure (road, trail, buildings, etc) are damaged Loss of human life
	Rainfall instead of snowfall	No snow deposition in the glaciers Shifting of snow line	Scarcity of drinking water and water for irrigation Dry soil moisture and ground water Dry springs Growth of local vegetation affected Fluctuation in regular flow volume of glacier fed rivers Damage of local earthen roof by rain Winter crops failure
	Increase in hail		Damages to crops and animals Damages to community and private properties like roof of the houses Damage to natural resources like forest seedlings
	Decline in dews and frost	Soil moisture affected	Crops and grasses are adversely affected (delayed and slowed down in plant growth rate)
Change in wind pattern	Wind blows any time of the year		Damage to crops
	Wind becomes stronger erosive		Damage to house roofs and other properties/resources
Fog line shifts/elongated fog episodes	Favourable environment for fungal growth in higher elevations	Increase in plant diseases	Spreading of crop diseases (mainly potato blight in most of the areas) and aphids

The impacts of climate change will be described in respect to the following sectors:

4.1. Water resources

One of the direct impacts of climate change is on water resources. Increase in temperature and deviation in precipitation patterns and a combination of both have affected the water resources. The increase in air temperature has directly resulted to faster melting of glaciers and snow. As a result, the glacier lines have receded and small glaciers at lower elevations have completely disappeared in the mountains causing water scarcity for irrigation, drinking and other uses. The cumulative impacts of water problem due to disappearance of small glaciers and snow deposits are going to be as large as the impacts of GLOF.

The melting of glaciers and snow in the mountains has affected the major river discharge in Nepal during dry season. There is a prediction of increase in annual river discharge until around 2030 and then decrease because of rapid melting of snow and glacier in the beginning, and then significant decrease of

available snow and glacier mass thereafter (IPCC 2007). However since the change in temperature and precipitation vary from one region to another the river discharge will also be affected accordingly. This prediction demands studies for individual glaciers and rivers. Annual discharge of snow fed rivers is increasing, except that of Narayani River, which has a slight decreasing trend. However, some rivers that originate from middle mountains like west Rapti and east Rapti have shown a negative trend (Figure 5). There is a need for assessment of the impacts of climate change on discharge of major river systems to understand the specific changes as the varied regional climate change will have varied impacts on river discharges over the regions and over the seasons.

The water sources in the middle hills of Nepal have been affected with reported events of drought and drying up. The deviations of rainfall from the normal dates have created a drought like condition with no rain when there is a need.

The water springs in the middle hills are drying which are essential for drinking and irrigation purposes.

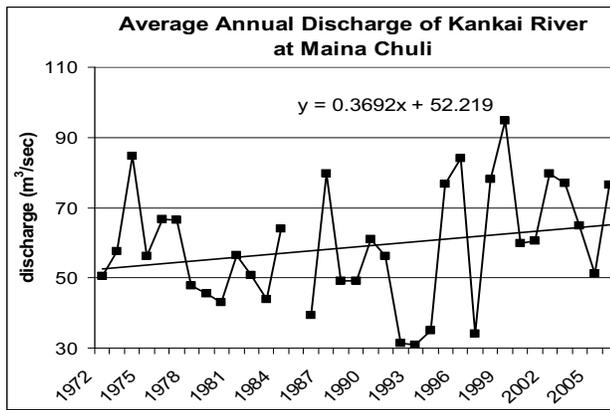
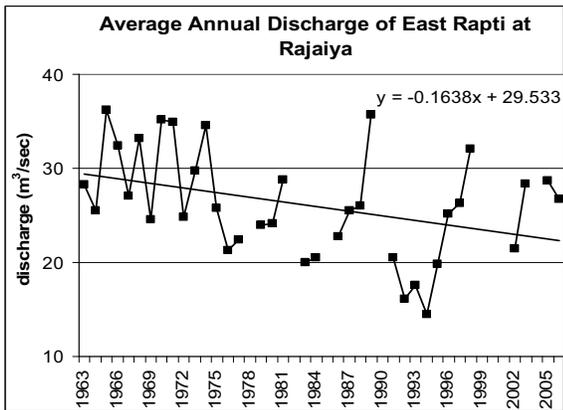
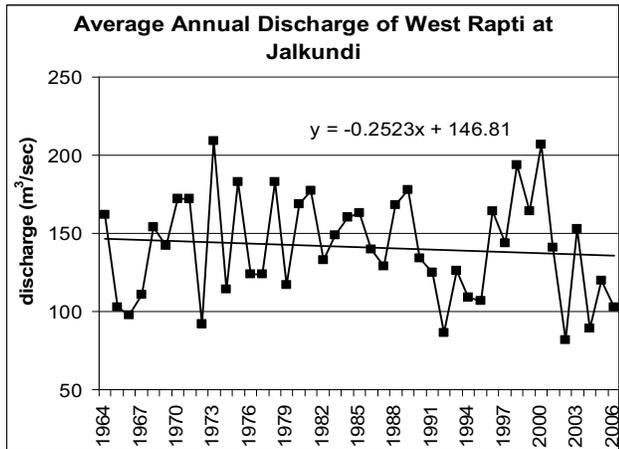
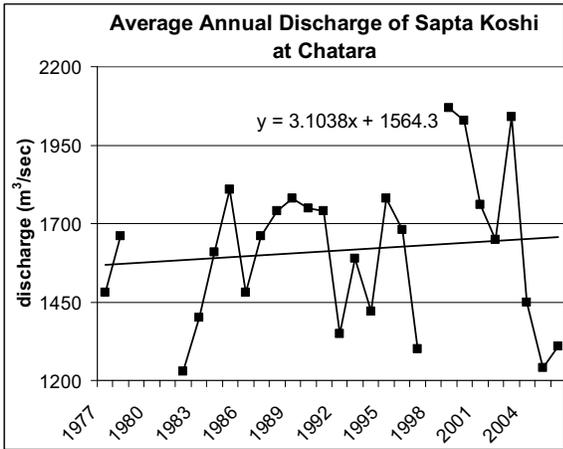
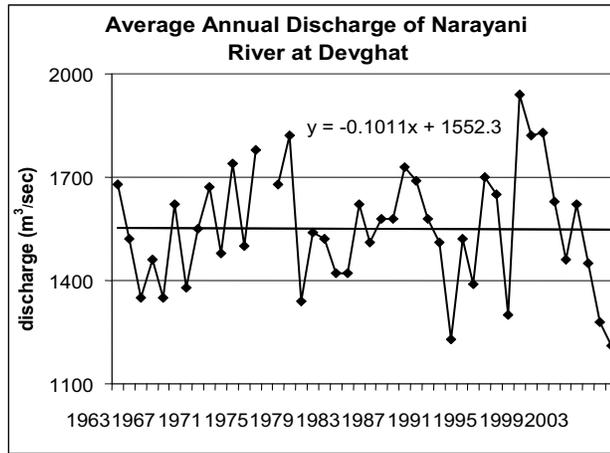
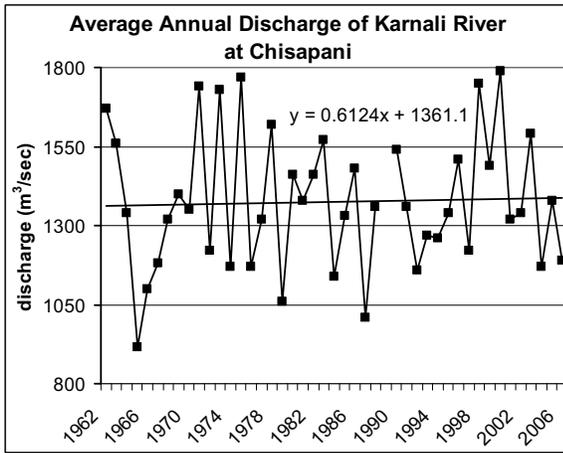


Figure 5: Average annual discharge of major river systems in Nepal (data source DHM, 2008)

The disturbed precipitation pattern has affected the ground water recharging system and the rising temperature have increased the evapo transpiration process resulting into less moisture in the ground leading to drying up of water springs in the hills and hardening of soil making ploughing difficult. However, the human activities in local resource management are equally responsible in addition to impacts of climate change.

In *tarai*, the ground water table has dropped deeper. The community perception to this is due to long periods of drought and less dews during winter compared to the past. It is also attributed to the lack of irrigation water from the rivers during winter which would also help in ground water recharging. As per the people perception, the river discharge has declined which results into less field irrigation during winter. Farmers in all the ecological zones have expressed their experience that there is less water flow in the rivers during dry season which means the dry season is becoming drier.

Field observations show that Tawa River in Jumla - high mountain region, had a good flow of water during winter in the past; but now (2008) the stream is fully dry during the month of *Chaitra* and *Baisakh* (April).

Similarly, in Doti, until 15 years ago, there were 5 water springs with plenty of water. Now, only 2 of

them have water and the quantity has decreased significantly.

In Salyan, the water springs used to burst in *Asadh-Bhadra* (July-August). There used to be 8 water springs in the village with good water discharge. But now the water flow has decreased to only around one-fourth of the past flow.

In Kailali (Tikapur), ground water table has further deepened. Hand pumps inserted 20 feet deep 37 years ago has no water now. About 25 per cent of such hand pumps have dried since 2063 (2006) especially during *Chaitra-Baisakh* (April-May). Five years ago, there used to be winter fog for about a week without any sunshine, but this phenomenon has decreased and local people feel warmer during the month of *Poush* (December-January) than before.

In Rasuwa, there is less snowfall and the water sources are depleting. According to the local people there are still sufficient water resources but it needs better management for sustainability. Water for irrigation is required during dry months and the sources are drying up due to change in rainfall pattern along with destruction of canals by landslides.

There were 10 water springs around the village in Lumle (Kaski) where availability of water was not an issue throughout the year, but now only five springs



Major Rivers of Nepal

Individual cases on perception on climate change

"Climate change has affected the availability of drinking water. We did not have our own water tap and we always dreamt of having one in front of our house, looks like it will remain a dream as the water sources around have dried up. We used to fetch 10 liters of water every day from the nearby tap within 10 minutes, but these days it takes more than 3 hours and my children are always late for school as their time is spent in fetching water before they go to school."

- Junkiri Majhi 30, Majimtar, Dhading

"Water was never a problem couple of decades back and we always had year round water supply. Today, the situation is different and we only have water three months in a year."

- People from Kalena VDC, Doti

"We had ten water springs around the VDC in Khudi and water was easily available throughout the year. At present, only three water springs exist and the volume of water flow has reduced significantly."

- People from Khudi VDC, Lamjung.

exist. Despite the change in rainfall pattern, community partially blames the road construction project and deforestation in the area that has contributed to drying up of some of the water sources.

Local people in Dhading have experienced a decrease in water resources since 2028 BS (1971). Previously there used to be sufficient water springs, now many of them have dried and there are difficulties even to get enough drinking water.

The ground water table in Rupandehi is also dropping significantly since the last eight years. In the past, local people could access the ground water by digging small holes along the riverbank, but today they have to use bores and pumps to access the ground water. The river water level used to get low only during *Baisakh-Jesth* (April-May), now it is completely dry during these months. Earlier the ground water was abundant and available at 2" pipe full at 150-250 ft deep pipe but it has reduced to 1-0.5" pipe with complete dryness during *Chaitra-Jesth* (March-May) since last four years. The boreholes now need deep up to 250 feet to reach the ground water. All the circumstances has increased the farmer's

economic burden and labour cost especially to poor households.

People in Makawanpur have also experienced drying up of water springs. However, they have perceived deforestation and increase in population as the major causes. Similarly, in Nawalparasi too the water sources are drying and the local people blame deforestation and flooding. The floods have destroyed the water sources in the rivers and streams by depositing sediments and debris making it difficult to access the water.

In Sankhuwasabha, there is an increase in water source originating from forest where forest has been conserved. However, there is scarcity of water resources in the village due to increase in population. The local people could not relate the change in water resources with change in climate.

Similarly there were about 10 water springs around the Khudi village of Lamjung which used to have water throughout the year in the past. Now only three water springs have water year round but the water volume has reduced drastically.

4.2. Agriculture

In Nepal, majority of the population are small land holding farmers. The nature of agriculture is subsistence and depends on natural climate. Once the climate is disturbed, the whole agriculture system is affected. As the farmers cannot predict the weather that they were accustomed to, the adverse impact of climate change on agriculture is highly significant. The impacts are multiplied by the fact that there is a lack of awareness on climate change at different levels, and lack of capacity to cope with adverse impacts of climate change.



Photo 3: Rice plants affected by drought

The impacts of climate change on agriculture are both direct and indirect. Rise in temperature and temporal and spatial change in rainfall pattern have direct impacts while disturbances in water resources for irrigation and incidences of pests and diseases are the indirect impacts of climate change on agriculture.

The rainfall is becoming more and more unpredictable which has negatively affected in the agriculture production since the farmers are planting and harvesting crops within certain dates of the year. The yield and the cultural practices depend on timely rainfall. When the sowing and planting activities are not done on time, the crop fails, leading to following

of land for a season. The farmers are not prepared to cope with such weather uncertainties because they still believe that rainfall will occur on certain dates of the year.

Due to uncertain rainfall pattern, rice is the most affected crop as it needs plenty of water compared to other crops (Gautam et al. 2007). The disturbance in monsoon rain is very likely to affect the rice production and there is a crucial relationship between rainfall and rice yield in Nepal (ibid). It has been reported that the crop productions in Nepal are decreasing except maize and paddy and there is increase in flowering but decrease in fruiting of fruits and vegetables.

In case of rice, usually one month old seedlings are transplanted. But in the absence of timely rainfall the seedlings cannot be transplanted on time which affects the yield adversely. Since the farmers depend on seasonal and timely rain they are not prepared with secondary seedlings of the same crop or alternative crops. Moreover, they do not practice storage of crop seeds incase the first sowing or planting fails. Rice is the most preferred crop and the main food grain of every Nepalese family. But due to the uncertain rainfall, there are practices that farmers have replaced the rice crop with other crops that need less water compared to rice.

The spring season crop in hills and *tarai* starts with sowing of maize with timely rainfall, but due to the erratic rainfall in recent year the crops are failing. The number of days without rainfall is increasing during winter. In 2009, there was no rain during the entire winter for more than seven months (October 2008 to April 2009). In one hand, this drought adversely affected the winter crop yield by 70 per cent loss in some of the hills and mountain districts in far and mid western development regions of Nepal (MoAC, WFP and FAO, 2009). On the other hand, it delayed the spring and summer crops.

The declining trends of river discharge have direct adverse impacts on agriculture mainly with inadequate water for irrigation. Moreover, the water

availability for irrigation has also been affected by landslides and debris flow which have washed away the irrigation channels and sub ducted the water under the debris making it inaccessible for use. This problem is becoming severe in the foothills of Churiya and the middle hills. As intensive rains have increased in Churiya ranges of Makawanpur, Chitwan and Nawalparasi, the soil erosion and landslides have also increased on the slope land cultivated areas.

In high mountains the small glaciers are disappearing resulting into drying up of water for irrigation. The amount of snowfall has diminished with precipitation occurring in the form of rain that does not enhance deposition of snow and glaciers which supplies water during winter and dry seasons. So, there is a reduction in the formation of glaciers as the existing glaciers are melting faster with no additional accumulation.

However, in the higher altitude areas, there are some positive impacts of increase in temperature through increase in growing seasons for the crops. One of the traditional cropping patterns in Jumla (2,344 masl) is rice and barley. Rice is grown from second or third week of *Jesth* (third week of May-first week of June) to first or second week of *Kartik* (third to fourth week of October). Barley is grown from *Poush/Phalgun* (November/March) to *Jesth* (May). Because of cold climate and delay in sowing season due to snow, barley usually takes longer for maturation. Moreover, barley used to be harvested even when it was not well ripen for timely rice transplantation since rice is the preferred crop. This ultimately would reduce the yield of barley. But, now there is less snow or no snow in winter, which favours early sowing or germination of barley leading to early maturation and leaving sufficient time for rice transplantation after harvesting of barley.

The cropping patterns in non rice planting fields are either maize or potato or mixed in the higher altitudes. Yields were not good when intercropped in the past. But, now intercropping of beans, maize and potato is a common practice which produces good yield. The farmers are also able to grow maize and potatoes in higher altitudes in the pastures. Therefore, they

have seen some benefits of increase in temperature with increase in cultivable land and growing season. However, there are indications that extension of agricultural lands into new areas has encroached the forest and pasture lands leading to degradation of environment and biodiversity, soil erosion, landslides and floods. Farmers in the hills are now able to grow crops that used to grow in lower altitudes earlier, but, there are emergences of new pests and diseases in higher altitudes and the local people perceive the climate warming as the cause.

Jumla

In Jumla, naked barley is now sown as the winter crop as the growing season has increased since past five years. The harvesting date of paddy is now 15 days early compared to the past. New species of crops like turmeric, cumin and bitter gourds are being cultivated in the open fields which were only grown inside the green houses in the past. The ripening of apples is also earlier and people mentioned the increase in crop diseases in recent years.

Doti

In Kalena VDC of Doti District, local people have changed the cropping pattern in order to cope with climate change. Significant area of rice plantation has been converted to millet fields. Two decades ago there were sufficient sources of water for rice planting, but now most of the water resources have disappeared prompting local people to grow millet. According to the people, many wetlands have dried due to increasing temperature in the area, therefore, they feel that there is less productivity of crops especially paddy crop in recent years. Before 2056 (1999), the paddy seedlings used to be ready after 15 days for transplanting, but now they are ready only in 10 days.

Salyan

Salyan District is in mid hills but it can grow Gautam-4 variety of wheat which is usually grown in *tarai* or lower altitude. Due to lack of water, some of the paddy fields have been converted into maize fields since last six years.

Kailali

In Tikapur, local people explained that watering paddy seedbed once a week was enough seven years ago, but now it needs watering in every 2-3 days due to the dryness of soil. Similarly, people also observed decreased trend in the paddy yield. They have also experienced irrigation problem for winter crops like wheat. For some years now, the farmers have not been able to bring adequate water from the Karnali River to the irrigation canal because of low river discharge during winter as they have perceived.

Kaski

People in Lumle village in Kaski District have experienced difficulties to plow the field when there is no rainfall for long period of time. Fifteen years ago, the soil used to remain moist and could be plowed even when there was no rainfall but now due to dry wind in winter, the soil becomes dry and hard to plow.

In Lumle, rice used to be generally transplanted on 20-22 *Jesth* (first week of June), but now it is 10-12 *Asadh* (third week of June) because of uncertain rainfall. Rainfall is occurring late in *Bhadra* (August-September) and the frequency of such late rainfall is increasing which is destructive to paddy crops at the harvesting stage. Infestations by stem borer and

aphids have increased in maize. Maize fields have been converted into grass fields (kharbari) because of drought during maize sowing season (March-April).

The stems of wheat have become too small to use for house roofing, according to the local people it is due to lack of irrigation or rainfall which has limited the growth of the crop. The winter crops including wheat used to be sown during *Mangsir* (November-December) and harvested in *Phalgun-Chaitra* (March). But due to lack of irrigation and winter rainfall, the area under wheat cultivation has significantly decreased. The yield per unit area has also declined to almost one third compared to normal yield in the past. Similarly, increase in the incidence of hail has also adversely affected the crop yield.

Lamjung

Compared to traditional varieties, the local people in Lamjung have found that improved varieties of maize are tolerant to low rainfall condition. People are now planting Arun 1 and 2, Manakamana Rato and Seto varieties of maize. Because of erratic rainfall (no rain when required), the planted potato tubers dry in the soil, the seed germination of paddy in seedbed is very low and more and more paddy field are left fallow due to lack of water for irrigation.



Photo 4: Karnali River



Photo 5: Banana plants destroyed by hail



Photo 6: Wheat crop heavily infested by disease

Insect pests have increased in maize. Leaf roll disease has increased in paddy. In four years time, potato blight and aphids in vegetable crops have increased in the village. The increase in crop pests and diseases has raised expenditure on insecticides and fungicides.

Farmers in Khudi village have reported increase in the incidence of potato late blight and this disease has also been now observed in higher elevations. As per the farmers' perception, the line of winter fog has shifted to higher elevation which is responsible for bringing the late blight to potatoes in higher altitude regions.

Rupandehi

The paddy seedbeds were irrigated once a week in the past, but now they need watering in 2-3 days intervals. Earlier, the paddy transplanting season was end of *Jesth* to first week of *Shrawan* (second week of June to third week of July) and harvesting season was first week of *Ashwin* (third week of September). But since 2055-2061 BS (1998-2004), the harvesting time has delayed until second week of *Kartik* (end of October). Since last 12 years the productivity of paddy (Radha-4, Saraju, Gorakhnath) has declined gradually. Sowing date of paddy has delayed due to late rainfall and the grains get dry at ripening stage due to lack of water. Earlier, the local people used to

sell surplus paddy, but now it is not even sufficient for their family consumption mainly due to drought resulting to decline in productivity.

The wheat season is from second week of *Mangsir* to second week of *Chaitra* (November end to March end), but now it ends by first week of *Chaitra* (third week of March) due to drought. This has decreased the wheat yield. Since 20 years back, the wheat required irrigation through ground water because of lack of surface irrigation water. The wheat grains now have more husks, it is mainly because of late rainfall during the wheat growing season. Due to drought (unavailability of water), 60 households out of 80 in the studied village have left around 100 bigha (approximately 70 ha) of land barren.

Local people shared their observation that there is a delay in the flower setting time of mango from first week to second or third week of *Magh* (third week of January to first or second week of February).

Nawalparasi

In Nawalparasi, winter dew used to be the source of soil moisture, but now it is becoming hazardous to crops. Local people reported that dews have burnt the crops in recent years. There is an increase in potato blight. Similarly, fungal infection on mustard and incidences of ticks in livestock are increasing.

Rasuwa

In Ramche village of Rasuwa District, more varieties and species of vegetables can be grown now. As alternatives to cereal crops, they are now opting vegetable farming and livestock keeping that can fetch good income. Fruit trees like mango can now be grown in lower altitudes and it produces good fruits as well.

Dhading

People from Khanigaun of Dhading District reported local paddy germinating early, during 15-25 of *Magh* (first to second week of February), some 2-3 weeks early of the normal dates. Rice used to be transplanted during the end of *Asadh* (second week of July) and harvested on 10-12 *Mangsir* (first week of December). Now, it is harvested on 26-27 *Kartik* (second week of November), nearly two weeks before the normal dates. Wheat seeds used to germinate in 12 days after the seeds were sown. But now they germinate within one week in first week of *Mangsir* (third week of November). Pear, lemon and guava used to set flowers in *Poush* (December-January) and fruits in *Magh* (January-February). Now they set flowers in *Kartik* (October-November) and fruits in *Mangsir* (November-December) showing erratic flowering and fruiting behaviour

People in Dhading mentioned about an increase in husk of paddy and millet, increase in potato late blight, increase of stem borer in banana, and increase in papaya diseases. The relationship of these problems with climate change is a subject of study. Local people also shared the increase in irregularity of windstorms which destroy the crops. In the past, windy days used to occur during *Chaitra-Baisakh* (April), now it occurs any month of the year.

Dolakha

In Dolakha, there is an increase in evidences of beruwa (leaf roll) and raate (brown disease) in paddy which has reduced its yield to half, from 30 pathi¹ to 15 pathi per ropani. Similarly, there are also increased

¹ 1 Pathi of rice = 2.5 kg approximately

incidences of stem borer and white grub in millet in last five years which has reduced the millet yield from 25:1 to 10:1 yield to seed. Also, incidences of leaf rust and black shoot have increased in wheat. The villagers attribute decreasing rainfall as a cause to these diseases.

Chitwan

Farmers in Jugedi village in Chitwan reported occurrences of livestock liverfluke in the upper villages, which were common only in the lower villages. This has abandoned buffalo keeping in the village in last 10-20 years. They perceive increased warming in higher altitudes have created favourable environment for liverfluke. Similarly, it is also observed that, there is a change in the cropping pattern in some farmlands. Due to lack of rainfall during transplanting time, some of the farmers have abandoned rice plantation in their farms and opted for maize and other cash crops cultivation.

Makawanpur

In Makawanpur, the decrease in rainfall has affected the maize sowing dates. Earlier, locals sowed maize during first week of *Phalgun* (third week of February), but now it is delayed to last week of *Phalgun* (second week of March).

Sankhuwasabha

The annual observed temperature in Sankhuwasabha shows a decreasing trend with locals perceiving an increase in growing period of crops. Due to decrease in temperature, the spring paddy takes longer time to germinate during *Magh-Phalgun* (February). At the same time, increased incidences of aphids in vegetables, white grub in maize and bugs in green vegetables are noticed.

4.3. Climate related hazards

Communities perceive an increase in disasters due to climate induced hazards like landslides, floods and droughts; the frequency and intensity of which is

directly related to the frequency of intensive rainfall. The hazards sometimes occur unexpectedly so the locals have to tackle those without full preparedness. Local people reported that there is an increase in flood intensity and frequency in most of the sites where this study was conducted. The historic time line also shows the increasing frequency of climate related hazards in the villages. Disasters, either due to extreme rainfall or no rainfall are increasing. Landslides in the hills and floods in the plains have been observed as major hazards. Drought has been found to be a common hazard for both hills and plains. Communities in hilly areas perceive increased occurrences of hailstorms as a disturbing event. Some of the community perceptions are presented below:

Rasuwa

People from Ramche village in Rasuwa District have observed increased evidences of landslides with

increased events of intensive rainfall during the monsoon. On the contrary, decreasing rainfall events during winter months from *Kartik* (September-October) to *Jesth* (May/June) has resulted into drought affecting the winter crops.

Due to the threat from landslides, people are worried and are in search of places to relocate. Local people want to control the landslides but due to the fragile geology it is almost impossible. Landslides have also reduced the areas of agricultural land thereby reducing the total agriculture production in the village.

Chitwan

Villagers from Jugedi khola² watershed in Chitwan District shared their experiences of increasing intensity and frequency of flashfloods in the village (Gurung and Bhandari 2009). Table 4 shows the disaster event trend in the Jugedi khola catchment areas:

2 Khola is a stream

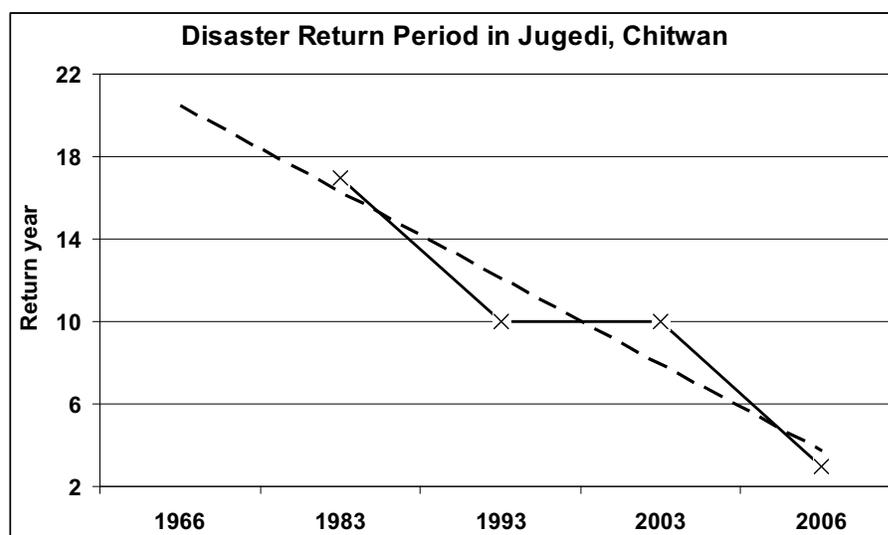


Photo 7: Landslides in the hills are in increasing trend

Table 4: Disaster events in Jugedi River, Chitwan District³

Year	Return period	Event	Effect	Solution
1966		<ul style="list-style-type: none"> Flood washed away humans in Jugedi khola 	Human deaths	No support from any organisation
1983	17 years	<ul style="list-style-type: none"> Productive irrigated lands and water mills damaged by floods in Kholaghari river 	Land and water mill destruction	No support from any organisation
1993	10 years	<ul style="list-style-type: none"> Productive irrigated land damaged and three people killed by Jugedi khola 	Loss of productive land and human deaths	No support from any organisation
2003	10 years	<ul style="list-style-type: none"> 5 people, 25 goats and some buffaloes killed due to flooding in Isti khola 8 people, 55 goats, 3 buffaloes, 3 bulls killed and 5 houses and about 2.6 ha of cultivated land destroyed by flood in Jugedi khola About 7.8 ha of cultivated land destroyed by flood in Bharlang khola 	Massive property losses, physical destructions and human deaths	DDC and Red Cross Supported the victims
2006 ¹	3 years	<ul style="list-style-type: none"> Loss of 12.33 ha of land equivalent to a minimum value of NPRs 5.55 million by flood and landslides¹. Destruction of five irrigation channels 	Massive land loss and irrigation channels washed away	No support from other organisations except rehabilitation of irrigation channels by Practical Action Nepal Office

Figure 6: Frequency of flood in Jugedi, Chitwan



Doti

The district is facing not only increase in disasters due to frequent intensive rainfall events but also an increase in frequency of droughts as the rainfall has become erratic. In 2004, the rainfall was late but when it occurred, it caused floods and landslides. The following table shows narrowing of the time of occurrence of drought in Doti.

³ From Gurung and Bhandari, 2009



Photo 8: Floods in the plains destroying crop land and infrastructure - Chitwan



Photo 9: Lands being left fallow because of no timely rainfall

Table 5: Drought events in Kalena village, Doti District

Year of event (BS)	Return period	Impacts from drought
2022 (1965)		Crop failure and starvation in the village
2057 (2000)	35 years	Yield declined by nearly 60 per cent
2060-2063 (2003-2006)	3 years	Late start of the rainy season
2066 (2009)	6 years	The whole winter (October 2008-May 2009) was dry with no rain resulting in winter crops failure

Figure 7: Frequency of flood in Kalena VDC in Doti

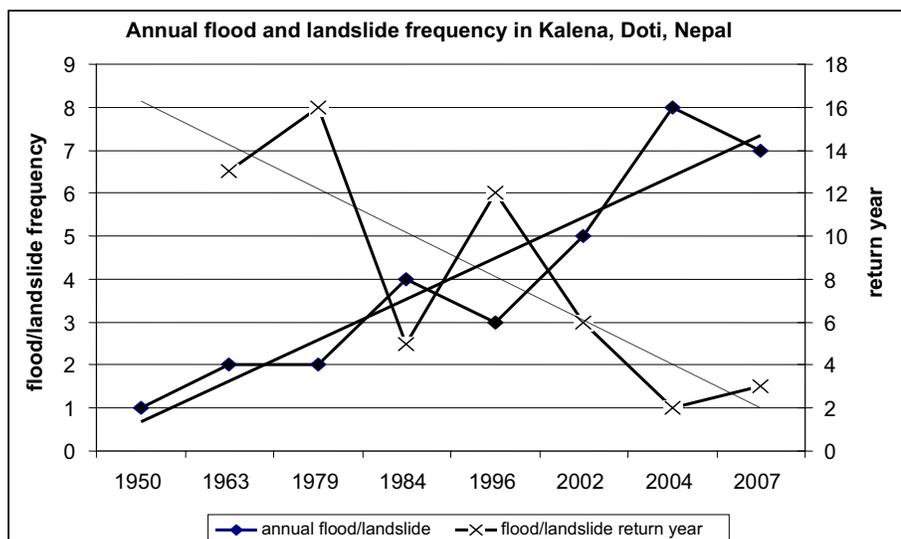


Table 6: Disaster events in Bhimphedi, Makawanpur District

Year of event (BS)	Return period(Years)	Loss from flood
2002 (<i>Shrawan</i>)		Maize and paddy field washed away by landslides and death of a person
2011 (<i>Shrawan</i> 11 and <i>Bhadra</i> 9)	9	Washed away lands, livestock and markets of the village
2018	7	Though floods occurred, it did not cause a huge loss except to 20 loads of maize
2031	13	Washed away a village completely (<i>Ranikhola basti</i>) causing death of 30 persons
2039 (<i>Shrawan</i>)	8	Flood and landslide occurred but did not cause much disaster
2046	7	Cultivated land washed away
2050 <i>Shrawan</i> 4	4	Lands, houses and livestock were washed away causing a huge loss
2059 <i>Shrawan</i> 3	9	Land, cattle and houses of Bhimphedi - 6 (<i>dammar</i>) were destroyed

Dhading

As per the information collected from the communities, floods and landslides are simultaneously occurring. In Dhodeni, drought events were also observed in the past however, since 2006, local people have experienced both drought and landslides because of erratic rainfall.

Table 7: Disaster events in Dhodeni, Dhading District

Events	Year in BS					
Landslide				2063	2064	2065
Drought (Year in AD)	2028 (1971)	2060 (2003)	2062 (2005)	2063 (2006)	2064 (2007)	2065 (2008)

Figure 8: Annual flood frequency in Thapapur VDC of Kailali District Lumle

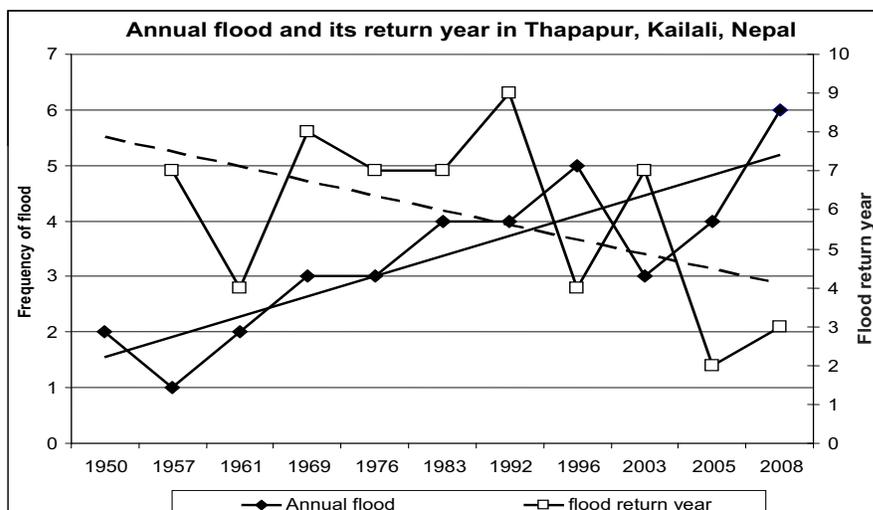




Photo 10: Flood destroying standing crop and affecting women and children

Lumle

In Lumle, the size and frequency of hail has increased that has destroyed the crops at any stage, especially during the months of April-May and October-November.

4.4. Infrastructure and buildings

The increased frequency and intensity of floods and landslides has adversely affected the infrastructures like irrigation channels, roads, bridges, houses and watermills at local level. The damage of infrastructures as reported by local people to the study team has already been highlighted in the previous section on climate related hazards.

The landslide at Dhobi Khola in Dhaibung VDC, Rasuwa has disrupted the road from Kalikasthan to Jibjibe which was reconstructed several times since the landslide first hit it. However this time, it could not be reconstructed because of heavy damage. Now, the only way to reach Jibjibe is to walk from Kalikasthan. People have also noticed reduction in water resources due to coverage of the streams by landslide debris.

A huge landslide in Rasuwa on 29 Shrawan 2059 (August 2002) killed 20 security personnel destroying the army barrack, swept away 17 houses and several

hectares of agricultural land, and destroyed irrigation canals in Ramche village in Rasuwa District.

Incidence of flood in Dewal Gaon, Jumla in 2065 (2008)

- *In 2008, the rainfall occurred in Jumla almost everyday, from the last week of Jesth (second week of June) which was unusual for the area. In September, there was a flood in Tila Nadi (river) in Dewal Gaon. Earlier, floods used to occur only in the months of July-August for which local people were prepared, but not in the month of September. The river swelled up continuously for two days which swept away four bridges and water mills, and destroyed the roads along the river. The locals reported the water level in the river being the highest till date they have ever observed. Several landslides occurred in the area due to heavy rainfall.*
- *The earthen roofed houses were damaged due to heavy and continuous rainfall. The flat earthen roofs could not resist such heavy rainfall due to which rain water leaked and the roofs of several houses collapsed.*
- *People in the area now have started to replace the earthen flat roofs with tin roof. Some have used plastic sheets with the mud to prevent water leakages and roof damages.*



Photo 11: Decrease in stream flow has affected the functioning of local water mills

Water mills threatened by reduction in source of water at Jibjibe, Rasuwa

Mr. Hem Bahadur Ghale from Jibjibe, Rasuwa worries as the water flow in a local stream is decreasing in recent days. He is the owner of two water mills located at the eastern boundary of Jibjibe settlement. The locals mainly bring maize to grind at his mills. His first mill is adjacent to the road. His two mills are operated from the same water source. The mills operate for six months in a year and Mr. Ghale is busy operating them. However, the operation of the mills is now threatened by decreasing flow of water in the stream. According to Mr. Ghale, the water flow from the source is in a decreasing trend compared to the past. Though not aware of its cause, Mr. Ghale is worried about the situation which might lead him to close his business.

4.5. Forest and biodiversity

Climate change, especially change in temperature has a profound impact on forest and biodiversity. Although their exact relationship with climate change has yet to be established, there are reports and evidences of disappearances of existing species and appearances of new plant and animal species. People have observed new species in higher altitude areas which could only be seen in the lower altitude. The off seasonal flowering, fruiting and sprouting of plants have been observed which might have been caused by change in temperature, according to the

local people. Local people have observed changes in the growth and nature of plant development and behaviour of animals. But they have not yet experienced the impacts of such changes on their livelihoods. However, in the foreseeable future, it is very likely that such changes will affect the whole ecosystem and the local biodiversity.

Early and late flowering and sprouting depends on temperature and moisture. Increase in temperature might enhance or delay flowering. Erratic rainfall pattern might enhance or delay sprouting of plants.

Similarly, human practices can also be regarded as the cause of some of the observed impacts, especially in appearances and disappearances of plants and animals.

Following field information based on the communities' experiences give some indications of the impacts of climate change on forest and biodiversity.

Jumla

In Jumla, local people have observed successful growths of pomegranate and grapes which did not use to grow in the past. Mosquitoes have started to appear. Flies used to appear in *Baisakh-Kartik* (third week of April-second week of October), but now, it appears even during *Poush-Magh* (January/February). The danfe and kalij pheasant are disappearing now.

Doti

In Doti, rhododendron used to set flowers after mid *Phalgun* (first week of March), but now they set flowers from *Magh* (second week of January). A change has also been noticed in growing time and period of grasses. Until 5-6 years ago, the grasses could be harvested in three days intervals, but now it takes seven days. Earlier, the grasses used to grow in *Baisakh* (third week of April), now they grow in *Jesth* (third week of May) mainly due to lack of soil moisture.

Salyan

There is a change in the location of the grasses in Salyan. The grasses locally called as *Parale*, *Athingar*, *Musekhuru*, *Setale*, *Chaule* and *Babiyo* which usually grow in dry and sloppy areas now appear in riverbanks site (wet areas) and the riverbank site species like *Leto* has disappeared. Similarly, oranges used to set flowers in *Magh-Phalgun* (February), now they set flowers in *Asadh* (June/July) as well. Orange plants used to elongate 1.5 metre long during the growing season 5-6 years back, but now it is not so elongated due to decrease in rainfall or soil moisture.

Some wild animals like owls and bats have disappeared from the village in four years time. A change in nesting

season of pigeons has been observed. As per the experience of the local people, pigeons usually did not nest in *Shrawan* (July/August), but now they are.

Kaski

People in Lumle have noticed shifting of fuelwood species like *Chuletro*, *Falat*, *Khasru* and *Banj* from lower to higher altitude areas. The flowering season of rhododendrons has shifted from end to first week of *Magh* (second week of February to second week of January). The sounds of birds like owl and *Kal Chaude* are less heard. Jackals have disappeared; wolf and vulture population have decreased. There were no mosquitoes 15 years back; they were few in number from 2049-2056 (1992-1999) during *Chaitra-Jesth* (March-June), now, they are common from *Chaitra-Bhadra* (March-September). However, locals did not completely want to attribute these changes to climate change. According to the local people, there are several factors like human encroachments and direct pressure on these species are equally responsible for the changes.

Lamjung

Before 2046 (1989), there were no mosquitoes. From 2048-2055 (1991-1998), they appeared during the month of *Baisakh-Jesth* (third week of April-second week of June); now they appear during *Chaitra-Ashwin* (third week of March to second week of October). The local people however perceive increase in human population and deforestation as a cause of appearance of mosquitoes.

The flowering period of rhododendrons and oranges have changed. Generally, the orange used to set flower in *Chaitra* (March/April), but now they set flowers in 17-18 of *Phalgun* (second week of March). Similarly, rhododendrons used to set flowers in *Phalgun* (February/March); now they set flowers in 10-12 of *Magh* (last week of January).

Rasuwa

In Rasuwa, mosquitoes and other insects have been observed in Ramche. Local people reported that the sound of a bird locally called *ketre* cannot be heard any more.

Dhading

According to the local people in Dhading, *Dhukur* has appeared after 10 years which had disappeared earlier. Parasitic plant (aijeru) is increasing among chilaune, katus and sal trees. The trees become red in the top and die back. There is an early leaf falling of fodder trees, which the local people attribute to long period of drought occurring frequently.

Dolakha

In Dolakha, due to soil dryness, the grasses sprout only during second week of *Phalgun* (last week of February) whereas it used to sprout in first week of *Phalgun* (third week of February). Vegetations (*siru*, *banmara*, pine, rhododendron, *jhingani*, *rakchan*, *machine*, etc.) have started to appear in the areas where there used to be snow in the past. There is less snowfall in the area although the local people have perceived an increase in the length of winter season.

Three years back, birds like *dhukur*, *jureli*, crow and *chepare* used to start nesting from *Magh* (third week

of January) but now they have started nesting during end of *Phalgun* (second week of March) indicating delay in spring season or elongation of winter season.

Nawalparasi

In Nawalparasi, grasses become dry on the ground in the month of *Bhadra* (August-September) which was not the case earlier. Some locally observed birds like *malchari* and crane have disappeared which were common 15 years back.

Rupandehi

In Rupandehi, grasses used to sprout in *Chaitra* (third week of March) eight years back, but now they grow only in *Baisakh* (April-May) due to lack of soil moisture.

Sankhuwasabha

In Sankhuwasabha, grasses used to grow fast because of good soil moisture and could be harvested in 15 days intervals, but now because of increased soil dryness, the grasses grow in a slow rate and are harvested in 25 days interval.



Photo 12: Trees have shown dying back symptoms

Birds like *theuwa*, *chanchari*, *ranichara*, *bhangeri*, vulture and migratory crane are disappearing in the area now.

4.6. Human health

The impacts of climate change on human health in Nepal are still not much known, but there are indications of direct and indirect impacts. Local people have experienced that working efficiency in the open field has decreased due to hotter days. There are evidences of increase in disease vector like mosquitoes in higher altitudes where they did not exist in the past. In the beginning, mosquitoes appeared for few months but now they exist for several months in a year. Similarly, local people have experienced increasing evidences of skin diseases

and some other diseases like Japanese encephalitis. Such expansion of vectors and diseases might cause a pandemic outbreak in villages or settlements where the local people do not have natural immunity power to fight against those diseases.

As the local livelihood options are negatively affected because of the impacts of climate change, local people are seeking alternative options outside their villages resulting in seasonal and periodic migration. Such migrations have also exposed them to new environment where they are becoming more susceptible to new diseases like Sexually Transmitted Diseases (STD) and HIV/AIDS. The increasing hardships in their existing livelihoods have also made them susceptible to malnutrition.

Table 8: Summary of impacts of climate change on human health

Location	Impacts of climate change on forest and biodiversity
Rasuwa	◆ It is more difficult now to work in daytime because of warmer days. More people are becoming sick these days compared to the past due to the changing climate. Local people have noticed an increase in skin diseases in recent days.
Kailali	◆ People have felt an increase in mosquito population and incidence of Japanese Encephalitis. In 2051 BS (1994), seven people died because of Japanese Encephalitis.
Salyan	◆ There was no mosquito in the village 25 years ago. Gradually, it appeared for four months from <i>Asadh-Ashwin</i> (third week of June to second week of October) five years back. Now, it appears for 10 months in a year except for the month <i>Mangsir-Magh</i> (third week of November-second week of February).
Dhading	◆ Skin diseases are increasing in both humans and animals which were not common 10 years back.
Nawalparasi	◆ Mosquito population is increasing after 22 years which has increased the probability of mosquito borne diseases.

5. Conclusions

Local people have perceived that there have been changes in local climate and it is affecting local environment and their livelihoods. However, it is difficult to isolate the impacts of climate change since a number of factors and causes are interrelated to each other. The interactions are ongoing between (1) impacts of climate change, (2) natural adaptation of plants and animals to new climate, (3) development practices and management of available resources and (4) development of new technologies that are constantly coming in the practice. Therefore, the observed impacts are not always the results of climate change. Some tools and methodologies are needed to help identify the real impacts due to climate change.

The impacts being expressed in this paper are solely based on the perceptions of local people, These information are not communicated to development workers and the research academia due to the lack of proper documentation of the issues. Undeniably, the impacts need further studies to understand the linkages more clearly and appraise the quantitative information that are attributable to climate change.

The increase in temperature has brought changes on germination, growth, flowering and fruiting behaviour of plants. As the cold season is shortening in most of the locations, the growing seasons are getting longer. An altitudinal upward shifting of plants was reported by communities in both forest species of day-to-day use like fuel and fodder, and agricultural crops. Communities have also reported disappearances of some wildlife species from the area, but this needs further studies for identifying the causes in detail. They have also shared the experience of habitat shifting by wildlife to higher altitude specifically by some bird species like pheasant.

Some areas are experiencing decreasing trend in temperature with elongation of winter season which has increased the maturation period of crops. Such community experiences on decreasing temperature trend match with the observed meteorological data of the areas.

Local people have experienced that crop species and varieties recommended for lower altitudes can now be grown in higher altitudes. This has increased the risk of encroaching higher altitude pasture and forest lands for crop cultivation.

Communities have perceived a decrease in annual rainfall though the recorded data show a slight increase over Nepal. The implications on livelihoods of the people from such changes are still to be explored which will help enhance the adaptation process.

The change in precipitation has profoundly affected the rain fed agriculture and the vegetative growth of forest plants. Local people have reported change in crop sowing dates due to erratic rainfall pattern and the crops are affected by either prolong periods with no rainfall or heavy intensive rainfalls that result into heavy runoff.

New pests and diseases on crops, forest plants and livestock are reported by local people. People from Dhading District reported symptoms of dieback in plants in *sal* forest in lower mid hills. Crops in higher altitude are now exposed to new diseases and insect pests through shifting of habitat of vectors and the microorganisms to which local people are not familiar. Similarly, the livestock parasites like liver flukes are seen in livestock drinking water sources in higher altitudes where they did not exist in the past. The interaction between temperature increase and erratic rainfall has resulted into multiplication of effects of pests and diseases on crops.

The changing climate – increasing temperature and erratic rainfall has directly affected the water resources. There are more events of rainfall than snowfall in mountains resulting into reduced snow deposition. Likewise, increasing temperature has melted small glaciers. The disappearances of small glaciers have resulted into water scarcity for irrigation and drinking purposes in the mountain regions. In the mid-hills, people have reported drying up of water springs which have also ultimately resulted into water scarcity. The water scarcity is very intensive during

dry season making dry season much drier than it used to be. In the *tarai* people have informed about decreasing level of ground water table. They have noted untimely recharge of the ground water due to erratic rainfall patterns while at the same time, its use has increased with increase in population and agricultural land. They also reported a decrease in the discharge of rivers making irrigation difficult during winter and dropping of ground water table.

Since the nature of rainfall has changed with an increase in intensive rainfall events, there is an increase in disasters due to landslides and floods. The intensity of hazards and their frequency has increased. Such hazards are responsible for destroying the physical infrastructures and loss of human lives and assets. Especially in the foothills and plains, floods, sedimentations and debris have damaged the productive lands, infrastructure and standing crops, and in the hills, the same have been damaged by landslides.

Local people have perceived that impacts of climate change have made their livelihoods harder in most of the cases. In case of water resources, conflicts have begun between the communities as the scarce resource becomes scarcer. When the existing resource base becomes insufficient to sustain the livelihoods, people try to access underexploited natural resources including water and forest that gives rise to increased competition and conflicts among them.

Human health is a highly potential sector that can be affected by climate change. Local people have observed disease vectors like mosquitoes and flies in high altitude areas where they did not exist before. Moreover, mosquitoes and flies appear for an extended period in places where they did not use to exist or exist only for few months. Such increased appearances and spreading of vectors has exposed local people to new diseases which they do not have immunity to fight back.

6. Recommendations

Agriculture, the main source of livelihood of the majority, is in the frontline of impacts of climate change. The impacts of climate change on other resources like water and forest also ultimately affect the agriculture sector and its productivity. Following points are recommended to help adapt to climate change in Nepal.

- 6.1 Development and promotion of technologies that enhance conservation of water and its sources; effective and efficient use of available water, and collection of rainwater have become the prime need under the changing climatic condition.
- 6.2 The niche of technologies in agriculture including varieties, pest and disease management, soil and water management, and storage and post harvest management have gradually changed or shifted. The new niches are to be identified and the existing technologies are to be appropriately placed in or promoted.
- 6.3 There is a change in timing of rainfall and right temperature for germination, growth and maturation of different crop species and varieties. These changes or shift in timing are specific to specific locations which need to be identified and actions are required accordingly through changes in crop calendars, cultivation practices and cropping patterns.
- 6.4 The technology development process in agriculture, especially the varietal development process, is to be speeded up. The impacts of climate change is being observed in a faster pace which is not likely to be addressed by the traditional or conventional breeding process which takes over 10 years to release an appropriate variety. So, innovative processes, approaches, or methodologies such as participatory breeding for technology development are recommended to be applied.
- 6.5 As the agriculture sector is affected and difficulties faced to sustain the agro-based livelihoods, there is a need for development and promotion of livelihood diversification. The use and encroachment on underutilised natural resources such as forest and pasture land are likely to increase. Therefore, in one hand there is a need to have early plans on how such resources could be fully utilised with least damage and on the other hand, avoid potential conflicts between communities and individuals over the ownership of the resources.
- 6.6. The impacts of climate change on livestock are still not adequately understood. There is some information where livestock parasites have now been found in higher elevations, the livestock disease months or seasons have shifted and livestock husbandry has been affected adversely by the change in growth behaviour of fodder and grasses in the pastures. However more studies are required in livestock and climate change.
- 6.7 The development planning processes should recognise the reality of climate change and its impacts and vice versa. Hydropower, irrigation, drinking water, roads and housing are the key infrastructures which are critical to climate change impacts. Therefore, climate change needs mainstreaming in those sectors to build their resilience.
- 6.8 The impacts of climate change on human health is less known. Nevertheless, communities from most of the sites visited have shared that vectors like mosquitoes and flies have appeared in higher altitude areas for extended period of time around the year. This has increased the probability of spreading of vector borne diseases in the areas where they did not use to exist. Under such circumstance, the diseases are likely to spread over a large population in a short period of time as the people have less

natural immunity to fight against the diseases. There is a high need that the vectors and the diseases are monitored and the preparedness should be enhanced in order to prevent the disease from being pandemic. The same applies to the plants and animal diseases and pests, both domestic and wild.

- 6.9 There are evidences of increasing landslides in the hills and floods and flashfloods in the foothills and *tarai*. These hazards are affecting and destroying the infrastructures, cultivated lands, other properties and human lives. Therefore, disaster risk reduction should be mainstreamed in all the development programmes and activities at both the individual and the community levels. Enhancing hydro meteorological forecasting and developing early warning system should be integrated in disaster risk reduction strategy.
- 6.10 Nepal possesses multiple microclimates and understanding the climate change and its impacts under such condition is complex. Little is understood on climate change and its impacts. In addition, there is low awareness among the planners and general public. Understanding of specific climate change issues, its impacts and awareness is urgently needed among all levels of people including planners, policy makers, communities and students.
- 6.11 Further studies are immediately required to look into the underlying linkages between climate change and its impact in different sectors like agriculture, water resources, human health, forest and biodiversity and infrastructures more systematically so that it can help focus

on the adaptation activities more strategically. The studies should also focus on future scenarios or projections of impacts of climate change along with the climate change scenario in those sectors identified above. Within these sectors, some key sectors such as agriculture, water resources, health, and climate induced disasters etc. need to be focused for further studies as the study on the whole sector can be a considerably huge task in itself. Such impact scenarios or projections will help consider the vast uncertainties that are associated with climate change and its impacts.

- 6.12 It is now obvious that there is a large variation in the degree of climate change from one microclimate to another along with their impacts on biophysical and socioeconomic sectors. Under such circumstances, the information provided by the communities is the only source as there is no any historical instrumental data to measure the impacts of such changes at local level. Therefore, collection and interpretation of local information need to be systematised and standardised.
- 6.13 There is an urgent need to help the communities build their resilience to impacts of climate change based on the information so far understood without waiting for the results of new studies. The poor communities are already enduring the adverse impacts of climate change. Delaying in supporting these communities will increase the cost to repair the damage. Based on this study, a number of interventions are urgently required in agriculture, water resources, livelihood diversification, disaster risk reduction, human health and biodiversity sectors.

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8. Annex A

Nepali calendar corresponding to English calendar

Nepali year (BS)	English year (AD)
2066	2009
2065	2008
2064	2007
2063	2006
2062	2005
2061	2004
2060	2003
2059	2002
2058	2001
2057	2000
2056	1999
2055	1998
2054	1997
2053	1996
2052	1995
2051	1994
2050	1993
2049	1992
2048	1991
2047	1990
2046	1989
2045	1988
2044	1987
2043	1986
2042	1985
2041	1984
2040	1983
2039	1982
2038	1981
2037	1980
2036	1979
2035	1978
2034	1977
2033	1976
2032	1975

Nepali month	English month
Poush	Dec/Jan
Magh	Jan/Feb
Phalgun	Feb/Mar
Chaitra	Mar/Apr
Baisakh (New Year)	Apr/May
Jesth	May/Jun
Asadh	Jun/Jul
Shrawan	Jul/Aug
Bhadra	Aug/Sep
Ashwin	Sep/Oct
Kartik	Oct/Nov
Mangsir	Nov/Dec
Poush	Dec/Jan

Annex B

Change in season as perceived by the communities

Village	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Dewal Gaun, Jumla	Snowfall season												
	Snowfall is erratic now												
Kalena, Doti				summer: before 1995									
				summer: now									
			winter: before									winter: now	
Kailali				Summer before									
			Summer now										
Khalanga, Salyan	winter: before									25 years back			
	winter: now											now	
Lumle, Kaski			summer: before 15 years										
			summer: now										
Khudi, Lamjung			Summer season before										
			Summer season now										
Ramche, Rasuwa					←	Rainy season used to start this time							
						←	Rainy season starts here now						
Dolakha	winter: 3 years before												
	winter: now												
	frost: before												
	frost: now												
Dhading			summer: 20 years before										
			summer: now										
Rupandehi		←	Summer used to start this time										
		←	Summer starts here now										
Nawalparasi			←	Summer used to start this time									
		←	Summer starts here now										
Bhimphedi, Makawanpur	Usual winter season						Usual rainy season				Usual winter season		
Sankhuwasa bha	winter: before										10 years before		
	winter: now												

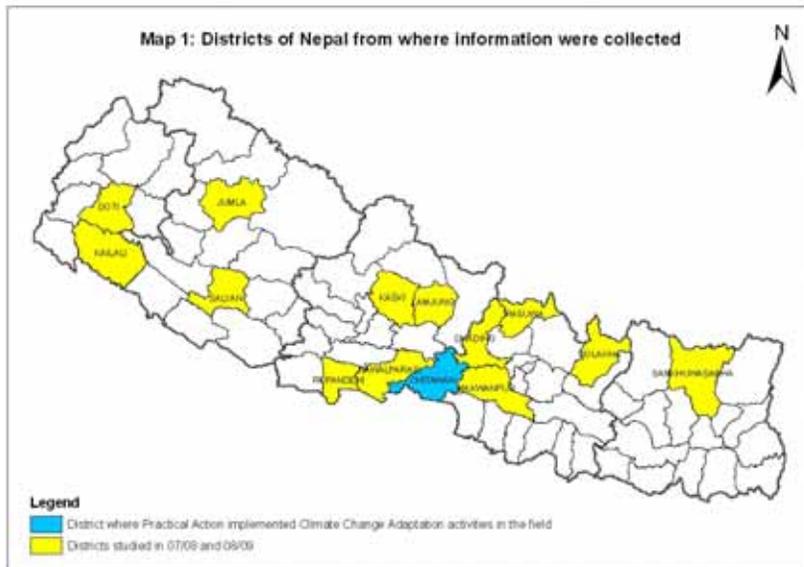
Annex C

Shifting in crop calendar

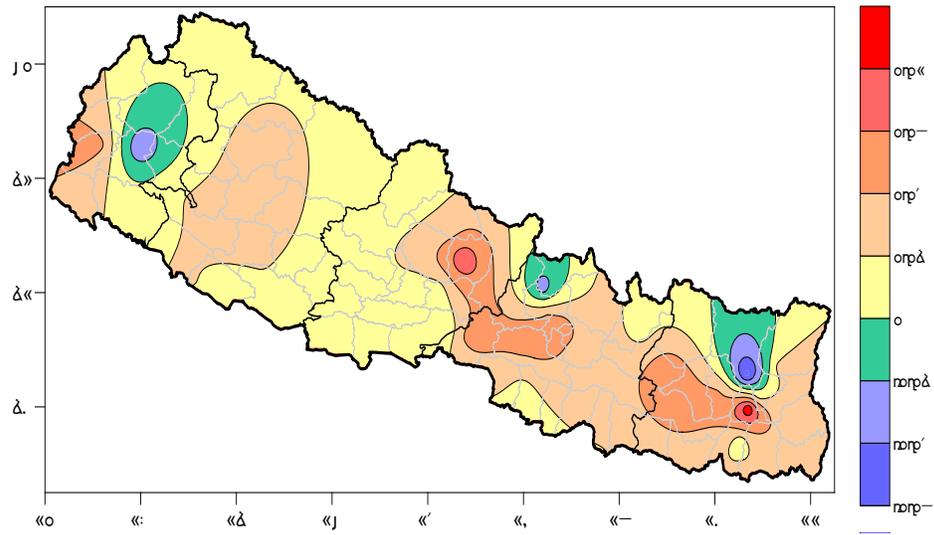


Legend

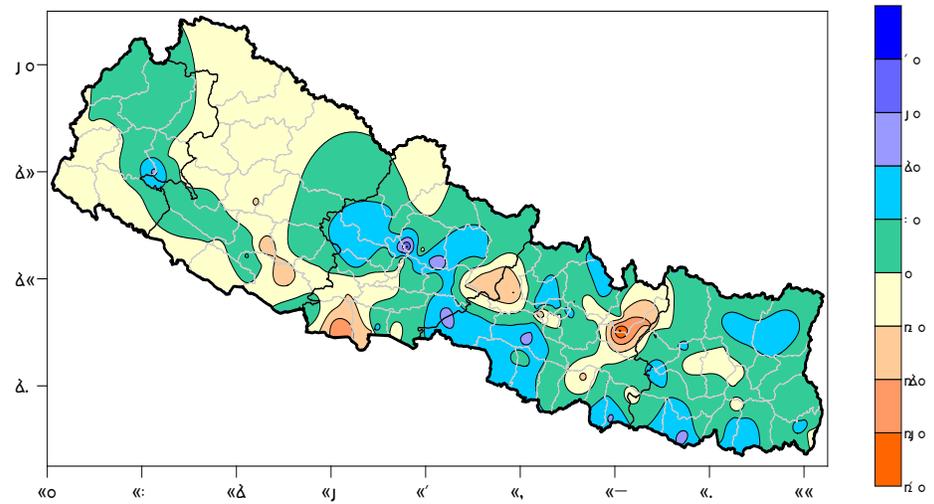
	Previous crop calendar
	Present crop calendar



Map 1: Map of Nepal, indicating the study districts

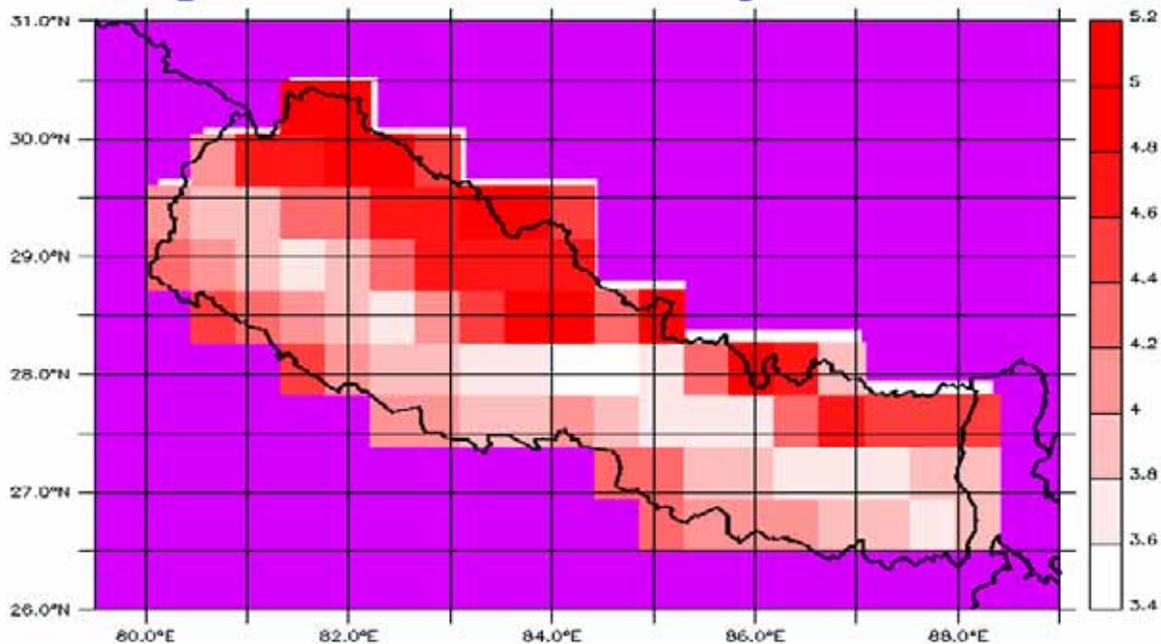


Map 2: Annual mean temperature trend over Nepal from 1976 to 2005 in °C/year



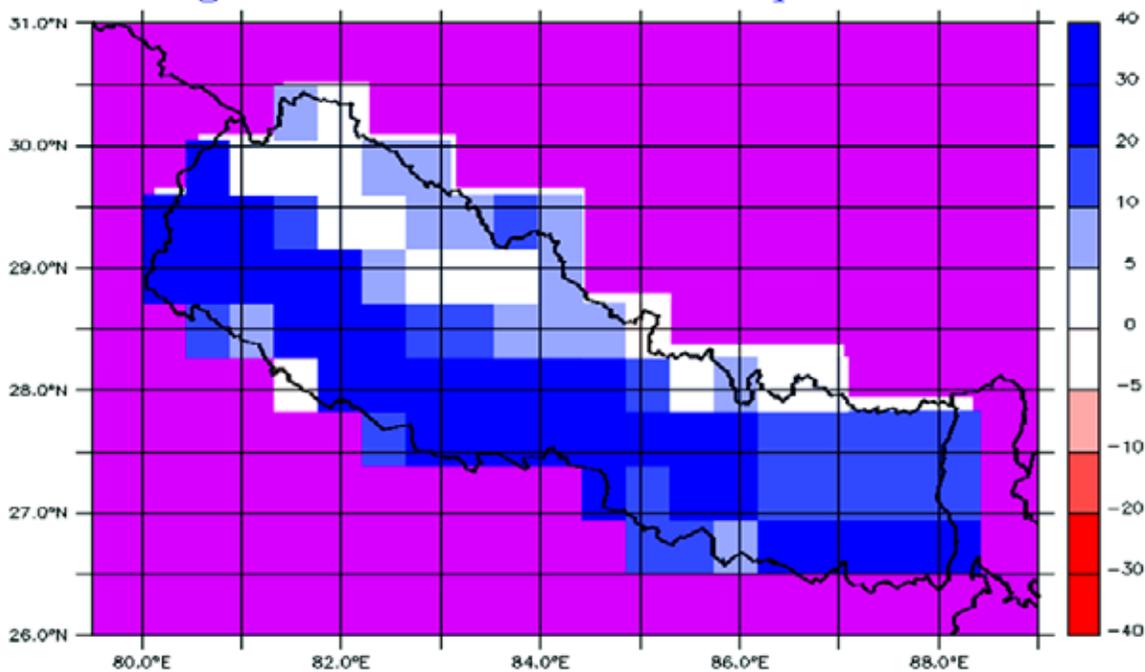
Map 3: Annual rainfall trend in Nepal from 1976 to 2005 in mm/year

Change in Mean Annual Temp.-A2 Scenario



Map 4: Mean temperature scenario over Nepal by 2100 based on PRECIS Model (from SEN 2009)

% Change in Mean Annual Precip.-A2 Scenario



Map 5: Precipitation scenario over Nepal by 2100 based on PRECIS Model (from SEN 2008)

In 1979, Practical Action started its work in Nepal, initially concentrating on the development and transfers of micro-hydro technologies, building the capacities of local manufacturers and rural entrepreneurs, and advocating for appropriate policies and institutions in the micro-hydro sector. After establishment of the Country Office in 1998, Practical Action diversified its activities into other forms of renewable energy and expanding into agroprocessing, rural transport and disaster management. Since 2003, Practical Action's programme in Nepal has been directed by the four International Programme Aims (IPAs): Reducing vulnerability; Markets and livelihoods; Improving access to useful services, systems and structures; and Responding to new technologies.

Practical Action believes that the right intervention – however small – can create jobs, improve health and livelihoods, give access to services and help people lead better lives. In its every effort, Practical Action aims to bring about positive and lasting changes in people's lives. Practical Action's programmes are driven by the needs of both the rural and urban poor, and are launched through partnership with government, nongovernment (I/NGOs) and private sector stakeholders. In Nepal, Practical Action is operating through a General Agreement and separate Project Agreements with the Social Welfare Council of the Government of Nepal.



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