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Climate Change Imprint and Impacts on Livelihood of Indigenous Nationalities: A Case of Chepang Community from Bhumlichowk Area, Gorkha District, Nepal

Samita Duwal[a*], Pawan K Neupane[b], Bimala Devkota[c],Yubak Dhoj G. C.[d]

[a]*Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal*

[b,c]*Nepal Academy of Science and Technology, Lalitpur, Nepal*

[d]*Ministry of Livestock Development, Kathmandu, Nepal*

[a]*Email: samitaduwal2@gmail.com/pawan.usk@gmail.com*

Abstract

Chepangs, one of the underprivileged indigenous, politically and socially marginalized nationalities of Nepal, are facing the consequences of climate change owing to their livelihood dependency on natural resources. This study intended to find out the perception and impacts of climate change on the livelihood of Chepangs living in fragile mountain slopes of Bhumlichowk area (the then Village Development Committee), Gorkha district, Nepal and explored some of the adaptation measures adopted by them. Impact assessment was conducted through analysis of meteorological data and people's perception on climate change in relation to their livelihood respectively applying Mann-Kendall statistical trend test and generalized questionnaire survey and Participatory Rural Appraisal tools. The results depicted rise in temperature in recent years in comparison to the past years while precipitation showed variable pattern. The maximum temperature increase was more pronounced than minimum and mean temperature. In case of seasonal mean temperature trend, highest increase occurred during monsoon season. The consequences of these changes affected mainly agriculture sector with decrease in crop production resulting food scarcity. Other impacts like increased intensity of disasters and declining Non-Timber Forest Products (NTFPs) were also observed.

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* Corresponding author.

The socio-economic vulnerability assessment showed that Thumka village, a community within the study area has the highest vulnerability index (2.50) to climate change because of its weak adaptive capacity. People have already perceived the environment changes at their locality and though having poor local adaptive capacity, adaptation measures like shifting sowing, agro-forestry, terracing etc. are being adopted by them. Strengthening their practices incorporating scientific knowledge is therefore envisaged to enhance the adaptive capacity of local people. It is also imperative to formulate and integrate adaptive strategies and plan in development plans of the study area which indeed will support the community to adapt with the impacts of climate change.

Keywords: Adaptive Capacity; Agro-forestry; Mann-Kendall statistical trend test; Participatory Rural Appraisal.

1. Introduction

Low degree of social and biophysical security driving from poverty and marginalization, the lack of entitlements to resources, power and decision making, the exposure to future hazards as well as other external stressors such as violent conflicts or epidemics determines the vulnerability of traditional and indigenous peoples to global environmental change [1]. Indigenous communities like Chepangs have intricate relationship with natural resources as their livelihood fully depends on natural ecosystems. Such marginalized, impoverished and vulnerable peoples live in diverse and fragile ecosystems [2] and environment they select or are yearn to live in are often physically isolated and harsh – often as a consequence of historical, social, political and economic exclusion [3]. So, the poor indigenous communities living in the remote area will suffer extremely from the adverse impacts of climate change. Therefore, Intergovernmental Panel on Climate Change (IPCC) reports published in 2001 and 2007 hence emphasized traditional and indigenous peoples though it has predominantly been laid on indigenous communities living in developed countries [1].

Nepal, a least developed country with annual increase rate of temperature 0.04^0C, is a home to 125 indigenous communities. Chepangs cover 0.25% of the total population (26.5 million) of Nepal [4] and are one of the underprivileged indigenous, politically and socially marginalized nationalities of Nepal facing the consequences of climate change owing to their livelihood dependency on traditional agricultural practices and natural resources. The primary lifestyle of the community includes hunting, foraging for wild roots, fishing and traditional farming near forests [5, 6]. Their traditional settlements lie on steep slopes in the Mahabharat and Churia range between 500 to 1500 masl [6]. Chepangs are supposed as the instigator of agrarian community using slash and burn technique. Still, they practice traditional agriculture system to sustain their life and do not have easy access to public services offered by the government.

In Nepal, local people are the live witness to climate change owing to global warming since they have good firsthand experience of snowfall pattern, event of coldest and hottest time, erratic rainfall pattern, heavy rainfall etc. which results into their livelihood to affect directly and indirectly [7]. The indigenous communities of Nepal like other parts of the world have first-hand experiences of impacts of climate change at their locality and therefore are applying their traditional indigenous knowledge to adapt with the impacts. Studying the ways of livelihood of indigenous community helps in identifying climate change impacts and the area that lacks adaptive capacity and exploration of their local adaptation practices. In this regard, the present study was carried out with

the board objective to assess the impacts of climate change in the livelihood of a Chepang community in Gorkha district, Nepal and document the indigenous practices adopted by them to secure their livelihood. The study specifically intended to (i) analyze the pattern and trends of climatic parameters based on the hydro-meteorological data and perceptions of Chepang community, (ii) analyze the impacts of climate change on livelihood of the Chepangs and (iii) understand existing indigenous knowledge for coping and adaptation strategies to climate change adopted by Chepangs.

1.1 Study Area

The study area Bhumlichowk (27°52′15″ N to 84º43′30″ E, 410-1730 masl, the then Village Development Committee) was located in southern part of Gorkha District in the Western Development Region of Nepal. The area accommodates highest number of Chepangs (1112) within the district (3545) [4]. It is bounded by Tanglichok in west, Trisuli River in south, Ghyalchowk in east and Darbung in north.

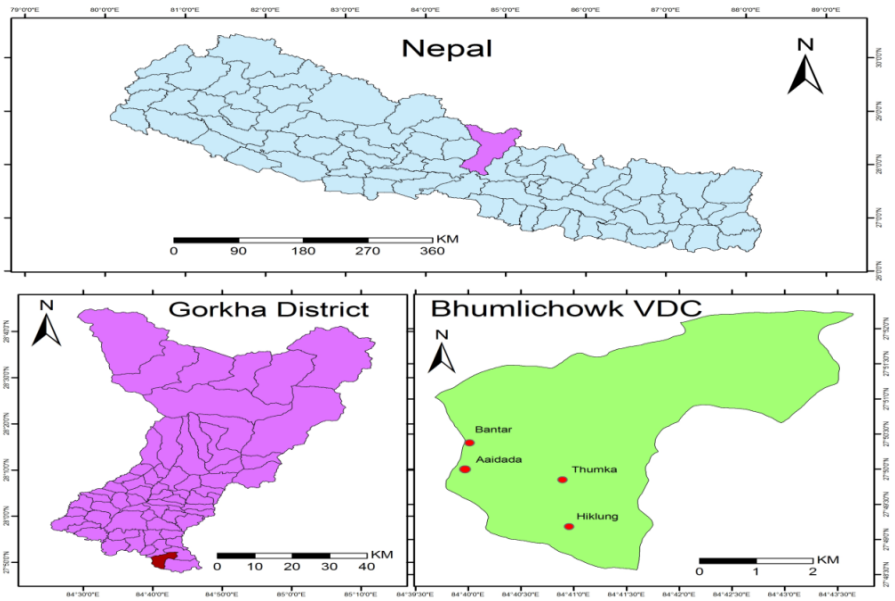

Figure 1: Location map of study area Bhumlichowk VDC (the then), Gorkha

2. Methods

2.1 Primary data collection

Four villages namely Aaidada, Bantar, Hiklung and Thumka were selected for the field study. Assuming a fixed sample size, the samples were divided proportionately among the villages in accordance with the total number of households in each village. This led to select 60 households randomly for household survey. Participatory Rural Appraisal (PRA) tools (Seasonal Calendar, Hazard Ranking & Resource Mapping) along with questionnaires and checklists were applied to get information on climate change and its impacts. A consultation meeting with key informants (teachers and local leaders/social workers) was also conducted to triangulate the documented information about the scenario of climate change, people's perception, agricultural pattern and its

change, water resource and its availability. Local stakeholders, elderly people, women, village leaders were involved for Focus Group Discussion (FGD). The socio-economic vulnerability assessment of each village was calculated by using six factors i.e. number of households, occupation, annual income source, literacy status, property value, food sufficiency and awareness among the people. The total score of each village indicates the Vulnerability Indices (VI) which were then classified into three categories using "Three Categorized Ranking Method" (TCR) assigning scores of 1 to 3, 1 being the least vulnerable [8].

2.2 Secondary data collection

The meteorological data (temperature & precipitation) of 35 years taken from 1979 -2013 recorded by Department of Hydrology and Meteorology (DHM) station nearest to study site in Gorkha district (DHM 2014) was analyzed to observe the trend and Mann-Kendall statistical trend test using software Addinsoft's XLSTAT 2013 assigned statistical significance to the trend. The yield of major food crops of the Gorkha district namely paddy, wheat, millet and maize from 2001 to 2012 was analyzed using simple linear regression model.

2.3 Socio-economic Vulnerability Assessment

Using six factors including number of households, occupation, annual income source, literacy status, property value, food sufficiency and awareness among the people as indicators, the socio economic vulnerability for each villages (Aaidada, Bantar, Hiklung & Thumak) was assessed that was used to determine the vulnerability index of the each village.

3. Result and Discussion

3.1 Temperature and precipitation trends

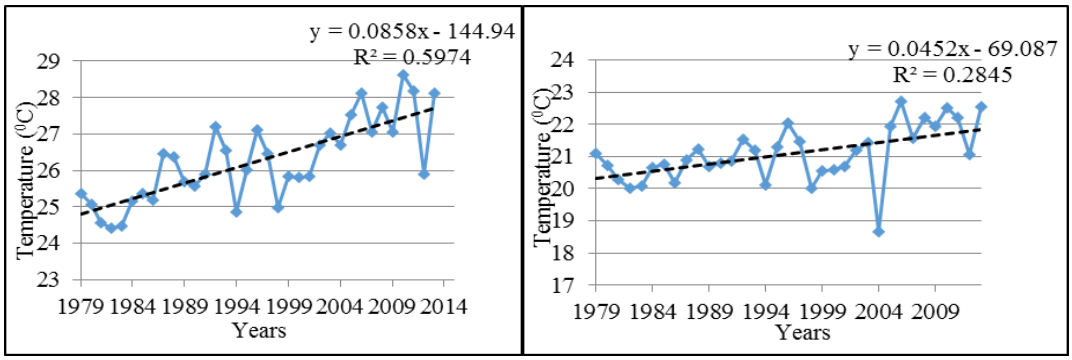

Figure 2a: Maximum temperature trend **Figure 2b:** Minimum temperature trend

The temperature analysis showed that the maximum and mean temperature is increasing at the rate of 0.085°C and 0.045°C per year respectively (Figure 2a &2b) which is statistically significant. Analysis of seasonal temperature trend exhibited that mean temperature trend of both pre-monsoon and monsoon is increasing at the rate of 0.052°C per year and 0.035°C per year respectively which is also statistically significant. Precipitation

data analyzed to observe the long term trend in precipitation indicated the variability of precipitation pattern (Figure 3) in the study area. The temperature rise in Nepal is within the range of 0.2°C-0.6°C per decade [9] and magnitude of warming was higher for maximum temperatures while minimum temperatures exhibited larger variability such as positive, negative or no change on the basis of data from 13 mountain stations of three decades (1980-2009) [10].

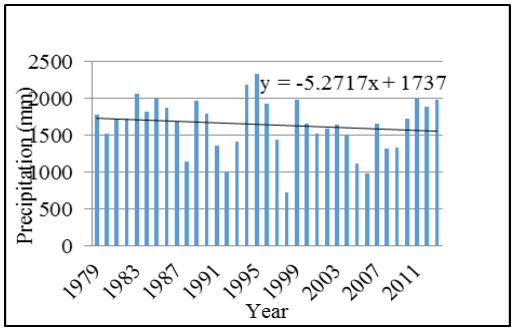

Figure 3: Annual precipitation pattern

3.2 Socio-economic characteristics of surveyed households

The detail socio-economic characteristics of the sampled respondents (60 households) are presented in Table 1.

Table 1: Socio-economic characteristics of surveyed households

Characteristics		Percentage	Characteristics	Percentage
Age			Gender	
Below 40		33	Male	46.42
40-60		55	Female	53.58
Above 60		12	Education	
Land holdings			Literate	45
Upland	Less than 2 ropani*	53	Illiterate	65
	2-4 ropani	41	Occupation	
	More than 4 ropani	6	Farming	69
Lowland	Less than 2 ropani	68	Wage labor	18
	2-4 ropani	30	Handicraft	3
	No lowland	2	Skilled nonfarm job	10

*1 ropani = 508.74 m^2

3.3 Climate Change Impacts

3.3.1 Agriculture

Chepangs residing in the study area mostly cultivate paddy, wheat, millet and maize as major food crops. Their subsistence rainfall-fed agricultural practices mostly depend on rainfall where irrigation facilities are yet to be constructed in possible areas. The analysis of yield of major crops showed slightly decreasing trend (Figure 4). The increasing trend of mean and maximum temperature effect the local climatic condition and the amount of soil moisture thereby increasing agricultural water demand leading to low agricultural yield.

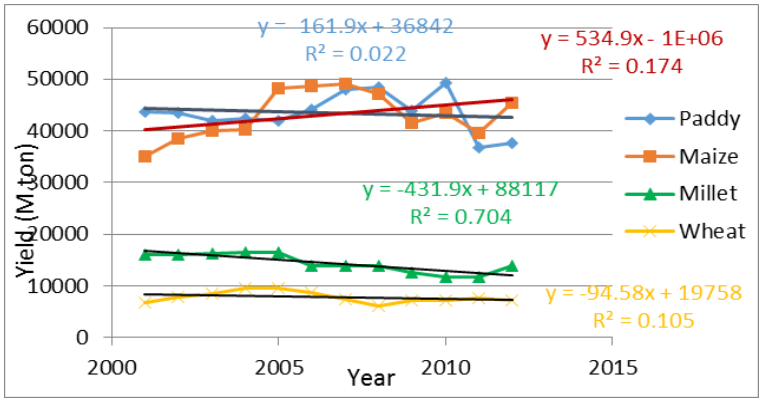

Figure 4: Trends of crops yield

Local people have also marked the decrease of agricultural production with changing climatic condition at their locality. Climate change affects peoples' lives and livelihood [11] that will be more adverse on community depending on agriculture production. In 20 years' time, majority of the respondents (73%) of the study area experienced that amount of crop yield (paddy, millet & wheat) had gradually decreased while 14% did not feel any significant change in crop yield. Only 13% respondents shared experience that the production has been increased due to the application of fertilizers and use of hybrid seeds. Majority of respondents (63%) opined that irregular, untimely and deceased rainfall is liable for declining crop production (Figure 5). The opinion of respondents meets with the findings that the yield of wheat and rice in Kaski district declined in three consecutive years (2003-2005) because of decreased rainfall [12]. Also, it was reported that most of people experienced that unfavorable distribution of rainfall and increasing temperature were key factors for decreasing in the amount of crops yield [13]. Few respondents mentioned that improper use of fertilizer (17%), pest/diseases (13%) and labor shortage/ disasters (7%) are liable for low production.

3.3.2 Food Security

Chepangs consume agricultural production, wild edible fruits like Chiuri (*Bassica butyracea*) and insects like Aringal (Hornets). About 70% households experience varying degrees of food deficiency each year while about 52% produced food enough for 6 months only and 18% could manage to serve their members for 9 months. For deficit period, mainly from March to July, they manage their food requirements by selling livestock, borrowing food from markets, collecting wild foods etc. About 20% of the households reported their production for the

whole year and 10 % had surplus amount of food (Figure 6). Since maximum numbers of households suffer food deficiency their food security seems to be more vulnerable in the context of changing climate they are experiencing at their locality. The community has decreasing trend of crop yield that will increase the possibility of food insecurity and future climate change will aggravate the livelihood conditions of the Chepangs.

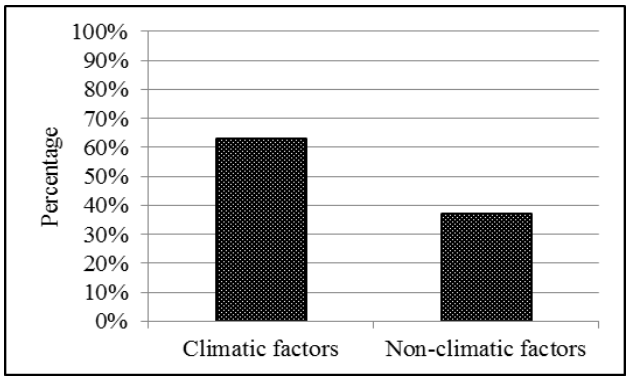

Figure 5: Perceived reason for decrease in agricultural production

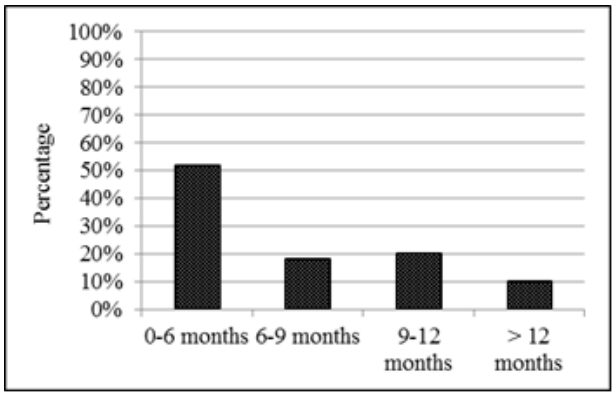

Figure 6: Food sufficiency

3.3.3 Forest

Community forests and conservation awareness has engendered improved forest condition. Most of the respondents (70.47%) favored the improvement of forest condition in comparison with past 10 years. The squandering of forest resources by uncontrolled and destructive harvesting methods, slash and burn has been reduced with the inception of leasehold forestry programs. The invasive species like Banmara (*Ageratina adenophora*) are increasing leading to the decrease in production of NTFPs like Harro (*Terminalia chebula*), Barro (*Terminalia bellerica*) and Amala (*Phyllanthus emblica*) and Chiuri (*Bassica butyracea*). This growth of invasive species will be favored by increased temperature and rainfall variability exacerbating the forest vulnerability.

3.3.4 Climate Induced Disasters

The common type of natural hazards prone to the study area included landslides, drought, soil erosion and

hailstorm etc. Most of the respondents (78%) agreed on augmentation of the intensity, duration and frequency of such disasters in recent years in comparison to the past.

3.3.5 Water Availability

In accordance with the results from survey, many small water sources 'kuwa' had dried out completely. About 30 % of the respondents agreed this. The main source of drinking water is pipelined supply that has been connected from the other village. The supply of water is less in dry months in comparison to other months. The temperature and rainfall trend were exhibited to be increasing in Dhare Khola watershed of Dhading district with 60% of sources to be dried and substantial decrease in water volume [14].

3.4 Climate Change Perception and Knowledge

Respondents living on four villages namely Aaidada (50%), Bantar (20%), Hiklung (20%) and Thumka (10%) have knowledge about the climate change (Figure 7). Other respondents lack its knowledge even though they are experiencing the impact of climate change.

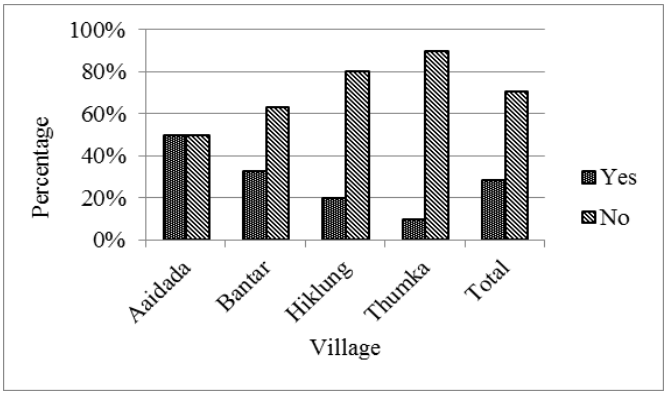

Figure 7: Status of local peoples knowledge on climate change

3.5 Local Perception on Climate Change

Of the total household respondents surveyed, 68% and 39.7% felt increase in summer and winter temperature respectively (Figure 8). Similarly, almost 81% of the total respondent felt delayed monsoon (Figure 9). They mentioned that monsoon starts on late June instead of the first week and sometimes monsoon even starts in July. Similarly, 9% among total respondents have experienced of rainy days before monsoon before June. This showed that the people are experiencing unusual pattern of rainfall. Precipitation becomes unpredictable and more erratic than ever with more droughts and shorter periods of heavy rainfall [9].

3.6 Socio-economic Vulnerability Assessment

Using six factors including number of households, occupation, annual income source, literacy status, property value, food sufficiency and awareness among the people as indicators, the socio economic vulnerability for each

village (Aaidada, Bantar, Hiklung & Thumak) was assessed that identified Thumka as the most vulnerable village because of its weak adaptive capacity including (90%) illiteracy, almost all of village respondents depend on agriculture to sustain their livelihood (Table 2). Similar result was found in the sudy of vulnerability assessment of different villages of Solukhumbu district which identified Ghat village as most vulnerable area [15].

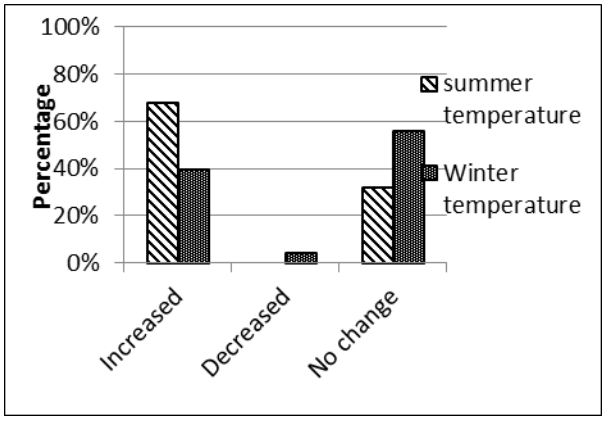

Figure 8: Perception on summer and winter temperature

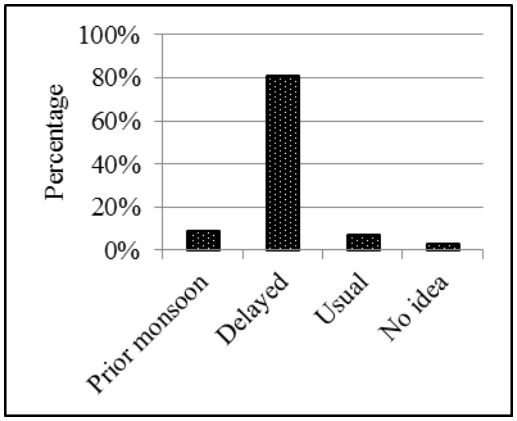

Figure 9: Perception on Monsoon rain

Table 2: Socio-economic vulnerability assessment of the four villages

Village	VI1	VI2	VI3	VI4	VI5	VI6	VI combined	Vulnerability
Aaidada	1	1	1	3	1	1	1.33	L
Bantar	2	1	1	3	1	1	1.66	L
Hiklung	3	2	2	1	2	2	2.00	M
Thumka	3	2	3	2	2	3	2.50	H
VI 1 – No. Of HHs, V 2- Occupation, VI 3- Education, VI 4-Property Value, V 5-Food Sufficiency, VI 6-Awareness;								
VULNERABILITY: L = Low, M = Medium, H = High								

The dependency of Chepangs on climate sensitive systems like agriculture and forest make them vulnerable to climate change. Inequality in income and land distribution, large household sizes, lack of quality housing, less mobility, low adaptive capacity are the major vulnerability indicators. The groups who are already discriminated and marginalized are experiencing the worst increase in vulnerability [16] and it was consistent with the findings of the study.

3.7 Coping and Adaptation Strategies

Chepangs are sentient towards the environmental change at their locality and practicing traditional ways to adapt with the changes. The study identified autonomous adaptation techniques being applied in agriculture include water storage, re-using household waste water, re-sowing of seeds and using high yielding varieties of seeds, pesticides, shifting to cash crops, using organic manure, shifting sowing dates, terrace farming, intercropping, constructing stone walls and agro-forestry. Still about 58% of sampled household sow indigenous types of maize seeds to sustain the drought. Only 5% of sampled households adopted green house for growing vegetables. Likewise in order to cope with food scarcity, most of the Chepangs collect wild edible foods like Chiuri (*Bassica butyracea*), Koiralo (*Bauhinia variegate*) and Githa (*Diascorea sativa*). In Nepal, with the formulation of Climate Change Policy and Framework for Local Adaptation Plan of Action, adaptation planning process and activities are in limelight. However, Chepangs at the study site are not aware about adaptation planning process and activities imperative to minimize climate change impacts.

4. Conclusion

Mean temperature was increasing significantly on the basis of data analysis of 35 years (1979-2013) from Gorkha station nearest to the study site. Likewise, seasonal temperature trend followed increasing pattern for each season with highest increase in winter season. In case of precipitation, though with less statistical significance, the trend was decreasing in all its forms at total annual and seasonal scales except pre-monsoon season. The research revealed that though people were not aware about climate change in the study area, they were acquainted with impacts. People's perception concludes that they are experiencing increased temperature, decreased rainfall, increased extreme rainfall events and increased disasters' events primarily the windstorms, landslides, hailstones, soil erosion, drought and irregularities in temporal distribution of precipitation. Similarly decreased crop productivity, drying up of water resources and decreased availability non-timber forest products are reported. Knowingly or unknowingly, very insignificant spontaneous coping mechanisms like re-using household waste water, re-sowing of seeds and using high yielding varieties of seeds in agriculture, pesticides, shifting to cash crops, using organic manure, shifting sowing dates, terrace farming, intercropping, constructing stone walls, agro-forestry and collecting wild foods are adapted within the community to minimize climate change impacts. Strengthening their practices with incorporation of scientific knowledge is therefore envisaged to enhance the adaptive capacity of local people. It is also imperative to formulate and integrate adaptive strategies and plan in development plans of the study area which indeed will support the community to adapt effectively with the impacts of climate change.

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