

論説 Article

Perceptions and Realities of Climate Change among the Chepang Communities in Rural Mid-Hills of Nepal

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Abstract: In order to formulate any coping or adaptation strategies, first of all the communities facing climate change should perceive that the changes are indeed taking place. This paper analyzes how the Chepangs, one of the highly marginalized indigenous nationalities living in the remote Mid-Hills of Nepal, perceive climate change. The study is based on household survey conducted among randomly selected 221 Chepang households. The community responses are compared with the actual trends of temperature and rainfall recorded in the meteorological stations located near the study sites. A probit model is used to analyze the characteristics that differentiate the respondents who perceive the changes in line with the recorded data from those who do not. Nearly one-third of the respondents are able to perceive the changes in line with the recorded data, meanwhile there are still many respondents who do not perceive any changes at all. Access to information, and extension services (as indicated by ownership of radio and membership in groups) are the most important factors facilitating perceptions of both temperature and rainfall changes. Cultivation of cash crops also facilitates perceptions of rainfall significantly. On the other hand, formal education and engagement in non-farm income sources reduce the ability to perceive the climatic changes. It is worth noting that, in case of temperature, farming experience is not sufficient to perceive the ongoing changes. Priority must be placed on the dissemination of relevant information at the community level and updating the educational curriculum to include the issues related to climate change.

Key Words: Climate change, perception, temperature and rainfall trend, probit

I. Introduction

Changes in climate is certainly happening everywhere, but how the local people perceive it determines how they formulate strategies to cope with the changes in the short run and to adapt to the long term changes. In other words, it is necessary to realize that some changes are going on in order to take actions to adjust to those changes (Deressa et al., 2011). It has been well realized that most of the climate change projections using empirical models are unable to capture the micro-level specificities of climate change (IPCC, 2007a). No doubt, these studies have contributed immensely to understand the bio-physical processes and impacts of climate change at the global and regional level. The major limitations of these models are twofold: firstly, they cannot model the climate phenomena at the local scale, and secondly very few of them integrate the socio-economic variables which are of immediate relevance to policy makers.

Although climate change is a universal phenomenon, its indicators and manifestations are entirely local, so are the adaptation choices, strategies, and practices. There has thus been increasing emphasis on the bottom-up approaches that climate change studies should be conducted at the local level where adaptations ultimately take place (Smit and Wandel, 2006). There has been some studies conducted over the last decade on perceptions of climate change at country level (Leiserowitz, 2007), or at local level in developed countries (Patino and Gauthier, 2009; Leiserowitz, 2006) as well as developing countries in Africa (Deressa et al., 2011; Gbetibouo, 2009; Maddison, 2007) and Asia (Chaudhary and Bawa, 2011; Byg and Salick, 2009; Vedwan, 2006; Dahal, 2005; Vedwan and Rhoades, 2001). In Asia, all these studies are conducted among the Himalayan communities of India, Nepal, and Tibet, probably because much of the attention in Asia has been received

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by the melting glaciers in the Himalayas (IPCC, 2007b). In Nepal, though few other studies on the local perceptions of climate change have been conducted in hills and low-lying plains (Tiwari et al., 2010; Bhusal, 2009), such studies are yet to be published in the peer reviewed literatures.

The view of local communities about the ongoing changes in climate, its causes and impacts can be entirely different from what science has explained about climate change. Byg and Salick (2009) report that Tibetans in Yunnan province give many spiritual reasons like angering of mountain gods as the causes of disruption in the climate patterns. Very often, the understanding of climate change by rural communities is a function of micro-level livelihood practices and is conditioned by the knowledge of crop-climate interaction. For instance, the apple growers in the Northwestern Himalayas of India notice changes in temperature and rainfall only for the period before apple harvest (Vedwan, 2006). Their perceptions of changes in snowfall in the area are very much linked to the various growth stages of apple; like late snowfall is easily noticed by the farmers because amount of snowfall is very important to determine the fulfillment of chilling requirements to break the winter-dormancy in apples. Similarly, shift in rainfall hampers the color development of apples and thus is remarkably mentioned by these farmers. However, once apples are harvested in September, changes in any of the climate variables are rarely reported (Vedwan and Rhoades, 2001). It is thus very important to first understand how local people understand the climate and how climate interacts with their livelihood activities. Unless adaptation policies and related projects address the local perceptions, it cannot be expected that the community will agree to and adopt the recommended practices. Furthermore, since rural communities are the ones who have closely observed the local climatic patterns, local knowledge can provide important insights into the phenomenon that has not yet been noticed or researched by the scientists. Patino and Gauthier (2009) demonstrate that local perspectives can be combined with scientific climate scenarios to draw policy recommendations from the community through participatory vulnerability mapping.

All the studies cited above show there are some members in every community who do not perceive any

changes in climate. Within those who perceive changes, not all of the perceptions match the meteorological records. Attempts have been made to understand the characteristics that differentiate the members who perceive the changes from those who do not perceive any changes across rural communities in Africa (Deressa et al., 2011; Gbetibouo, 2009; Maddison, 2007). It has been noted that both individualistic and general characteristics affect ability to perceive. While individualistic factors like age and household size do not have much policy implications, others like gender differences, education, and farming experience have important policy relevance. Among other factors, access to information, social networks, infrastructure like distance to market, and engaging in non-farm income sources are found to determine the ability to perceive changes in temperature and rainfall. Furthermore, there are factors specific to agriculture like farm income, farm extension services, nature of farming (subsistence or commercial), soil quality, access to irrigations that affect perception of climate change. Such type of analysis is important as it helps to characterize those members who have the ability to perceive changes in climatic variables versus those who cannot, thereby highlighting the factors that need to be addressed in order to facilitate perceptions and finally adaptations to climate change at the local level. The limitation of the above cited literatures is that they analyze determinants of the ability to perceive some changes in temperature and rainfall, regardless of whether the perceptions are in line with the meteorological data or not. As stated before, even among those who perceive some changes, not all are in line with the recorded data. There is thus a need to separate those who can perceive the changes in the same direction as recorded in the meteorological stations versus those who cannot do so. Furthermore, there is dearth of quantitative studies on the factors determining the community perceptions in South-Asian or Nepalese context.

This paper analyzes how the study community in the rural Mid-Hills of Nepal perceives the changes in temperature and rainfall and whether these perceptions match with the recorded data or not. Further analysis will be done to determine what characteristics differentiate those who can perceive the changes in line with the recorded data from those who either cannot perceive any changes and/or perceive the changes in the wrong

direction. The next section describes the study community, study sites, data sources, and the empirical model used in the paper. The third section of the paper discusses the findings. The last section concludes the paper, and draws relevant policy recommendations.

II. Methodology

1. Chepangs: The study community

Chepangs are one of the indigenous nationalities¹⁾ of Nepal having a population of 52,237 constituting 0.23% of the total population. Majority of the Chepangs lives in the hilly villages of Chitwan, Makwanpur, Dhading and Gorkha districts. In Nepal, indigenous nationalities represent the marginalized section of the country both spatially as well as socio-economically. Not only do the majority of indigenous people reside in the geographically remote parts of the country, but also their socio-economic and human development indicators lie far below the national average. Based on the Nepal Living Standards Survey 2003/04, hilly indigenous people (besides Newar and Thakali²⁾) have higher poverty incidence of 43% compared to the Tarai indigenous people having poverty incidence of 33% (NIRS, 2006). The Chepang community has been categorized as one of the highly marginalized indigenous nationalities from the hills. Although their native area is surrounded by major highways of the country (Figure 1), feeder roads joining the area to the highways are very few. The geographical remoteness is further compounded by constant landslides along the walking trails during the rainy season and poorly developed infrastructures like limited communication facilities, electrification, bridges, health centers, and schools. Literacy rate among this community is very low, which has hampered their representation in the administrative as well as political spheres. As a result, despite being situated geographically quite near to the capital city Kathmandu (Figure 1), they are still marginalized from the mainstream of development of the country. Chepang thus qualify as an appropriate representative of the marginalized group of people in Nepal and is thus selected as the population for this study.

Chepangs are believed to be until the last 100-150 years ago a nomadic group ranging the forests of Nepal as described by Brian Hodgson in his 1848 article to be “living entirely upon wild fruit and the produce of the

chase” (Hodgson, 1874, p. 45). Nearly a century later, a comprehensive study by Rai (1985) reported that, though Chepangs still practiced a good deal of hunting and gathering, agriculture formed the mainstay of their livelihood, and they practiced *khoriya* cultivation. Under this system, a patch of land is cleared in the forest and cultivated for 2-3 years before the soil become exhausted. It is then left fallow allowing sufficient time for vegetation to regenerate; meanwhile they clear and cultivate other patches of land. However, introduction of new government policies have put restrictions on hunting, gathering, and clearing of forest patches. The most notable of such policies is the Private Forest Nationalization Act enacted in 1957, which transferred all the forests that had been traditionally used by the community under the government ownership. As a result, the *khoriya* patches left for regeneration within the forest area now belong to the government. In addition, enactment of Forest Act 1993 formed a base for the introduction of community and leasehold forestry, which banned all the hunting and cultivation activities within the forest area, thereby negatively affecting the traditional system of the Chepang livelihoods (Upreti and Adhikari, 2006). Furthermore, cadastral survey conducted in the Chepang area in early 1970s only registered lands that were permanently cultivated as private properties, thereby failing to recognize *khoriya* patches as land suitable for registration (Aryal and Kerkhoff, 2008). Due to the failure of government policies to recognize the traditional rights of resource ownership, Chepangs lost their access to forest resources and *khoriya* patches, leading to the transition of their livelihood to sedentary agriculture (FORWARD, 2001). Chepangs predominantly rely on rain-fed subsistence agriculture. Due to rugged topography and stony nature of the land, only a small percentage of Chepang households are fully food self-sufficient (Piya et al., 2011a). Chepangs still depend upon wild and uncultivated edible plants (Maharjan et al., 2010). Chepangs also depend upon livestock, wage laboring, collection and sale of forest products, handicrafts, skilled non-farm jobs, salaried jobs, and remittance for cash income (Piya et al., 2011b).

2. Study area and data source

More than 95% of the total Chepang population resides in Chitwan, Makwanpur, Dhading and Gorkha

districts (CBS, 2008). To ensure representativeness of the sample selected, all the four districts have been covered by this study. The native area of the Chepangs only covers a small portion of these districts (Figure 1).

Chepang settlements are situated along the geographically fragile and steep Mahabharat Hills within these districts. Few of the Chepang settlements in Chitwan and Makwanpur districts can be found at lower altitude of around 250 meters above sea level (masl). However, majority of the settlements are found at altitudes higher than 1000 masl, ranging up to 1920 masl represented by the Siraichuli peak located in Kaule Village Development Committee (VDC³) of Chitwan district, which is also the highest point along the whole of Mahabharata range. The Chepang settlements on hill tops are scattered and connected by narrow foot-trails. One Chepang settlement is separated from the other by a rivulet that flows in the grove between the ridges so that in order to go from one settlement to another, one has to

climb down the grove, cross the rivulet, and again climb up the ridge. During monsoon, the rivulets are flooded, and the ridges are very slippery so that movements across the settlements become very difficult; the trails are covered by bushes with plenty of leeches, and falling stones with constant danger of landslides. For the purpose of this research, one VDC from each district is selected as the study VDC. Kaule VDC from Chitwan district, Kankada VDC from Makwanpur district, Mahadevsthan VDC from Dhading district, and Bhumlichowk VDC from Gorkha district are selected based on the dominance of Chepang population. Chepangs form the most dominant population in Kaule and Kankada VDC, and second most dominant population in Mahadevsthan VDC. In Gorkha district, Chepangs do not form a clear majority in any of the VDCs; thus, Bhumlichowk VDC is selected as this VDC accommodates the highest Chepang population within Gorkha district. The altitudinal range and the percentage

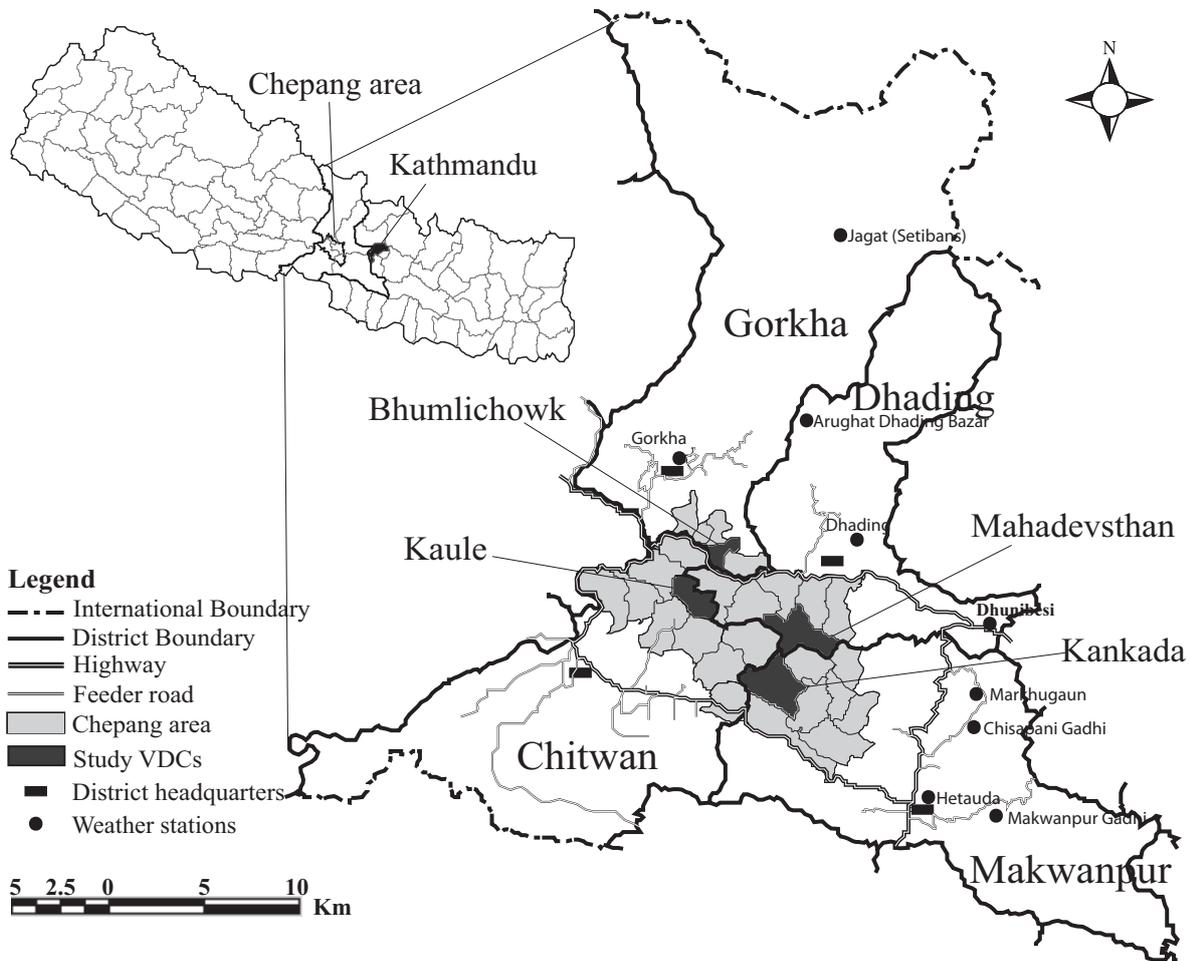


Figure 1 Map of study districts showing Chepang area, study VDCs, and weather stations considered for this study

Table 1 Altitudinal range, Chepang population, and sample size in the study VDCs

District and VDC	Altitudinal range of the VDC (masl) ^a	Chepang population in the VDC ^b	Sample size (number of Chepang households) surveyed	
			February – March, 2010	May – June, 2011 (final sample)
Chitwan – Kaule	810 – 1920	3155 (67.3)	60 (11.4)	58 (11.03)
Makwanpur – Kankada	385 – 1710	4056 (52.3)	60 (8.9)	56 (8.28)
Dhading – Mahadevsthan	550 – 1930	1857 (30.0)	60 (19.4)	54 (17.4)
Gorkha – Bhumlichowk	410 – 1730	911 (24.3)	60 (39.5)	53 (34.9)

Note: Figures in parenthesis indicate percentage of the VDC total

Source: ^a NGIIP, 2006a; NGIIP, 2006b ^b CBS, 2002a; CBS, 2002b

of Chepang population in the study VDCs are given in Table 1.

This study is based on the primary data collected by household survey conducted in two phases. The first phase of household survey was conducted in February-March 2010 and the second phase in May-June 2011. Sixty randomly selected households from each VDC form the sample for the household survey. Household survey was conducted using semi-structured interview schedule. The researchers visited the selected households and face-to-face interviews were conducted with the household members on the selected household's premises. All the households covered by the survey were untouched by roads and not connected to the central electricity grid. The first phase of the household survey was focused on collection of data related to demographics, livelihood assets, livelihood activities, income sources, and expenditures. Besides the household survey, group discussions were carried out to assess the general changes in climate variables and obtain a timeline of climate related disasters as far as they could remember. Based on the overall general information obtained from the group discussion in 2010, semi-structured interview schedule was designed and follow-up field visit was again made in May-June 2011. This time the same households covered in 2010 were revisited for gathering supplementary data. Out of the total 240 households covered in 2010 field survey, 58 households in Chitwan, 56 households in Makwanpur, 54 household in Dhading, and 53 households in Gorkha could be revisited in 2011 survey; thus the final sample constitutes a total of 221 households (Table 1). The main purpose of this household survey was to find out whether individual households perceived any changes in climate, and if they did, what were the changes perceived, adaptation strategies

adopted, and the impacts felt on crop production and livelihood assets. Time frame of past ten years was considered since longer time frame would be difficult for the respondents to remember and be subjected to recall bias (Gbetibouo, 2009). Also, the year 2001 was taken as the reference year because in July 2001, a large landslide in Kankada VDC claimed more than 60 human lives and caused huge property damage. The Chepangs in all the districts are aware of this epoch making incident, thus it becomes easier for taking this incident as a reference.

For comparing the community perceptions with the actual climate data, historical weather data comprising of mean monthly maximum temperature, minimum temperature, and rainfall were obtained for the year 1975-2008 from the Department of Hydrology and Meteorology (DHM) in Kathmandu, Nepal. Unfortunately, there are no weather stations located within any of the study VDCs. Thus, other weather stations located within the four districts at a similar altitudinal range as the study VDCs were selected for the study purpose. It comprises of four weather stations from Makwanpur district (Chisapanigadhi, Hetauda, Markhugaun, Makwanpurgadhi), three from Dhading district (Arughat, Dhading, Dhunibesi), and two from Gorkha district (Jagat-setibans, Gorkha). The locations of these weather stations within the respective districts are shown in Figure 1. The altitude, latitude and longitude of these weather stations are given in Table 2. Rainfall data is available for all these stations, whereas temperature data is available only for one station in each district (Hetauda, Dhunibesi, and Gorkha). As for Chitwan district, all the weather stations are located below 300 masl, which is far below the altitudinal range of the study VDC (810-1920 masl). Therefore, none of the weather stations are considered from Chitwan district. This poses limitations

Table 2 Weather stations selected for the purpose of the study

District	Weather Stations	Altitude (masl) ^a	Latitude ^a	Longitude ^a	Available data
Chitwan	None available within the similar altitudinal range as the study VDC				
Makwanpur	Chisapaani Gadhi	1707	27.55	85.13	Precipitation (1970 – 2008)
	Hetauda	474	27.42	85.05	Precipitation (1966 – 2008) Temperature (1966 – 2008)
	Markhugaun	1530	27.62	85.15	Precipitation (1972 – 2008)
	Makwanpur Gadhi	1030	27.42	85.17	Precipitation (1975 – 2008)
Dhading	Arughat Dhading Bazar	518	28.05	84.82	Precipitation (1971 – 2008)
	Dhading	1420	27.87	84.93	Precipitation (1970 – 2008)
	Dhunibeshi	1085	27.72	85.18	Precipitation (1971 – 2008) Temperature (1975 – 2008)
Gorkha	Jagat (Setibans)	1334	28.37	84.9	Precipitation (1971 – 2008)
	Gorkha	1097	28.0	84.62	Precipitation (1971 – 2008) Temperature (1971 – 2008)

Source: ^a Raw data from DHM

for triangulating the perceptions of respondents from Chitwan district due to lack of recorded climate data for the given elevation range within the district.

3. Probit analysis of determinants of perception

Studies on climate change perceptions have adopted various models to analyze the factors determining perceptions: ordinal and nominal logistic regressions (Byg and Salick, 2009), Heckman probit selection model (Deressa et al., 2011) and binomial probit model (Gbetibouo, 2009; Maddison, 2007). This paper analyses which type of respondents perceive temperature and rainfall changes in line with the recorded data by running a simple binomial probit model. Data analysis and statistical software (STATA) is used to run the probit analysis. The variables of the model are presented in Table 3. The models are run separately for changes in temperature and rainfall. Recorded data shows increasing summer temperature, decreasing winter temperature, and decreasing annual rainfall over the last ten years. Around 32% of the respondents perceive temperature (sum of those perceiving hotter summer, colder winter and both) and 37% perceive rainfall in the same direction as shown by the records. The perceptions are discussed in detail in the next section of the paper.

Ten independent variables have been chosen based on previous literatures and specific characteristics of the study community. The average age of the respondents is 38.43 years. Literatures show that with age, the ability to

perceive changes improves (Deressa et al., 2011), basically due to knowledge gained from increasing experiences (Gbetibouo, 2009; Maddison, 2007). In the context of rural communities in developing countries, male respondents can perceive changes better, mainly due to their regular contact with outsiders and better access to information sources such as radios. However, some studies show that gender does not necessarily differentiate the ability to perceive climate change (Maddison, 2007). Education may influence perceptions either positively (Deressa et al., 2011; Maddison, 2007) or negatively (Gbetibouo, 2009). The average years of schooling among the respondents is very low (only 1.6 years), thereby reflecting the low literacy rate among the Chepang community. Access to information, extension services, and social networks have been shown to have positive influence by all the literatures. In the study area, provision of village level extension services by the government agencies is totally absent. However, there are many non-governmental organizations (NGOs⁴) working in the field of agriculture, livestock, forestry, health, drinking water, and renewable energy. Such organizations work with the community by forming small groups of households and provide relevant trainings (like construction of poly-tunnels for off-season vegetable production, and plastic-ponds for water collection) to the group members. Thus membership in such groups and participation in trainings provided by these development agencies are the major sources of

Table 3 Description of variables for the probit model

Response Variables	Unit	Mean ^a	
Perceive hotter summer and/or colder winter	Dummy; 1 = Yes, 0 = Otherwise	0.32 (0.47)	
Perceive decreasing rainfall	Dummy; 1 = Yes, 0 = Otherwise	0.37 (0.48)	
Independent Variables	Unit	Mean ^a	Direction of influence
Age of respondent	Years	38.43 (15.92)	+
Gender of respondent	Dummy; 1 = Male; 0 = Female	0.56 (0.50)	+ / -
Education of respondent	Years of schooling	1.6 (2.5)	+ / -
Own radio	Dummy; 1 = Yes, 0 = No	0.66 (0.48)	+
Membership in groups	Dummy; 1 = Yes, 0 = No	0.65 (0.48)	+
Participate in trainings	Dummy; 1 = Yes, 0 = No	0.37 (0.48)	+
Share of farming income (agriculture and livestock)	Percentage of total	52.51 (26.35)	+
Cultivate cash crops	Dummy; 1 = Yes, 0 = No	0.57 (0.47)	+ / -
Share of non-farm remunerative income (salaried job, and non-farm skilled job)	Percentage of total	9.83 (20.17)	+ / -
Share of income from (wage labor)	Percentage of total	26.3 (25.85)	+ / -

Note: Figures in parenthesis indicate standard deviation

Source: ^a Field survey 2010/2011

information, as well as extension services for this community. Although more than 65% of the respondents have membership in such community groups, only 37% have participated in the trainings provided by the development agencies. Furthermore ownership of radio has also been taken as a proxy for access to relevant information.

Previous studies also suggest that the nature of livelihood activities that the household depends on and the degree of dependence on a particular livelihood source determine the level of interaction of the household members with the natural environment, thereby determining the ability to perceive any changes occurring in the climatic trends. Deressa et al. (2011) shows that higher farm income positively affects the perception of climate change while non-farm income has negative effects. On the other hand, study by Maddison (2007) shows that dependence on non-farm income does not necessarily hinder the ability to perceive some changes in climate. However, these studies do not differentiate between high-paid non-farm jobs and less-paid non-farm labor. Table 3 shows that farming (comprising of both agriculture and livestock) is the major livelihood sources for the Chepang households as 52.51% of the total income is derived from farming. The nature of farming has also been taken as a determinant of perception of

climate change. While Maddison (2007) shows that subsistence farmer are more capable of perceiving the changes, Gbetibouo (2009) shows the opposite. In this study, 57% of the interviewed households cultivate at least one kind of cash crop (like tomato, cucumber, beans, blackgram, horsegram) to be sold in the market. Non-farm income has further been divided into remunerative income sources and wage labor. Remunerative non-farm income sources (salaried jobs and skilled non-farm jobs) that are not dependent on natural resources only form 9.83% of the total income. These sources are termed as remunerative sources because annual income from these sources is higher compared to other sources (Piya et al., 2011b). Wage labor, which is also a non-farm source, contributes around 26.3% to total income.

III. Results and discussion

The respondents were first asked if they have ever heard anything about climate change. Only 11.8% of the respondents replied that they have heard about it. The source of information was cited as radio by 6.9%, staffs of NGOs by 2.5% and teachers at school by 1.5% of the respondents. Then they were further asked if they can say what climate change means. Only 4.5% of the respondents could reply that the phenomenon is related to changes in weather patterns, temperature, rainfall,

wind, floods, landslides, and the environment. Similar situation is reported by Byg and Salick (2009) in Tibet where the respondents have never heard the term climate change. Most of the Chepangs may not literally understand what climate change means; but many of them can perceive how weather pattern has been varying over the years. They have experienced, for instance, that the rainfall patterns are changing, winter and post-winter rains are decreasing, monsoon is arriving late but causing lots of damage when it arrives, summer is getting hotter, hailstorms are increasing in frequency, and so on. This section presents an overall view of how the study community perceives the ongoing changes in climate. Trends of temperature and rainfall are presented as graphs side by side to community perceptions to see if the perceptions really match with the actual trends. Trend analysis has been done for two different time periods, the long-term trend for 1975-2008 and short-term trend for the time period of 2001-2008. The latter period was chosen since our household survey was more focused on the perceptions based on last ten years (2001-2010). Rural households tend to form their perception based on more recent events (Maddison, 2007), thus community perception is believed to be more representative of the climatic patterns after 2001. As stated in methodology section, there are no weather stations at the suitable elevation within Chitwan district; this puts limitations in the triangulation of the perception of respondents from Chitwan district. The comparison of perceptions with

that of recorded data is possible only for the remaining three districts.

1. Changes in temperature: Perceptions and actual trends

Regarding the changes in temperature, majority of the respondents have noticed the rising summer temperature (47.5%), while nearly 9.5% of the respondents perceive that summer has become cooler. For the winter temperature, nearly 21.8% perceive that winter is becoming colder while nearly equal percentage of the respondents (22.6%) perceive that winter is getting warmer. The perceptions are similar to those reported by other studies done in hills of Nepal where majority of the respondents perceive increasing overall temperatures (Bhusal, 2009; Tiwari et al., 2010); however these studies do not differentiate seasonal temperatures. Qualitative study by Dahal (2005) in the high Himalayas reports that the community perceived winters to be warmer and less frosty. In our study, there are also a significant proportion of the respondents (38.5%) who do not perceive any changes in temperature. The reason why many respondents cannot perceive long-term changes in temperature might be because of what Vedwan and Rhoades (2001) describe as the lack of ‘visual salience’. According to them, visual salience of rainfall facilitates better perception, whereas changes in temperature are comparatively perceived lesser. The detail of the categories of response to temperature

Table 4 Perceptions of changes in temperature

Perceptions	Number of response				
	Chitwan (n = 58)	Makwanpur (n = 56)	Dhading (n = 54)	Gorkha (n = 53)	Aggregate (n = 221)
Hotter summer	5 (8.6)	9 (16.1)	8 (14.8)	8 (15.1)	30 (13.6)
Cooler summer	2 (3.4)	2 (3.6)	-	-	4 (1.8)
Colder winter	-	-	2 (3.7)	1 (1.9)	3 (1.4)
Warmer winter	-	2 (3.6)	-	1 (1.9)	3 (1.4)
Hotter summer and colder winter	-	7 (12.5)	15 (27.8)	14 (26.4)	38 (17.2)
Hotter summer and warmer winter	15 (25.9)	3 (5.4)	6 (11.1)	13 (24.5)	37 (16.7)
Cooler summer and colder winter	2 (3.4)	4 (7.1)	1 (1.9)	-	7 (3.2)
Cooler summer and warmer winter	3 (5.2)	4 (7.1)	1 (1.9)	2 (3.8)	10 (4.5)
Fluctuating between the years	1 (1.7)	-	-	-	1 (0.5)
No changes perceived	26 (44.8)	25 (44.6)	20 (37.0)	14 (26.4)	85 (38.5)
Don't know	2 (3.4)	-	1 (1.9)	-	3 (1.4)

Note: Figures in parenthesis indicate percentage
n = number of sample households

Source: Field survey, 2010/2011

changes has been tabulated in Table 4.

Districtwise responses show that in Chitwan and Makwanpur, there is quite a big proportion (44.8% and 44.6% respectively) of respondents who do not perceive any changes in temperature; the proportion is 37.0% and 26.4% for Dhading and Gorkha, respectively. Of the remaining who perceives changes, majority perceive rising summer temperature (34.5%, 34.0%, 53.7%, and 66.0% in Chitwan, Makwanpur, Dhading, and Gorkha, respectively). Regarding the winter temperature, the

response is not as uniform and clear as the summer temperature. In Chitwan, majority (31.1%) perceive winter is getting warmer; in Makwanpur nearly 19.6% perceive colder winter while 16.1% perceive warmer winter; in Dhading majority (33.4%) perceive colder winter; and in Gorkha the two figures are again closer with 29.7% perceiving warmer winter and 28.3% perceiving colder winter.

The recorded summer temperature trend is shown in Figure 2, and winter temperature trend in Figure 3.

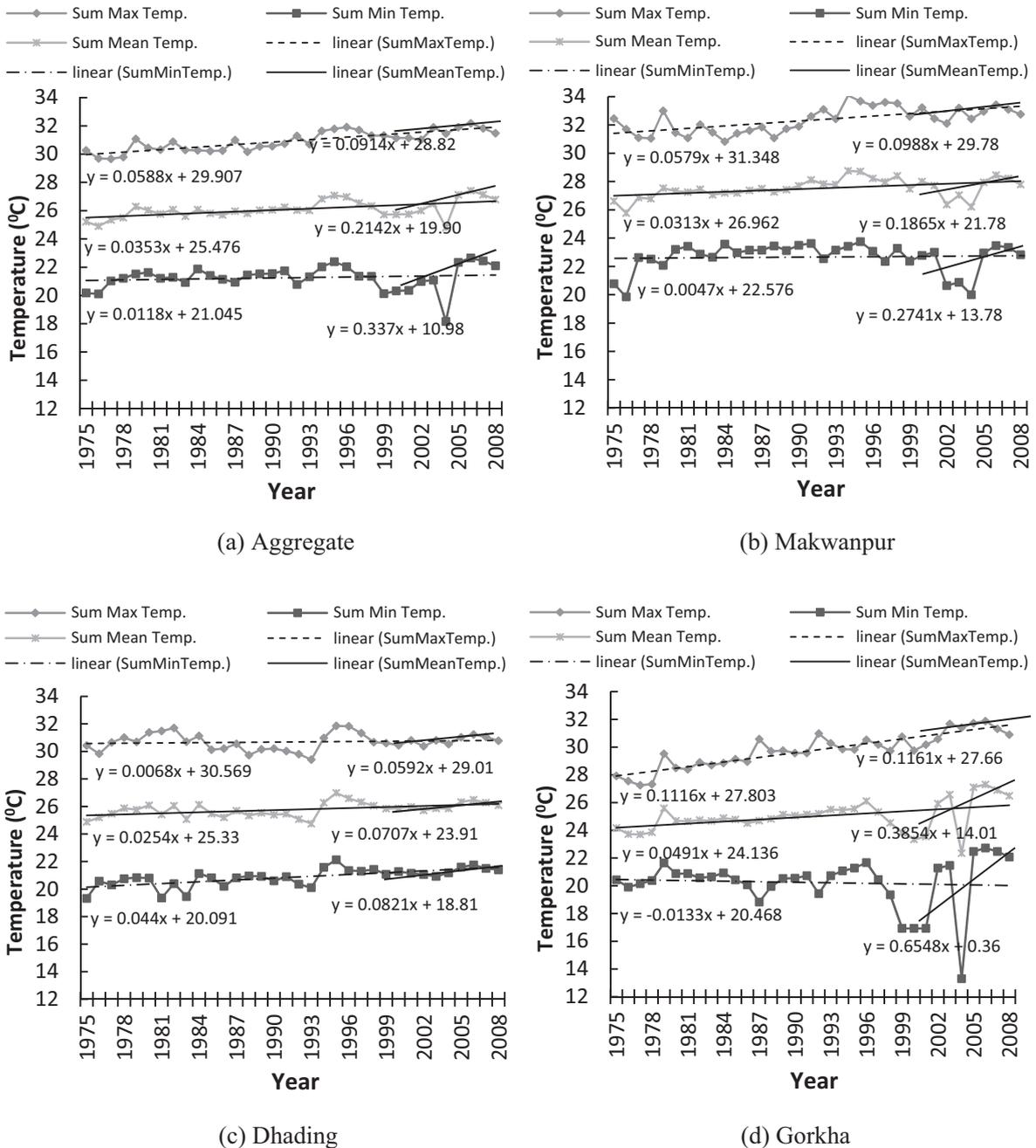


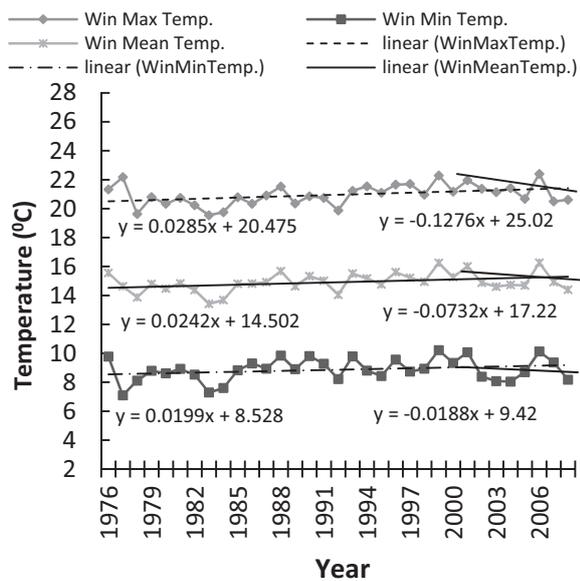
Figure 2 Average summer temperature trend (May-Aug) for the selected stations

Source: Raw data from DHM

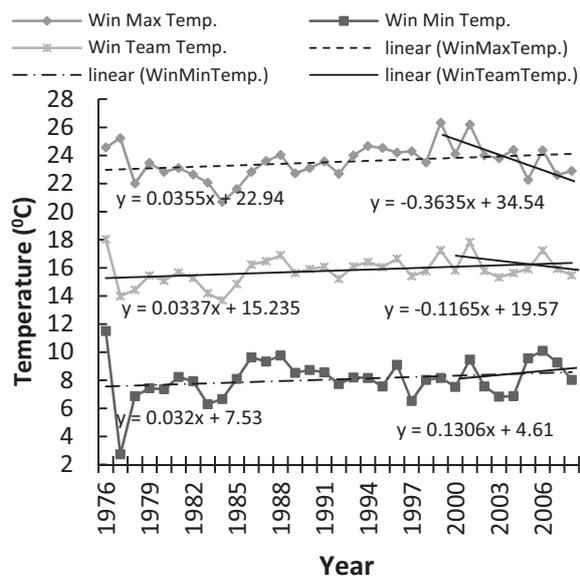
The long-term summer temperature (May-August) shows rising trend for all the districts except for the minimum summer temperature in Gorkha. In the short-run also, the temperatures show an increasing trend in all the districts, and the rate of increase is faster than that in the long-run. The rate of increase in summer temperature is highest for Gorkha; unsurprisingly 66.0% of the households in Gorkha perceive the hotter summer. The perceptions regarding summer temperature is rightly perceived in other districts also, as majority of those who responded

felt that summers are getting hotter in all the study sites.

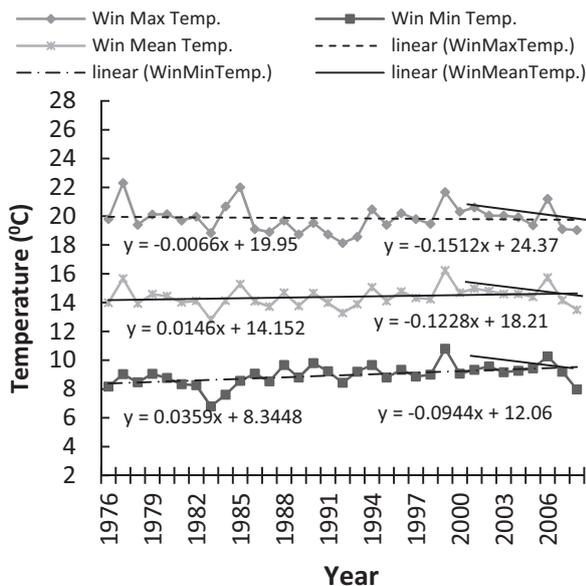
In the long-run, trend analysis of winter temperature (December of earlier year, January and February) shows varying results with winter temperatures rising for Makwanpur district, maximum winter temperature falling for Dhading district and minimum winter temperature falling for Gorkha district (Figure 3). The long-term mean winter temperature, however, shows a rising trend in all the districts. However, the trend analysis of short-term winter temperature shows quite



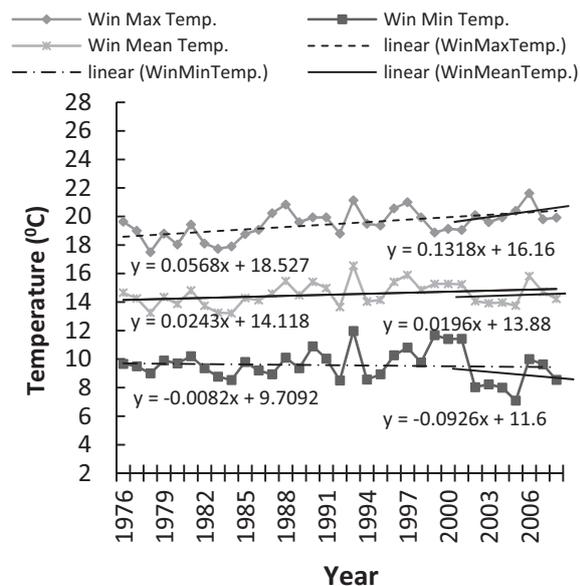
(a) Aggregate



(b) Makwanpur



(c) Dhading



(d) Gorkha

Figure 3 Average winter temperature trend (Dec-Feb) for the selected stations

Source: Raw data from DHM

surprising results. The short-run mean winter temperature shows a falling trend in all cases except for Gorkha. However even in Gorkha, the minimum temperature is decreasing over the last ten years, which means winter nights are getting colder. As stated before, the perception regarding winter temperature is not clear among the respondents with almost equal percentage saying both warmer and colder winter in Makwanpur (16.1% and 19.6% respectively) and Gorkha (30.2% and 28.3% respectively). In Dhading, most of the respondents (33.7%) rightly perceive colder winter, while in Chitwan most of them perceive warmer winter (31.1%). Much can't be said about the perceptions in Chitwan district due to lack of recorded data for comparison.

2. Changes in rainfall: Perceptions and actual trends

Perception of rainfall was asked to the respondents in terms of rainfall quantity as well as timings (Table 5). In terms of quantity majority of the respondents perceive decreasing rainfall and in terms of timings majority of the respondents perceive rainfall is arriving later in all the study sites. This perception is quite similar to what is mentioned in the studies conducted in the Himalayas (Chaudhary and Bawa, 2011; Byg and Salick, 2009; Vedwan, 2006), whereby the community perceived that snowfall and rainfall has shifted to a later timing. Most of the respondents (36.7%) feel that the total rainfall has decreased; the next majority of respondents (23.5%) feel that rainfall is unpredictable in terms of quantity (sometimes high, sometimes low); there are also quite

many respondents (21.3%) who feel that rainfall is coming later than the usual time. Quite many respondents in Chitwan and Dhading perceive the unpredictable nature of rainfall. Other studies in Nepal also report that most respondents perceive rainfall to be very unpredictable regardless of whether the study was conducted in low-lying Tarai, mid-hill, high-hills, or mountains (Tiwari et al., 2010; Bhusal, 2009; Dahal, 2005). In our study, there are around 13.2% to 16.7% of respondents who do not perceive any changes in rainfall; yet this is far less compared to those who did not perceive any changes in temperature.

Triangulating the rainfall perceptions with actual trends was difficult, since monthly averages can give the picture of total amount but do not give a picture of rainfall timings. Trend for total annual rainfall is presented in Figure 4. Rainfall patterns show that the interannual variations are very large for all the districts, thereby making the rainfall pattern quite unpredictable. The rainfall pattern for overall Nepal also follows the same pattern of large variations, making it difficult to draw a single conclusion regarding the rainfall patterns (Practical Action, 2009). Trend analysis for rainfall was also done for two time periods, the first being the period of 1975-2008, and another for the period 2001-2008. Similar to winter temperature, trend diagrams for annual rainfall also shows that the trends for the two different time periods can be totally different. For Makwanpur district, for example, while the trend in the longer run is seen to be slightly increasing, for the period after 2001,

Table 5 Perceptions of changes in overall rainfall pattern

Perceptions	Number of response				
	Chitwan (n = 58)	Makwanpur (n = 56)	Dhading (n = 54)	Gorkha (n = 53)	Aggregate (n = 221)
Decreased total rainfall	12 (20.7)	19 (33.9)	17 (31.5)	33(62.3)	81 (36.7)
Increased total rainfall	6 (10.3)	10 (17.8)	3 (5.6)	3 (5.7)	22 (9.9)
Late rainfall than usual	16 (27.6)	11 (19.6)	10 (18.5)	10 (18.9)	47 (21.3)
Early rainfall than usual	3 (5.2)	4 (7.1)	2 (3.7)	3 (5.7)	13 (5.9)
More damaging	8 (13.8)	10 (17.8)	12 (22.2)	3 (5.7)	23 (10.4)
Unpredictable	25 (43.1)	8 (14.3)	19 (35.2)	7 (13.2)	52 (23.5)
No changes perceived	9 (15.5)	9 (16.1)	9 (16.7)	7 (13.2)	34 (15.4)
Don't know	3 (5.2)	2 (3.6)	2 (3.7)	2 (3.8)	9 (4.1)

Note: Figures in parenthesis indicate percentage
Percentage may not add up to 100 due to multiple answers
n = number of sample households
Source: Field survey 2010/2011

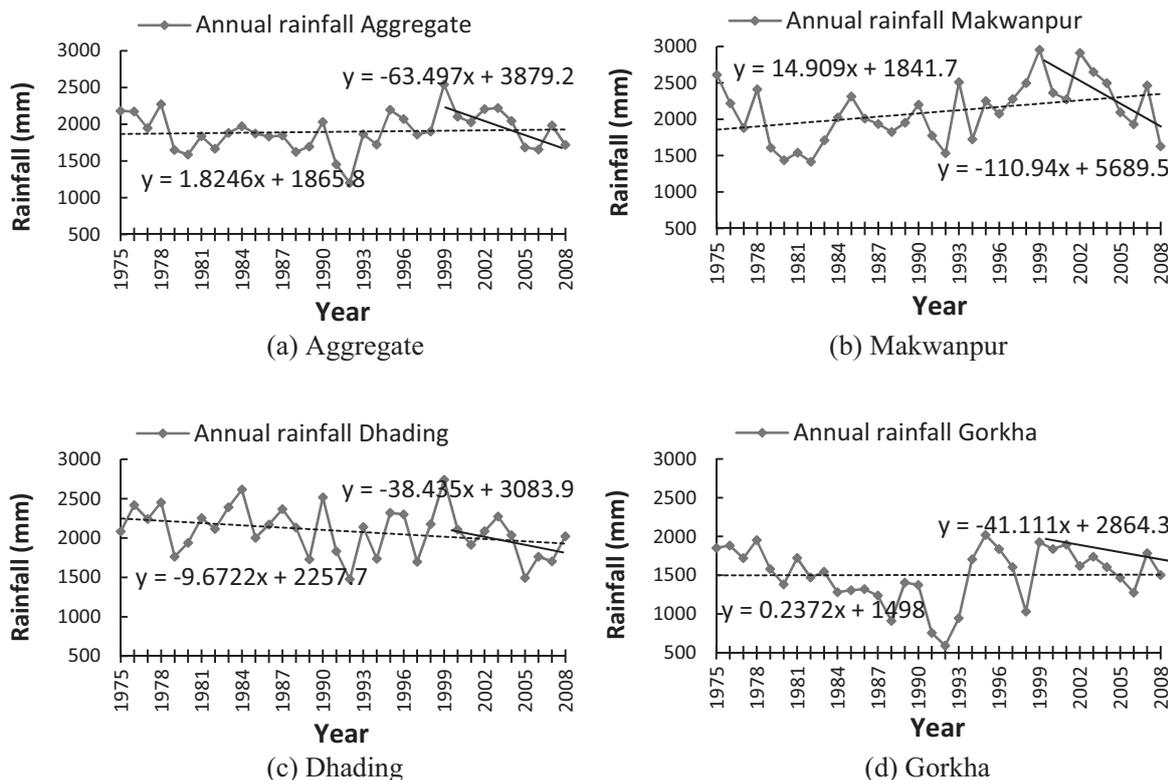


Figure 4 Total annual rainfall averaged for the selected stations

Source: Raw data from DHM

the rainfall amount shows drastically decreasing trend. For the other two districts also, rainfall after 2001 is decreasing at a faster rate than the overall trend. The actual rainfall trend matches with the community perception, where majority say that quantity of rainfall is decreasing and is unpredictable. Among the four study sites, vast of majority of respondents from Gorkha (62.3%) could perceive decreasing rainfall in line with what the records show, while the proportion was least for Chitwan (20.7%). Alternatively, those perceiving unpredictable nature of rainfall (that is high in some years and low in others) is the highest in Chitwan (43.1%) and lowest in Gorkha (13.2%). Many respondents feel that rainfall pattern is unpredictable probably due to large interannual fluctuations in the rainfall quantity.

3. Factors that facilitate perceptions

As discussed above, the recorded meteorological data shows hotter summer, colder winter and lesser annual rainfall. Of the total respondents, only 32% perceived the temperature trends in the right direction (sum of those perceiving hotter summer, colder winter,

and both), while 37% perceived the decreasing rainfall in line with the recorded data (Table 3). The probability to perceive temperature and rainfall in accordance with the station data was tested against ten socio-economic characteristics of the respondents or the households by running two separate probit models, one for temperature and the other for rainfall. The results of the probit model are presented in Table 6. Both the models are statistically significant at 1% level of significance. The positive sign of the coefficients denote that the factor enables perceptions in the right direction, while negative sign denotes that the particular factor does not facilitate perceptions.

For the temperature model, interestingly, only four variables viz., gender, ownership of radio, membership in groups and participation in trainings have positive coefficients. As described under the methodology section, the last three variables denote the access of the households to information and extension services. These three variables also have positive effect in the rainfall perceptions. Ownership of radio is significant in the rainfall model, and membership in groups is significant in both the models. This result confirms the earlier

Table 6 Results from the probit model

Independent variables	Perceive hotter summer and/or colder winter		Perceive decreasing rainfall	
	Coefficient	P-value	Coefficient	P-value
Respondent's age	-0.010	0.118	0.001	0.929
Respondent's gender	0.012	0.952	0.143	0.466
Respondent's education	-0.065	0.10*	-0.013	0.738
Own radio	0.307	0.133	0.404	0.043**
Memberships in groups	0.484	0.019**	0.323	0.105*
Participation in trainings	0.144	0.465	0.145	0.45
Farm income	-0.011	0.095*	0.001	0.892
Cultivate cash crops	-0.253	0.171	0.353	0.055**
Non-farm remunerative income	-0.010	0.183	-0.001	0.944
Income from wage labor	-0.015	0.035**	-0.000	0.974
Constant	0.628	0.327	-1.216	0.058**
LR Chi ² (10)	17.01		15.91	
Prob > Chi ²	0.0742*		0.1023*	
Log likelihood	-130.245		-137.260	
Pseudo R ²	0.061		0.055	

Note: **, * indicate significant at 5% and 10% level of significance respectively

literatures (Deressa et al., 2011; Maddison, 2007) about the importance of information and extension services in assisting the rural communities to perceive the ongoing changes in climate variables, which further facilitates them to formulate strategies to adjust to these changes. Possession of radio will facilitate the household's access to information related to weather forecasts and agriculture. Currently, the weather forecasts in Nepal are made through radios and televisions for everyday weather, however there are no programs that give seasonal weather forecasts or combine these forecasts with agricultural advice. Program on agricultural information (like diseases and pest control, seeds, varieties, livestock breed) is broadcasted weekly, however these information are rarely discussed in connection with weather or climate. At the time of survey, radio was owned by 66% of the households while none of the households owned a television. Village-level extension services by the government agencies are absent in the study area. The government agriculture service centers are often situated far away from these remote settlements and the extension agents rarely visit these villages due to geographical difficulties. However, there are some NGOs⁴⁾ implementing development projects especially in agriculture, livestock, forestry, health, infrastructure, and renewable energy. These NGOs form groups at the community level and provide the extension services and relevant capacity development trainings to those groups. Memberships in

one or more of these groups are shown to significantly enable the respondent to perceive changes in both temperature and rainfall.

In the temperature model, coefficients for farm income and cash crops are both negative, implying that merely higher dependence on farming is not sufficient to notice the changes in temperature. As stated before, temperature lacks visual salience as a result of which perceiving temperature is more difficult than perceiving rainfall (Vedwan and Rhoades, 2001). Perceptions of changes in temperature can be facilitated only by proper dissemination of climate related information and extension services at the community level. In the rainfall model, however, the coefficient for both farm income and cash crops is positive. Since agriculture in the study hills are primarily rainfed, time and quantity of rainfall is very important for such households. This shows that those households who are dominantly dependent on agriculture and livestock for their livelihoods follow the precipitation trends more closely. Those households cultivating at least one type of cash crop to sell in the market are found to have significantly higher probability to perceive the changes in rainfall. That means those households cultivating cash crops perceive decreasing rainfall significantly better than those who only practice subsistence agriculture. This result is in contradiction with the findings of Maddison (2007), where it is reported that subsistence farmers are better able to

perceive changes in both temperature as well as rainfall. In our study, there can be two explanations for why households cultivating cash crops are better able to perceive the changes in these climate variables. Firstly, cash crops like vegetables are by nature more susceptible to decreasing rainfall compared to traditional crops like millet, thus farmers cultivating vegetables will be following the rainfall patterns with greater care. Secondly, those farmers who cultivate cash crops are those who have received related trainings from the NGOs, thus they are better informed about these phenomena. Results in Table 6 show that if the household depend more on non-farm sources like salaried jobs (teaching), skilled jobs (carpenter, cook, carpet weaving), and wage labor (carrying loads, working in limestone mines, constructing roads), such households follow both temperature and rainfall trends less closely. This result is relevant because these non-farm income sources are not dependent on natural resources, and thus are less affected by climatic variables. Similar results have been reported by Deressa et al. (2011) where by farm income has significant positive effects on climate change perception, and non-farm income has negative effects though not significant.

Age and gender of the respondents are found to be non-significant in our study. This is in contrast to the previous studies like Deressa et al. (2011) reporting age of the household head as a significant factor. However, others like Byg and Salick (2009) opine that age is not a significant factor in perception. Respondents' age has negative sign for temperature, again implying that simply experience is not sufficient to perceive changes in temperature. On the other hand, rainfall is visually salient, so that ability to perceive rainfall changes increases with age. The positive sign on gender reveals that males have higher probability to perceive the changes in climate because males have more frequent contacts with development workers and have better access to information sources. Males are also more flexible in terms of their times to listen to radio while females are more involved in household chores and thus rarely find time to listen to radio broadcasts. Similar trends have been reported in farming communities in rural South Africa (Below et al., 2010). The direction of influence of education is also quite startling, as it contradicts the more usual concept that with education,

ability to perceive will increase (Gbetibouo, 2009). However, in our study the direction of influence is negative for both temperature as well as precipitation and is significant for temperature. The implications here are two-fold: firstly, with higher education, the probability of pursuing non-farm jobs increases, thereby paying lesser attention to climate; secondly the curriculum in the schools do not yet cover the issues of climate change and its impacts on rural livelihoods, thereby failing to raise the awareness among the students regarding the subject.

IV. Conclusion and policy implications

The trend analysis of temperature and precipitation trend for both long-term and short-term provides some important insights. Firstly, the direction of trends can differ for the two time-periods, as shown by the trends for winter temperature and annual rainfall. Secondly, as seen in the case of rainfall, community perceptions are more in line with short-term trends, rather than with the long-term trends. It is the latest trend that has effects on the people's livelihoods directly and the decisions taken to adapt accordingly. Policy makers should be critical to analyze both the long term as well as the short term trends, before implementing any development decisions.

Around one-third of the respondents in this study perceive the changes in line with the data recorded in the weather stations. A matter of concern is that there is a significant proportion of population who has not been able to perceive any of those changes, thereby calling for a need for awareness raising and information dissemination in these rural areas, where the livelihoods are predominantly dependent upon farming. Unless the community realizes that there have been changes going on in the weather patterns, they cannot be motivated to take appropriate measures to adapt to their farming systems according to these changes. Results of probit analysis well demonstrates the importance of information dissemination and community level extension services, which are very effective to inform the people about such changes and to convince them to take necessary adaptation actions. The NGOs and local governments working at the grassroots level can play an important role for disseminating the relevant information and conducting awareness raising campaigns. For this, the staffs themselves need to be knowledgeable about the changes, the

impacts, and possible adaptation strategies. There is a need to first train the development workers working at the community level, so that they can effectively convey the messages to the community. Besides, our education system needs to update the curriculum so as to include climate change, its impacts, and possible mitigation-adaptation measures in order to raise awareness among the young students.

Another facet where the government can improve is to conduct seasonal weather forecasts and assist the rural households to design their crop calendar in accordance to these forecasts. Only broadcasting such information through radio is not sufficient as not all the households possess radios; and even if possessed women may not have time to listen to those broadcasts. These types of information will be more effective if broadcasted by extension agents through direct interaction with the community. Agricultural extension services are very poor in this community especially from the side of the government. Village level extension service systems need to be improved and such programs should emphasize participation of both males and females.

Finally, there is a need to expand the existing meteorological facilities especially in the hills and mountains. Without recorded data, monitoring the changes is not possible, thus establishment of small hydrological stations at the local level is recommendable. As already recommended by Dahal (2005), training the staffs and students at local schools or members of local community-based organizations to obtain readings from rain-gauge and thermometers would not only make it possible to generate datasets on local climate, but it would also be easier to raise awareness among the local communities about the changing climate, and the appropriate measures that can be taken to tackle its adverse impacts.

[End notes]

1) According to the National Foundation for Development of Indigenous Nationalities Act 2002, the term indigenous nationalities refer to tribes or communities having their own mother language and traditional rites and customs, distinct cultural identity, distinct social structure and written or unwritten history. Based on the same Act, Nepal Government has identified 59 Indigenous Nationalities who are classified into five groups comprising of endangered, highly marginalized, marginalized, disadvantaged, and advanced group based on a

composite index comprising of variables like literacy rate, housing, land holdings, occupation, language, graduates, residence, and population size. The indigenous nationalities are further classified into Mountains, Hills and Tarai based on the geographical location where they form a majority (NIRS, 2006).

- 2) Newars and Thakalis are the only two indigenous nationalities falling under the advanced category.
- 3) VDCs are the lowest administrative tiers in Nepal, composed of 9 wards.
- 4) The major NGOs who have worked or are currently working in the study areas are Support Activities for Poor Producers of Nepal (SAPPROS), Forum for Rural Welfare and Agricultural Reform for Development (FORWARD), Local Initiatives for Biodiversity Research and Development (LI-BIRD), Focus Nepal, Shanti Nepal, Center for Community Development Nepal (CCDN), Center for Community Development and Research (CCODER), Manahari Development Institute (MDI), and Practical Action Nepal. These organizations provide rural community development services mostly in the sector of agriculture, livestock, natural resource management and conservation, drinking water, community health, savings and credits, small-scale irrigation, and renewable energy (micro-hydro, solar lighting systems, and improved cooking systems).

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(2012年1月11日受付)

(2012年2月8日受理)