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RESEARCH ARTICLE

CLIMATE CHANGE PERCEPTION AMONG PEASANTS: ROLE OF ROAD INFRASTRUCTURE AND COOPERATIVES

[1,*]Hem Raj Regmi, [1]Kedar Rijal, [1]Ganesh Raj Joshi, [1]Ramesh Prasad Sapkota, [1]Sridhar Thapa and [1]Ganesh Thapa

[1]PhD Student, Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal
[2]Professor, Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal
[3]Visiting Professor; Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal
[4]Assistant Professor, Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal
[5]VAM Officer, UN World Food Program, Chakupat Lalitpur
[6]Consultant (Evaluation specialist), Asian Development Bank

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ABSTRACT

Climate change has been a serious environmental threat and has already harmed people and ecosystem across the globe. One of the ways to cope with the climate change can be through increasing farmers' awareness about climate change and motivating them to adopt the suitable measures to increase the resilience against the climate change. Using a case study from Nepal, the present study explores the importance of access to roads and farmers' association with the cooperatives towards increasing the climate change awareness among rural farmers. We sampled 300 rural households from three districts (Mugu, Dailekh and Banke) that represents agro-ecological diversity (mountain, hill and terai) of Nepal. Results from binary logistic regressions shows that the households located close to the motorable roads are likely to be more aware of the climate change. Households affiliated with the cooperatives are more likely to perceive the climate change. While higher savings from crop incomes have positive influence towards climate change perception, higher savings from livestock are less likely to perceive climate change. Findings of the study underscores the improvement of road infrastructure and formation of cooperatives which are likely to increase farmers' awareness towards climate change.

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INTRODUCTION

Climate change has been the greatest environmental threat harming people and ecosystem across the globe (Omann *et al*., 2009; Dhiman *et al*., 2010; Crossman *et al*., 2011; Tai *et al*., 2014; Lee *et al*. 2015; Smith *et al*., 2017; Bastiaansen *et al*. 2020). Agricultural production risks, arising due to the climate changes, have been a great concern to the marginalized and vulnerable population of developing countries (Koundouri and Nauges, 2005; Isik and Devodas, 2006; McCarl *et al*., 2008; Carew *et al*., 2009; Reddy and Pachepsky, 2000; Shultz *et al*. 2020). Its consequences are more severe for agricultural households that depend on rain-fed agriculture for their livelihoods and have little or no resources to diversify the agricultural production risks. Climate changes are significantly associated with the variability of the crop yield (Alexandrov and Hoogenboom, 2000; Chandio *et al*. 2020), and has negatively impacted agricultural production, food security and sustainable livelihoods (Magadza, 2000; Kurukulasuriya and Rosenthal, 2003; Abraha and Savage, 2006; Soler *et al*. 2007; Lobell *et al*., 2008; Mishra *et al*. 2015; Connolly-Boutin and Smit 2016).Dell *et al*., (2011) revealed global warming to substantially reduce economic growth in poor countries with negative effects on agricultural and industrial output. Mitigating the adverse effects of climate change has been a daunting task for many developing countries in Africa and South Asia (Tol, 2002; Mendelsohn *et al*., 2006; Bryant *et al*. 2020). Studies suggest that the South Asia and Africa, which is home to the large proportions of food-insecure population, are likely to suffer from the climate change impacts in absence of

Corresponding author: **Hem Raj Regmi,**
PhD Student, Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal.

suitable adaptation measures (Lobell *et al*., 2008). In fact, human behaviors are the root of escalating environmental problems. Individuals' decision and their coping strategies to mitigate the deleterious effects of climate change depends on the level of their awareness and perception towards the hazards of climate change (Arbuckle *et al*. 2013; Hu and Chen 2016). The climate change can be successfully tacked only if the causes and the consequences of the risks are understood by the farmers and particularly by the one who needs to adopt mitigation practices (Brody *et al*. 2008). The extent of behavioral changes for climate change mitigation partly depends on how one perceived the climate change risk (Brody *et al*. 2012). Farmers, who are aware of the negative impact of climate change, can take local climate into account and develop their ability to mitigate the impacts of global warming impacts (Mendelsohn & Dinar, 1999).However, not all the farmers are likely to be aware of the climate change and adjust their farming practices accordingly. Therefore, understanding the farmers' perception of the negative impact of climate change on agricultural production is a very important issue and critical for an effective policy making for mitigating against climate change. Using a case study of Nepal, this study attempts to assess the factors influencing the climate change awareness/perception of rural farmers focusing on the role cooperatives and access to road infrastructure. Furthermore, the study also assess the adaptation measures practiced by the agricultural households to cope against the climate changes.

Nepal has witnessed global warming and erratic rainfall pattern over the past decades. As shown in Figure 1, the average rainfall is declining while the maximum temperature is increasing in the country. Since agriculture is mainly rainfed in nature with the availability of perennial source of irrigation in only 36% of the cultivated land (MOAD, 2017), the erratic and decreasing amount of precipitation across years is likely to undermine agricultural productivity and threaten smallholders' livelihood. Moreover, increasing trend of maximum temperature can be detrimental to the agricultural system that requires low temperature for flowering and fruiting in the mountainous region of the country. Due to the continuous drought, some of the food surplus districts in Nepal have been converted to the food deficit districts in 2007. About 7% of the paddy land remained fallow in 2006/07 which lead to reduce the national paddy production by 12.5% (Regmi, 2007). Few studies have assessed the effects of climate change on agricultural production in Nepal (Malla, 2009; Poudel and Kotani, 2009; Sapkota *et al*., 2010; Gent and Maraseni, 2012).However, there is a scarce literatureon assessing the factors influencing the climate change awareness/perception in the country. This study attempts to fill this void.Given the renewed attention by Nepal Government towards the construction of the roads and emphasis on organizing the farmers through formation of cooperatives, we focus on assessingits effects on influencing the climate change awareness/perception ofrural farmers.

METHODOLOGY

Description of Study Area and Data Collection: We selected three districts i.e. Mugu from Mountainous region, Dailekh from hilly region and Banke from Terai region to assess farmer's perception towards climate change (Figure 2). These districts were purposefully selected on the basis of vulnerability to climate change and food security situation capturing the agro-ecological variability of the country. For example, Mugu has high vulnerability index (MoE, 2010) and is a highly food insecure district (NeKSAP, 2011). It is one of the most remote and the least developed district in the country. Likewise, Dailekh has moderate vulnerability index (MoE, 2010) and is a moderate food insecure district. And Banke has low vulnerability index and is a food secure district (NeKSAP, 2011). All these three districts are based on Karnali river basin and lies in the mid-western part of the country. Five communities, that are located near the weather stations from each district, are purposefully selected to assure the data recorded in the weather stations accurately reflects the climate change pattern of the surveyed communities. Twenty households from each community were selected which resulted to 100 households from each district and sample size of 300 households from the study districts. The questionnaire was pre-tested and revised before its full implementation in the ground. The socio-economic information, household facilities, perception on climate change, changes in temperature and rainfall, types and intensity of disaster, damage and loss in agriculture, and coping strategies adapted to mitigate the climate change were collected from the sampled households.

Empirical Model: Binary logistic regression models and multivariate probit models are commonly used to study the relationship between climate change awareness/perception as dependent variable (Thoai, Rañola, Camacho, & Simelton, 2018; Lobell *et al*., 2008; Mendelsohn & Dinar, 1999). We assess the factors influencing climate change awareness as well as climate change perception using binary logistic regression model.

Increasing farmers' awareness towards climate change is important to incite the farmers to adjust the farming system to cope with the climate change. Several factors are likely to influence the climate change awareness. Our objective is to understand what types of farmers are likely to be more aware of the climate change. We modeled farmers' climate change awareness behavior by specifying $Y_i = 1$ if farmers have heard about the climate change (proxy of climate change awareness), otherwise 0. Given the limited dependent binary variable, alogit model was developed. Under the distributional property of error component as type 1 extreme value, the binary logit model yields the probability (P_i) towards climate change awareness as follows (Pyndick and Rubinfeld, 1991):

$$P_i(Y_i = 1) = \frac{1}{1 + \exp(-Y_i)} \quad (1)$$

The model assumes that the farmers' behavior towards climate change awareness depends on following set of characteristics i.e. socio-economic characteristics (S) that includes gender, last year saving from crops and livestock, annual income of household in last year, education, association with organization such as cooperatives (Cop), deforestation and natural reasons perceived as reasons of climate change (C), experience in farming (F), intensity of coping strategies adopted (I), access to road infrastructure proxied by the distance to motorable road (R), status of loss faced in agriculture (L) and the status of change in the food consumption habit (H). We first predicted the parsimonious model with only including roads or cooperatives affiliation (Cop) as follows:

$$Y_i = \alpha + \varphi I + \delta Cop + \epsilon \quad (2)$$

If the effects of the roads or cooperatives is driven by the omitted variables, then the coefficients that turn to be significant will be insignificant when controlled for the possible set of covariates. Therefore, we predicted full model controlling for the set of variables as follows:

$$Y_i = \alpha + \beta S + \gamma C + \theta F + \varphi I + \delta Cop + \vartheta R + \omega H + \tau L + \mu \quad (3)$$

Factors influencing climate change perception: Although farmers have heard about climate change, not all of them are likely to perceive the climate change. In fact, the perception towards climate change is likely to be realized after experiencing local weather for a long span of time. We defined 25 years as a threshold such that farmers assess whether the climate pattern of their place is different than it was 25 years ago. Our interest is to understand the characteristics of farmers that are likely to perceive the climate change. We modeled farmers' climate change perception behavior by specifying $Y_i = 1$ if farmers perceive the climate of their place is different than it was 25 years ago, otherwise 0. Given the limited dependent variable (binary variable), a logit model was developed. Under the distributional property of error component as type 1 extreme value, the binary logit model yields the probability (P_i) towards climate change perception as follows:

$$P_i(Y_i = 1) = \frac{1}{1 + \exp(-Y_i)} \quad (4)$$

The study assumes that the farmers behavior towards climate change perception depends on following set of characteristics i.e. socio-economic characteristics (S) that includes gender, last year saving from crops and livestock, education, association with the organization such as cooperatives (Cop), climate change awareness (C), experience in farming (F), intensity of coping strategies adopted (I), access to road infrastructure proxied by the distance to motorable road (R), extent of disaster experienced (D) and the status of change in the food consumption habit (H). Similar to the climate change awareness model, we first predicted the parsimonious model with only including road or cooperatives affiliation (Cop) as follows:

$$Y_i = \alpha + \varphi I + \delta Cop + \epsilon \quad (5)$$

Since there can be omitted variables likely to influence the placement of roads and formation of cooperatives, and also influence the level of awareness towards climate changes, we predicted full model assuming Y_i as a linear function of explanatory variables (Pyndick and Rubinfeld, 1991) as follows:

$$Y_i = \alpha + \beta S + \gamma C + \theta F + \varphi I + \delta Cop + \vartheta R + \omega H + \tau D + \mu \quad (6)$$

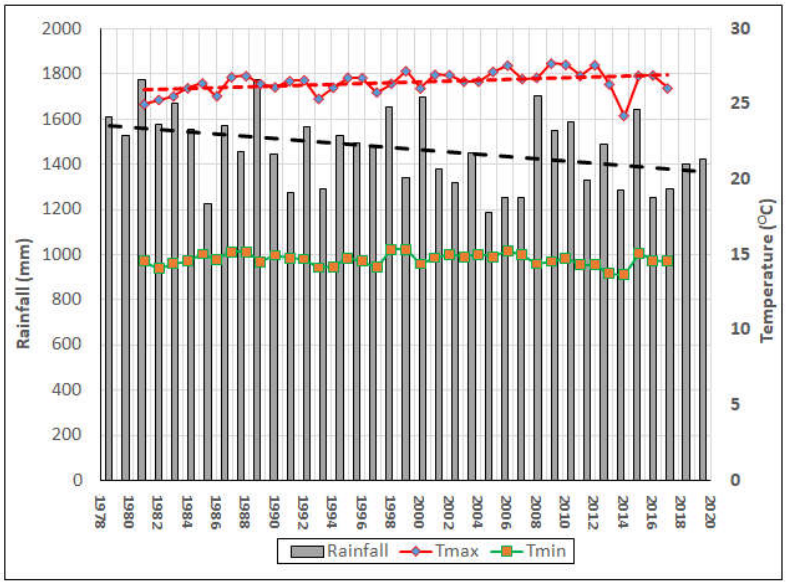
where $\alpha, \beta, \gamma, \delta, \varphi, \vartheta, \omega, \tau$ are the parameters of model to be estimated and μ is the random error term. In both the climate change awareness and perception models, we control for location specific characteristics by including district fixed effects to account for geographical heterogeneity. The model is estimated using econometric software Stata version 13.

RESULTS AND DISCUSSION

Descriptive Results: Table 1 presents the descriptive statistics of the variables used in the empirical analysis. Dependent variables of interest are the indicator of climate change awareness (Heard about climate change: Yes=1, No=0) and indicator of climate change perception (Has climate changed relative to 25 years ago?). While only 30% of the surveyed households have heard about climate change, 96% of the surveyed households have perceived climate change. About 62% have been involved in the community-based organizations. And 63% of the participants are associated with the cooperative/small group. The annual saving from the crops (93 thousand) is at least four times higher than the annual savings from the livestock (22 thousand). Such savings indicate the high importance of agricultural in the livelihood of the surveyed households. About 60% of the surveyed households are male headed while 40% are female headed. On an average, a household head has 40 years of experience in agriculture. These are the households who derives their livelihood primarily from an agriculture sector.Agricultural experience was found to positively influence the farmers' adaptation of practices to mitigate the climate change in Thailand (Arunrat, *et al*. 2017). The average coping index is about 10 indicating the use of average number of 10 coping strategies by a household. The average years of education of the respondent is about 13 years. The average distance to motorable road is about 9 kilometers. Especially the surveyed households from Mugu have poor access to motorable roads. About 78% of the households have changed their food consumption habit.

About 10% of the surveyed households had loss in agriculture. Deforestation and natural reasons have been perceived as one of the reasons of climate change by 77% and 48% of the households, respectively. About 11% of the households stated that the climate change events have impacted the family at the moderate or high disaster level. Using t-test, we test if the variables significantly differ between the households who are aware and not aware of the climate change. Similarly, we also tested if the variables significantly differ between those households perceiving and not perceiving the climate change. The t-test reveals that the mean of few variables (income, association with the community-based organizations, deforestations perceived as a reason of the climate change) significantly differ between those households who are and who are not aware of the climate change. Similarly, mean of the variables (association with the community-based organizations and cooperatives/small groups) significantly differ between those households who perceive and do not perceive the climate change. In the empirical analysis, we included several explanatory variables to understand the characteristics of households influencing awareness/perception towards climate change.

We finalized 31 major coping strategies after reviewing the literature and consulting with the selective farmers in the study areas. Farmers were asked to select the multiple strategies adoptedto cope against the climate change. Figure 3 shows the distribution of the number of coping strategies adopted by the farmers. The highest number of farmers have adopted 28 coping strategies. Overall, the distribution is skewed towards right indicating the relatively low number of coping strategies adopted by the farmers.



Source: Department of Hydrology and Meteorology, Nepal

Figure 1: Average rainfall and temperature (maximum and minimum) in Nepal (1977-2019)

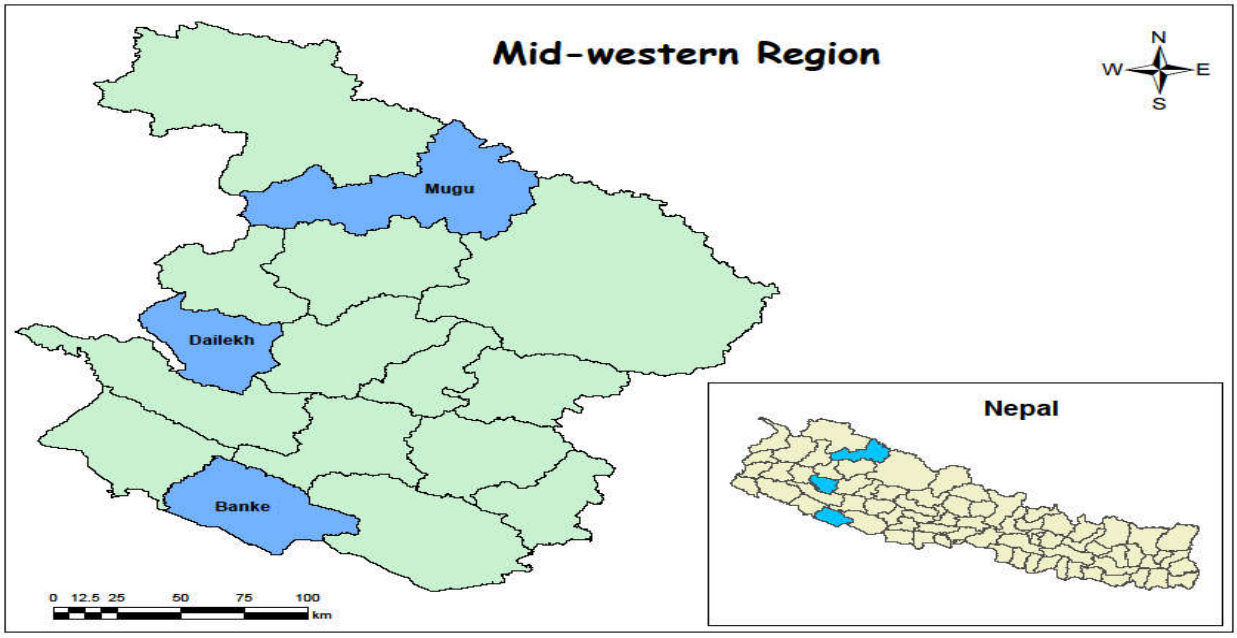


Figure 2. Map of Nepal and mid-western development region (colored districts are study areas)

Table 2 summarized the coping strategies adopted by the surveyed households. The top five strategies adopted are 1) cultivate new crops (59%); 2) increased application of in-organic fertilizers (59%); 3) mixed cropping (58%); 4) participate in community based natural resource management (57%); and 5) increase use of compost fertilizers (55%). The least adopted strategies to cope against climate change are livestock and crop insurance 6%), use of cold storage (4%) and seed bank (3%). Crop insurance and cold storage facility may not be available to farmers specially in remote regions of the country. Seed bank is a new concept and many farmers are unaware of it. Adoption of improved crop variety was ranked as the most important measures practiced by farmers in Ghana (Ndamani and Watanabe 2015). Our study also shows cultivating new crops as the top-most coping strategy adopted by the surveyed farmers. One expects that farmers with higher awareness towards climate change should adopt more number of coping strategies than farmers with lower awareness.

The coping index was simply estimated by summing the total number of coping strategies adopted by the households. We explored whether the households living near to the motorable roads have adopted higher intensity of coping index. While we found the linear and negative relationship between the coping index and the distance to motorable road for those households who have perceived the climate change. However, no meaningful relationship exists for the households who have not perceived the climate change (Figure 4). Households living close to the motorable roads are found to adopt higher number of coping strategies in comparison to those households living distance from the motorable roads underscoring the importance of road infrastructure in mitigating the climate change. Farming experience may matter in adopting the number of coping strategies. Farmers with increasing years of experience are likely to face the climatic shocks and should be more aware of the climate change. Figure 5 shows the relationship between the coping index and the years of

Table 1. Descriptive statistics of the variables included in the empirical analysis

Variables	Has heard about climate change (mean)?			Has climate changed relative to 25 years ago (mean)?			Total Sample (mean)
	No	Yes	t stat	No	Yes	t stat	All
Heard about climate change (Yes=1, No=0)				0.18	0.30	0.86	0.30
Has climate changed relative to 25 years ago (mean)?							0.96
Have involved in community-based organization (Yes=1, No=0)	0.58	0.69	1.71*	0.36	0.63	1.75*	0.62
Have membership in any cooperative/small group (Yes=1, No=0)	0.62	0.66	0.61	0.27	0.64	2.51**	0.63
Last years' saving amount from crops (in 1000 Rs.)	92.14	96.66	0.19	116.82	92.58	0.43	93.49
Last years' saving amount from livestock (in 1000 Rs.)	25.86	16.10	0.86	24.27	22.89	0.05	22.94
Gender (Male=1, Female=0)	0.62	0.54	1.31	0.45	0.60	0.99	0.60
Years of experience on agriculture	39.92	39.20	0.41	36.91	39.81	0.69	39.70
Coping index	9.13	10.28	1.54	8.18	9.52	0.75	9.47
Education level of the respondent	13.45	13.54	0.16	13.55	13.47	0.05	13.47
Distance to motorable road (km)	11.66	5.20	0.38	13.27	9.59	0.88	9.73
Change on food consumption habit (Yes=1, No=0)	0.77	0.82	0.57	0.82	0.78	0.21	0.78
Has bear loss in agriculture (Yes=1, No=0)	0.09	0.12	1.51				0.10
Total annual income of a household in the last year (in log)	11.71	11.66	4.28***				11.70
Deforestation perceived as one of the reasons of climate change (Yes=1, No=0)	0.72	0.89	3.09***				0.77
Natural reasons perceived as one of the reasons of climate change (Yes=1, No=0)	0.48	0.48	0.04				0.48
Variables	Has heard about climate change (mean)?			Has climate changed relative to 25 years ago (mean)?			Total Sample (mean)
	No	Yes	t stat	No	Yes	t stat	All
Heard about climate change (Yes=1, No=0)				0.18	0.30	0.86	0.30
The events have impacted family either moderate or high disaster (Yes=1, No=0)				0.09	0.11	0.21	0.11
District is Dailekh (Yes=1, No=0)	0.38	0.22	3.80***	0.18	0.34	1.06	0.33
District is Mugu (Yes=1, No=0)	0.37	0.28	0.87	0.64	0.33	2.12**	0.33
District is Banke (Yes=1, No=0)	0.26	0.51	2.67**	0.18	0.34	1.06	0.33

Notes: t test conducted to test if the differences in the mean is statistically different from zero or not ***p<0.01, ** p<0.05, * p<0.1, Source: Derived from Primary Survey 2018

Table 2: Strategies adopted by the farmers to cope against climate change

Strategies	Obs.	Mean	Std. Dev.
Cultivate new crop	300	0.59	0.49
Increased inorganic fertilizer	300	0.59	0.49
Started mixed cropping	300	0.58	0.49
Participated in community based natural resource management	300	0.57	0.5
Increased compost fertilizer	300	0.55	0.5
Investment in livestock pests and diseases	300	0.45	0.5
Changed in cultivation technique	300	0.45	0.5
Switched to another livestock	300	0.44	0.5
Participated in road & infrastructure improvement	300	0.44	0.5
Participated in flood/landslide risk reduction/water mgmt. activities	300	0.42	0.49
Started more off farm activities	300	0.41	0.49
Shifted to non-agricultural employment	300	0.39	0.49
Temporary out-migration	300	0.39	0.49
Raise improved breed of livestock	300	0.33	0.47
Left land fallow	300	0.31	0.46
Visited concerned offices seeking advice to reduce climate change impacts	300	0.28	0.45
Adopted improved seeds	300	0.28	0.45
Change on planting time	300	0.24	0.43
Provided supplemental irrigation management	300	0.23	0.42
Started agroforestry	300	0.22	0.42
Started both crops and livestock farming	300	0.21	0.41
Contributed in soil and water conservation	300	0.2	0.4
Crop cultivation only	300	0.18	0.38
Received agriculture skill dev. training	300	0.15	0.36
Investment in pond	300	0.13	0.33
Strategies	Obs.	Mean	Std. Dev.
Used of tunnel technique for vegetable farming	300	0.09	0.29
Raised livestock only	300	0.09	0.29
Livestock insurance	300	0.06	0.23
Agriculture insurance	300	0.06	0.23
Used cold storage	300	0.04	0.19
Started seed bank	300	0.03	0.16

Source: Derived from Primary Survey, 2018

experience in agriculture for those households who have and have not perceived the climate change. For those households perceiving the climate change, the coping index increased with the increase in the years of experience in agriculture. Finally, we assessed whether the households with higher intensity of coping index have incurred lower losses from the disaster events (Figure 5). We surmise that adoption of the more number of coping strategies should translate to reduced loss from disaster. In fact, we found a negative and weak relationship showing the positive effects of coping strategies on mitigating loss from the disaster.

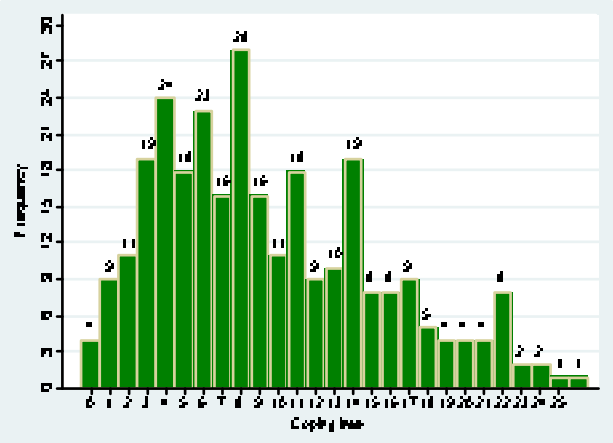


Figure 3. Distribution of coping index (number of coping strategies) adopted by farmers

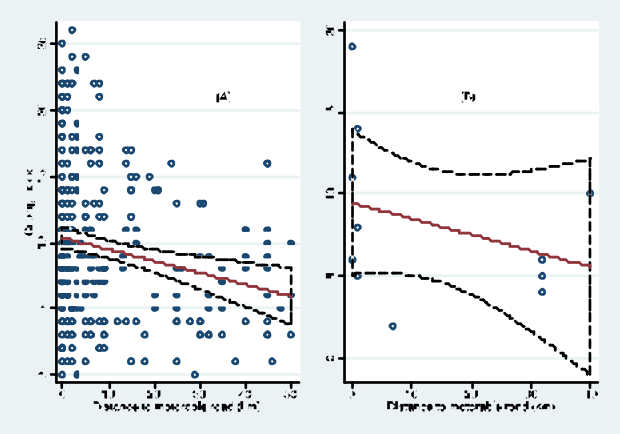


Figure 4: Influence of access to motorable road on the coping strategies adopted for those households who have perceived the climate change(A) and haven't perceived the climate change (B)

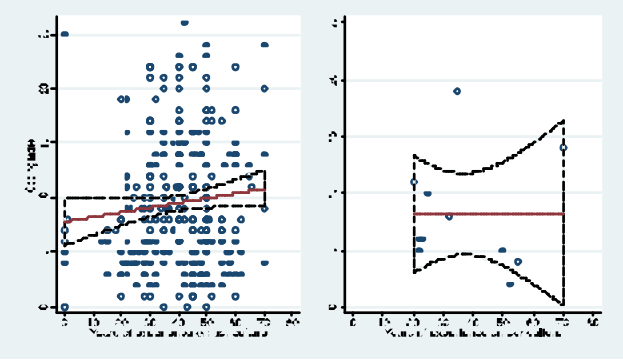


Figure 5: Influence of years of experience on agriculture on the coping strategies adopted for those households who have (A) and haven't perceived the climate change (B)

Empirical Results: Table 3 presents the empirical results on factors influencing climate change awareness. Since the model estimates from the binary log it model cannot be interpreted in a meaningful way except the sign of the coefficients, we estimated the marginal effects which are interpreted in terms of probability. Robust standard errors are estimated accounting the unknown source of heterogeneity and addressing clustering issue at the district level. First we predicted the models including only the road/cooperatives related variables.

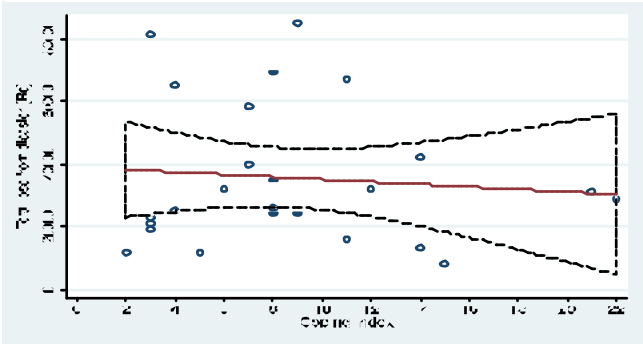


Figure 6: Influence of coping strategies adopted and the total loss (in Rs) from disaster

If the significance of the variables is retained even after controlling the additional variables, our results is due to the effects of the explanatory variables of interest (roads and cooperatives) rather than from the omitted variables. Results indicate that the road variable is significant at less than 1% even after controlling the full set of variables. This indicates that the roads matters for climate change awareness. An increase in distance to the motor able road by a kilometer reduces the probability of being aware to the climate change by 1%. Improvement and better connectivity of the road network have found to reduce child malnutrition (Thapa and Shively 2018) and food prices and variances in Nepal (Shively and Thapa 2017). However, cooperative variable was not found to be significant. While households perceiving deforestation as one of the reasons for climate change have 17% higher probability of being aware of the climate change, households perceiving natural reasons as one of the reasons for climate change have 19% lower probability of being aware to the climate change. These coefficients are statistically significant at less than 5% level. Households involved in the community organizations are 14% more likely to be aware of climate change. Although households with higher saving from crops are more likely to be aware of climate change, households with lower saving from livestock are less likely to be aware of climate change. Households incurring loss in agriculture have 11% higher probability of being aware to climate change. Households changing the food consumption habit have 14% higher probability of being aware to the climate change. Households from Mugu and Banke have about 12% and 36% higher probability of being aware to the climate change in comparison to the households from Dailekh. Further, table 4 presents the empirical results related to factors influencing the climate change perception. We estimated the robust standard errors controlling for heterogeneity issues emerging from unknown sources. Instead of interpreting the log of odd ratio, we interpreted the marginal effects for the convenience of interpretation. The cooperative variable is statistically significant at less than 1% in the full model indicating the positive influence of households' affiliation with cooperatives on climate change perception. Households affiliated with the cooperatives have about 4% higher probability of perceiving climate change. Those households who are aware of climate change are more likely to perceive climate change. The coefficient is statistically significant at less than 1% level. Similar to the climate change awareness model, the households with higher savings from crops are more likely to perceive climate change while the households with higher savings from livestock are less likely to perceive climate change.

Table 3: Factors influencing climate change awareness

VARIABLES	Roads	Cooperatives	Full Model
Distance to motorable road (km)	-0.01***		-0.011***
	(0.001)		(0.001)
Have membership in any cooperative /small group (Yes=1, No=0)		0.034	0.007
		(0.040)	(0.039)
Deforestation perceived as one of the reasons of climate change (Yes=1, No=0)			0.177**
			(0.074)
Natural reasons perceived as one of the reasons of climate change (Yes=1, No=0)			-0.191***
			(0.007)
Have involved in community based organization (Yes=1, No=0)			0.140***
			(0.030)
Last years' saving amount from crops (NRs.)			0.000***
			(0.000)
Last years' saving amount from livestock (NRs.)			-0.002**
			(0.001)
HH head is male (Yes=1, No=0)			-0.099
			(0.110)
Years of experience on agriculture			-0.002
			(0.001)
Coping index			-0.004
			(0.005)
Education level of the respondent			-0.001
			(0.007)
Total annual income of a household in the last year			-0.019
			(0.019)
Has bear loss in agriculture			0.108**
			(0.044)
Change on food consumption habit			0.138***
			(0.049)
Mugu	0.068***	0.042***	0.120***
	(0.002)	(0.003)	(0.005)
Banke	0.287***	0.260***	0.385***
	(0.001)	(0.001)	(0.017)
Observations	291	291	291

Note: Results are the marginal effects. Notes: Results are marginal effects. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.
Source: Derived from Primary Survey, 2018

Table 4. Factors influencing climate change perception

VARIABLES	Roads	Cooperatives	Full Model
Distance to motorable road (km)	-0.001		-0.000
	(0.001)		(0.001)
Have membership in any cooperative/small group (Yes=1, No=0)		0.039***	0.043***
		(0.006)	(0.012)
Heard about climate change (Yes=1, No=0)			0.010***
			(0.003)
Have involved in community based organization (Yes=1, No=0)			0.003
			(0.011)
Last years' saving amount from crops (NRs.)			0.000***
			(0.000)
Last years' saving amount from livestock (NRs.)			-0.000***
			(0.000)
HH head is male (Yes=1, No=0)			0.014
			(0.009)
Years of experience on agriculture			0.000***
			(0.000)
Coping index			-0.002
			(0.001)
Education level of the respondent			0.000
			(0.002)
The extent to which the events have impacted family (Yes=1, No=0)			0.003
			(0.018)
Change on food consumption habit			0.006
			(0.015)
Mugu	-0.047***	-0.044***	-0.041***
	(0.008)	(0.007)	(0.004)
Banke	0.002	-0.001***	0.000
	(0.005)	(0.000)	(0.007)
Observations	291	291	291

Notes: Results are marginal effects. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.
Source: Derived from Primary Survey, 2018

Table 5: Robustness test

	Climate change awareness		Climate change perception	
VARIABLES	Model-1 (Logit model)	Model-2 (LP model)	Model-3 (Logit model)	Model-4 (LP model)
Deforestation perceived as one of the reasons of climate change (Yes=1, No=0)	1.295***	0.144		
	(0.440)	(0.052)		
Natural reasons perceived as one of the reasons of climate change (Yes=1, No=0)	-0.252	-0.200***		
	(0.499)	(0.019)		
Have involved in community based organization (Yes=1, No=0)	0.556**	0.107*	0.237	0.010
	(0.252)	(0.030)	(0.690)	(0.019)
Have membership in any cooperative/small group (Yes=1, No=0)	-0.172**	0.015	1.879**	0.064**
	(0.080)	(0.030)	(0.928)	(0.009)
Last years' saving amount from crops (NRs.)	0.001*	0.000*	0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)
Last years' saving amount from livestock (NRs.)	-0.009**	-0.000	-0.001*	-0.000
	(0.005)	(0.000)	(0.001)	(0.000)
HH head is male (Yes=1, No=0)	-0.458	-0.079	0.743**	0.025
	(0.509)	(0.117)	(0.321)	(0.024)
Years of experience on agriculture	-0.008	-0.002	0.012*	0.000
	(0.006)	(0.002)	(0.006)	(0.000)
Coping index	0.003	-0.004	-0.070	-0.002
	(0.033)	(0.005)	(0.096)	(0.003)
Education level of the respondent	-0.014	0.001	0.017	0.001
	(0.029)	(0.007)	(0.090)	(0.004)
Total annual income of a household in the last year	-0.085	-0.029		
	(0.075)	(0.024)		
Has bear loss in agriculture	0.590***	0.094**		
	(0.111)	(0.021)		
Distance to motorable road (km)	-0.05***	-0.009**	-0.013	-0.000
	(0.008)	(0.001)	(0.032)	(0.002)
Change on food consumption habit	0.348***	0.120	0.237	0.007
	(0.126)	(0.042)	(0.887)	(0.030)
Mugu		0.168***		
		(0.015)		
Banke		0.392***		
		(0.015)		
Heard about climate change (Yes=1, No=0)			0.678***	0.019***
			(0.004)	(0.001)
The extent to which the events have impacted family (Yes=1, No=0)			0.452	0.015
			(0.780)	(0.020)
Constant	-0.138	0.474	1.572	0.883***
	(1.536)	(0.307)	(1.715)	(0.082)
District Fixed Effects	No	Yes	No	Yes
Observations	291	291	291	291
R-squared		0.193		0.033

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Source: Derived from Primary Survey, 2018

Finally, we conducted the robustness checks to understand if the results are sensitive to any changes in model specifications (using linear probability model), and with and without accounting the district fixed effects (Table 5). Although there is a slight change in the magnitude of the coefficients, overall the sign and significance of the results from the main models (Tables 3 and 4) are preserved showing the robustness of the findings.

Conclusion

Climate change has been a serious threat to the livelihood of smallholders who depend on the rainfed agriculture. Farmers have adopted several coping strategies to tackle against climate change, however, not all the farmers are likely to be aware of climate change or have perceived the climate change. It is important to sensitize the farmers regarding the consequences of climate changes and inculcate the mitigating strategies to fight against climate change. This study examines the coping strategies adopted by the farmers to alleviate the effects of climate change and further assesses the factors influencing the climate change awareness/perception. The study uses household survey data collected from 300 households from Mugu, Dailekh and Banke i.e. districts representing the agro-ecological diversity of the country. Results indicate that households affiliated with the community-based organization have higher probability of being aware to the climate change underscoring the importance of such institution. Households located near the motorable road have higher probability of being aware to the climate change. Although households with increased saving from crops have higher probability of being aware to the climate change, households with increased savings from livestock have lower probability of being aware to the climate change. This suggests that the climate change awareness programs should be targeted towards the households focusing mainly on raising livestock. Households affiliated with the cooperatives have increased probability of climate change perception of about 4% indicating the importance of farmers' association with the cooperatives. Improving road infrastructure and encouraging formation of community level organization and cooperatives are likely to create the climate change awareness to the farmers. Moreover, diversifying crops to minimize risks, changing planting dates and cultivating off-season vegetables could be viable options for adaptation to climate change in Nepal. Intervention of market-based instruments such as minimum support price and crop insurance could help to minimize dependency on unusual weather as well as reduce crop loss from climate change. Early warnings on likely occurrence of climate disaster and organizing climate change awareness campaigns will help to prevent the sudden loss from the unexpected climate related consequences. Findings of this study are expected to support in

developing adaptation strategies to cope with the climate change, and address the food security situation in the country.

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