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An Assessment of Locals' Perception on Changing Climate in Chitwan, Nepal

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Abstract
Climate change and natural calamities are serious global issues and Nepal is facing huge challenge due to dependency of most of the household on climate sensitive sector. A survey research was done to assess the locals' perception and realities of changing climate in settlements adjacent to Narayani basin located in Bharatpur-15 and Bharatpur-16 of Chitwan district. The locals' response were compared with the actual trends of temperature and rainfall recorded in the meteorological station located near the study area. A probit model was used to analyze the characteristics that differentiate the respondents who perceive the changes in line with the recorded data from those who do not. Drought was perceived to be the most important hazard by the respondents. Average annual rainfall was found to be in decreasing trend by 9.8mm per year. Likewise, summer temperature was found to be increasing with trend of 0.0025°C per year and winter temperature was found to be decreasing with trend of 0.0267°C per year. Trend analysis of temperature and precipitation support the respondents' perception as that of hotter summer, colder winter and decreased rainfall. From probit model, it was found that those household involved in commercial vegetable farming and those having access good communication asset have significantly higher probability to perceive the changes in rainfall and temperature.

Keywords
Climate Change, Perception, Hazard, Trend Analysis, Probit Model

1. Introduction

Climate change and natural calamities are the prime cause of hunger and affect all dimensions of food security including access to food, availability and stability of supplies, and nutrition across the world [1]. Nature dependent and geographically, socially and economically disadvantaged communities are at great risk and vulnerable to future climate change [2]. The chief bearers and victims of climate change are vulnerable groups in developing countries, particularly those whose livelihood is dependent on land use [3]. Nepal is more vulnerable to climate change than many countries due to high poverty and low adaptive capacity [4]. Nepal has experienced direct impacts of climate change and it is the fourth most vulnerable country with respect to climate change in the world. People living in mixed agro-livestock system like in context of Nepal are highly vulnerable to climate change [5]. Shift in rainy seasons and increasing intensity and variability of rainfall can raise the likelihood of extreme events including rainstorms and dry spells, which destroy or interrupt the physical development of crops worsening food security [6]. Erratic pattern of rainfall in Chitwan and increased temperature are likely to have adverse impact on agriculture production. Sharper and shorter spells of monsoon reduce ground water recharge [7]. Local communities from Chitwan experienced the change in the climate in recent years and are also following some adaptation strategies to respond changing climate in their livelihood at farm level. Consideration of farmers' knowledge and perception on climate change risks allows for management-level institutions to connect with concerns, knowledge, and endogenous adaptation at local level and provide insights to local conditions, vulnerabilities, and oppurtunities [8]. This study attempts to scrutinize awareness level of household on climate change and examine the consistency of

perception with scientific finding. Likewise, analysis of factors affecting the characteristics that differentiate the respondents who perceive the changes in line with the recorded data from those who do not were carried out.

2. Material and methods

2.1 Sampling design

The study was conducted in the central region of inner Terai of Nepal. Chitwan district was purposively selected for the study. The study focuses to explore the perception of households' whose livelihood depend on climate sensitive sector, agriculture and forestry. For this settlements in Bharatpur-15 and Bharatpur-16 adjacent to Narayani basin were surveyed. Simple random sampling method was adopted for survey. Sampling size was calculated using the formula [9];

$$S = \frac{N}{1+N(e)^2} \tag{1}$$

where,
$S =$ Sample size
$N =$ Population size, and
$e =$ Marginal error.
Considering 0.1 marginal error , sample size was calculated to be 96 samples. So, 100 samples were surveyed from two wards with extra 4 samples to be used in case of missing values.

2.2 Data collection and analysis

Both primary and secondary data were used in this study. Primary data were collected from household survey. Semi-structured questions were asked focusing on the individuals perceptions on climate change which include familiarity about the term and pattern of the temperature and precipitaion. Likewise, household were asked about their perception on major climate change related hazard they were facing. Similarly, socio-demographic questions related to information about household members like age, gender, education, occupation, income, household assets, involvement in trainigs, etc. were included in the questionnaire.
The secondary data were obtained from Department of Hydrology and Meteorology (DHM). Temperature and precipitaion data of 30 years (1990-2019) of nearest station from the research site were used. Data was analysed using Microsoft Excel and STATA.

2.3 Indexing / Scaling

Indexes and scales are important and useful tools in social science research. They have both similarities and differences among them. An index is a way of compiling one score from a variety of questions or statements that represents a belief, feeling, or attitude. Scales, on the other hand, measure levels of intensity at the variable level, like how much a person agrees or disagrees with a particular statement. For finding the major hazard, hazard ranking was done in scale of 1, 0.8, 0.6, 0.4, and 0.2 based on the respondent perception about them. The indexing was done as per the score. The index of major hazard was calculated by using the forced ranking as per the following formula:

$$I_{imp} = \Sigma \frac{S_i F_i}{N} \tag{2}$$

where,
$I_{imp} =$ Index of major hazard,
$S_i =$ Scale value,
$N =$ Total number of respondent, and
$f_i =$ Frequency of scale value given by the respondents.

2.4 Probit regression model

With the use of probit model we analyzed which type of respondents perceive temperature and rainfall changes in line with the recorded data. STATA 14.2 was used to run the probit analysis. The model were run separately for changes in temperature and rainfall. Probit model establishes relationship between probability values and explanatory variables and ensures the probability value between 0 and 1. Nine independent variables were used as described in Table 2. The probit model is given by;

$$Y = \alpha_i + X_i\beta_i + \varepsilon_i \tag{3}$$

where,
$Y =$ A dependent variable (perceive hotter summer and colder winter, perceive decrease in rainfall). $Y_i = 1$ if the respondent perceive hotter summer and colder winter and $Y_i = 0$ otherwise. Similarly $Y_i = 1$ if the respondent perceive decrease in rainfall and $Y_i = 0$ otherwise.
$X_i =$ The (1 x K) vector of other determinant influencing the locals' perception about the changes in the temperature and precipitation.

β_i = The (K x 1) vector of unidentified parameters, and
ε_i = The error term

Table 1: Description of independent variables for the probit models to analyze perceptions.

Dependent variables	Unit	Mean	S.D.
Perceive hotter summer and colder winter	Dummy; 1=yes, 0=otherwise	0.45	0.5
Perceive decrease in rainfall	Dummy; 1=yes, 0=otherwise	0.65	0.48

Table 2: Description of dependent variables for the probit models to analyze perceptions.

Independent variables	Unit	Mean	S.D.
Age of respondent	Years	46.08	12.96
Gender of respondent	Dummy; 1=male; 0=female (+)	0.38	0.487
Schooling of respondent	Years of schooling (+)	6.06	4.18
Commercial vegetable farming	Dummy; 1=yes, 0=no (+)	0.18	0.38
Share of farming income (agriculture and livestock)	Percentage of total (+)	31.94	34.59
Non-farm remunerative income	Percentage of total (-)	41.44	38.34
Income from wage labour	Percentage of total (-)	6.16	16.93
Fixed broadband internet	Dummy; 1=yes, 0=no (+)	0.52	0.5
Participate in vocational training	Dummy; 1=yes, 0=no (+)	0.49	0.5

3. Results and discussions

3.1 Familiarity of respondent with the term climate change

Most of the respondents were unaware about the term climate change. Only 8% of respondents were familiar with the term. Proactive respondents having higher level of education, participating in various trainings and having access to good communication only had strong knowledge on climate change.

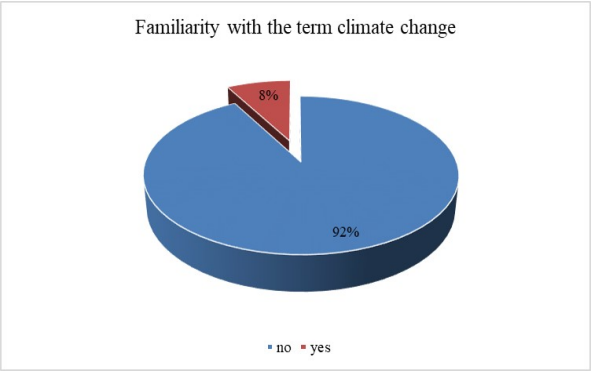

Figure 1: Familiarity of respondent with the term climate change

3.2 Perception on changes in temperature and precipitation

Regarding the changes in temperature, majority of respondents had felt increase in summer temperature and decrease in winter temperature (45%). Locals' viewed that days have become hotter and hotters as compared to the past years. 24% respondent perceive fluctuation in temperature between years, 6% perceive no changes in the temperature pattern and 25% respondent had no idea about the changes in temperature.

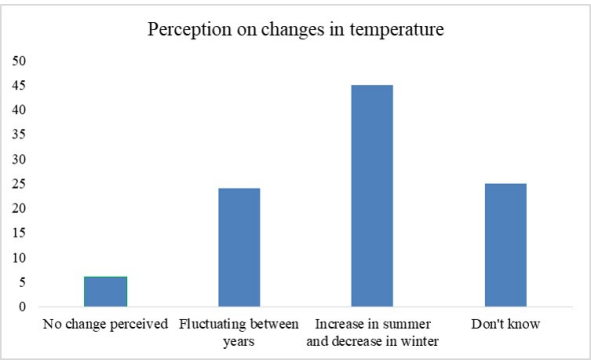

Figure 2: Perception of household on changes in temperature

Majority of household (65%) perceived decrease in precipitation. They reported that decrease in rainfall had become serious issue on rainfed farming. 18% household perceived increase in precipitation, 11% household didn't perceive any change in precipitation whereas 6% household were unaware about the quantity of rainfall.

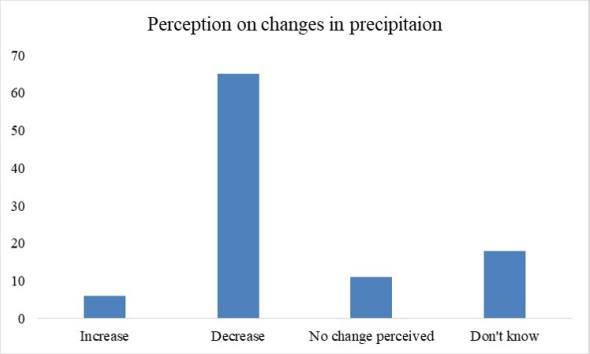

Figure 3: Perception of household on changes in precipitaion

When we look at onset of monsoon, majority of household (71%) have no idea about the monsoon timing. 22% household perceived late onset of monsoon and 7% perceive early onset of monsoon. In the study area 85% household depend on agriculture and timely monsoon is one of the important factor for improving agricultural production.

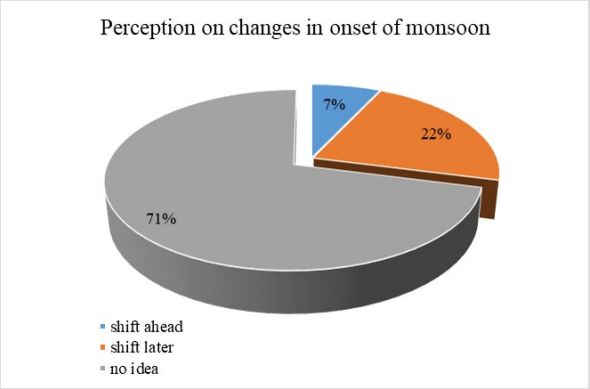

Figure 4: Perception of household on changes in onset of monsoon

3.3 Major climate induced hazard and their ranking

Drought was found to be more severe hazard from the survey because of lack of canal irrigation. Even though there were households who irrigate their land it was through underground irrigation. Severe drought leads to decrease in the underground water affecting the irrigation and thus yield of crops. Vegetable farmers were highly affected by the hailstorm and was ranked second. Problem of pest was ranked less severe by households than drought and hailstorm stating that there was easy access to pesticide for pest control. Households solely depending on rainfall for cultivation stated unseasonal rainfall as problematic however, it was ranked less severe than other hazard.

Table 3: Ranking of climate change related hazard

Climate change related hazard	Index	Rank
Drought	0.668	1
Hailstorm	0.662	2
Insect pest	0.656	3
Cold waves	0.522	4
Erratic rainfall	0.49	5

3.4 Trend of rainfall and temperature

Rainfall and temperature data of 30 years of Rampur station was taken from department of hydrology and meteorology. Average annual rainfall was found to be 2004.94mm with the standard deviation ($\pm$415) with decreasing trend of 9.8mm per year.

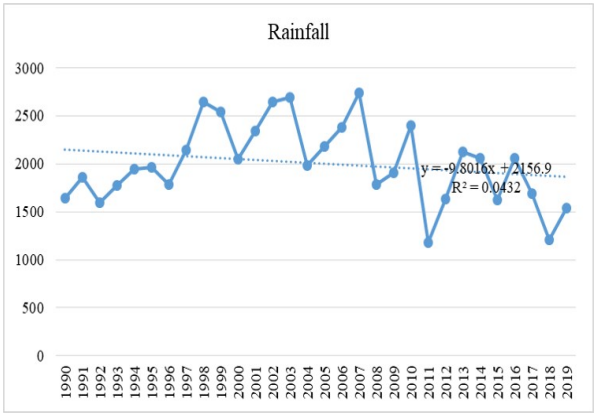

Figure 5: Rainfall trend of Rampur

Summer temperature was found to be increasing with trend of 0.0025°C per year and winter temperature was found to be decreasing with trend of 0.0267°C per year.

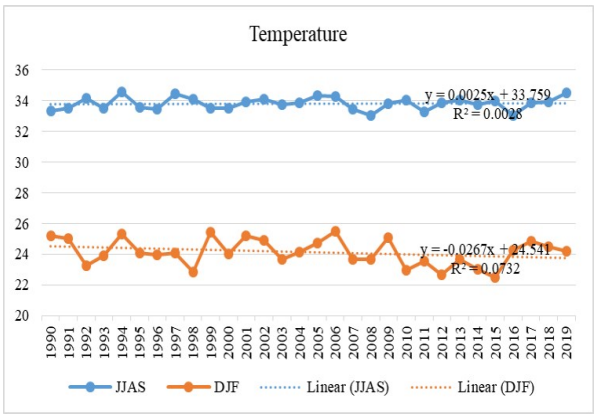

Figure 6: Temperature trend of Rampur

3.5 Results for the binomial probit model for the determinants of perception

The result from the study shows 45% respondent perceived hotter summer and colder winter and 65% respondent perceived decrease in rainfall. The ability of the respondents to perceive temperature and annual rainfall in line with the recorded data was analyzed using binomial probit model. Multicollinerity was tested among explanatory variables. Variance Inflation Factor (VIF) was found to be less than 10 which shows no multicollinearity problem among explantaory variables. The result of the probit model are presented in Table 4 and Table 5. Model run for perceiving hotter summer and colder winter is significant at 1% level of significance and model run for perceiving decreasing rainfall is significant at 5% level of significance. The percentage correctly predicted for the temperature model is 72% and that for the rainfall model is 69%. The estimates are presented in terms of marginal effects. The positive sign of the estimates denotes that the factor enables perceptions in the right direction, while negative sign denotes that the particular factor does not enable perceptions in the right direction.
For the temperature model all the variables have positive coefficients.

Table 4: Estimates from the probit models to analyze perception for temperature.

Independent variables	Marginal effect	P value
Age of respondent	0.0013235	0.729
Gender of respondent	0.1932925	0.05**
Schooling of respondent	0.0062727	0.584
Commercial vegetable farming	0.5370665	0.001***
Farm income	0.001815	0.322
Non-farm remunerative income	0.0009254	0.541
Income from wage labor	0.0063656	0.023**
Fixed broadband internet	0.2768788	0.013**
Vocational training	0.0414916	0.667

Note: ***, **, * indicate significant at 1%, 5% and 10% level of significance, respectively

For the rainfall model six variables, gender, commercial vegetable farming, farm income, non-farm remunerative, income from wage labour, and fixed broadband internet have positive coefficients. Schooling of respondent is found to be non-significant in this study. Gender of respondent was found to be highly significant in both temperature and rainfall model.

Table 5: Estimates from the probit models to analyze perception for temperature.

Independent variables	Marginal effect	P value
Age of respondent	-0.009703	0.012**
Gender of respondent	0.2558558	0.007***
Schooling of respondent	-0.0005809	0.962
Commercial vegetable farming	0.2308089	0.092*
Farm income	0.0028747	0.097*
Non-farm remunerative income	0.0007841	0.575
Income from wage labour	0.0001706	0.954
Fixed broadband internet	0.2301409	0.027**
Vocational training	-0.127144	0.892

Note: ***, **, * indicate significant at 1%, 5% and 10% level of significance, respectively

Male perceived the changes in correct direction. This contradicts with previous studies that there is non-existence of gender imbalance in climate change perception between male and female[10]. Non-farm income was assumed to negatively affect perception [11] but in this study such relation was not established. It was found to have non-significant positive relation. Likewise, farm income was found to have significant positive relation on rainfall model. Those household involved in commercial vegetable farming have significantly higher probability to perceive the changes in rainfall and temperature. This similar to previous [12], where it is reported that commercial farmers are better able to perceive changes in both temperature as well as rainfall. There can be two explanations for why households involved in commercial vegetable farming are better able to perceive the changes in these climate variables. Firstly, vegetables are by nature more susceptible to decreasing rainfall compared to other cereal crops, thus farmers cultivating vegetables will be following rainfall patterns with greater care. Secondly, farmers

who cultivate cash crops are those who have received related training(s) from the NGOs, thus they are better informed about these phenomena. Ownership of fixed broadband internet is significant in both models. Possession of fixed broadband internet facilitate the household's access to information related to weather forecasts. It indicates the need of communication in awareness about changing climate.

4. Conclusions and recommendations

Variations in temperature and precipitation patterns have impacts on various aspects of local life. Decrease in rainfall, increase in summer temperature and decrease in winter temperature were experienced by households which was in accordance with data of the nearest meteorological station. Drought was perceived to be major hazard caused by climate change. The main factors significantly affecting awareness level associated with climate change were age, gender, involvement in commercial farming and possession of fixed broadband internet. Thus, strong communication channel should be established to increase awareness about climate change and disseminate various adaptation strategies at local level. Likewise, programs should be targeted focusing the marginalized group who are more affected by the changing climate.

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