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Perception of Climate Change among Rural Households: A Case Study from the Himalayan 'Cold Desert' Ladakh, India

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ABSTRACT

Initiatives for sustainable development could be hampered by climate change, especially in underdeveloped nations. A significant body of research shows that developing economies are vulnerable to climate change because of their strong dependency on fossil fuels and industries susceptible to climate change, like tourism and agriculture. This study used farming household survey data to better understand how climate change impacts interact with socioeconomic developments and are seen at the local level. This study evaluated opinion components using data from a questionnaire survey conducted in 2022 (N = 64), and provided aspects that are similar to or dissimilar from those found in the pertinent literature. Binary logistic regression was utilized in the statistical analysis to predict whether climate change is a very serious issue for farm households or not. Study employed the questions about general air pollution concerns, increasing tourism, alternation in precipitation, increase in annual temperature, increase in the incidence of disease and insect pests as response variables. It has been concluded that rising number of tourists visiting the Ladakh valley, increase in the annual temperature and disease and insect pest incidence on crops had a significant impact on the farm households concern about climate change. It was observed that local communities today have a better understanding of climate change.

Keywords: Climate concern, perceptions of climate change, Ladakh, binary logistic regression

In recent years, there has been an increase in worry about climate change in many parts of the world (Capstick, *et al.* 2015). It is believed that the Himalayas are undergoing rapid climate change, which will have negative effects on the environment, society, and the economy for more than two billion people. Data on the severity of climate change or its effects on the area, however, are scarce (Chaudhary & Bawa, 2011). Despite being dependent on local climate characteristics, farmers' assessments of climate change are consistent with meteorological study. Many farmers in eleven African nations think that temperatures have already risen. The likelihood of noticing climate change is higher among those with the most farming expertise (Maddison, 2006). Since most smallholder farmers lack the resources to adapt, they are especially vulnerable to climate change (Ayanlade *et al.* 2017). Additionally, respondents claim that the profitability and output of vegetable farms have been impacted by climate change. Even some of the respondents made predictions on how climate change would impact their future descendants' quality of life (Adiyoga, 2018).

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Areas of the leeward side of the Pir Panjal Range have experienced a decrease in the winter snowfall component of total winter precipitation as a result of "global warming," delaying the onset of winter and early spring and effectively shortening the snowfall season (Bhutiyani *et al.* 2010). It is crucial to investigate how people view the climate and the environment in general in order to comprehend how people would react to climate change. Local knowledge of climate should be incorporated into every strategy intended to lessen the effects of climate change since it serves as the foundation for decision-making (Vedwan and Rhoades, 2001). Climate change is a top issue for the Chinese government and the Chinese people, which may help to explain why China is actively moving toward being a worldwide leader in this area (Wang *et al.* 2020). Over the past few decades. There has been many fold increase in the number of climate related disasters. Much of India's population still lives in the rural areas and is involved in agriculture and other Agri based activities. The greater variability in rainfall and temperature, etc. experienced of late has directly affected the livelihood and well-being of millions of rural households. India's national action plan on Climate Change 2008 identifies a range of priority areas for coordinated intervention at the national and state levels. However, there would have been better results if rural households been given a greater role.

The literature cited above demonstrates that the majority of investigations concentrate on populated states. At the same time, there is a dearth of knowledge regarding the climate concerns of smaller countries. Concerns about the climate could be different in a nation like India due to its historical background. Therefore, we thought it worthwhile to carefully investigate a certain Ladakh region "cold desert" in the Himalaya. We think that analyses of local climate change issues are not yet available here, and profound research in union territory of Ladakh will give new experience about environmental awareness of tribal area.

The main aim of this study is to provide a comparable and relevant view of aspects of climate change concerns in the Himalayan 'cold desert' Ladakh context. Based on the above starting points, the factors that determine climate concerns in general are summarized based on the related literature. Then, taking these factors into account, a case study is presented in which the attitudes of the population of the group of settlements studied are described in detail.

MATERIALS AND METHODS

Study Area and the Method of Sampling

The selected study area represents a Himalayan cold desert Ladakh, its consist of two districts. One of the selected districts is a tourism hub Leh, while the other one is Kargil. Sample of 64 farmers have been taken, then 31 farmers from Leh and 33 farmers from Kargil have been selected by using proportional allocation method. The well-structured questionnaire was used in conducting the survey. The selected respondents read the questions by them and interviewer helped with interpreting the questions where necessary.

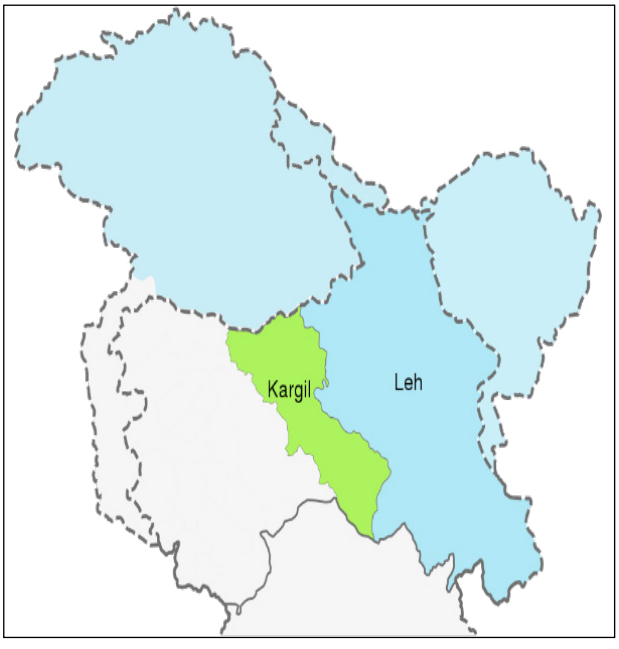

Fig. 1: Map of the study area

Data Analysis

Statistical analysis of the data was performed using the software SPSS 22. Binary logistic regressions were applied in the statistical analyses. Regression analysis was applied to predict the probability of which variables affect the degree of climate concern. Since dependent variables were recoded into dichotomic variables (1 or 0), binary logistic regression was

used for the analyses. The following questions of the questionnaire were used for the binary logistic tests:

- Climate change is a serious problem in Ladakh
- What is your source of information related to Climate Change
- Reasons for climate change
- Tourism is responsible for Climate change
- Air pollution is responsible for climate change
- You are willing to change your lifestyle in order to fight against Climate Change
- Do you think it is possible to fight against climate change
- Do you think selective waste collection help in fight against climate change
- Do you think using, energy effective devices help in fight against climate change
- Do you think buying environmentally friendly products help in fight against climate change
- Do you think using renewable energy will help in fight against climate change
- Do you think using public transport will help in fight against climate change
- Do you think walking/bicycling will help in fight against climate change
- Do you think using electric cars will help in fight against climate change
- Is there unavailability of local water sources
- Spring timing of cropping season increased
- Precipitation patterns altered
- Annual temperature increased
- Disease and insect pest incident increased in crops

Regression analysis was applied to predict the probability of which variables affect the degree of climate concern. Since dependent variables were recoded into dichotomic variables (1 or 0), binary logistic regression was used for the analyses. Independent variables with the highest regression coefficient (B) have the most significant impact on the prediction of the dependent variables.

The probability of success modeled using the following logit model:

$$ln(p/(1 - p)) = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8$$

Where,

$ln(p/(1 - p))$ = Climate change is a serious problem in Ladakh (Yes = 1 and No = 0)

X_1 = Age

X_2 = Sex

X_3 = Education

X_4 = Tourism (Yes = 1 and No = 0)

X_5 = Air pollution (Yes = 1 and No = 0)

X_6 = Alteration in precipitation (Yes = 1 and No = 0)

X_7 = Annual temperature increased (Yes = 1 and No = 0)

X_8 = Disease and insect pest incident increased in crops (Yes = 1 and No = 0)

RESULTS

Demographics and Socioeconomic Analysis

For both Leh and Kargil, the population is increasingly elderly and consists of farmers who were born in the area. The 67.2% of the participants surveyed were of the age group of 30-54 years and 20.3% were of less than 30 years (Table 1). In Ladakh, approximately 12.5% of the surveyed respondents were over the age of 54 years. Of the total farmers surveyed in Ladakh, 45.3% were women and 54.7% were men. About 87.5 percent of the total population was educated upto matric level and above. More than 25 percent family members were educated up to higher secondary and above.

Table 1: Demographic and Socio-Economic Characteristics for farmers in Ladakh

Characteristics	Frequency	Percent	Cumulative Percentage
District			
Leh	31	48.4	48.4
Kargil	33	51.6	100
Age			
Less than 30 years	13	20.3	20.3

30 to 54 years	43	67.2	87.5
More than 54 years	8	12.5	100
Gender			
Female	29	45.3	45.3
Male	35	54.7	100
Education Qualification			
Illiterate	8	12.5	12.5
Primary School	14	21.9	34.4
High School	26	40.6	75
Higher Secondary	7	10.9	85.9
Graduation and above	9	14.1	100

Perceived Impacts and Community Attitudes toward Climate Change

Bar graph below shows that farmers marked most frequently TV, radio, and internet as their primary sources of information regarding climate change. About 29.7% respondents told that it was TV where they first time heard about climate change although they are experiencing the change in the temperature and precipitation patterns in climate before but not bothering about that so much.

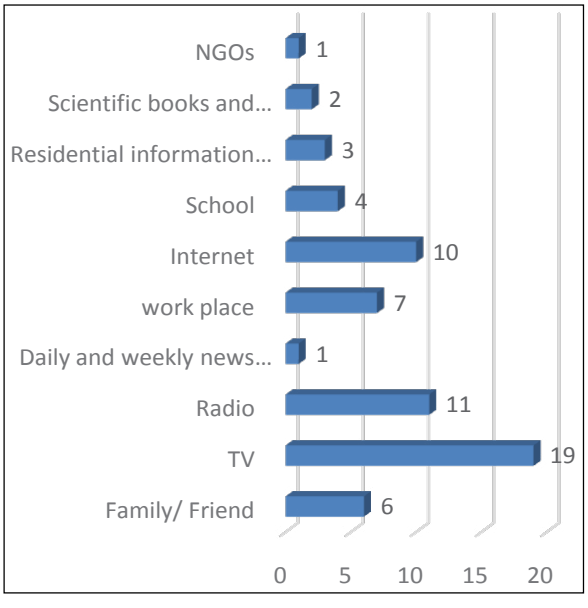

Fig. 2: Source of information related to Climate Change

7.8% of the farmers believe that climate change occurred in the Ladakh Valley is due to natural reasons, 42.2% of the farmers said that it was due to man-made reasons, whereas, 50% of the farmers are of the view that it was due to both natural and man-made reasons.

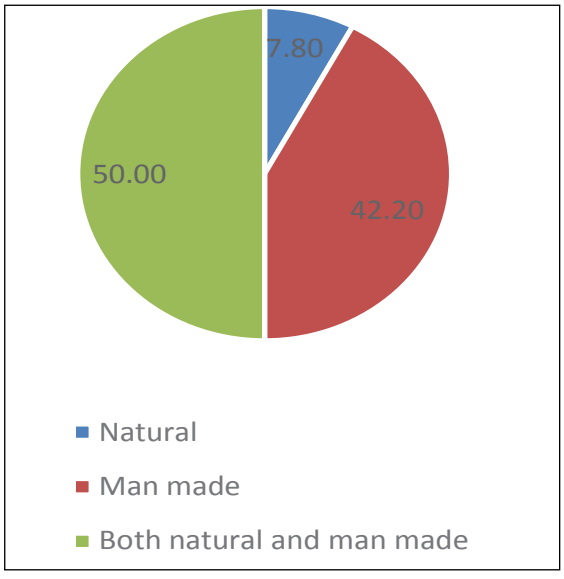

Fig. 3: Reasons for climate change

It was observed that approximately 86% of the farmers believe that it is possible to fight against climate change. However, rest of the farmers believe that it is impossible to fight against climate change and it can't be reversed.

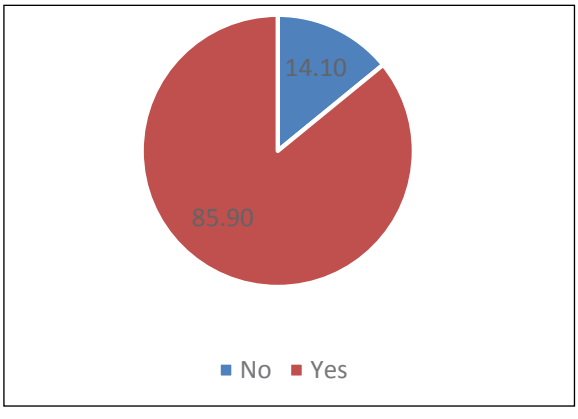

Fig. 4: Farmers perception possibility to fight against climate change

Model Fit

In multiple regression, the model fit is measured by the square of the multiple correlation coefficient R square, which is also called the coefficient of multiple determination. In binary logit, commonly used measures of model fit are based on the likelihood function and are Cox and Snell R Square and Nagelkerke R square.

Table 2: Model Fit summary

Cox & Snell R Square	Nagelkerke R Square
0.520	0.799

Normally used is Nagelkerke's R^2, this is an adjusted version of the Cox & Snell R-square that adjusts the scale of the statistic to cover the full range from 0 to 1. Here, 79.9% change in the criterion variable can be accounted to the predictor variable in the model.

Classification table

Classification table provides an indication of how well the model is able to predict the correct category once the predictors are added into the study. The model correctly classified 93.8 percent of cases overall (sometimes referred to as the percentage accuracy in classification: PAC).

In other words, this is the rate of correct classification if we always predict that a respondent would choose that climate change is a serious problem in Ladakh. Specifically, it presents information on degree to which the observed outcomes are predicted by the model.

Table 3: Classification table

Observed		Predicted		
		Climate change is a serious problem in Ladakh		Percentage Correct
		No	Yes	
Climate change is a serious problem in Ladakh	No	11	3	78.6
	Yes	1	49	98.0
Overall Percentage				**93.8**

Significance testing

The significance of the estimated coefficients is based on Wald's statistic. This statistic is a test of significance of the logistic regression coefficient based on the asymptotic normality property of maximum likelihood estimates and is estimated as:

$$Wald = (a_i/SE_{ai})^2$$

Where,

a_i = logistical coefficient for that predictor variable

SE_{ai} = Standard error of the logistical coefficient

Table 4: Variables in the equation and their significance

Variables	B	S.E.	Wald	df	Sig.	Exp (B)
Age	2.858	1.564	3.340	1	.068	17.427
Sex	-1.400	1.512	.858	1	.354	.247
Education	.316	.626	.254	1	.614	1.372
Tourism	4.972	2.215	5.036	1	.025	144.273
Air pollution	26.402	20313.980	.000	1	.999	
Alteration in precipitation pattern	21.997	28420.723	.000	1	.999	
Annual temperature increased	4.497	2.016	4.978	1	.026	89.759
Disease and insect pest incident increased in crops	3.007	1.514	3.942	1	.047	20.219
Constant	-62.170	34934.158	.000	1	.999	.000

This table shows the relationship between the predictors and the outcome. B (Beta) is the predicted change in Log Odds - for 1 unit change in predictor, there is Exp(B) change in the probability of the outcome. The beta coefficients can be negative or positive, and have a t-value and significance of the t-value associated with each. Odds Ratio is equal to 1 means probability of falling into the target group is equal to the probability of falling into the non-target group. Odds ratio is more than 1 means probability of falling into the target group is greater to the probability of falling into the non-target group, the Event is likely to occur. Odds ratio is less than 1 means probability of falling into the target group is Less to the probability of falling into the non-target group, the Event is unlikely to occur. It was concluded rising number of tourists visiting the Ladakh valley, increase in the annual temperature and increase in disease and insect pest incidence on crops had a significant impact on the farm households concern about climate change. It was found that the odds of farmers choosing climate change is a serious problem in Ladakh are 144 times higher than other farmers who do not think so and believe tourism is not responsible of climate change. Whereas, the odds of farmers choosing climate change is a serious problem in Ladakh are 89.75 times higher than other farmers who do not think so and believe increase in annual temperature is

not responsible for climate change. However, odds of farmers choosing climate change is a serious problem are 20 times higher than other farmers who do not think so and reported that disease and insect pest incident are not increased in crops.

CONCLUSION

It has been concluded that rising number of tourists visiting the Ladakh valley, increase in the annual temperature and increase in disease and insect pest incidence on crops had a significant impact on the farm households concern about climate change. It was further observed that local communities today have a better understanding of climate change and believe that it is possible to fight against climate change. While the tourist boom has undeniably created employment opportunities in the region of India, it has led to severe after-effects on the environment. With more tourists coming in, there is a growing problem of improper disposal of garbage and plastic waste in the area. Infrastructure for waste disposal and management is still lacking, resulting in an impact on the fragile ecosystem in Ladakh. Although international and national policies have been formulated with large scale investments, it is necessary to have a suitable local action plan for implementation and enforcement initiated and coordinated by local governments in the context of greater devolution that has taken place. With ruler households among the most vulnerable to climate change effects.

An action plan can be prepared in Ladakh by organizing high level meetings, Socioeconomic surveys and energy use mapping can be carried out. Several multi-sectoral schemes can be implemented to reduce emissions, increase carbon sequestration, and preserve ecology and biodiversity. Black carbon that is responsible for fast melting of glaciers can be reduced by using less automobiles near the glaciers and by stopping burning pruned branches of apple tree. While the tourist boom has undeniably created employment opportunities in this region of India, it has led to severe after-effects on the environment. Tourists can be motivated to avoid single use plastics in the valley and go for unique experiences beyond visiting star attractions, choose locally grown vegetables and fruits to support the local farmers, waste less water, choose homestays over swanky hotels and use dry compost toilets wherever possible. Through the ongoing decentralization process, which ensures people's participation, rural households can play a crucial and frontline role in coordinating effective responses to climate risks. Enabling adaptation and building climate change resilient communities.

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