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Relationship between Climate Change Perception of Local Communities, Agriculture and Gender Variations in Fozal Valley of Kullu District, Himachal Himalayas

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***Abstract*:** The climate change perception of local communities is an integral component of the decision-making process. Several attempts have been made to understand the local communities' perceptions towards climate change in the Indian Himalaya. However, limited information is available on how gender affects the local communities' climate change perception. The present study was an attempt to cover this knowledge gap. A semi-structured questionnaire survey was conducted in 4 villages in the upper Beas valley of Himachal Pradesh to document their perception towards climate change impacts in the region. The local inhabitants perceive that advancing developmental activities are enhancing the climate change impacts in the valley. The inhabitants are experiencing changes in local climate conditions such as an increase in annual temperature while precipitation, annual snowfall, and number of chill units are decreasing, which is a determining factor for a higher yield of traditional mountain crops. The annual average temperature, average annual maximum, and minimum temperature for the period 1990-2010 also show an increasing trend. A significant variation was noted between men and women's responses to climate change. The present study suggests that local communities' suggestions and issues need to be incorporated while designing and implementing climate change adaptation and mitigation strategies.

Keywords: Community perception, Climate change, Gender, Fozal valley, Adaptation and mitigation

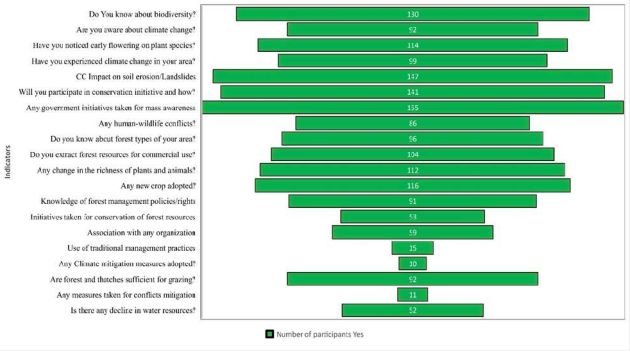
The Himalaya and the people inhabiting the Himalayan region are perceived to be the most vulnerable to the impacts of global and regional climate change. Thus, assessing the local community's perception of climate change is critically important for designing the adaptation and mitigation strategies. Climate change perception is determined by the social, cultural, economic, and institutional make-up of the surrounding environment (Carr 2008). A large body of literature exists that clearly demonstrates that within the community, perception was influenced by factors such as gender, ethnicity, and caste system and it is observed that women perceive the climate change challenge differently. In the Indian Himalayan Region, women are more dependent on natural resources and are at the front of climate change challenges (Nellemen et al 2011). Adzawla et al. (2019) also highlighted that climate change severely impacts women due to their low adaptive capacity. In the eastern Himalaya, women have admitted that climate change has negatively impacted their regular practices of collection of forest foods, crop harvesting, fermenting, and food storage (Bhadwal et al 2019). Parties to the UNFCC have also identified the role of women in climate change responses due to their traditional knowledge and direct relationship with nature. It has also emphasized developing gender-responsive national climate policies. Understanding the socioeconomic status of women in mountain communities and ensuring power equity are thus critical for effective adaptation and mitigation strategy implementation (Drenkelman 2010, Eastin 2018). The women in the Indian Himalaya are responsible for all household activities, livestock management, and agricultural activities and should be placed at the center of climate change adaptation and mitigation planning due to their intense involvement with nature and its resources (Nellemen et al 2011). Women's underrepresentation in decision-making and adaptation planning processes may result in the continuation of current vulnerabilities in the future. To address this issue, the present study aims to present the varied inter-group responses of local communities with a focus on how women's responses differ from men's responses towards climate change and the various adaptation strategies as suggested by the local communities.

MATERIAL AND METHODS

Study area: Fozal Valley is a biodiversity-rich region located in the Kullu district of Himachal Pradesh. The valley is dominated by an agro-pastoral economy, with agriculture, horticulture, and animal husbandry as the main sources of income, followed by employment in the private and public

sector. Almost every household owns agricultural land and livestock for their day-to-day requirements. Apple (*Malus pumila*) and cash crops (*Phaseolus vulgaris, Brassica oleracea, Allium sativum*, *Pisum sativum* and *Diasporus kaki*) are the main agricultural crops. Agriculture is of subsistence type and is dependent on climatic conditions for good yield. Agricultural fields are too small for mechanization to increase production. Apart from this, the collection and trade of important medicinal and aromatic plants provides vocational income to the rural communities of the valley. The region is undergoing moderate urbanization and a transition from the traditional agriculture-based economy to modern livelihood options such as small-scale business development. The valley has been inhabited for generations by indigenous and tribal communities like *Jehcchas, Gaddis, Gurjars* along with other communities The social structure of the area represented a higher proportion of younger population in the age group 18-45 years. However, the older population with age between 50-80 years are always preferred to be a better information resource for climate change perception exercises in the IHR as they are witnesses of gradually changing climate conditions at the local level. The traditional knowledge of local communities can provide valuable information and management options to mitigate climate change in their areas.

Household survey: The household surveys were conducted in four villages of Fozal valley, Kullu district, Himbari, Dhara, Runga, and Beasar (Fig. 1) and collected information from 127 participants, 61 male and 66 female, using semi-structured questionnaires. Different indicators were used for collecting information on the socioeconomic status such as age, gender, education, income source, and perception of local communities. However, only 22 indicators through 3 responses; Yes, No, and Can't say are discussed in this paper (Graph 1).



Graph 1. Indicators used to assess perception of local communities towards climate change

Respondents above the age of 18 or the head of the household were preferred for information collection. Key informants in each village, such as the village head (Sarpanch, Pradhan, Mahila mandal, or affiliated to any local governing body) were identified and interviewed using the same semi-structured questionnaire. The semi-structured questionnaire was followed by an open-ended discussion to document any additional information not included in the questionnaire. The survey was conducted as part of a larger study focused on the assessment and valuation of high-altitude ecosystems in Himachal Pradesh in relation to climate change. All information was collected with the consent of local communities and is shared with them, and the communities understand and agree that some of the

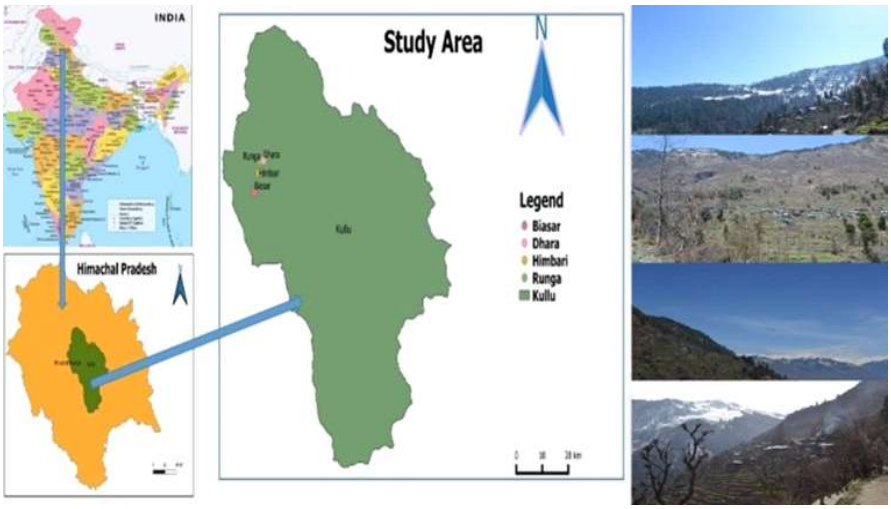


Fig.1. Right corner: Map of study area; Left corner from top to bottom: General view of Himbri, Beasar; Dhara and Runga

information may be published with proper acknowledgment.

Analysis of socioeconomic data and response to climate change: The collected data was analyzed by calculating the percentage for each indicator. A mixed effects model was used to explore the possible effect of socioeconomic factors on climate change perception. The study includes 7 explanatory variables in the analysis-age, gender, education level of respondent, number of crops cultivated, number of sources of income, land type, and village size-which were referred to as independent variables or predictor variables, while response variables are the variables one would be interested in predicting or forecasting. Village size was used as a fixed variable in the analysis. A set of 4 questions from the semi-structured interview was selected for the analysis. A negative, positive, or neutral score was assigned for each response to the questions, which were later added to calculate a mean perception score. Perception scores of 1 were considered negative. Scores > 1 were considered positive, scores of 0 were considered neutral (Suryawanshi et al. 2014). The range of the mean perception score varies from -4 to 4, with -4 representing the most negative perception and 4 representing the most positive perception.

Mixed effect model: A mixed effect model was used to identify the factors influencing the difference in perception of men and women towards climate change. The perception score was used as a response variable and the socioeconomic factors-age, education, number of crops cultivated, number of sources of income, land type, and sources of income were used as explanatory variables. Village size was used as a fixed variable and gender was used as a random effect. The lmer command from the package lme4 in R version 3.3.2 (2016-10-31) was used. Each model included individual and village-level explanatory variables (Johnson and Omland 2004, Suryawanshi et al 2014). The effect of gender on perception of climate change was interpreted based on the parameter estimate from this model. Residuals of this model were regressed against gender to assess its effect on perception. The Chi square test was used to test the significance of the obtained response.

Recent studies have collected information on traditional knowledge in the eastern Himalayas (Sharma and Shrestha 2016, Chaudhary and Bawa 2011, Chaudhary et al 2011) and western Himalayas (Sharma and Uniyal 2020, Shukla et al 2019, Pandey et al 2018, Basannagari et al 2013). A total of 22 indicators were used to assess the perception of local communities towards climate change in the Fozal valley (Fig. 1). The information was collected through 3 responses; Yes, No, and can't say. The analysis reveals that a significant proportion of respondents are aware of biodiversity (74.2%) and forest types (54.85%) of their area and half of the respondents are experiencing climate change (56.57%) in the form of early flowering in agricultural and horticultural crops (65.14%), soil erosion or landslides (84%), and change in species richness of plants and animals (64%). More than half of the respondents have adopted new crops (66.28%). Although a few respondents admitted exploiting forest resources on smaller scales, a large portion of them expressed their willingness to participate in the conservation initiatives (80.57%).

RESULTS AND DISCUSSION

Local perception towards climate change: A significant proportion of the community (72%) perceive that mainly developmental activities, road construction, dam construction, infrastructural developments, intensified tourism and agricultural activities, land use change, deforestation, and soil degradation through intensive use of pesticides in agricultural fields are enhancing the pressure on the carrying capacity of natural resources and thus resulting in changes in climate conditions, temperature, precipitation, and snowfall pattern (Fig. 2). However, 22% of the respondents believe that developmental activities along with natural factors are responsible for this change in climatic conditions. The majority of the villagers mentioned that the temperature has become warmer and snowfall has decreased in their area in the last decade. The local communities' perception that the climate is warming is in accordance with various other studies claiming that the temperature is showing an increasing trend while precipitation and annual snowfall are showing a decreasing trend in the district (Sen and Aditya 2015, Chaudhary and Bawa 2011, Rana et al 2011).

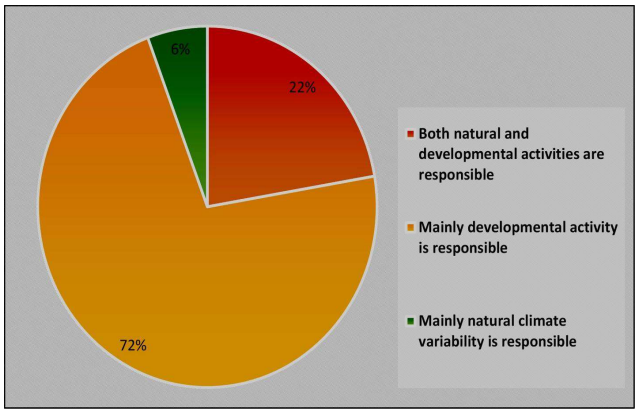


Fig. 2. Climate change perception of local communities

Climate change impact on forest resource availability and agriculture and horticulture productivity: Most of the respondents admitted a decrease in the forest resource availability, mostly due to increased encroachment in the

forest area, land use change, and conversion of forest area to agricultural fields (Fig. 3). The changing climate conditions are making the environment suitable for invasive species and changing the natural community composition of the forest. Increased temperature trends and decreased snowfall have also resulted in changes in agricultural patterns such as crop selection, seed sowing season, and harvesting time. Farmers are moving towards cash crop cultivation (rajmah, cauliflower, garlic, peas, diasporus kaki). The local communities perceive that there is a decrease in the number of chill units as compared to previous years. Chilling units are essential for many traditional agricultural and horticultural crops in the mountain regions. A decrease in chill units is also one of the factors influencing agricultural practises to change. In lower elevations, farmers have switched to alternate crops or shifted their orchards to higher elevations.

Differences in perception towards climate change as a variation of gender: Men and women have culturally designated roles in the surveyed area. Women were intensely involved in household practices and livestock management and agricultural practices. Henceforth, women are perceived to be highly vulnerable to climate change. A significant difference is noted between men and women's perception towards climate change (Fig. 3). More than 50% of the women respondents have perception score in the range 0 to -4 indicating a comparatively negative perception towards climate change impacts. 40.38 % of the total variance of the random effects is attributed to the nested effects (Chi-square, X-squared = 47.005, p-value = 9.422e-07). The random variable gender was negatively correlated with age, education, total sources of income, total crops cultivated. The negative perception score was supported by the views that there is loss in agricultural productivity, drying of tradition water sources, increased incidences of natural disasters, change in flowering and fruiting phenology of agricultural crops and adoption of new crop plants preferably cash crops due to climate change.

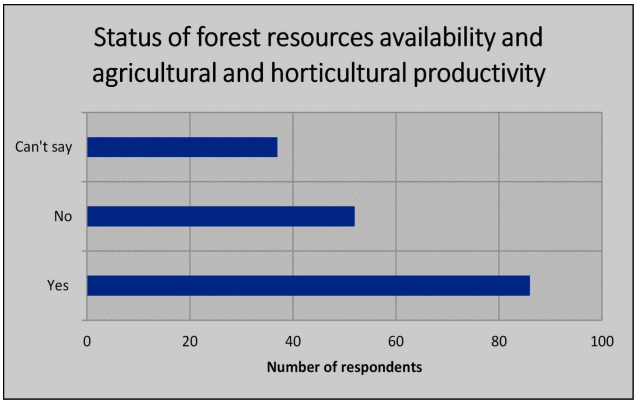


Fig. 3. Climate change impact on forest resource availability and agriculture and horticulture productivity

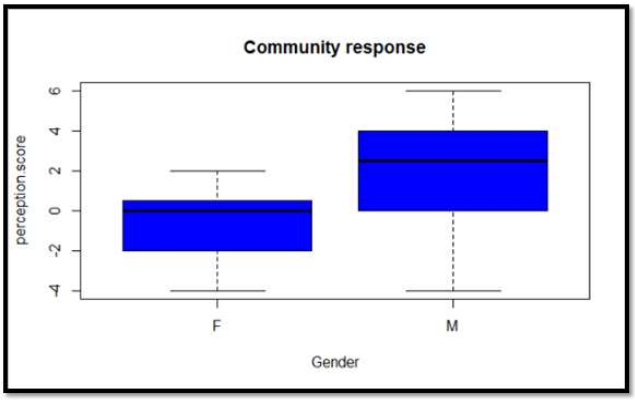


Fig. 4. Perception of climate change from gender perspective

CONCLUSION

A large proportion of the surveyed population is aware of climate change, biodiversity and forest types of their area, mainly dominant conifers (Cheed), Quercus forest (Kharshu, Banjh) and Cedrus forest (Deodar). However, the species richness has decreased substantially. Collection of forest resources is a regular practice in the valley. However, most of the collected produce is used for meeting household demands rather than economic gains. The local communities are experiencing climate change through irregular and extreme rainfall patterns, a reduction in the number of winter days, increased landslide incidences, and the drying up of natural water resources. The local communities reflected that many of the farmers are shifting to modern agricultural practices, use of intensive pesticides, and mixed farming of horticultural and cash crops to cope with climate change. Traditional crops like *Sesamum indicum*, *Vigna mungo*, *Gossypium sp.*, pulses, *Indigofera cassioides* (Kathi), *Paspalum scrobiculatum* (Kodra) and *Lens culinaris* are now not grown due to poor yield, productivity, reduced market demand and changed climatic conditions. The traditional disease and pest tolerant varieties of wheat, maize, and paddy are now being replaced by hybrid/high yielding varieties (HYV). The hybrid varieties are more prone to diseases and require a huge amount of pesticide application. This shift to modern agriculture has resulted in the complete erosion of some of the important genetic resources and decreased soil fertility. A few of the crops which have suffered a loss in productivity and are rarely cultivated by farmers due to climate change include *Eleusine coracana* (Marua, Mandal), *Setaria italica* (Kangani), *Panicum miliaceum* (Cheena) and other crops such as grain amaranth, grain chenopods, buckwheat, barley (hulled and hull less). Changing climate conditions have also made the

environment suitable for some of the invasive species (*Ageratum spp., Parthenium spp.*) to grow in the area. Human population growth necessitates more resources for survival, resulting in human encroachment on forest areas and increased conversion of forest areas to agricultural and grazing lands, as well as incidents of human-wildlife conflict with wild boars and brown bears. Night guarding, occasional killing of wildlife, were some of the measures listed for conflict mitigation by the local communities. Formally designed plantation activities were observed in the survey area, but gaps in knowledge of forest management policies and rights at the grassroot level were discovered. It demonstrates the potential for involving local communities in management practices. Despite their close relationship with the area's natural resources, women are less aware of climate change adaptation measures. Women's participation in decision-making and adaptive strategies is under represented. It reflects on the scope of improvising the adaptation strategies with equal representation of gender in the planning process.

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