Range Management and Agroforestry 45 (1) : 184-187, 2024
ISSN 0971-2070 (Print); 2249-5231 (Online)
https://doi.org/10.59515/rma.2024.v45.i1.27

Short communication

Vulnerability to climate change among the *Changpa* pastoral nomads of Leh-Ladakh

Sanjit Maiti*, Sanchita Garai, Mukesh Bhakat, K. S. Kadian

ICAR-National Dairy Research Institute, Karnal-132001, Haryana, India
*Corresponding author email: sanjit.ndri@gmail.com

Received: 18th February, 2023 Accepted: 23rd January, 2024

Abstract

Pastoral nomads of the Himalayan region are the least responsible but most threatened by climate change. Therefore, the present study was conducted to analyze vulnerability to climate change among the randomly selected 200 *Changpa* pastoral nomads of Leh-Ladakh. A vulnerability to climate change index was developed underlying the principle of IPCC by using 18 household-level indicators of bio-physical and societal importance. The study indicated that the average vulnerability scores of *Changpa* pastoral nomads were positive, which indicated their shock-absorbing capacity to extreme climatic conditions, whereas 32% of the households were extremely vulnerable. But vulnerability index score of 7.50% of households was negative, which indicated their inability to cope with the extreme climatic conditions. Hence, immediate attentions are required to formulate better adaptation strategies to improve the adaptive capacity of the vulnerable *Changpa* pastoral nomads to changing climate conditions.

Keywords: *Changpa*, Climate change, Ladakh, Pastoral nomads, Vulnerability

Vulnerability indicator is a fundamental concept of research on climate change (Hinkel, 2011; Sarkar *et al*., 2017). The IPCC defined 'vulnerability as the propensity or predisposition to be adversely affected.' A vulnerable system is more sensitive to climate stimulus than a system having more adaptive capacity (Smit and Wandel, 2006). This vulnerability can be determined by the character, magnitude and rate of climate change, the system's sensitivity and its adaptive capacity (McCarthy, 2001). Vulnerability has multi-dimensional drivers. Climate events are becoming a significant aspect of it, which needs to be addressed with utmost care (Smit and Wandel, 2006; Cutter, 2008; Prasad *et al*., 2014).

Changpa, nomadic pastoralists who originally migrated from Tibet in the eighth century A.D. (Jina, 1999), used to graze the rangelands of the Changthang region of Leh-Ladakh and rear different categories of livestock, including yak, sheep, goat and horse. These livestock species are adapted to the hostile and marginal pastures of the region and provide a range of animal products and services. The domestic Changthangi goats of the Changthang region produced the finest cashmere or *pashmina* fiber in the world (Misra *et al*., 1998; Ahmed, 2002). But in the recent past, *Changpa* pastoral community is faced newer challenges due to the degradation of high-altitude pastures and, subsequently, shortage of feed and fodder resources due to climate change. Tundup *et al*. (2016) observed that from 2003 onward monthly daily minimum temperature during May increased from 4 to 8°C up to 2007 in Leh district. The further monthly mean daily maximum temperature was higher (>20°C) before 2003 but decreased from 2003 to 2009 (range 15–20°C) and snowfall was a common phenomenon during month of May before 2003, but it was not observed during 2003 to 2009. Tundup *et al.* (2016) also concluded that *Changpas* acutely feel climate change and in recent years, the migration routes of *Changpas* have changed due to a decrease in pasture land. However, these challenges would transform into threats as a synergistic effect of impending climatic change in the region. Therefore, studies on vulnerability to climate change among the *Changpa* pastoral nomads of the *Changthang* region of Leh-Ladakh were considered as an important response option worthy of research and assessment, not simply to guide the selection of best adaptation and mitigation policies but to reduce the vulnerability of climate change

effect on people, thus to minimize the costs on strategy and/or policy framing in the long run.

The present study was carried out in the purposively selected Changthang region of Leh-Ladakh. Changthang region is the home of *Changpa* pastoral nomads. Bhasin (2012) reported that there were 14 groups of *Changpas*, averaging 130 families in each group. About 1500 *Changpas* are residing in the Durbook and Nyoma blocks of the Leh district. In the present study, *Changpa,* with more than 30 years of experience in yak, sheep, goat, and cattle rearing as their main income, was considered as respondents. A total of 200 respondents were selected randomly for the study.

The study was based on secondary data (climatic parameters) and primary data collected at the household level, either from doorstep or grazing land. Household-level data were collected by using various indicators of adaptive capacity and sensitivity. Climatic indicators were calculated from the climatic data generated by the Defence Institute of High Altitude Research, Leh. Livelihood vulnerability was postulated as the vulnerability of a household as a function of the household's exposure, adaptive capacity and sensitivity, which help them to cope with, recover from and adapt to climate change and its impacts. A composite vulnerability to climate change index (VCCI) was developed by underlying the principle of Maiti *et al.* (2015a).

Adaptive capacity was conceptualized as the overall effect of five types of livelihood capital, *viz*., human, social, physical, natural and economic capital. Nine indicators were identified from a different source of published literature and consultation with the experts for calculating adaptive capacity at the household level and these were the average age of adult household members, number of bovines in the herd, number of small ruminants in the herd, social participation, community participation, community cohesiveness, distance to market, distance to the human health center and distance to a veterinary center.

For the study, historical changes in climatic variables were considered as the indicators of exposure. Two climatic parameters, *viz*., temperature and precipitation (considering both rainfall and snowfall), were considered. There were constraints regarding the availability of a long-range climatic data set for the Leh-Ladakh region. Therefore, published climate data of the Defence Institute of High Altitude Research, Leh, was considered to calculate the parameters of exposure like the average change in monthly maximum temperature from normal during the last ten years, the average change in monthly minimum temperature from normal during last ten years, coefficient in variation of snowfall during last ten years and yearly average deficit in total precipitation during last ten years. Five indicators were also considered to calculate the degree of sensitivity of the household in the study area. These were dependent ratio, proportion of income from livestock, wool production, distance to collect drinking water and livestock mortality during the last ten years.

Principal component analysis (Ravindranath *et al.,* 2011; Maiti *et al.,* 2015a) was used to identify the significant indicators and eliminate non-significant indicators. Two-factor analyses (one for adaptive capacity and another for sensitivity) for each data set (indicators) were run, choosing Principal Component Analysis (PCA) for extraction and the varimax method for rotation of factors in SPSS20. Indicators having a communality value less than 0.50 were dropped for further analysis, *i.e.,* assignments of weights to the indicators. Methods followed by Feroze and Chauhan (2010) and Maiti *et al*. (2015a) were adopted to assign the weight to indicators. Finally, the composite vulnerability to climate change index (VCCI) for each household was calculated by the formula of Maiti *et al. (*2015a); Livelihood vulnerability = Adaptive capacity – (Exposure + Sensitivity).

All the nine identified indicators of adaptive capacity had a communality value of more than the cut-off (0.50). The identified indicators were fixed according to their weightage score and indicators with higher weightage were comparatively more important determinants than the indicators with lower weightage (Table 1). Among the identified indicators of adaptive capacity, 'number of the bovines in the herd' had the highest influence on the overall adaptive capacity of farm family with a weightage of 2.44, followed by 'distance to market' (2.36), 'community participation' (2.01), 'community cohesiveness' (2.00), 'average age of the adult household members' (1.98) and 'number of the small ruminants in the herd' (1.93). Changthang Pashmina Growers Cooperative Marketing Society was established by the government in 1995 with the objective of eliminating middlemen and giving nomads a better price for their produce, *i.e.,* raw pashmina fiber and assured market for their produce. The marketing aspect had the highest influence on the adaptive capacity of *Changpa* pastoral nomads to cope up with climate change. On the other hand, *Changpas* had to travel a long distance to avail the infrastructural facilities like human and veterinary health centers. But many times, particularly in extreme winter, it was very difficult to access the service of these centers. Therefore, these infrastructural facilities had a comparatively lower level of influence on the adaptive capacity of *Changpa* pastoral nomads.

The communality values of each five indicators were above the cut-off, *i.e*., 0.50. Therefore, indicators were further analyzed for weightage calculation (Table 2). It was found that wool production was the highest sensitive indicator to climate change with a weightage of 1.59, followed by livestock mortality during the last ten years (1.56), the proportion of income from livestock (1.20), dependency ratio (0.99) and distance to collect drinking water (0.86). Newey (2020) argued that if weather patterns

Table 1. Relative importance of the indicators used to measure adaptive capacity (n = 200)

S. No.	Indicators of adaptive capacity	Calculated weightage
1	Average age of the adult household members	1.98
2	Number of the bovines in the herd	2.44
3	Number of small ruminants in the herd	1.93
4	Social participation	1.61
5	Community participation	2.01
6	Community cohesiveness	2.00
7	Distance to market	2.36
8	Distance to human health centre	1.26
9	Distance to veterinary centre	1.46

Table 2. Relative importance of the indicators used to measure sensitivity (n = 200)

S. No	Indicators of sensitivity	Calculated weightage
1	Dependent ratio	0.99
2	Proportion of income from livestock	1.20
3	Wool production	1.59
4	Distance to collect drinking water	0.86
5	Livestock morality during last 10 years	1.56

continue to change, then it could have an irreversible impact on pashmina goat-rearing in the Changthang region. Therefore, the production of the pashmina fiber was supposed to be highly sensitive to climate change in the Changthang region of Leh-Ladakh.

The index value for the adaptive capacity, exposure and sensitivity of the sample households of the *Changpa* pastoral nomads were recorded (Table 3). Net vulnerability value was positive which indicated higher adaptive capacity than the combined effect of exposure and sensitivity among the *Changpa* pastoral nomads of the Changthang region. It was also found that 7.50% (Fig 1) of *Changpa* pastoral nomads had negative vulnerability value, which is a matter of serious concern and these households are under threat to any type of shocks related to climate change. Hence, necessary efforts might be undertaken to improve their adaptive capacity as well as to reduce their sensitivity to climate-led disasters. Maiti *et al*. (2015b) studied the vulnerability to climate change of *Brokpa* pastoral nomads in western Arunachal Pradesh and found that the vulnerability profile of Brokpa was largely influenced by their adaptive capacity than exposure and sensitivity. Aryal *et al*. (2014)

Table 3. Vulnerability and its components among the *Changpa* pastoral nomads (n = 200)

Adaptive capacity	Sensitivity	Exposure	Vulnerability
6.09 ± 0.10	1.29 ± 0.14	3.08	1.69 ± 0.08

also studied the vulnerability of the transhumant pastoral communities of Nepal as a function of the differential level of exposure, sensitivity and adaptive capacity. Piya *et al*. (2012) reported that adaptive capacity was the main driver of higher-level vulnerability among the Chepang community of Nepal. However, Tambe *et al*. (2011) found higher vulnerability in Sikkim due to higher exposure and sensitivity to climate change. Whereas Shrestha (2011) reported different causes of higher levels of vulnerability among the highlanders of Nepal and these causes were income and the fragile ecosystem of the region.

All the sampled *Changpa* pastoral nomads of the Changthang region were categorized into low, medium, and extreme levels of vulnerability (Table 4). It clearly depicted that 42.50% of the *Changpa* were moderately vulnerable. But 32.00 and 25.50% of them had extreme and lower levels of vulnerability, respectively. Maiti *et al*. (2015b) also studied the differential level of vulnerability among the *Brokpa* pastoral nomads of western Arunachal Pradesh and found nearly half of *Brokpas* were highly vulnerable. Bhutiyani *et al*. (2007), Chevuturi *et al*. (2018) and Tundup *et al*. (2016) reported the climatic scenario is changing in Leh-Ladakh, which has made the life and livelihood of *Changpa* more fragile. Mahapatra (2013) reported that the life of *Changpas* became more vulnerable due to untimely heavy snowfall and the death of more than 25000 livestock in Changthang region.

The present study successfully integrates the bio-physical with social indicators to comprehend the impact of climate change on indigenous communities, which were found to be highly vulnerable. But they were least

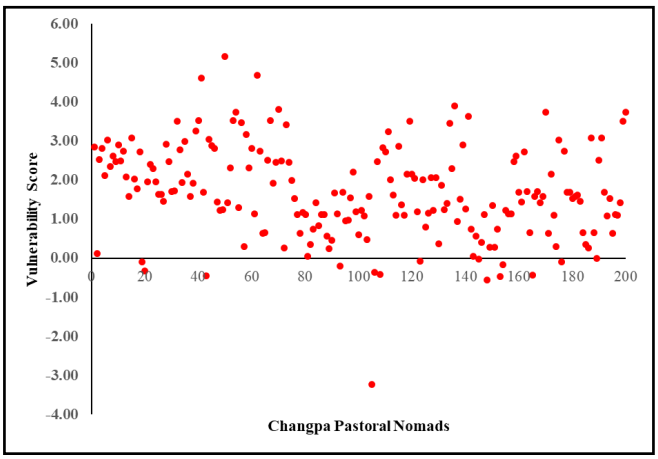

Fig 1. Household-wise vulnerability status of *Changpa* pastoral nomads

Table 4. Differential level of vulnerability among the *Changpa* pastoral nomads (n = 200)

S. No	Level of adaptation	Frequency	Percentage (%)
1.	Extremely vulnerable	64	32.00
2.	Moderate vulnerable	85	42.50
3.	Lower vulnerable	51	25.50

responsible for climate change. The study also found that 7.50% of the *Changpa* pastoral nomads had a negative vulnerability index score which is an alarming situation. Hence, necessary efforts may be initiated to improve their adaptive capacity to cope with the changing climatic scenario.

Acknowledgment

The authors express their sincere gratitude to the Indian Council of Social Science Research (ICSSR), New Delhi, for funding in the form of a major research project and Dr. Mohammad Iqbal, Chief Animal Husbandry Officer, Ladakh Autonomous Hill Development Council (LAHDC), Leh, for providing necessary help during the field study. We also extend our gratitude to the Director, ICAR-National Dairy Research Institute, Karnal, Haryana for guidance, support and encouragement.

References

Ahmed, M. 2002. *Living Fabric: Weaving Among the Nomads of Ladakh Himalaya*. Orchid Press, Bangkok.

Aryal, S., G. Cockfield and T. N. Maraseni. 2014. Vulnerability of Himalayan transhumant communities to climate change. *Climatic Change* 125: 193-208.

Bhasin, V. 2012. Life on an edge among the *Changpa*s of Changthang, Ladakh. *Journal of Biodiversity* 3: 85-129.

Bhutiyani, M.R., V.S. Kale and N. J. Pawar. 2007. Long-term trends in maximum, minimum and mean annual air temperatures across the north-western Himalaya during the twentieth century. *Climatic Change* 85: 159-177.

Chevuturi, A., A. P. Dimri and R. J. Thayyen. 2018. Climate change over Leh (Ladakh), India. *Theoretical and Applied Climatology* 131: 531-545.

Cutter, S. L. 2008. Temporal and spatial changes in social vulnerability to natural hazards. *Proceedings of the National Academy of Sciences* 105: 2301-2306.

Feroze, S. M. and A. K. Chouhan. 2010. Performance of dairy self help groups in India: principal component analysis approach. *Indian Journal of Agricultural Economics* 65: 308-318.

Hinkel, J. 2011. Indicators of vulnerability and adaptive capacity: towards a clarification of the science–policy interface. *Global Environmental Change* 21: 198-208.

Jina, P. S. 1999. The Chang Pa of the Ladakh Himalayas: Some observations on their economy and environment. *Nomadic Peoples* 3: 95-112.

Mahapatra R. 2013. Biting cold for pashmina. Down to Earth. http://www.downtoearth.org.in/coverage/biting-cold-for-pashmina-40887 (accessed on September 06, 2017).

Maiti, S., S. K. Jha, S. Garai, A. Nag, R. Chakravarty, K. S. Kadian, B. S. Chandel, K. K. Datta and R. C. Upadhaya. 2015a. Assessment of social vulnerability to climate change in the eastern coast of India. *Climatic Change* 131: 287-306.

Maiti, S., S. K. Jha, S. Garai, A. Nag, A. K. Bera, S. M. Deb and R. C. Upadhaya, 2015b. Social vulnerability of alpine transhumance pastoralists of western Arunachal Pradesh to climate change. *Range Management and Agroforestry* 36: 92-98.

McCarthy, J. J., O. F. Canziani, A. A. Leary, D. J. Dokken and K. S. White. 2001. *Climate change 2001: impacts, adaptation and vulnerability*. Cambridge, Cambridge University Press. UK. pp. 1032.

Misra, R.K., B. Singh and V. K. Jain. 1998. Breed characteristics of Changthangi pashmina goat. *Small Ruminant Research* 27: 97-102.

Newey, A. 2020. The Pashmina goat herders in a struggle against climate change. https://edition.cnn.com/style/article/pashmina-goat-herders-struggle-against-climate-change/index.html#:~:text=And%20despite%20the%20snowfall%2 C%20the,from%20the%20coarse%20outer%20fur (accessed on September 06, 2017).

Piya, L., K. L. Maharjan and N. P. Joshi. 2012. Vulnerability of rural households to climate change and extremes: Analysis of chepang households in the mid-hills of Nepal. In: Proceedings of *International Association of Agricultural Economics (IAAE) Triennial Conference* (August 18-24, 2012). Foz do Iguacu, Brazil.

Prasad, R., A.K. Pandey, R. Newaj, S. K. Dhyani, N. K. Saroj and V. D. Tripathi. 2014. Risk and vulnerability due to climate change and adaptation initiatives for agricultural resilience in Panna district of Madhya Pradesh, central India. *Range Management and Agroforestry* 35: 157-162.

Ravindranath, N. H., S. Rao, N. Sharma, M. Nair, R. Gopalakrishnan, A.S. Rao, S. Malaviya, R. Tiwari, A. Sagadevan, M. Munsi, N. Krishna and G. Bala. 2011. Climate change vulnerability profiles for north-east India. *Current Science* 101: 384-394.

Sarkar, S., R. N. Padaria and A. Bhowmik. 2017. Analyzing farmers' vulnerability and adaptation strategy to climate change in arid ecosystem of India. *Range Management and Agroforestry*. 38: 127-133.

Shrestha, S. L. 2011. Effect of the climate change on the socio-economy and vulnerability of farmers in Nepal. M Sc Thesis. Graduate School for International Development and Cooperation. Hiroshima University, Hiroshima, Japan.

Smit, B. and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*. 16: 282-292.

Tambe, S., M. L. Arrawatia, N. T. Bhutia and B. Swaroop. 2011. Rapid, cost-effective and high resolution assessment of climate-related vulnerability of rural communities of Sikkim Himalaya, India. *Current Science* 101: 165-173.

Tundup, P., M. A. Wani, S. Dawa, S. Hussain and A. P. Rai. 2016. Influence of climate change on traditional agriculture of cold desert region-Ladakh. *Global Journal of Biosciences and Biotechnology* 5: 449-452.