ACCST Research Journal **ISSN 0972-7779**
Volume - XXI, No. 4, October 2023
Journal website: www.internationaljournalsiwan.com
ORCID Link: https://orcid.org/0009-0008-6661-0289
Google Scholar: https://scholar.google.com/citations?user=KJ4eXesAAAAJ&hl=en
Refereed and Peer-Reviewed Quarterly Journal

Social Vulnerability Assessment to Climate Change in Kullu Valley

by **Ranjeet Kumar,** *Research Scholar,*
Department of Geography,
Delhi School of Economics, University of Delhi - 110007, India
Email: ranjeet.dse09@gmail.com

Anju Singh, *Associate Professor,*
Department of Geography,
Aditi Mahavidyalaya, University of Delhi - 110039, India
Email: anjusingh.geog@gmail.com

(Received: September 19, 2023; Accepted: October 25, 2023;
Published Online: October 30, 2023)

Abstract:

Kullu valley is a Himalayan region in the state of Himachal Pradesh, India. Though the region is known for its rich biodiversity, cultural heritage and tourism potential, however, the valley is also highly vulnerable to climate change as there is strong evidence of increasing temperature, erratic rainfall, melting glaciers, landslides and floods in recent years. This paper aims to assess the vulnerability of Kullu valley to climate change by calculating vulnerability index of seventy six villages located in the region. The paper uses a combination of methods, such as literature review, stakeholder consultations, field surveys and GIS analysis, to collect and analyze data on various indicators of vulnerability.

The paper also finds that the sensitivity of the valley is high due to its dependence on ecosystem services such as water, forests and agriculture for livelihood sustenance. Moreover, the paper reveals that the adaptive capacity of the valley is low due to various factors such as poverty, low level of awareness, inadequate infrastructure and weak institutional arrangements. The paper concludes that Kullu valley is highly vulnerable to climate change and needs urgent and coordinated action to reduce its vulnerability and enhance its resilience.

Introduction:

The issue of susceptibility to environmental shifts has long been a central focus in geography. Many geographic studies emphasize the intricate and multifaceted nature of the causes and impacts of social and environmental transformations (Barnet et al., 2008). Human-induced alterations to the environment pose threats to both individual livelihoods and global sustainability. Climate change, in particular, is anticipated to alter temperature and precipitation patterns, potentially exacerbating vulnerabilities (Postel and Vickers, 2004; Safriel et al., 2005; Solomon et al., 2007). Over the coming decades, the vulnerability to climate change is expected to escalate due to factors such as development pressures, population growth, and environmental degradation (ISDR, 2002). Therefore, there is an urgent call for the development of methodologies to assess the vulnerability of communities and regions to such crises and to pinpoint areas where interventions can mitigate this vulnerability (Acosta, 2008).

The IPCC's Third Assessment Report defines vulnerability as "the degree to which an environmental or social system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes". Evaluating vulnerability necessitates a comprehensive assessment that spans various disciplines and scales, demanding innovative geographical tools and frameworks. Vulnerability is context-dependent, with different regions or communities facing unique challenges (Brooks, Adger, and Kelly, 2005). Social vulnerability encompasses both internal, person-specific factors and external, socioeconomic and locational factors. Internal factors may include race, ethnicity, gender, age, religion, disability, and health status. External factors encompass socioeconomic status, housing type, assets, access to social networks, education, cultural knowledge, and political power, all of which contribute to meeting fundamental needs such as water, food, shelter, clothing, and cultural values (Cutter and Finch, 2008;

Cardona et al., 2012; Fu¨ssel, 2012). Additionally, there are overarching determinants of vulnerability, including developmental factors that shape vulnerability across diverse socioeconomic contexts (Brooks et al., 2005). Notably, vulnerability is dynamic, evolving with changes in both biophysical and socioeconomic characteristics of a region (Adger and Kelly, 1999).

Study Area:

Kullu Valley popularly known as ‘Devbhumi’ (Valley of God) lies within the North Western Himalaya and start from Rohtang Pass on upper side and upto Aut in South, extending up to approximately 85 km in length and 3-5 km in width. Kullu Valley is situated at 32^{o} N latitude and 77^{o} E longitudes (Figure 1).

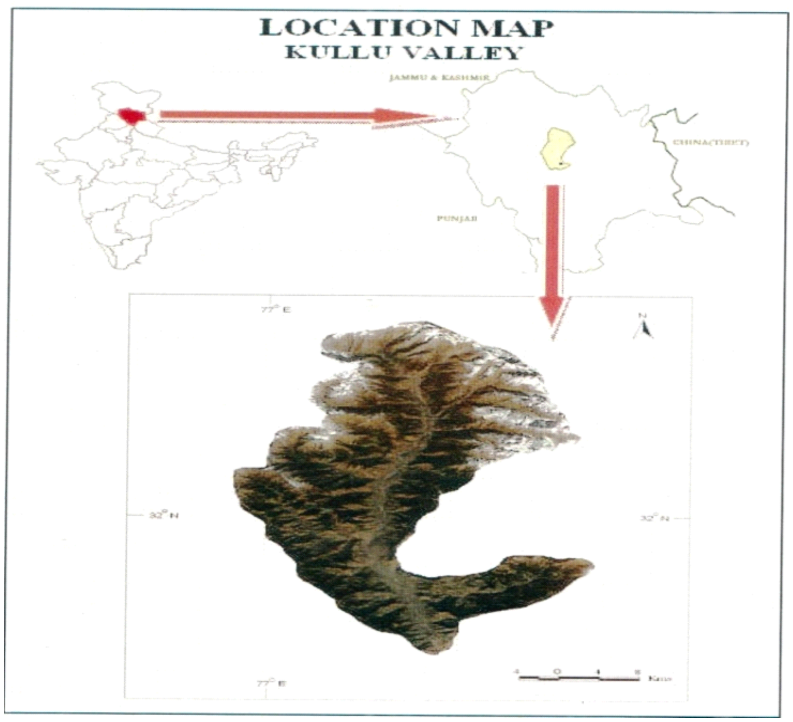

Figure 1: Location Map of study area

The Valley has been divided into two parts on the basis of altitude i.e. Lower Kullu Valley (800-1200 m onwards) and Upper Kullu Valley (1200 m onwards).The study area comprises of seventy six villages which have high physiographic and socioeconomic variations.

Data Base and Methodology:

Social Vulnerability to Climate Change assessment is based on calculation of vulnerability index of all seventy six villages of the region. This vulnerability index is helpful in the identification of different vulnerability zones. The vulnerability index is based on a set of factors. The important components of any sector that are most likely to be affected by climate change are chosen as factors for vulnerability index. The factors taken into consideration are Literacy Rate, Percentage of Agricultural Laborers, Percentage of Farmers, Percentage of SC and ST Population, Population Density, Population per Commercial Bank, Gross Cropped Area/Gross Irrigated Area, Percentage of Area under Food Crops to Gross Area Sown, Number of Land Holdings less than 1 hectare/ Total Land Holdings, Per cent of Cultivable and Waste Land, Number of Drinking Water Sources, Water Availability during summer and Slope aspects of different regions. The indicators selected for constructing the climate change vulnerability index in Kullu Valley are prioritized and ranked based on their importance, exposure, and susceptibility (Shukla, 2003). The statistical data on above indicators have been collected from village directory and district statistical abstract.

The indicators considered for vulnerability analysis have different units. Therefore, UNDP's Human Development Index (UNDP, 2006) is followed to normalize them.

The value 1 corresponds to maximum vulnerability and 0 corresponds to minimum vulnerability. Where indicators increase the vulnerability, the normalization has been based on the formula:

$$X_{ij} = \frac{\max(X_{ij}) - \min(X_{ij})}{X_{ij} - \min(X_{ij})}$$

where X_{ij}, $i = 1,2,..., M$; $j = 1,2,..., K$. M represents the regions/villages and K stands for indicators. For indicators with decreasing vulnerability, normalisation has been based on following formula:

$$Y_{ij} = \frac{\max(X_{ij}) - \min(X_{ij})}{\max(X_{ij}) - X_{ij}}$$

After normalization, the weighted composite index method developed by N.S. Iyengar and P. Sudarshan in 1982 published in a special issue of Economic and Political Weekly (2048-52), titled "A Method of Classifying Regions from Multi-variate Data" is used for preparing the vulnerability index (Table 1). Further using cluster analysis, the final index is clustered into three groups of high, moderate and low vulnerability.

Population density:

Demographic factors such as population growth and density are important determinants of vulnerability assessment. A higher density would imply that more people are dependent on available resources for their livelihood. Water, an essential resource for livelihood, will have more demand with an increase in population density. This further affects the consumption patterns of agriculture and water for different purposes. The population of the region is variedly distributed, driven largely by natural and socio-cultural factors. The northern part of the region has a very high density, while the central and southern parts have the least. The settlement alongside the River Beas is densely populated. This indicator makes the central region more vulnerable as compared to the rest of the region.

Scheduled Tribes (ST) and Scheduled Caste (SC) Population:

Social discrimination exists in many forms; one of them is caste. Being treated as of higher order, the SC and ST populations have been marginalized from the main stream of socioeconomic growth. So when extreme events like drought strike, they have very little to rely on, as they are the most deprived sections of society. Nearly half of the population of the northern region is comprised of the SC and ST populations, falling into the high category, making it more vulnerable to drought than the rest of the region.

Gross cropped area / Gross irrigated area:

The ratio used as an indicator gives insight into both the cropped area and the irrigated area of the total area. The higher value of this indicator implies that a higher per cent of the region is unirrigated in relation to the total area under crops. Better irrigation facilities can cope with drought conditions as compared to unirrigated areas. The south-west of the region has better irrigation facilities and hence comes under a low category. The southern part has higher ratio values, implying most of the region is unirrigated, falls under the high and medium categories, and therefore is more vulnerable to environmental change.

Uncultivable and waste land:

There are various reasons for the land left uncultivated, fallow, and waste. It may be due to the unavailability of irrigation facilities, unfertile soil, mismanagement of land resources, and many more, but whatever the reason, it implies the inability to put it under cultivation. So a higher percentage of this indicator has been used here as an indicator of high vulnerability to climate change. Most of the area in Kulu Valley falls into the low and moderate categories, while only two blocks in the north fall into the high category.

Land holding size:

Small landholdings restrict farmers from investing enough in farming infrastructure. Further small farm size implies small income. Large land holdings owned by large farmers have more capability to adapt to and mitigate extreme events like drought. Here, as an indicator, the ratio of land holdings less than one hectare to the total number of land holdings has been used. This indicator identifies the number of small land holdings and what proportion they comprise of total land holdings. Only a small part of the region comes under the category of low, while the majority comes under the categories of moderate and high, stating that more than 70 percent of the land holdings are of small size and hence have high vulnerability.

Slope Aspects:

The higher slope of land leads to low groundwater infiltration and more water flow. This has a severe impact on the quality of the soil, which makes it unfit for agricultural activities. The region along the valley has a gentle slope, while it is higher in the southern part of the region, reaching up to 135 m/km, making it more vulnerable.

Population per Commercial Bank:

Branches of the banks are opened on the basis of transactions as well as various government initiatives, the former being more important. One uses a bank not only as a depositor of money but also for credit and insurance purposes. More branches in an area denote more usage of credit and debit facilities by the people. These institutional facilities help minimize the losses arising from extreme events such as droughts. This develops the coping capacity of the people, as with the help of these institutional facilities, people can diversify their income sources, avail irrigational facilities, drought-resistant varieties of seeds, etc. The large population per commercial bank is used here as an indicator of high vulnerability, and vice versa. Most of the region falls into low and moderate categories.

Result and Discussion:

The region has been divided into three categories, each depicting three levels of vulnerability (Figure 2).

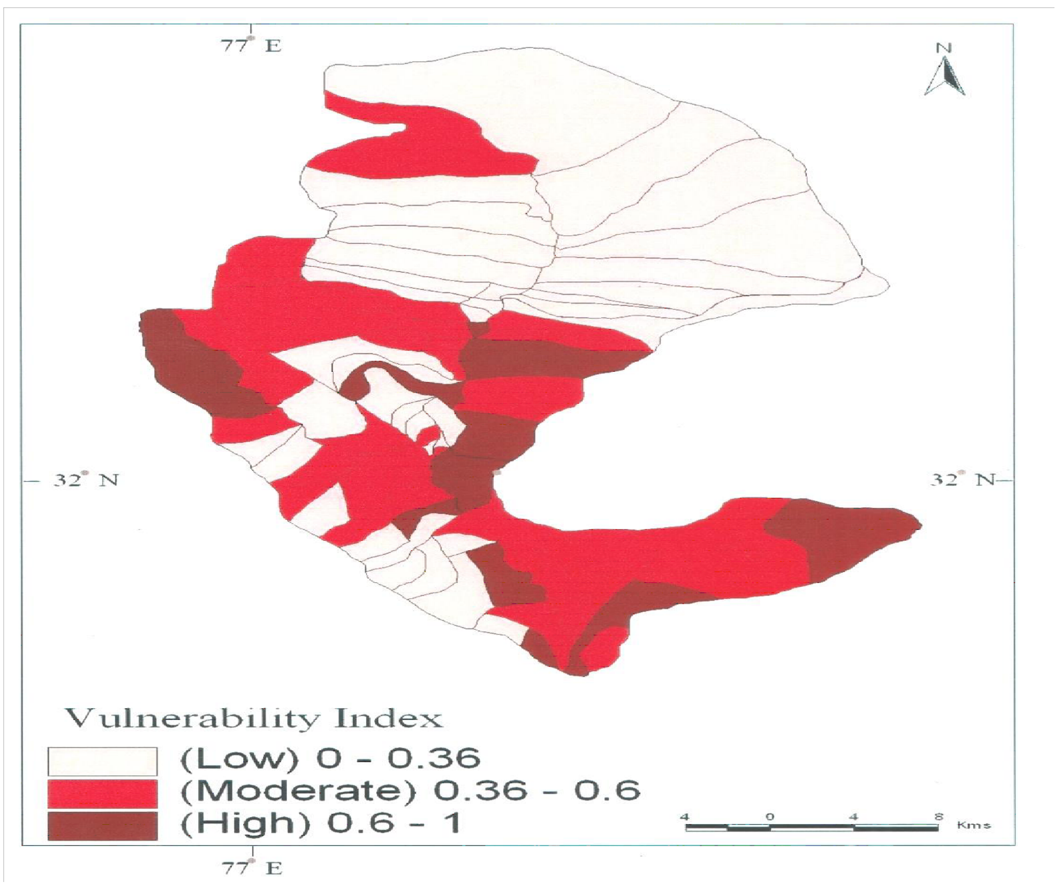

Figure 2: Vulnerability status of Kullu valley

High vulnerability:

More than half of the area has been categorised under high climate change vulnerability, covering nearly half of the total area of the region and having index values higher than 6. This category covers the southern part of the Kullu valley and is distributed across villages like Samshi, Kharal, Lalji, Katain, Parli Kais, Fojal, Hat, etc. Physiographically, the region covers the central and southern portions of Kullu Valley. These blocks recorded the highest percentage of female illiteracy, unirrigated area, low ground water level, and high SC and ST populations. Geographical proximity makes these villages share common attributes of vulnerability.

Moderate vulnerability:

The second category of moderate drought vulnerability occupies the central portion of the region, with index values ranging from 0.36 to 0.60. The number of blocks under this category is higher as compared to the high climate change

Table 1: Vulnerability status of villages

Village	Final Index Score	Vulnerability to Climate Change
Shamshi	1	High
Kharal	0.82	High
Kais	0.76	High
Bebchi	0.74	High
Katrain	0.7	High
Balh	0.67	High
Parti	0.67	High
Diar	0.65	High
Pichhli	0.63	High
Nathan	0.62	High
Hat	0.62	High
Fojal	0.6	High
Jana	0.58	Medium
Majhat	0.5	Medium

Bhalynnl	0.49	Medium
Dobhi	0.49	Medium
Pichlihar	0.47	Medium
Mandalgarh	0.47	Medium
Peej	0.45	Medium
Hallan II	0.45	Medium
Buruwa	0.43	Medium
Mashna	0.41	Medium
Shillihar	0.4	Medium
Meha	0.4	Medium
Balh	0.39	Medium
Shillihar	0.36	Medium
Ralgarh	9.2	Low
Garamng	0.2	Low
Bashkht	0.25	Low
Manjhlihar	0.25	Low
Jandor	0.25	Low
Bhumtir	0.24	Low
Jagatsukh	0.24	Low
Sari	0.24	Low
Kharihar	0.23	Low
Gahar	0.22	Low
Bran	0.21	Low
Barahar	0.2	Low
Neol	0.2	Low
Mohal	0.58	Medium
Dunkhri Gahar	0.57	Medium
Bajaura	0.56	Medium
Rote-II	0.55	Medium
Kashawri	0.54	Medium

Dughilag	0.54	Medium
Manjhli	0.52	Medium
Dawara	0.52	Medium
Nagar	0.51	Medium
Brahman	0.51	Medium
Bangoi	0.51	Medium
Panjan	0.36	Medium
Gojra	0.35	Low
Bhullang	0.34	Low
Bandrol	0.33	Low
Bari	0.33	Low
Nasogi	0.33	Low
Phallan	0.31	Low
Badgran	0.3	Low
Palchal	0.29	Low
Shirar	0.29	Low
Riyara	0.28	Low
Khokhan	0.28	Low
Shigli	0.18	Low
Sajla	0.17	Low
Manali	0.16	Low
Shallin	0.14	Low
Biasar	0.13	Low
Shillihar	0.12	Low
Prini	0.12	Low
Soil	0.11	Low
Hallan-I	0	Low
Bustori	0	Low
Kurjan	0	Low

vulnerability category and comprises Jana, Mohal, Rote, Bajaura, Naggar, Bangoi, etc. Geographically, these villages occupy the central and southern parts of the region. On the basis of indicators, these villages have the highest area under food crops as a whole, while in other categories they fall under the high, moderate, and low vulnerability categories, showing a mixed pattern.

Low vulnerability:

Northern part of the valley mostly falls under this category, with an index value below 0.35. Some of the villages that fall under low-vulnerability areas are Neol, Manali, Soil, Pirni, Karjan, etc. These villages came under the low category in almost all the indicators except in a few categories in which they came under the high category, but the final index value shows that these high indicator values are undermined by the better performance of other indicators.

Conclusion:

The physiographic and socioeconomic factors make the entire region highly vulnerable to climate change. Uneven hilly terrain puts hindrance to the expansion of irrigation facilities for instance the canal irrigation and further, hard rocky surfaces make the groundwater inaccessible for agriculture. Coupled with these factors, agriculture remains dependent on monsoon for irrigation. One can even withstand these situations if farmers have the capability to manage the resources properly. But with a high percentage of the population comprising SC and ST and a lower literacy rate, farmers lack the means to employ new farming techniques and adaptation measures to cope with climate crisis. The income of large section of population is highly dependent on agriculture and tourism sector and both sectors are highly vulnerable to climate change. Thus there is need for more diversification of livelihood to minimize the impact and vulnerability of area with respect to climate change.

References:

1. Acosta Michlik, L., Kumar, K.S.K., Klein, R.J.T., & Campe, S. (2008) : Application of fuzzy models to assess susceptibility to droughts from a socio-economic perspective. *Regional Environmental Change, 8*(4), 151-160.

2. Adger, W.N., & Kelly, P.M. (1999) : Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change, 4*(3-4), 253-266.

3. Barnett, J., Lambert, S., & Fry, I. (2008) : The hazards of indicators: insights from the environmental vulnerability index. *Annals of the Association of American Geographers, 98*(1), 102-119.

4. Brooks, N., Adger, W.N., & Kelly, P.M. (2005) : The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation.

5. Cardona OD, Van Aalast MK, Bikmann J, Fordham M, McGregor G, Mechler R (2012) : Determinants of risk: exposure and vulnerability. In: Managing the risks of extreme events and disasters to advance climate change adaptation. Cambridge University Press, Cambridge.

6. Cutter SL, Finch C (2008) : Temporal and spatial changes in social vulnerability to natural hazards. PNAS 7(105):2301-2306. doi:10.1073 pnas.0710375105

7. Fu¨ssel HM, Klein RT (2006) : Climate change vulnerability assessments: an evolution of conceptual thinking. Clim Chang 75:301-329. doi:10.1007/s10584-006-0329-3.

8. International Strategy for Disaster Reduction (ISDR). (2002) : *Living with risk: A global review of disaster reduction initiatives*. United Nations, Geneva: ISDR.

9. IPCC. (2007) : *Climate Change 2007: Impacts, Adaptation and Vulnerability*. The Working Group Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Cambridge University Press, Cambridge.

10. Postel, S., & Vickers, A. (2004) : In Starke, L. (Ed.), *State of the world 2004*. Norton, Washington, DC.

11. Safriel, U., Adeel, Z., Niemeijer, D., Puigdefabregas, J., White, R., Lal, R., King, C. (2005) : Drylands. In: Hassan, R., Scholes, R., & Ash, N. (Eds.), *Ecosystems and human well-being: Current state and trends. Vol 1*. Island Press, Washington, DC, pp. 623-662.

12. Solomon, D., Qin, D., Manning, M., Marquis, M., Averyt, K.B., Tignor, M., Chen, Z. (Eds.). (2007) : *Climate change 2007: The physical science basis*. Cambridge University Press, Cambridge.