

# Assessing Vulnerability to Natural Hazards: An Intra-District Analysis of Chamba, Himachal Pradesh

## Abstract

**Introduction:** This study examines the susceptibility of Chamba District, Himachal Pradesh, to natural hazards, with the goal of identifying the environmental dangers in the area and the elements that contribute to its vulnerability. The report utilizes an intra-district analysis to offer detailed insights into the specific issues encountered by various tehsils within Chamba District.

**Methodology:** The assessment includes component indices and composite scores for each Tehsil, which cover social, economic, institutional, infrastructure, and ecological variables. The Chamba Tehsil exhibits a relatively lower level of vulnerability, as evidenced by higher scores in major component indices. On the other hand, Holi Tehsil is more susceptible to risks, mainly because of issues related to its infrastructure and ecological resilience.

**Results:** The findings highlight the complex and varied aspects of vulnerability, emphasizing the need for a comprehensive strategy. The differences among Tehsils emphasize a range of distinct difficulties, which require specific and customized strategies. The resilience of Chamba Tehsil indicates a favorable pattern, whilst the challenges faced by Holi Tehsil highlight particular areas that require targeted assistance.

**Conclusion:** To mitigate vulnerability, it is necessary to not only build physical infrastructure but also address socio-economic imbalances, strengthen institutions, and promote ecological sustainability. It is crucial to develop customized plans that take into account the distinct issues faced by each Tehsil. Community engagement, awareness-building, and capacity-building efforts are crucial in decreasing vulnerability and utilizing local knowledge and abilities to strengthen resilience against natural catastrophes.

**Keywords:** Vulnerability, Hazards, Socio-Economic, Ecological, Disaster Resilience

## 1. Introduction

The vulnerability of communities to natural hazards is of paramount importance in ensuring the well-being and sustainable development of regions. Natural disasters including floods, earthquakes, and landslides can significantly disrupt the socio-ecological system and provide difficulties for people's quality of life. The goal of this research is to evaluate the Tehsils in the Chamba District's socio-ecological vulnerability to natural calamities. The research focuses on a variety of factors, including social, economic, institutional, infrastructure, and ecological elements that all work together to influence a region's overall vulnerability. Acquire a thorough grasp of the vulnerability levels and spot areas that need attention and action by looking at several indicators within these components [1].

Policymakers, local government officials, and community stakeholders may prioritize resources, create focused plans, and put policies into place that will improve the district's overall vulnerability thanks to the evaluation of socio-ecological vulnerability at the Tehsil level. The results of this research will be used as a basis for making decisions based on solid facts, supporting the creation of wise policies and effective interventions that increase the community vulnerability in Chamba District. Learn a lot about the elements that support or impede the socio-ecological vulnerability of the Tehsils by analyzing the strengths and weaknesses within each component. With the ultimate objective of building more vulnerable communities that are better able to endure and recover from the effects of natural calamities, this information will guide future planning and development projects. To evaluate the socio-ecological vulnerability of Tehsils in the Chamba District, Examine the particular elements of social, economic, institutional, infrastructure, and ecological indicators in the sections that follow. The study will give insights for targeted actions and policies to promote vulnerability and ensure sustainable development in the face of natural hazards, as well as a thorough knowledge of the existing level of vulnerability [2].

## 2. Literature Review

**Abdullah Al Mamun et al. (2023)** delve into the crucial issue of livelihood vulnerability within char land communities in Bangladesh. Char lands are vulnerable riverine islands prone to both climate change and natural hazards. In this study, the authors apply a Livelihood Vulnerability Index to assess the multifaceted dimensions of vulnerability faced by these communities. They explore the complex interplay between climate change impacts and natural hazards on the livelihoods of char land residents [2]. The study offers valuable insights into the challenges faced by vulnerable communities and provides a systematic framework for assessing their vulnerability, facilitating informed policy interventions and resilience-building efforts. **Yuting Peng (2023)** proposed research focuses on the integration of ecosystem services indicators into vulnerability and risk assessments for deltaic social-ecological systems.

Deltas are particularly vulnerable to climate change and environmental hazards. Peng's framework acknowledges the intricate relationship between ecosystem services and the resilience of deltaic communities. By incorporating ecosystem services indicators, the study offers a holistic perspective on vulnerability assessment [12]. This approach enhances the understanding of how ecosystem services can mitigate or exacerbate vulnerability in deltaic regions, facilitating more effective adaptation and risk reduction strategies. **Shah Fahad et al. (2023)** investigated present a comprehensive study that quantifies household vulnerability while considering regional environmental indicators and climate change mitigation efforts [4]. The research employs a combination of vulnerability frameworks to analyze the intricate relationship between household vulnerability, environmental conditions, and climate change mitigation practices.

By merging these dimensions, the study offers a nuanced understanding of the factors that contribute to or mitigate vulnerability at the household level. This integrated approach contributes to more effective policy development and planning for sustainable development

and climate resilience. These studies collectively highlight the evolving landscape of vulnerability assessment in the context of climate change, natural hazards, and environmental sustainability. They underscore the importance of adopting multidimensional frameworks that consider the complexities of social, ecological, and environmental systems when evaluating vulnerability and devising strategies for resilience and adaptation. **Twinkle Thakur et al. (2023)** proposed investigates the vulnerability of various sectors in Lug Valley, located in the Kullu District of Himachal Pradesh, to the impacts of climate change [4]. The study examines how climate change affects different aspects of this region, including water resources, agriculture, and livelihoods.

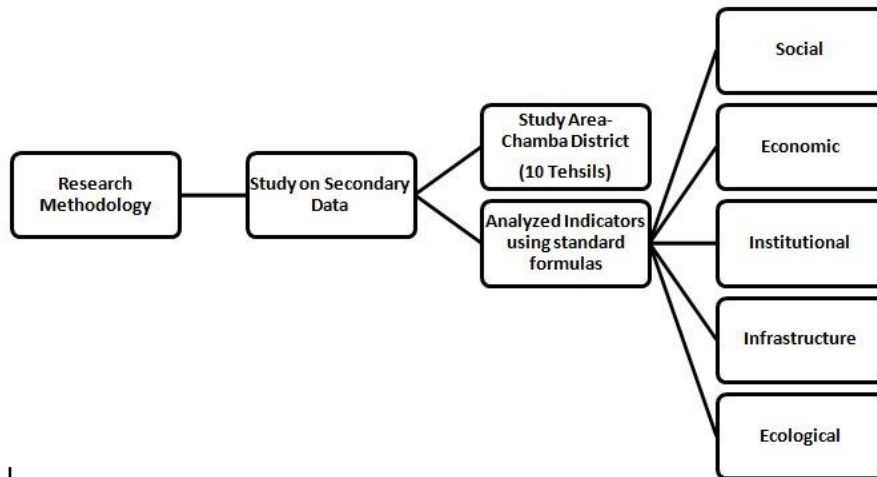
Thakur employs a multidisciplinary approach to assess vulnerability, considering both environmental and socio-economic factors. The findings provide valuable insights into the complex interactions between climate change and different sectors in Lug Valley, offering a foundation for informed decision-making and adaptation strategies to enhance resilience in this vulnerable region. **Jagpal Singh Tomar et al. (2021)** introduced study focuses on assessing the vulnerability and risk associated with forest fires in the Sirmour district forest of Himachal Pradesh, India. Using geospatial tools and techniques, the research offers a comprehensive analysis of the forest fire hazards in this region. By integrating various spatial data layers and risk assessment methodologies [5]. The study provides valuable insights into the area's most susceptible to forest fires and their potential impacts on the environment and communities.

Tomar's geospatial approach enhances understanding of forest fire vulnerability and aids in the development of effective forest fire management and mitigation strategies. **Barman et al. (2023)** introduced research carried out an ecological evaluation of the Himalayan district of Chamba's Ban oak (*Quercus oblongata* D. Don). The suitability ranges and conservation implications of this species are assessed by their research, which is significant for the biodiversity and ecosystem services of the area. The study underlines how crucial it is to comprehend the biological needs of local species in order to develop successful conservation plans [6]. It emphasizes the need of protecting native tree species in the Himalayan ecosystem and offers insightful information about current and upcoming conservation efforts for Ban oak [4]. **S. Khanduri (2021)** focuses on the development and failure of natural dams in the Himalayan region of Uttarakhand, using data from the Tehri Garhwal District's Lwarkha, Chamba Tahsil. The study looks into the geological processes and variables that lead to the construction and possible failure of natural dams, which can put downstream towns in grave danger.

It clarifies how crucial it is to comprehend the geomorphic processes in the Himalayan region in order to improve mitigation and preparedness measures for disasters, especially in places that are vulnerable to the construction of natural dams [7]. **Kanwarpreet Singh and Virender Kumar (2018)** investigated out a hazard evaluation of landslip disasters in the Himalayan region of Chamba, which is extremely tectonic. To determine the area's landslip susceptibility, their study uses the analytical hierarchy approach and the information value method. The study emphasizes the necessity of taking preventative action to lessen the

likelihood of landslides in the Chamba region and stresses the significance of precise hazard assessments for disaster management in the Himalayan regions that are subject to geological activity[9].

### 3. Research Methodology



**Figure 1.** Research Design

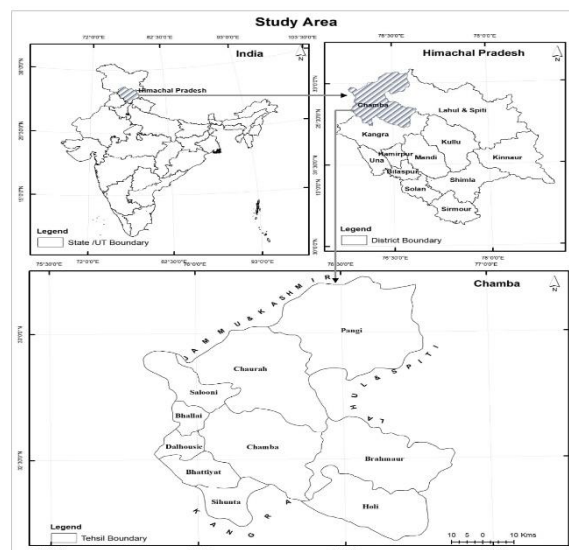
The study conducted in Chamba District, Himachal Pradesh, entailed a thorough examination of many indicators in ten Tehsils. These indicators covered a wide range of areas including social, economic, institutional, infrastructure, and ecological issues. The primary approach employed in this study methodology was the utilisation of secondary data acquired from reputable sources such as government papers, census data, academic publications, and statistics handbooks. The major goal was to thoroughly comprehend and appraise the complex terrain of Chamba District by systematically evaluating important indicators within each area. The study focused on the 10 Tehsils of Chamba District as its geographical focal points. The choice of these locations was essential, taking into account criteria such as the availability of data, the relevance to the research goals, and the representative qualities that accurately portrayed the varied socio-economic and ecological dynamics of the district. The careful selection process helped to guarantee a thorough examination that encompassed the subtleties and differences across various regions in Chamba.

The research technique entailed the meticulous selection of indicators that were in line with particular areas. Within the social sphere, metrics encompassed population demographics, literacy rates, healthcare accessibility, and education levels. Economic indicators include measures such as GDP, per capita income, employment rates, and agricultural production. Institutional indicators encompassed elements of governance frameworks, administrative efficacy, and the provision of public services. Infrastructure indicators are concerned with aspects such as road networks, electricity availability, water provision, and communication facilities. Ecological indicators primarily focused on forest cover, biodiversity, as well as the

quality of air and water. The essence of this methodology resides in the meticulous examination of the gathered secondary data. Researchers utilised conventional formulas and statistical methods to examine and decipher the indications throughout the eleven Tehsils of Chamba District. This procedure entailed computing pertinent indices, ratios, percentages, and other statistical metrics to juxtapose and differentiate the socio-economic, institutional, infrastructure, and ecological facets among various locations within the district.

### 3.1 Profile of the Region

Chamba is nestled in the western Himalayas of northern India and shares its borders with the Jammu and Kashmir Union Territory to the north, Punjab to the west, Haryana to the southwest, and other districts of Himachal Pradesh to the east and south. Its strategic location in the Himalayan foothills makes it a region of significant geographical importance. The district of Chamba exhibits a diverse range of altitudes. The town of Chamba itself sits at an elevation of around 996 meters (3,268 feet) above sea level.



**Figure 2.** Study Area Chamba District Himachal Pradesh

The table no. 1 presents a comprehensive overview of population and demographic data for various tehsils within the Chamba district of Himachal Pradesh. It's evident that Chamba tehsil stands out as the most populous and geographically extensive in the district. With 307 villages and a total population of 43,772, it is not only the largest in terms of population but also in the number of households in rural areas, with 15,920 households. This data suggests that Chamba tehsil is a significant administrative and population center in the district.

In contrast, Pangi tehsil emerges as the smallest in terms of population, with only 1,246 residents, and it also has a smaller number of households in rural areas at 3,952. This reflects the more remote and less densely populated nature of Pangi, which is characteristic of some hilly and remote areas in Himachal Pradesh.

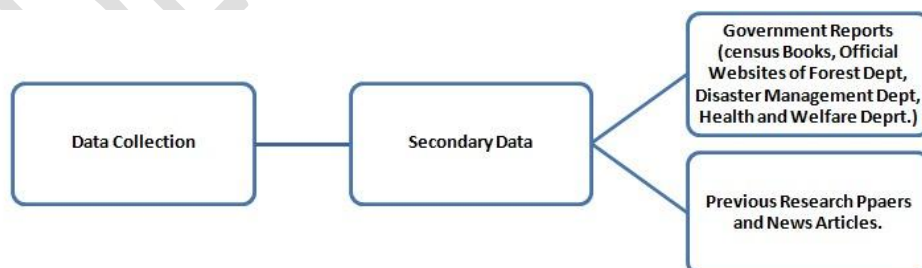
**Table no. 1** Show demographic data of Chamba District Tehsil-wise

Tehsil name	Total Villages	Population				Rural Population	Number of households in Rural
		SC	ST	Gen+OBC	Total		
<b>Chamba</b>	307	43,772	39,786	95,695	179,253	15,920	31,344
<b>Chaurah</b>	306	23,009	6,610	49,369	78,988	78,988	14,142
<b>Saluni</b>	176	13,270	4,383	30,286	47,939	47,939	8,815
<b>Dalhousie</b>	126	7,016	9,240	30,504	46,760	36,160	17,338(approx.)
<b>Bhattiyat</b>	132	5,958	10592	26,417	42,967	37,392	7,596
<b>Sihunta</b>	97	6,415	15280	18,176	39,871	39,871	8,297
<b>Bhalai</b>	80	6,444	477	18,405	25,326	25,326	4,774
<b>Brahmaur</b>	111	2,448	21,177	1,389	25,014	25,014	5,142
<b>Pangi</b>	106	1,246	17,016	606	18,868	18,868	3,952
<b>Holi</b>	139	2,112	10,939	1,043	14,094	14,094	3,027

### 3.2 Data Collection

The research methodology utilized in this study was a thorough examination of both prior research and official sources to meticulously evaluate susceptibility to natural disasters. In order to ensure the acquisition of accurate and comprehensive information, secondary data sources were selected as the major method of data gathering. The accuracy and dependability of government records, particularly census books, and data from earlier study were considered essential.

The study's relevancy and currency were ensured by incorporating latest research findings and authentic government reports as a fundamental basis. The research attempted to gain a comprehensive understanding of the many dimensions of vulnerability in the researched region by utilizing these sources. This methodology not only enabled a thorough investigation of the issue, but also assured that the conclusions were based on trustworthy and validated information, so strengthening the reliability and credibility of the research results.



**Figure 3.** An Overview of the Data Collection Approach

### 4. Result and Discussion

The results and discussion section of a research paper on vulnerability indicators and factors in Chamba, Himachal Pradesh, presents a comprehensive analysis of the findings obtained through the vulnerability assessment. This study focuses on identifying and

understanding the factors contributing to socio-ecological vulnerability in the region. The results section succinctly highlights the key vulnerability indicators across different components, such as social, economic, institutional, infrastructure, and ecological. The discussion section delves into the implications of the identified vulnerability factors, providing insights into the complex interactions and relationships among various indicators. The discussion extends to the potential impacts of these vulnerabilities on the local communities and ecosystems within Chamba. It may address how identified factors influence the region's resilience to natural hazards and their capacity for adaptive strategies.

Comparisons with established benchmarks or thresholds help contextualize the vulnerability levels and facilitate a deeper understanding of the region's susceptibility to various risks. The results and discussion section of this research paper on vulnerability indicators and factors in Chamba, Himachal Pradesh, serves as a critical exploration of the study's findings. The vulnerability of the Tehsils has been calculated using 25 indicators based on secondary data sources. According to above mentioned selected indicators of the component social, economic, institutional, infrastructure and ecological and composite vulnerability calculated at the block level which have been presented in the table no.2.

**Table 2.** Tehsil wise component indices and vulnerability Index to natural hazards in Chamba District

Name of Tehsil	Component Indices					Composite Score
	Social	Economics	Institutional	Infrastructure	Ecological	
Chamba	0.58	0.57	0.30	0.67	0.58	0.54
Chaurah	0.55	0.35	0.38	0.60	0.39	0.454
Saluni	0.32	0.39	0.51	0.78	0.24	0.448
Dalhousie	0.47	0.34	0.49	0.52	0.40	0.444
Bhattiyat	0.38	0.61	0.83	0.41	0.44	0.534
Sihunta	0.40	0.42	0.62	0.42	0.32	0.436
Bhalai	0.39	0.31	0.55	0.54	0.45	0.448
Brahmaur	0.43	0.50	0.37	0.65	0.61	0.512
Pangi	0.29	0.32	0.20	0.23	0.54	0.316
Holi	0.28	0.40	0.39	0.047	0.40	0.3034

The table provides a comprehensive analysis of various tehsils within Chamba District, highlighting their development or vulnerability based on a set of component indices and a composite score. Five important factors are used to evaluate each tehsil: social, economic, institutional, infrastructure, and ecological. These characteristics cover a broad spectrum of elements that support the tehsils' general quality of life and ability to withstand adversity and natural disasters. With a composite score of 0.54, Chamba Tehsil is noteworthy for appearing to be the least susceptible or most developed of the tehsils under analysis.

**Table no. 3.** Socio-Ecological Vulnerability Index

Value	Rank	Name of tehsil
>0.524	High	Chamba, Bhattiyat
0.362-0.524	Moderate	Chauraha, Saluni, Dalhousie, Sihunta, Bhalai, Brahmaur
<0.362	Low	Holi, Pangi

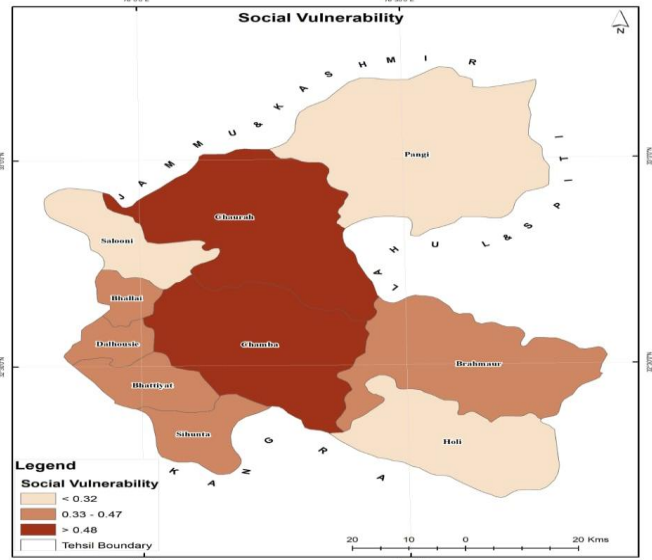
Table no. 3 provides a comprehensive analysis of the vulnerability ranking of tehsils within Chamba District, using specific vulnerability values as a basis for classification. The tehsils are grouped into three distinct categories, each indicative of the level of vulnerability present in those areas. In the "High Vulnerability" category, Chamba and Bhattiyat stand out as tehsils with vulnerability values exceeding 0.524. This classification suggests that these areas face a relatively higher level of vulnerability compared to others within the district.

#### **4.1 Vulnerability Profile of Various Components**

This research paper delves into the nuanced vulnerability profile of various components within Chamba, Himachal Pradesh, shedding light on the multifaceted dimensions of susceptibility to natural hazards. Employing a comprehensive approach, the study identifies and analyzes distinct components encompassing social, economic, institutional, infrastructure, and ecological aspects. The research meticulously examines indicators pertinent to each component, utilizing a diverse array of data sources, including governmental departments, research institutions, and relevant entities. Through a meticulous process of data analysis, the paper discerns intricate relationships, patterns, and trends within these components, contributing to a nuanced understanding of vulnerability.

The assessment extends beyond a singular focus on each component's vulnerability, encompassing an evaluation of interdependencies and systemic influences. As part of this comprehensive analysis, the paper assigns appropriate weights to indicators, facilitating a more accurate representation of their relative significance in vulnerability profiles. The aggregation of these weighted indicators generates component-specific scores or indices, contributing to an intricate understanding of vulnerability at the micro-level.

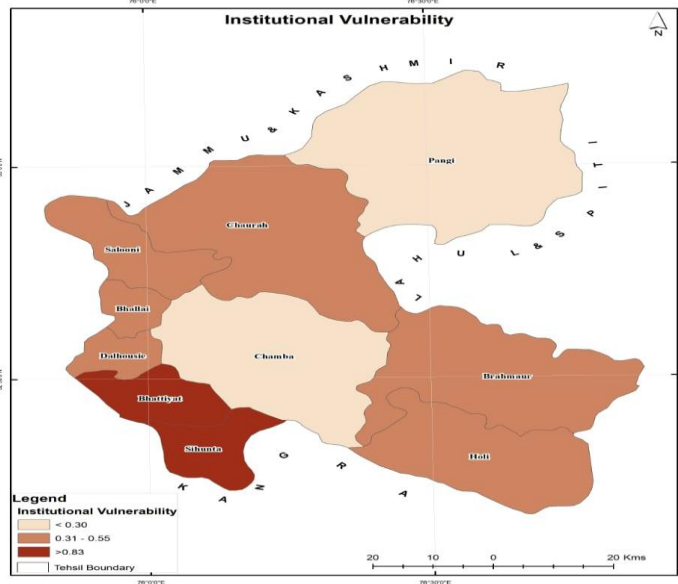
#### **A. Social Vulnerability**



**Figure4.** Level of Social vulnerability of the Tehsils in Chamba District

The examination of the sociological component data in Chamba District offers intriguing revelations on the Tehsils' susceptibility. The most recent table offers a thorough overview of numerous indicators in the various Tehsils of the Chamba District. The Tehsils' illiteracy rates have changed, indicating advancements in certain sectors.

**B. Institutional Vulnerability**

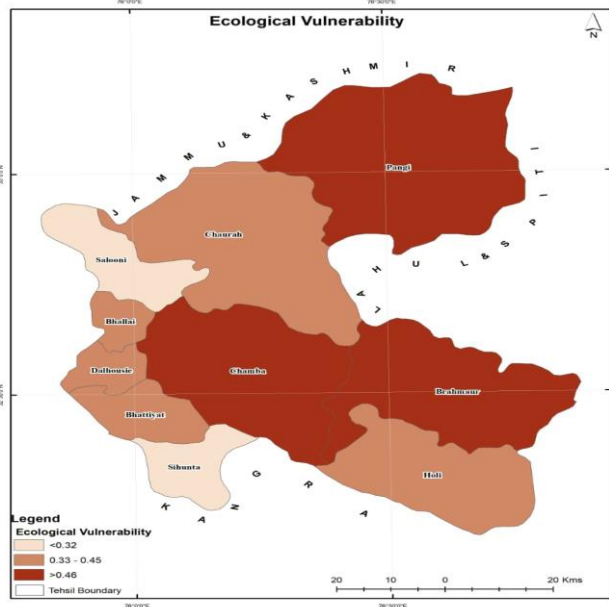


**Figure5.** Level of Institutional vulnerability of the Tehsils in Chamba District

The following table provides a complete evaluation of the efficiency of local institutions in the several tehsils that make up the Chamba District. The table delves into the institutional vulnerabilities of each of the tehsils that are included in the district. The component indices, with a particular emphasis on the institutional dimension, offer helpful insights into the degree

to which these tehsils are well-equipped and robust in the face of natural calamities and other obstacles.

**C. Economic Vulnerability**

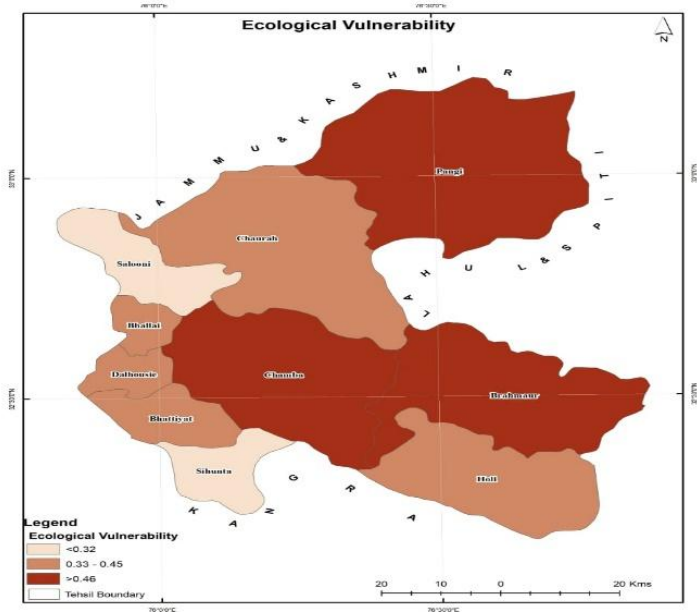


**Figure6.** Level of Economic vulnerability of the Tehsils in Chamba District

The data on the Economic Component that are provided for each Tehsil in the Chamba District provide useful insights into the various economic landscapes and levels of vulnerability that are present throughout the region. The following table provides a detailed summary of the social component indices for several tehsils located within Chamba District. This table sheds light on the varying levels of social development and sensitivity to natural hazards that each of these tehsils possesses. These indices, which serve as vital indicators of the quality of life and availability to essential services in each tehsil, provide valuable insights into the overall social well-being of the inhabitants of those tehsils.

**D. Infrastructure Component**





**Figure8.** Level of Ecological vulnerability of the Tehsils in Chamba District

The table provides a clear overview of the ecological vulnerability of the different tehsils in the Chamba District, illuminating the varying degrees of ecological health and environmental challenge resilience. The ecological dimension is the focal point of the component indices in the table, which provide an indication of how capable certain tehsils are of managing and reducing ecological threats. Leading the table with the greatest ecological index (0.58) is Chamba Tehsil. Based on this rating, Chamba Tehsil appears to have a somewhat robust and healthy ecological ecosystem, with plenty of forest cover, sustainable water resources, and good environmental management techniques.

## 5. Conclusion

The assessment of vulnerability to natural hazards in Chamba District, Himachal Pradesh, revealed significant insights into the region's susceptibility and contributing factors. The intra-district analysis provided a nuanced understanding of challenges across tehsils. Tehsil-wise indices highlighted the multifaceted nature of vulnerability, influenced by social, economic, institutional, infrastructure, and ecological factors. Chamba Tehsil displayed relatively lower vulnerability, scoring higher in most indices, while Holi Tehsil faced challenges in infrastructure and ecological resilience, rendering it more vulnerable. The findings stress the need for a holistic approach, addressing socio-economic disparities, fortifying institutions, and promoting ecological sustainability. Tailored strategies for each Tehsil are crucial, recognizing unique challenges. Local communities are integral to resilience-building, necessitating active engagement, awareness, and capacity-building initiatives in vulnerability reduction strategies.

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