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

Abstract

This research paper presents a comprehensive assessment of vulnerability to natural hazards in Chamba District, Himachal Pradesh, offering insights into the region's susceptibility to environmental risks and the contributing factors shaping its vulnerability. Conducting an intra-district analysis has provided nuanced insights into the diverse challenges encountered by different tehsils within Chamba District. The Tehsil-wise component indices and composite scores highlight the multifaceted nature of vulnerability, influenced by social, economic, institutional, infrastructure, and ecological factors. Chamba Tehsil demonstrates relatively lower vulnerability, showcasing higher scores across most component indices. Conversely, Holi Tehsil emerges as one of the more vulnerable areas, primarily due to infrastructure and ecological resilience challenges. These findings emphasize the need for a holistic vulnerability assessment approach. Mitigating vulnerability demands not only improving physical infrastructure but also addressing socio-economic inequalities, fortifying institutional mechanisms, and fostering ecological sustainability. Tailored strategies for vulnerability reduction must acknowledge the unique challenges and opportunities within each Tehsil. Active community engagement, awareness-raising, and capacity-building initiatives are essential components of vulnerability reduction strategies. Local communities' involvement in disaster risk reduction efforts is crucial, leveraging their knowledge and capacities to build resilience.

Keywords: Vulnerability, Hazards, Socio-Economic, Ecological, DisasterResilience

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.***PUT A CITATION***

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.(***CITATION)***

2. Literature Review

Abdullah Al Mamun et al. (2023) introduced research entitled ***"Livelihood Vulnerability of Char Land Communities in Bangladesh"***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 [1]. 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 entitled ***"Integrating Ecosystem Services into Deltaic Social-Ecological Systems Vulnerability Assessment"***research focuses on the integration of ecosystem services indicators into vulnerability and risk assessments for deltaic social-ecological systems. ***Do not mention the title here. Only in the references list***

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 [2]. 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 research entitled ***"Quantifying Household Vulnerability, Environmental Indicators, and Climate Change Mitigation"*** present a comprehensive study that quantifies household vulnerability while considering regional environmental indicators and climate change mitigation efforts [3]. 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 research entitled***"Vulnerability to Climate Change in Lug Valley, Kullu District, Himachal Pradesh"***research 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 research entitled ***"Forest Fire Hazards Vulnerability and Risk Assessment in Sirmaur District, Himachal Pradesh"***study focuses on assessing the vulnerability and risk associated with forest fires in the Sirmaur 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 entitled ***"Ecological Assessment and Conservation of Ban Oak (Quercus oblongata D. Don)"***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)** proposed research entitled ***"Formation and Failure of Natural Dams in Uttarakhand Himalaya"***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)**investigatedresearch entitled ***"Hazard Assessment of Landslide Disaster in***

Chamba Region"authors 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

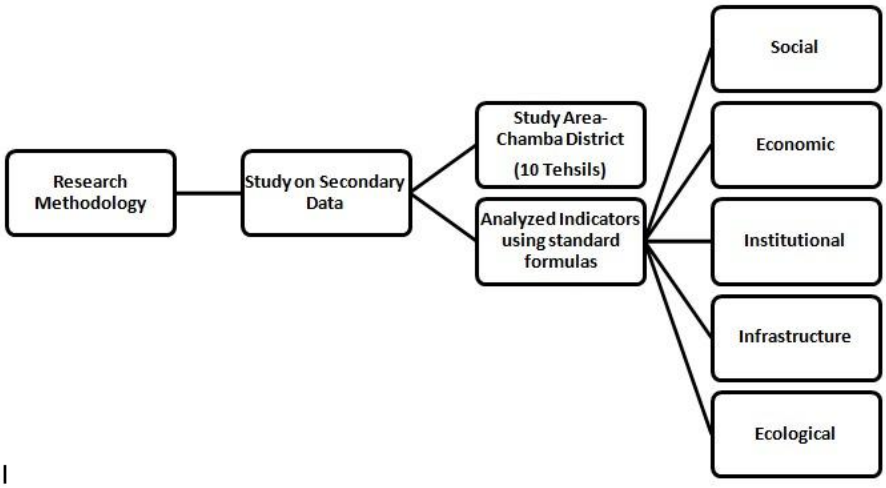

Figure 1. Research Design

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The study focusing on Chamba District in Himachal Pradesh involves an in-depth analysis of various indicators across ten Tehsils, encompassing diverse domains such as social, economic, institutional, infrastructure, and ecological aspects. This research methodology predominantly relies on secondary data obtained from reliable sources including government reports, census data, academic publications, and statistical handbooks. The primary objective is to comprehensively understand and evaluate the multifaceted landscape of Chamba District through a systematic assessment of key indicators within each domain. Chamba District's ten Tehsils serve as the geographical focal points for this study. The selection of these areas is crucial, considering factors like data availability, relevance to the research objectives, and representative characteristics that reflect the diverse socio-economic and ecological dynamics of the district. This meticulous selection aids in ensuring a comprehensive analysis that captures the nuances and variations across different regions within Chamba.

The research methodology involves/involved the careful curation of indicators aligned with specific domains. For instance, within the social domain, indicators might include population

demographics, literacy rates, healthcare access, and education levels. Economic indicators could encompass GDP, per capita income, employment rates, and agricultural productivity. Institutional indicators might involve aspects of governance structures, administrative efficiency, and public service delivery. Infrastructure indicators could focus on factors like road networks, electricity access, water supply, and communication facilities. Finally, ecological indicators might revolve around forest cover, biodiversity, air, and water quality. The crux of this methodology lies in the rigorous analysis of the collected secondary data. Employing standard formulas and statistical tools, researchers will analyze and interpret the indicators across the ten Tehsils of Chamba District. This process involves calculating relevant indices, ratios, percentages, and other statistical measures to compare and contrast the socio-economic, institutional, infrastructure, and ecological aspects across different regions 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.

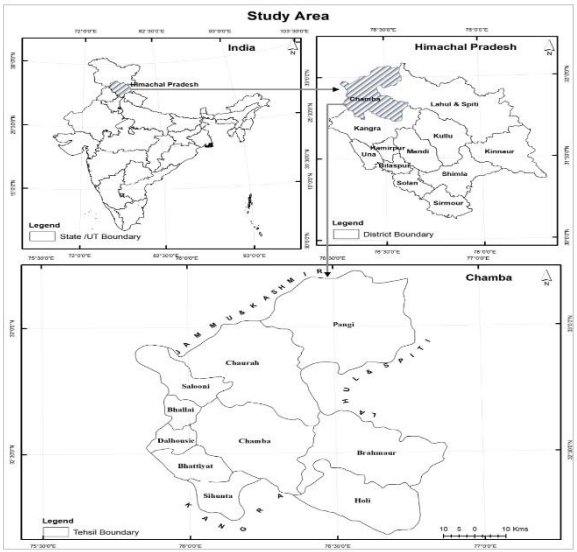

Figure2. Study Area Chamba District Himachal Pradesh

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

3.2 Identification and Assessment

In undertaking a comprehensive socio-ecological vulnerability assessment to natural hazards in the Tehsils of Chamba District, a systematic eight-step process is implemented. Firstly, the identification of indicators is crucial, involving the selection of indicators for each component (Social, Economic, Institutional, Infrastructure, and Ecological) based on their relevance to vulnerability assessment. The indicators listed in a prior table serve as a foundational starting point. Subsequently, data collection ensues, wherein relevant data for each indicator is gathered from diverse sources, including government departments, research institutions, and other pertinent entities. The emphasis is on obtaining recent, accurate, and Tehsil-specific data.

Following data collection, a meticulous data analysis commences, involving computations of values, percentages, ratios, and other statistical measures to discern patterns, trends, and relationships. Moving forward, the vulnerability of each component is assessed by scrutinizing the values and relationships of the indicators within that specific component. This assessment involves comparisons against benchmarks or established thresholds, as well as consideration of positive or negative relationships between indicators and vulnerability. To refine the assessment, appropriate weights are assigned to indicators within each component based on their relative importance. The aggregation of these indicator values results in an overall score or index for each component. Subsequently, the overall socio-ecological vulnerability is determined by combining component scores or indices.

This amalgamation considers the weights assigned to each component, acknowledging their relative significance in the overall vulnerability assessment. The interpretation and validation of results from the penultimate steps, requiring a comprehensive understanding of the vulnerability assessment findings. Stakeholder engagement, involving local communities and experts, facilitates result validation and provides diverse perspectives. Finally, the process concludes with the identification of strengths and weaknesses within each Tehsil. This step aims to pinpoint areas of high vulnerability, areas requiring improvement, and the specific vulnerabilities and capacities unique to each Tehsil. The eight-step process ensures a robust and nuanced socio-ecological vulnerability assessment tailored to the diverse components and contexts within Chamba District's Tehsils.

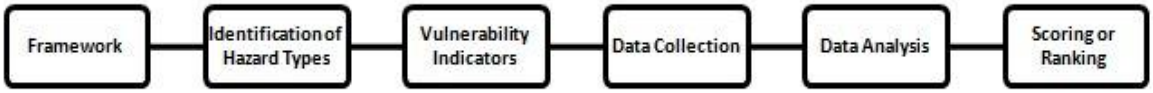

Figure 3. Vulnerability AssessmentFramework

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.

4.1Vulnerability 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

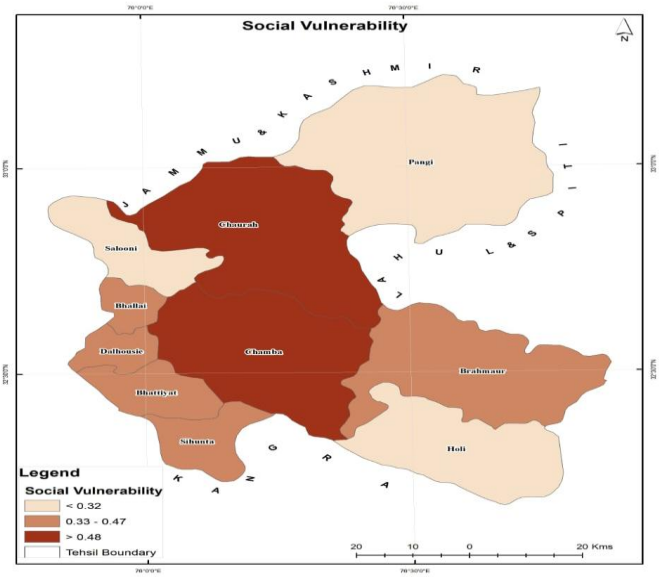

Figure4. Level of Social vulnerability of the Tehsils in Chamba District

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

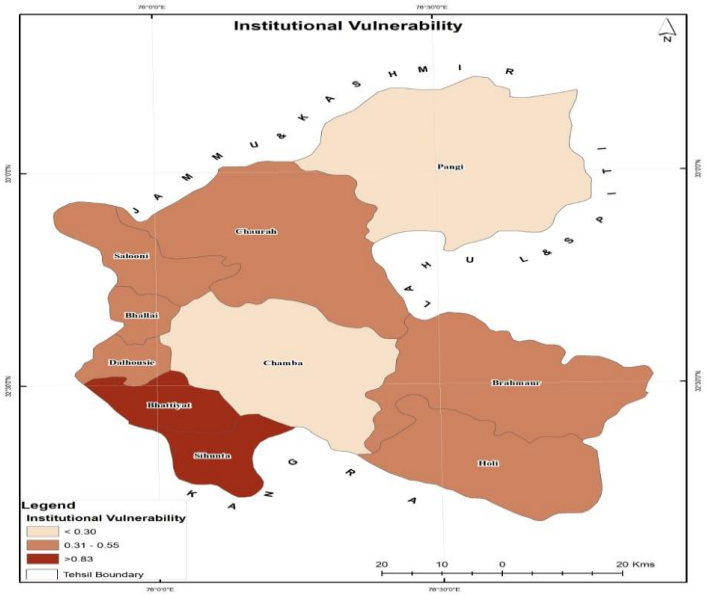

Figure5. Level of Institutional vulnerability of the Tehsils in Chamba District

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

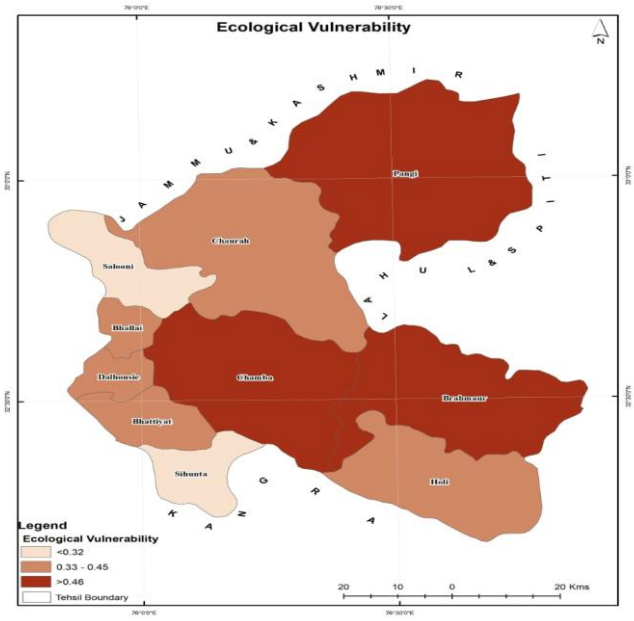

Figure6. Level of Economic vulnerability of the Tehsils in Chamba District

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

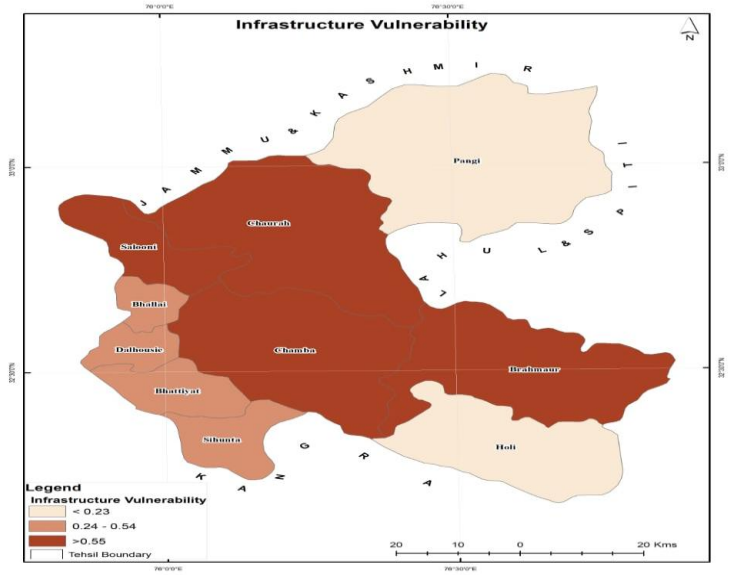

Figure7. Level of Infrastructure vulnerability of the Tehsils in Chamba District

The comprehensive analysis presented in the table meticulously scrutinizes the extent of vulnerability within the infrastructure across each distinct Tehsil constituting the Chamba District. Through this detailed evaluation, it vividly highlights the diverse spectrum of preparedness levels and the capacity of each Tehsil to confront and overcome challenges related to its physical infrastructure. This scrutiny unveils a nuanced understanding of the varying strengths and weaknesses inherent in the infrastructure of each Tehsil, offering valuable insights into their resilience against potential adversities and their readiness to address infrastructure-related hurdles. Such a comprehensive assessment enables a clearer grasp of the intricate differences among Tehsils, providing a platform to prioritize and strategize improvements in infrastructure development tailored to the specific needs and vulnerabilities of each area within the Chamba District.

5.5 Ecological Component

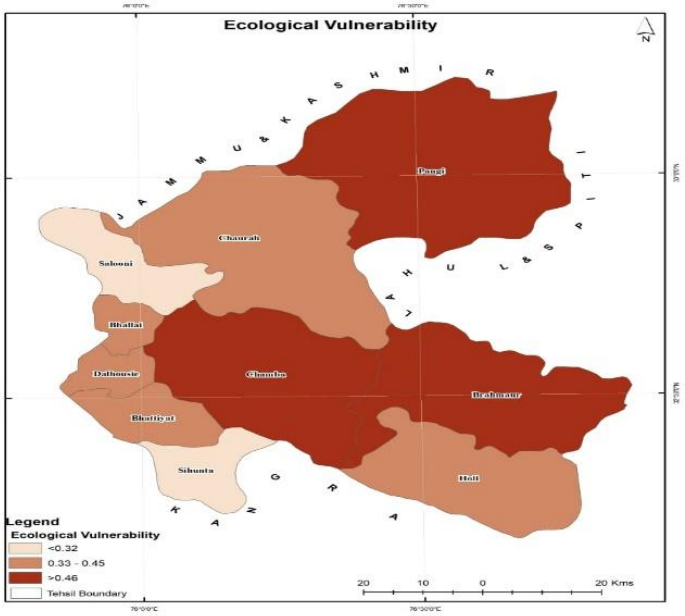

Figure8. Level of Ecological vulnerability of the Tehsils in Chamba District

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, has provided valuable insights into the region's susceptibility to environmental risks and the factors contributing to its vulnerability. Through a comprehensive intra-district analysis, gained a nuanced understanding of the diverse challenges faced by different tehsils within Chamba District. The Tehsil-wise component indices and composite scores highlight the multifaceted nature of vulnerability. Social factors, economic conditions, institutional capacity, infrastructure resilience, and ecological considerations all play pivotal roles in shaping vulnerability to natural hazards. Chamba Tehsil emerges as relatively less vulnerable, benefiting from higher scores in most component indices. In contrast, Holi Tehsil appears as one of the more vulnerable areas, primarily due to challenges in infrastructure and ecological resilience. The findings underscore the importance of a holistic approach to vulnerability assessment. Addressing vulnerability requires not only enhancing physical infrastructure but also addressing socio-economic disparities, strengthening institutional mechanisms, and promoting ecological sustainability. Strategies for reducing vulnerability must be tailored to the specific context of each Tehsil, recognizing their unique challenges and opportunities. Local communities play a vital role in building resilience to natural hazards. Their knowledge, capacities, and participation in disaster risk reduction efforts are pivotal. It is imperative that vulnerability reduction strategies include active community engagement, awareness-raising, and capacity-building initiatives.

References

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Alphabetical order

1. Al Mamun, A., Islam, A. R. M. T., Alam, G. M., Sarker, M. N. I., Erdiaw-Kwasie, M. O., Bhandari, H., & Mallick, J. (2023). Livelihood vulnerability of char land communities to climate change and natural hazards in Bangladesh: an application of livelihood vulnerability index. *Natural Hazards*, *115*(2), 1411-1437.
2. Peng, Y., Welden, N., & Renaud, F. G. (2023). A framework for integrating ecosystem services indicators into vulnerability and risk assessments of deltaic social-ecological systems. *Journal of Environmental Management*, *326*, 116682.
3. Fahad, S., Su, F., & Wei, K. (2023). Quantifying households' vulnerability, regional environmental indicators, and climate change mitigation by using a combination of vulnerability frameworks. *Land Degradation & Development*, *34*(3), 859-872.
4. Thakur, T., Chand, K., Kuniyal, J. C., Singh, S. K., Kanga, S., & Meraj, G. (2023). Vulnerability to Climate Change in Different Sectors of Lug Valley, Kullu District of Himachal Pradesh. In *Advances in Water Resource Planning and Sustainability* (pp. 183-201). Singapore: Springer Nature Singapore.
5. Tomar, J. S., Kranjčić, N., Đurin, B., Kanga, S., & Singh, S. K. (2021). Forest fire hazards vulnerability and risk assessment in Sirmaur district forest of Himachal Pradesh (India): A geospatial approach. *ISPRS International Journal of Geo-Information*, *10*(7), 447.

6. Barman, T., Samant, S. S., Tewari, L. M., Kanwar, N., Singh, A., Paul, S., & Lata, S. (2023). Ecological assessment and suitability ranges of Ban oak (Quercus oblongata D. Don) in Chamba district, Himalayas: implications for present and future conservation. *Brazilian Journal of Botany*, 1-21.
7. Khanduri, S. (2021). Formation and Failure of Natural Dams in Uttarakhand Himalaya: An Observation from Lwarkha, Chamba Tahsil of Tehri Garhwal District, India. *International Journal of Earth Sciences Knowledge and Applications*, *3*(1), 12-22.
8. Singh, K., & Kumar, V. (2018). Hazard assessment of landslide disaster using information value method and analytical hierarchy process in highly tectonic Chamba region in bosom of Himalaya. *Journal of Mountain science*, *15*(4), 808-824.
9. Ram, P., & Gupta, V. (2022). Landslide hazard, vulnerability, and risk assessment (HVRA), Mussoorie township, lesser himalaya, India. *Environment, Development and Sustainability*, 1-29.
10. Jamwal, A., & Chand, K. (2022). Vulnerability Assessment of Avalanches in Upper Satluj Basin, District Kinnaur, Himachal Pradesh, India: A Geographic Information System (GIS)-Based Approach. In *Remote Sensing and Geographic Information Systems for Policy Decision Support* (pp. 137-148). Singapore: Springer Nature Singapore.
11. Kumar, A., Sharma, R. K., & Bansal, V. K. (2022). Spatial Prediction of Landslide Hazard using GIS-multi-criteria Decision Analysis in Kullu District of Himachal Pradesh, India. *Journal of Mining and Environment*, *13*(4), 943-956.
12. KUMAR, V. (2022). Disaster Management System in Himachal Pradesh.
13. Magray, A. A., Singh, K., & Sharma, S. Comparative Analysis of Certainty Factor and Analytic Hierarchy Process for Landslide Susceptibility Zonation in Parts of Solan, Himachal Pradesh, India. *Quaestiones Geographicae*.
14. Kumar, L., Sharma, V. R., & Sanu, S. K. EXAMINING KULLU DISTRICT'S PAST DISASTROUS INCIDENTS AND ITS IMPACT ON LIVELIHOOD: WITH SPECIAL REFERENCE TO EARTHQUAKE.
15. Ali, N., Alam, A., Bhat, M. S., & Shah, B. (2022). Using historical data for developing a hazard and disaster profile of the Kashmir valley for the period 1900–2020. *Natural Hazards*, *114*(2), 1609-1646.
16. Pandey, D. D., Banshtu, R. S., Singh, K., &Versain, L. D. (2020). Landslide Hazard Assessment Using Probabilistic and Statistical Approaches: A Case Study of Chamba Region, Himachal Pradesh, India.
17. Singh, U. S. Assessment of Livelihood Practices and Resilience: An Inter-District Analysis of Himachal Pradesh.
18. Pandey, D. D., Banshtu, R. S., Mahajan, A. K., &Versain, L. D. (2021). The Comparison Between Certainty Factor Method and Index of Entropy Method For Landslide Hazard Assessment: South Western Chamba District, Himachal Pradesh, India.