INTERNATIONAL RESEARCH JOURNAL OF HUMANITIES AND INTERDISCIPLINARY STUDIES
(Peer-reviewed, Refereed, Indexed & Open Access Journal)
DOI : 03.2021-11278686 ISSN : 2582-8568 IMPACT FACTOR : 8.031 (SJIF 2025)

Multi-Hazard Vulnerability Assessment of North Kashmir-An Analysis to Evaluate Disaster Risk for Better Management of Disasters and Building Capacity in the Region

Mohmad Suhail Wani[1], Dr. Rupinder Kaur Sharma[2], Prof. Pervez Ahmed[3]

[1]Ph.D Research Scholar, Desh Bhaghat University, Mandi Gobindgarh, Fatehgarh Sahib (Punjab, India) E-mail: suhailwani1911@gmail.com

[2]Associate Professor, Desh Bhagat University, Mandi Gobindgarh, Fatehgarh Sahib (Punjab, India) E-mail: ap.hotelmgt@deshbhagatuniversity.in

[3]Professor, University of Kashmir, Hazratbal Srinagar (Jammu & Kashmir, India) E-mail: dr.parvez@uok.edu.in

DOI No. 03.2021-11278686 DOI Link :: https://doi-ds.org/doilink/09.2025-15247639/IRJHIS2509003

Abstract:

Multi-hazard approaches for risk assessment are applied in two ways: First we need to study single hazards in each area before combining our results. The level of impact between a hazard and vulnerable entities at risk depends on the identified weak points. Due to distinct natural terrain Jammu & Kashmir encounters multiple kinds of risks which make it difficult to manage untoward events. North Kashmir in the Himalayan seismic zone experiences various natural threats including earthquakes floods landslides and snowslides. Through extensive hazard analysis this project measures risks from different disasters to suggest specific protective actions. This research measures vulnerability through combinations of poverty levels, population growth numbers, human settlement trends, forestry losses, environmental stress, climate effects, public understanding gaps, direct field checks and local stakeholder insight. It takes together both physical landscape threats and societal impacts to generate a multi-risk vulnerability scale. The research shows major differences in disaster risk between particular districts and villages showing us the necessity to plan local disaster protection. Our research supports better management of disasters in North Kashmir while also building stronger communities that withstand risks better.

Keywords: *Multi-hazard vulnerability, disaster risk reduction, Himalayan seismic zone, poverty, resilience, climate change.*

Introduction:

Disaster risk is continually changing due to natural and human induced activities. The rising frequency of disasters necessitates improved techniques to analysing and controlling disaster risks at

the national and regional levels. Multi-Hazard Vulnerability Assessment (MHVA) has been widely used to better understand how numerous threats interact and affect communities collectively. This approach examines hazards as interacting systems, demonstrating their cumulative effects on both the built and natural ecosystems (Gallina et al., 2016).

One of the most important metrics in disaster risk management is vulnerability, which measures a community's or system's susceptibility to harm from hazardous events. The susceptibility stems from a complex interplay of physical, social, economic, and environmental elements that influence a community's ability to respond to and recover from disasters (Cutter, 2003). Natural variables such as geographic location, as well as manmade factors such as urbanisation and a lack of sufficient disaster planning, all contribute to increased susceptibility. For example, in North Kashmir, MHVA absorbs the interaction of many natural dangers that typically occur concurrently.

North Kashmir is located in the North-western Himalayan range, a hilly region prone to earthquakes, floods, and snow avalanches. Because it is closer to active faults in the Himalayan seismic zone, it is more likely to experience significant earthquakes that cause widespread damage to people and infrastructure (Bilham, 2004). Extreme weather patterns, such as strong monsoon rains and quick snowmelt, pose additional threats in this already susceptible region. Human actions like deforestation and inappropriate land use have the potential to exacerbate these natural hazards by eroding topsoil and increasing vulnerability to floods and landslides (Negi et al., 2020).

Aside from the aforementioned physical problems, the region also has significant socioeconomic issues, which heighten catastrophe susceptibility. Poverty, limited access to education, insufficient supply of basic services, and underdeveloped healthcare facilities are among the socioeconomic issues. Hazardous places with high population expansion and unplanned settlements exacerbate these vulnerabilities. Political instability and insecurity make it harder for the administration to carry out efficient disaster preparation and response efforts (Ghosh & Hussain, 2018). Climate change creates additional issues such as altering weather patterns, rising temperatures, and shifting rainfall systems, all of which enhance the likelihood of disasters (IPCC, 2014).

Objectives:

To study and understand the disaster profile and vulnerability of North Kashmir.

Review of Literature:

Understanding Multi-Hazard Vulnerability:

Multi-hazard vulnerability determines how susceptible communities and environments become to many different threats that can strike at the same time or follow one another directly. Traditional risk evaluations study one hazard at a time but cannot detect the complete risks created by different threats working together. MHVA tracks combined hazard effects to deliver a more

correct view of disaster risk than single-hazard assessments (Gallina et al., 2016). This system uses specific tests to research disaster risk elements besides checking exposed areas and reaction levels of affected elements. The UNDRR highlights flood-prone mountain ranges as places that need multi-physical hazard mitigation for universal disaster risk reduction success.

Disaster Vulnerability in the Himalayan Context:

The Himalayan region is at high risk because of its special geographic conditions and climate. Earthquakes represent major safety threats since North Kashmir falls in Zone V which marks India's highest hazard zone with regard to earthquakes. Earth movements such as landslides and avalanches happen often on slopes that are both steep and rain-prepared. Heavy rain and trapped glacier water regularly cause flooding problems across lower land areas. Climate change raises disaster risks through unstable rainfall patterns and more frequent extreme weather occurrences according to Sharma and colleagues (2018).

Himalayan research shows how environmental damage increases disaster risk. The fast removal of forests from the land by agricultural farmers and woodcutters damages slope stability and weakens the natural protection of this area (Negi et al., 2020). Rapid urban expansion and rising populations make places more susceptible to natural disasters when development reaches danger-prone land.

Socio-Economic Dimensions of Vulnerability:

The position a community holds in economic and social life sets the limits of disaster risk. Disaster vulnerability targets poor communities first because poverty stops people from getting needed resources to handle trouble situations. North Kashmir residents experience extreme poverty plus restricted education health and infrastructure services which form an unbreakable vulnerability loop (Sharma et al. 2018). The growing number of residents and spreading communities put heavy strain on natural resources that have worsened environmental problems and raised disaster potential.

North Kashmir faces substantial difficulties because its people are poorly aware of disasters and unprepared for them. Most communities in North Kashmir do not understand what dangers exist in their area plus do not recognize how to prepare for and respond to disasters. The findings underline why local communities need DRR activities that teach them effectively plus train staff and engage residents at home (Twigg 2009).

Multi-Hazard Vulnerability Assessment in Practice:

Research into disasters in vulnerable regions shows how MHVA works in practice. Research in Nepal proved that rural communities suffered critical damage when earthquakes and landslides struck together so authorities need to manage multiple risks together (Shrestha et al., 2017). Research in Himachal Pradesh shows climate change contributes to flood and landslide disaster amplification so scientists suggest local solutions adapted to each area's specific risks (Negi et al., 2020).

Research shows we need specific disaster planning strategies that acknowledge each region's unique needs. Our research team should build a MHVI structure tailored to North Kashmir's regions to reveal local vulnerability problems and plan DRR actions. Using scientific research alongside local knowledge helps MHVA improve our disaster management system to build better resilience.

Database and Methodology:

This study uses a holistic, integrated approach, gathering both qualitative and quantitative data as part of an assessment of multi-hazard vulnerability in North Kashmir. The process is guided by a goal that includes not only identifying the region's hazards and vulnerabilities, but also developing methods to improve disaster resilience and risk reduction. This section will describe the study area, data gathering techniques, analysis methodologies, and the creation of the Multi-Hazard Vulnerability Index (MHVI) for the region.

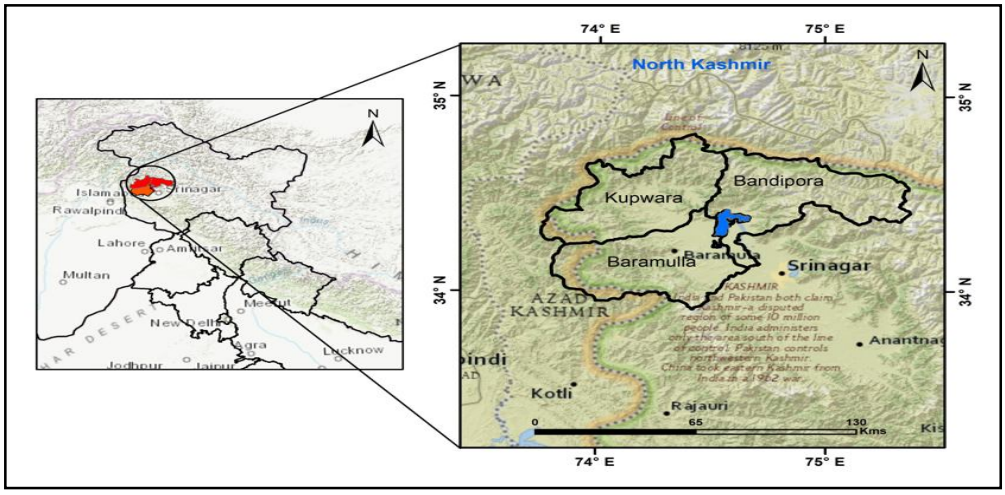
This research is centred on North Kashmir's multi-hazard vulnerability and tries to improve catastrophe risk management systems while also building resilience. It advises developing a framework for a Multi-Hazard Vulnerability Index (MHVI) that incorporates multiple types of hazards and vulnerability characteristics for different assessments. The study's identification of catastrophe hotspots and susceptible groups is expected to aid in the development of tailored disaster mitigation measures.

The study uses data from North Kashmir to objectively examine regional disaster risks and make practical recommendations for increasing resilience. In doing so, the research aims to give policymakers with strong data to aid in the development of evidence-based Disaster Risk Reduction plans, as well as local authorities with the best damage control techniques. Overall, this study aims to strengthen community resilience in North Kashmir by improving disaster preparedness and protecting lives and livelihoods. The following points are taken into consideration in order to understand the multi-hazard vulnerability assessment of North Kashmir:

1. Assessment of individual and combined hazard impacts in North Kashmir.
2. Evaluation of socio-economic and environmental vulnerability factors contributing to disaster risk.
3. Check localized Disaster Risk Reduction strategies to enhance community resilience.

Study Area:

Figure 1: Location Map Study Area



North Kashmir has a diverse geological and ecological makeup, placing it in the Himalayan Seismic Zone, which includes the districts of Baramulla, Kupwara, and Bandipora. Natural disasters have a different influence on each district because of its unique physical characteristics and socioeconomic conditions. Located in the Seismic Zone, seismic activity is common, and the geography, combined with the climate, makes it vulnerable to landslides, avalanches, and flash floods. This danger profile is so complex that vulnerability assessments must be comprehensive.

Season	Average Temperature (°C)	Average Rainfall (mm)	Average Snowfall (cm)
Winter (Dec-Feb)	0 to 7	65	150
Spring (Mar-May)	8 to 19	100	20
Summer (Jun-Aug)	20 to 30	150	0
Autumn (Sep-Nov)	10 to 20	70	5

Table1: Average Climate of Study Area

Baramulla: Baramulla, located on the banks of the Jhelum River, has a unique combination of flooding, seismic risk, and environmental degradation. Because of its proximity to the river, the region experiences annual flooding, primarily during the monsoon season. Furthermore, deforestation and urban growth have increased the risk of landslides in certain locations. The district is also vulnerable to earthquakes due to its placement in the seismic zone. Baramulla's socioeconomic conditions are a mix of rural and semi-urban, with poverty, poor infrastructure, and a lack of catastrophe awareness making it vulnerable.

Kupwara: Kupwara is mountainous region and forested, with steep slopes and high elevations that make it prone to avalanches and landslides. The district is frequently hit by heavy snowfall during the winter months, and the combination of rapid melting and monsoon rains heightens the landslip risk. Kupwara's distant position and lack of proper infrastructure make disaster response less

effective, heightening its vulnerability. The district's economy is based on agriculture and forestry, and rural communities are frequently cut off during severe weather events, raising the danger of deaths and economic losses.

Bandipora is located in the Himalayan foothills. Wular Lake, one of Asia's largest freshwater lakes, has a considerable impact on flood dynamics. The area is subject to flooding from both the lake and upstream river systems, particularly during the spring and summer months. Growing population and urbanisation have resulted in encroachment into floodplains, exacerbating flood risks. Bandipora is seismically vulnerable, which could lead to earthquakes and jeopardise the region's infrastructure and lives. Rapid urbanisation, along with poor land use planning, has increased the district's vulnerabilities.

Despite the geographical proximity of these districts, susceptibility profiles vary due to changes in physical geography, socioeconomic situations, and environmental degradation between districts. Thus, the localised approach to vulnerability assessment will be examined for each hazard and risk encountered in the various districts.

Hazard Profile:

This study investigates North Kashmir's multi-hazard vulnerability in order to gain a thorough understanding of susceptibility linked with many natural and human-caused hazards in a specific region of study. Observations from qualitative, primary sources over a period of several months, including inputs from stakeholder consultation and pertinent surveys, as well as authorised secondary literature sources, would clearly demonstrate the intricacies and multifaceted aspects of that danger landscape. These include a variety of seismic, hydrological, geological, and climatic risks for this region, all of which have serious consequences for its population. However, the interaction of these risks and socioeconomic situations adds to the vulnerability of local communities.

Earthquakes: North Kashmir is located in one of the world's most seismically active regions, owing to its location at the collision boundary of the Indian and Eurasian tectonic plates. Geological factors in the area, such as numerous fault lines and unstable rock formations, promote frequent seismic activity. Historical earthquakes, such as the 2005 Kashmir earthquake, have caused widespread devastation, loss of life, and long-term displacement of communities (Bhat et al., 2015). Poorly built structures and lax enforcement of seismic safety rules exacerbate the effects of earthquakes, particularly in rural areas. Singh et al. (2018) emphasise that the region's unstable geological structure contributes to its susceptibility, necessitating robust earthquake-resistant construction techniques and community preparedness measures.

Human casualties have been terrible in North Kashmir. The human cost includes not just the death toll, but also the long-term psychological and social trauma that communities must endure while rebuilding their lives. In addition, there is an economic impact, as houses, businesses, and even

critical infrastructure such as roads and bridges are frequently damaged. Older seismic zones, which have built infrastructure, are the most vulnerable structures and typically do not meet modern seismic criteria. Thus, efforts to reduce earthquake risks should focus on hardening buildings against seismic pressures, developing early warning systems, and increasing community readiness for such disasters.

Floods: Flooding is a regular concern in North Kashmir, especially when high rainfall coincides with Himalayan snowmelt during the monsoon season. The Jhelum River, known as the region's lifeline, frequently floods the plains by overflowing. In September 2014, catastrophic floods induced by excessive rainfall displaced over a million people and inundated 3,000 communities, resulting in an estimated economic loss of $6.56 billion (about ₹40,000 crore) (Khan & Bhat, 2018). Floodplain encroachment, insufficient drainage infrastructure, and poorly maintained embankments all contribute to an increased risk of flooding. According to Khan et al. (2021), poor urban planning has increased the frequency and severity of flooding in the region. Floodplain restoration and the construction of resilient drainage systems are therefore critical methods for future flood management.

Flooding on the Jhelum River can be caused by a variety of circumstances, including development on floodplains, river management, and a lack of appropriate drainage systems. In some areas, urbanisation has further eroded the natural flood plains, increasing the likelihood of urban floods. The erosion of embankments caused by inadequate maintenance or strong weather conditions can result in uncontrolled surges along rivers, exacerbating the situation. Flooding in the region produces significant economic loss due to the damage done to agriculture, infrastructure, and local economies. Crop and agricultural degradation increases food insecurity and reduces farm households' revenues. Robust flood management systems, enhanced drainage infrastructure, and a strategy for minimising urban encroachment in flood-prone areas can all contribute to lowering the flood risk in north Kashmir.

Landslides: The Himalayan terrain's steep and unstable slopes make North Kashmir prone to landslides, particularly during the monsoon season or following seismic events. Landslides frequently block vital transportation routes, shut off towns, and result in deaths, severely disrupting day-to-day activity (Rai et al., 2019). Unsustainable land-use practices, such as deforestation and inappropriate development on steep slopes, exacerbate the risk of landslides. This approach causes soil erosion, reducing the region's inherent resilience. Landslip occurrence and impact can be significantly reduced through mitigation techniques such as afforestation, slope stabilisation, and tougher building standards.

One of the most serious issues with landslides is that they can occur unexpectedly, leaving little time for residents to flee or take other precautions. Poor land management, deforestation, and poor construction all contribute to the landslip impact. Landslides are almost certain to occur again in

places with slope building, or, more precisely, tree clearance. This emphasises stricter land-use planning and better construction techniques in these areas. Reducing landslip hazards necessitates strong community resilience, early warning systems, and public knowledge. Furthermore, soil conservation techniques such as reforestation, slope stabilisation, and improved farming methods can help to reduce landslides' frequency and severity.

Avalanches: Avalanches are another major concern, particularly in high-altitude regions like Baramulla, Kupwara, and Bandipora, where substantial snowfall occurs during the winter. The Jammu and Kashmir Disaster Management Authority (JKDMA) regularly issues avalanche warnings for these regions. For example, in March 2024, the JKDMA issued a medium-danger level warning for locations over 2,400 meters and advised residents to avoid unsafe areas (Kashmir Observer, 2024). Similar advisories were issued in January 2025 following new snowfall (Greater Kashmir, 2025). The ongoing risk of avalanches necessitates sophisticated early warning systems and public awareness. There is also a need to construct infrastructure in avalanche-prone places that can bear snow loads, and people should be educated on safety precautions when such events occur.

Avalanches are especially dangerous in mountainous areas because they can bury entire settlements, demolish transportation lines, and kill individuals. Avalanches are more likely to occur when the snowpack becomes unstable, which is frequently caused by heavy precipitation or fast temperature swings. The avalanches not only interrupt the local inhabitants, but also tourists and transportation, which are critical to the region's economy. Better avalanche monitoring systems, more accurate prediction models, and community-wide preparedness are also required. Following avalanche alerts and creating infrastructure that can resist snow buildup will help to reduce the risk.

Fires: Fires in North Kashmir can occur at any time of year, affecting both residential and woodland regions. The primary sources of fires in the area include electrical failures, unintentional human behaviours, and the intentional burning of forest land to prepare it for agriculture. During the dry summer, fires in forested areas are highly destructive, destroying flora and fauna, speeding up soil erosion, and contributing to air pollution. Housefires are known to destroy property and, in some cases, kill and injure people in densely packed wooden home communities with inadequate firefighting infrastructure (Qadri et al., 2021).

For example, the number of forest fires has increased. For example, over 1,500 fires have been reported in Jammu and Kashmir during the last decade. Thus, in such instances, an absence of preparedness, such as a lack of qualified workers and contemporary firefighting equipment, exacerbates the problem. Instead, it is necessary to immediately boost fire safety by establishing community fire management plans, providing fire prevention education, and constructing better-equipped fire stations.

Socio-Economic Context:

Socioeconomic factors greatly influence North Kashmir's ability to respond to and recover from disasters. The region faces a number of socioeconomic issues that make it more vulnerable to dangers.

- **Poverty and unemployment:** North Kashmir is one of India's poorest regions, with many people living on subsistence agriculture. Because of their low economic base, many households are unable to plan for or recover from natural disasters. Because financial resources and job possibilities are rare after an earthquake or flood, affected populations typically rebuild their homes and businesses over a period of years. It also restricts access to other important services such as healthcare, increasing the susceptibility of local communities to disasters. The reliance on seasonal employment leaves few options for a long-term source of income, making communities even more vulnerable to calamities.
- **Infrastructure and Access to Services:** North Kashmir is undeveloped, with limited access to health care, education, and emergency services. Road, communication, and electrical networks are in disrepair, limiting the region's ability to respond to and recover from disasters. Isolated communities, particularly in hilly areas, are the most susceptible since they cannot obtain fast assistance. Many roads and bridges become unusable after heavy rainfall, landslides, or snowfall, delaying response and exacerbating the suffering of affected populations. Better communication and infrastructure upgrades are required to better disaster response.
- **Agricultural Dependency:** Agriculture provides a living for the vast majority of families, either directly or indirectly. Flooding, landslides, heavy rains, droughts, and unseasonal snowfalls can all destroy crops and infrastructure, leading in food insecurity. Traditional farming techniques that ignore weather variations exacerbate these vulnerabilities. To reduce the long-term effects of these hazards on local lives, the region must diversify its economy, provide training in sustainable agriculture, and provide farmers with access to disaster-resistant infrastructure.

Environmental Vulnerabilities:

The environmental qualities of North Kashmir are both a cause and a result of the region's vulnerability to natural disasters.

- **Deforestation and Land Degradation:** Overexploitation of forest resources for agriculture, construction, and fuel has resulted in extensive deforestation in portions of North Kashmir. This has destabilised the terrain, increasing the risk of soil erosion and landslides, as well as reducing its ability to absorb rainwater, which increases flooding. Deforestation also reduces ecosystems' ability to regulate the local climate, resulting in more frequent and severe

extreme weather occurrences. Forest restoration and improved land management methods will be critical to increasing the region's environmental resilience.

- **Biodiversity Loss:** North Kashmir's biodiversity is rapidly declining as a result of human activities such as deforestation, mining, and overgrazing. The decline of local species and habitats has an impact on other ecosystems in the region, resulting in the loss of critical natural services such as fertile soil, pollination, and water purification, among others. A region's biodiversity declines, making it more vulnerable to different environmental changes and natural calamities. Preserving the area's natural strength necessitates actions such as habitat protection and restoration, both of which are important biodiversity conservation efforts.
- **Water Resources:** North Kashmir is especially sensitive to climate change, which alters rainfall patterns, glacier melting rates, and river flow. Because of rising temperatures in this region, glaciers that feed into the River Jhelum are retreating at a rapid pace. This may jeopardise long-term water supplies as well as the risk of floods, as rapid glacier melting frequently raises river discharge and creates unexpected flooding. Sustainable water management and climate-resilient infrastructure are required to maintain a consistent supply of water while reducing flood danger.

Results and Discussion:

Hazard Analysis:

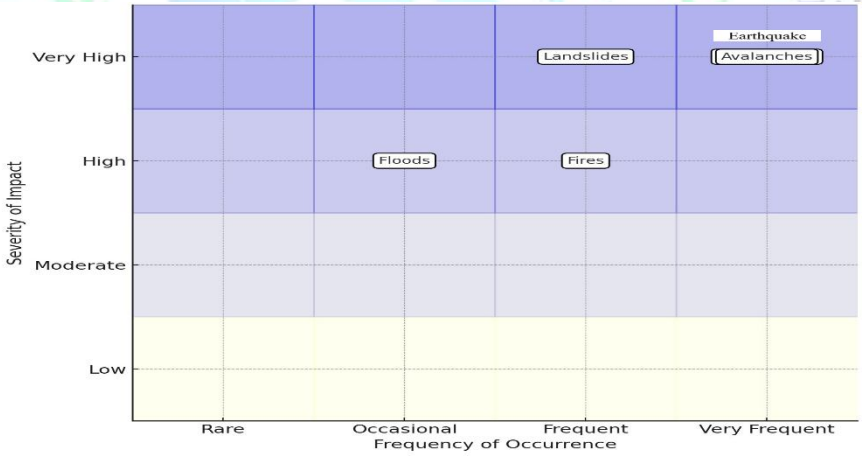


Figure 2: Risk Matrix of Hazards

Interpretation: The hazard analysis for North Kashmir shows a clear differentiation in terms of frequency, severity of impact, and impacted areas for each hazard, emphasising the region's vulnerability to natural catastrophes.

Earthquakes are events with a moderate to high frequency of occurrence, indicating that they pose a significant risk to the region. An earthquake's immediate effect is structural collapse, primarily of buildings, roads, and bridges, which disrupts daily life and impedes emergency

response. Because the entire region is at risk, seismic-resistant construction and early warning systems are critical in reducing the consequences of such catastrophes.

Floods occur seasonally, beginning with the monsoon and ending with snowmelt. Floods can also cause crop damage and displacement, particularly in low-lying places like the Baramulla and Bandipora plains. Seasonal flooding disrupts the agricultural sector and uproots vulnerable communities. These events can be predicted using time-series analysis of precipitation data, and improving flood defences like embankments and drainage systems are key steps that must be prioritised for better flood risk management.

During the rainy season, landslides occur often along North Kashmir's hilly terrain. These events also cause road closures and human fatalities, sealing off distant villages and delaying rescue efforts. Increased rainfall, deforestation, and unregulated construction are all factors that contribute to frequent landslides. To lessen landslip threats, vulnerable zones must install slope stabilisation techniques, improved land use planning, and afforestation programs.

Furthermore, avalanches provide a significant winter-specific hazard, primarily affecting high-altitude settlements. They result in the loss of both lives and infrastructure, making places like Gurez Valley particularly vulnerable to winter calamities. Avalanches can be mitigated by implementing snow barriers, early warning devices, and evacuation procedures to protect people living in avalanche-prone locations.

Fires, albeit another common threat, are classified as moderately severe. Fires can occur at any time of year and at any wind speed, impacting both residential and woodland regions. Fires occur frequently in areas with high temperatures and dryness, as well as when human activities such as agriculture or urbanisation generate fire-prone circumstances. Wildfires, particularly in forested areas, may be deadly, spreading quickly and causing extensive damage to homes, natural resources, and even death. Fire would destroy property and significantly disrupt life in the town, particularly in residential areas. While fires can be as devastating as earthquakes or avalanches, their impact is more localised since they strike a specific area rather than spreading regionally, as in the cases of the three above. Despite their less destructive nature, fires are always a risk, particularly in vulnerable areas or during extreme weather conditions such as heatwaves or dry periods.

Overall, North Kashmir is vulnerable to a variety of natural hazards, necessitating the development of a regional disaster management policy. These risks periodically resurface, emphasising the importance of a complete risk assessment and capacity-building activities that include both mitigation and preparedness measures for various locations.

Vulnerability Analysis

Factor	**Observations**	**Quantitative Impact Data**	**Source**

Socio-Economic	High poverty, inadequate infrastructure	32% households below poverty	Field Observations
Environmental	Deforestation, climate change impacts	12% forest cover loss (2010-2020)	Remote Sensing Data
Population Density	Increased strain on resources	267 persons/km² (Baramulla)	Census Reports
Infrastructure	Poor connectivity, unsafe buildings	65% structures non-resistant	Government Records

Table 2: Factors of Vulnerability

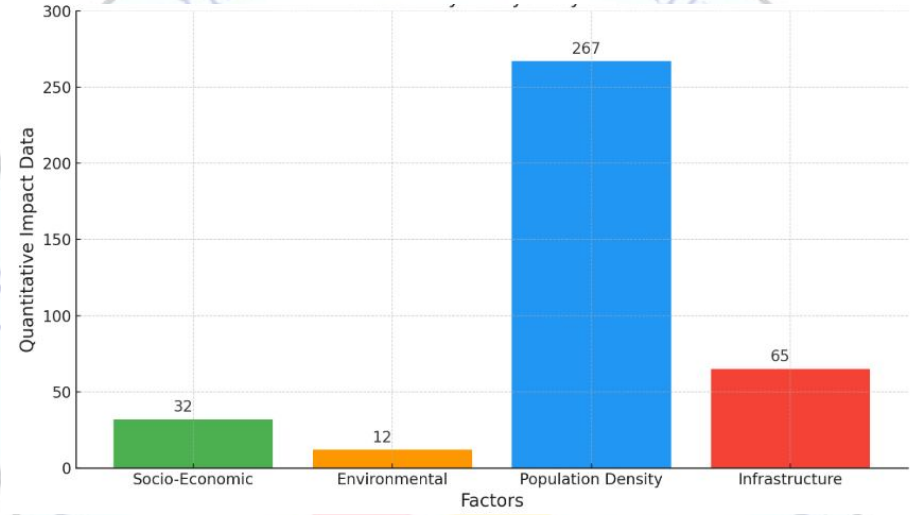


Figure 3: Vulnerability Analysis

The vulnerability analysis highlights major difficulties in earthquake preparedness and response. Socioeconomic issues have a considerable influence, with 32% of households living below the poverty line. High levels of poverty and inadequate infrastructure limit the community's ability to invest in disaster preparedness or recover adequately from the effects of an earthquake. Economic constraints often prevent these households from affording resilient housing or accessing resources in the event of a disaster.

Environmental vulnerability is also demonstrated. Between 2010 and 2020, the region lost around 12% of its forest cover, diminishing the ecosystem's natural ability to buffer against secondary hazards such as landslides and soil erosion. This increases the risks in the context of such earthquakes, as degraded land is more unstable during an earthquake.

The Baramulla district has a population density of 267 people per square kilometre, which puts additional strain on resources and infrastructure. The risk of casualties will increase, evacuation

will be more difficult, and all available resources will be stretched during and after the crisis. Managing a densely populated area during an earthquake is difficult, so the risks must be addressed.

One of the major obstacles would be infrastructure, as 65% of the region's structures are not earthquake resistant. Poor connectivity and dangerous buildings increase the chance of widespread damage and casualties, extending recovery times. The absence of resilient infrastructure also impedes rescue and relief efforts, making impacted communities vulnerable to further harm.

Overall, it emphasises the socioeconomic, environmental, demographic, and infrastructural variables that contribute to the region's vulnerability. Addressing the issues necessitates an integrated approach that includes targeted effort to combat poverty, environmental protection, population management, and infrastructure development to lessen the risks posed by earthquakes.

Multi-Hazard Vulnerability

District	Population Density	Forest Cover (%)	MHVI Score	Vulnerability Level	Key Observations
Baramulla	267	18	High	High	Dense settlements, environmental degradation
Kupwara	135	38	Medium	Medium	Landslides, avalanche-prone
Bandipora	200	25	Medium	Medium	Flood-prone, socio-economic vulnerabilities

Table 3: Multi-Hazard Vulnerability Index

Interpretation: The above Multi-Hazard Vulnerability Index for the three districts of North Kashmir i.e. Baramulla, Kupwara, and Bandipora—is intended to analytically highlight disparities in susceptibility among the population, forest cover, and any other relevant factors.

Baramulla is rated highly vulnerable, with the greatest population density of 267 people per square kilometre and only 18% forest cover. The numerous settlements increase the risk of deaths and property damage after a disaster, whilst the low forest cover signals serious environmental deterioration. All of these factors contribute to Baramulla's high MHVI score, demonstrating the crucial need for focused disaster mitigation initiatives.

Kupwara has a low population density of 135 people per square kilometre and a relatively high forest cover of 38%. These elements alone give some resistance, but the district remains relatively vulnerable due to its landslip and avalanche risk in steep and mountainous terrain. Thus, a medium MHVI score indicates moderate susceptibility, yet particular treatments are still required in risk-prone locations.

Bandipora has medium vulnerability, with an average population density of 200 people per square kilometre and 25% forest cover. The district's flood-prone characteristics, as well as socioeconomic vulnerabilities such as poor infrastructure and poverty, make it more vulnerable to

disaster. However, its MHVI grade is significantly lower than Baramulla's; Bandipora also requires significant attention, particularly to strengthen flood defences and socioeconomic conditions.

In conclusion, while Baramulla is the most fragile, each is distinct and presents its own set of concerns. Efforts to reduce susceptibility will be required to expand forest cover, control specific hazards such as floods and landslides, and improve various regional socioeconomic circumstances in the region.

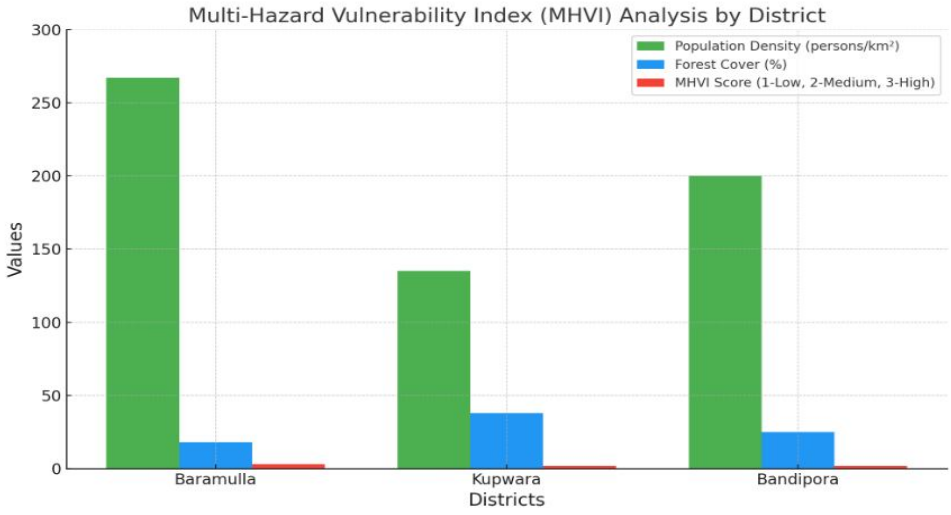


Figure 4: District-Wise MHVI Analysis

The grouped bar graph depicts the MHVI analysis for Baramulla, Kupwara, and Bandipora. It analyses population density, forest cover, and MHVI scores for each district to show the unique vulnerability elements. Baramulla has the highest population density and MHVI score, whereas Kupwara has the most forest cover, showing relative resilience.

Suggestions:

Based on the analysis presented in the research, the following suggestions are proposed to improve disaster risk management and enhance resilience in North Kashmir:

1. The paper emphasises MHVA as an important tool for comprehending the integrated risks involved. To integrate risk mitigation methods across many hazards, it is necessary to fully institutionalise MHVA in regional DRM policies.
2. Because most structures are classified non-resistant to earthquakes and account for 65% of the total, earthquake-resistant construction becomes a priority. Policies requiring construction codes, retrofitting older structures, and encouraging resilient infrastructure development should be established.
3. The area's frequent flooding necessitates the installation of improved drainage systems, floodplain restoration, and robust embankments. Investing in flood warning systems and community awareness campaigns will dramatically reduce flood damage.
4. Deforestation causes environmental degradation, which increases the risk of landslides and

flooding. Reforestation programs, combined with stricter land use rules, can help restore ecological balance and stabilise slopes in risky locations.

5. Disaster preparedness training and awareness programs should be implemented to educate local residents about potential dangers and response tactics. This includes training volunteers and preparing communities for emergency situations.
6. Improving communication networks, expanding emergency services in remote locations, and pre-positioning relief supplies will all help to ensure quick and effective disaster response.
7. Poverty and unemployment in the region will reduce vulnerability by allowing the community to invest in disaster preparedness. Socioeconomic activities such as diversifying livelihoods and improving education should be prioritised.
8. Climate resilience in disaster risk management policies is crucial to meet the growing variability of weather patterns. This involves advanced climate modelling as well as long-term adaption plans for agricultural and water management.
9. Each district, including Baramulla, Kupwara, and Bandipora, has unique vulnerabilities. District-specific MHVI risk reduction plans must be developed, with a focus on the relevant profiles.
10. Improving cooperation among local governments, academic institutions, and international organisations will allow for knowledge sharing, resource mobilisation, and successful catastrophe risk reduction initiatives.

Conclusion:

The study convincingly demonstrates the complex interplay of ecological and socioeconomic elements that contribute to North Kashmir's vulnerability to disasters. Using a Multi-Hazard Vulnerability Assessment (MHVA), the study emphasises the importance of a comprehensive strategy to disaster risk reduction that includes both hazard-specific and community-centered interventions.

This means that focused efforts in crucial sectors such as infrastructure resilience, environmental restoration, and socioeconomic development are critically important. According to the study, community engagement and capacity building are inextricably linked and must be combined in order to inculcate disaster preparedness and resilience.

The region is also vulnerable to the effects of climate change, necessitating comprehensive adaptation plans to protect livelihoods and ecosystems. Implementing these proposals will lessen disaster risks while simultaneously promoting long-term development in North Kashmir.

Future initiatives will focus on improving the integration of scientific research and local knowledge to create more strong, evidence-based policies. Collaborative and personalised initiatives in North Kashmir will contribute to a more resilient future, where communities will be better

prepared to withstand and recover from calamities.

References:

1. Ahmad, S., & Shah, M. (2021). Community-based disaster risk reduction in North Kashmir: Challenges and opportunities. ***International Journal of Disaster Studies, 15***(3), 203–217.
2. Bhat, M. I., Alam, A., Ahmad, B., & Sheikh, M. I. (2015). Seismic activity in the Kashmir region: A historical perspective. ***Journal of Earthquake Studies, 22***(4), 341–358.
3. Bhat, M. S., Ghosh, S., & Hussain, M. (2015). Seismicity of the Kashmir Valley: A review. ***Journal of Seismology, 19***(1), 1–12.
4. Bilham, R. (2004). Earthquakes in India and the Himalaya: Tectonics, geodesy, and history. ***Annals of Geophysics, 47***(2–3), 839–858.
5. Cutter, S. L. (2003). Social vulnerability to environmental hazards. ***Environmental Science & Policy, 7***(4), 529–547.
6. Birkmann, J. (2007). Risk and vulnerability indicators at different scales: Applicability, usefulness, and policy implications. ***Environmental Hazards.***
7. Gallina, V., Torresan, S., Critto, A., Sperotto, A., Glade, T., & Marcomini, A. (2016). A review of multi-risk methodologies for natural hazards: Consequences and challenges for a climate change impact assessment. ***Journal of Environmental Management, 168***, 123–132.
8. Ghosh, S., & Hussain, M. (2018). Political instability and its impact on development in Kashmir. ***South Asian Journal of Policy Studies, 3***(1), 23–36.
9. Ghosh, S., Hussain, M., & Raina, A. (2020). Climate change and water resources in Kashmir Valley. ***Environmental Monitoring and Assessment, 192***(8), 1–17.
10. Greater Kashmir. (2025, January 10). Avalanche alert issued for Bandipora district. Retrieved from https://www.greaterkashmir.com
11. IPCC. (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. ***Intergovernmental Panel on Climate Change Report.***
12. Kamp, U., et al. (2019). Landslide hazards in the Kashmir Himalayas. ***Landslides.***
13. Kappes, M. S., et al. (2012). Challenges of analyzing multi-hazard risk. ***Natural Hazards.***
14. Kashmir Observer. (2024, March 15). JKDMA issues avalanche warning for high-altitude regions. Retrieved from https://www.kashmirobserver.net
15. Khan, M. A., & Bhat, A. A. (2018). Flood risk assessment in the Kashmir Valley using remote sensing and GIS. ***Natural Hazards, 93***(3), 1245–1260.
16. Khan, M. A., Ghosh, S., & Hussain, M. (2021). Infrastructure development and disaster resilience in Kashmir. ***Asian Journal of Disaster Risk Reduction, 8***(1), 15–28.

17. Khan, S., & Bhat, R. A. (2018). Flood vulnerability in the Jhelum basin: An assessment of recent flood impacts. ***Environmental Hazards, 10***(3), 198–210.
18. Kumar, P., & Kumar, S. (2017). Geography and environment of Kashmir: Socio-economic implications. ***Geographical Research, 55***(3), 276–290.
19. Kumar, P., Ghosh, S., & Bhat, A. A. (2020). Land-use changes and their impact on disaster risk in Kashmir. ***International Journal of Disaster Risk Reduction, 51***, 101–112.
20. Mazrocchi, S., et al. (2012). Integrating hazard and vulnerability assessments for disaster risk reduction. ***Journal of Risk Analysis.***
21. Ministry of Rural Development. (2019). Poverty and Employment in Jammu and Kashmir: A Statistical Handbook. ***Government of India.***
22. Negi, P., Joshi, V., & Thakur, S. (2020). Environmental degradation and disaster vulnerability in Himachal Pradesh: A multi-hazard perspective. ***Environmental Science Journal, 12***(4), 145–155.
23. Qadri, S. A., Bashir, S., & Dar, N. A. (2021). Human and environmental impacts of fire incidents in North Kashmir. ***Journal of Environmental Management, 29***(1), 56–72.
24. Rai, S., Kumar, P., & Hussain, M. (2019). Landslide susceptibility mapping in the Kashmir Valley. ***Landslides, 16***(4), 941–954.
25. Raina, I. (2020). Forest fire trends in Jammu and Kashmir: A decade-long analysis. ***Himalayan Environmental Studies, 8***(3), 102–118.
26. Rashid, A., Ghosh, S., & Khan, A. (2021). Biodiversity loss and ecosystem services in Kashmir Valley. ***Environmental Science and Policy, 117***, 69–81.
27. Shah, F. A. (2019). Avalanche risk in high-altitude areas of North Kashmir. ***Avalanche Studies.***
28. Sharma, R., Singh, S., & Kumar, A. (2018). Understanding socio-economic vulnerabilities in disaster-prone regions of the Himalayas. ***Himalayan Research Bulletin, 22***(1), 34–49.
29. Shrestha, S., Bajracharya, S., & Khanal, N. (2017). Earthquake and landslide risk in Nepal: A case study of Gorkha. ***Natural Hazards Journal, 17***(3), 567–582.
30. Srinagar Development Authority. (2019). Regional Development Plan for Srinagar City. ***Government of Jammu and Kashmir.***
31. Twigg, J. (2009). Characteristics of a disaster-resilient community: A guidance note. ***International Federation of Red Cross and Red Crescent Societies.***
32. United Nations Office for Disaster Risk Reduction (UNDRR). (2015). Sendai Framework for Disaster Risk Reduction 2015-2030. ***Geneva: UNDRR.***
33. Wani, A. A., Ghosh, S., & Hussain, M. (2020). Agricultural vulnerability and food security in the Kashmir Valley. ***Sustainable Agriculture Research, 9***(2), 1–12.