**Vulnerability Assessment and Socioeconomic Development of Landslide Hotspots in India: An Overview of Recent Developments in Asia**

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**ABSTRACT**

A study of current advancements in the socioeconomic growth and vulnerability assessment of landslide hotspots in India and Asia is provided in this review. Ten research articles on various subjects are evaluated, including the use of remote sensing and GIS techniques for landslide identification, the efficiency of education and awareness campaigns in lowering landslide risk, and the role socioeconomic development plays in reducing landslide susceptibility. The literature gap analysis shows the importance of further investigation into how climate change affects landslide susceptibility and the efficiency of evacuation plans for vulnerable communities. Overall, the examined literature highlights the significance of integrating interdisciplinary methods and community participation in creating successful strategies for reducing landslide risk and promoting socioeconomic development in landslide-prone regions.

**Keywords:** Landslide, Vulnerability Assessment, Socioeconomic Development, India, Asia.

1. **INTRODUCTION**

In many regions of Asia, landslides constitute a serious natural hazard that may lead to severe economic and societal damage. To lower the danger connected with landslides, it is essential to analyze the regions that are vulnerable to them and implement strong socioeconomic strategies. This essay offers a summary of current advancements in vulnerability analysis and socioeconomic growth in India's landslide hotspots. To find new developments in this subject, ten studies published in 2022 were examined. The research examined many facets of assessing the susceptibility to landslides, including the application of statistical models, remote sensing, and GIS approaches. These studies also made clear how crucial it is to take socioeconomic aspects into account when evaluating vulnerability to fully comprehend how landslides affect populations. In addition to pointing out significant gaps in the body of literature, the studies under consideration also highlighted the need for more research that takes into account the many social, economic, and political issues that influence landslide risk. A comprehensive and integrated strategy that takes into account the diversity of populations impacted by landslides and the different dimensions of vulnerability is also required. Overall, the studies that have been evaluated offer insightful information on the difficulties and prospects for risk assessment and socioeconomic development in landslide-prone areas of India and the larger Asian region. To reduce the dangers posed by landslides and guarantee sustainable socio-economic growth in these areas, more research and coordinated efforts are required.

1. **LITERATURE REVIEW**

The studied literature shows current advancements in landslide hotspot vulnerability assessment and socioeconomic development in India and other Asian nations. To evaluate landslide susceptibility and vulnerability, a variety of approaches including remote sensing, GIS, and statistical models were utilized. The studies also stress the significance of include socioeconomic elements in the management and reduction of landslide risk. More study is still required to fill in the gaps in the literature, particularly in regards to assessing the efficiency of mitigation measures and incorporating community participation in landslide risk management.

**2.1 Bhunia & Shit, 2021:** The use of geospatial technology in identifying and controlling various dangers is discussed in the paper. The authors describe the various geospatial technologies, including remote sensing, geographic information systems (GIS), and global positioning systems (GPS), as well as their use in hazard mapping and evaluation. Additionally, they emphasize the significance of combining various datasets and technological platforms to raise the precision and dependability of hazard analysis. The chapter examines case studies from several Asian nations that show how geospatial technology may be applied to multi-hazard risk assessment, including flood, earthquake, and landslide risk mapping. The authors conclude by talking about the role that geospatial technology will play in multi-hazard risk assessment and emphasizing the importance of continuing innovation and cross-sectoral cooperation for better hazard management and catastrophe resilience in Asia. Overall, the chapter offers insightful information about the function of geospatial technology in hazard assessment and management, emphasizing its significance in reducing the effects of natural disasters in the area.

**2.2 Gayen & Villalta, 2021:** In the study article, it is discussed how West Bengal's Purba Medinipur district's societal vulnerability to natural disasters is assessed. To pinpoint the most at-risk groups in the research region, the authors used a social vulnerability index (SVI). The SVI was created through the study's use of several statistical and geographical methods. The results of the investigation showed that, because of their geographic position and socioeconomic level, riverine and coastal areas are more susceptible to natural disasters. Lack of knowledge, education, and access to information are among the main barriers to natural hazard adaptation that the study also noted. The authors came to the conclusion that the SVI's most vulnerable neighborhoods should be the primary target of any effective catastrophe risk reduction strategy. As they create targeted interventions to lessen social vulnerability and strengthen the resilience of vulnerable communities to natural disasters in the study area, policymakers and planners can benefit from the insights provided by this study.

**2.3 Samanta et al., 2021:** In the Darjeeling Himalayas in West Bengal, India, the study sought to evaluate the likelihood of landslides at the village level using a weighted sum approach to multi-criteria decision-making. Landslide-prone locations were found and mapped using a mix of field observations, landslide inventory, and satellite image interpretation. The weighted sum approach was used to determine the likelihood of a landslide based on six distinct variables, including slope, aspect, curvature, lithology, land use, and distance from drainage. According to the findings, 5.5% of the research area was extremely vulnerable to landslides, whereas 32.5% was just moderately vulnerable. The study also showed that slope, lithology, and curvature were the primary determinants of landslide vulnerability. The results might assist the local government in implementing preventative steps to lessen the likelihood of landslides in the region. The study also emphasizes how crucial it is to analyze landslide susceptibility using a multi-criteria decision-making approach, since this method can yield results that are more precise and trustworthy than those obtained using a single element, as is the case with standard single-factor analysis.

**2.4 Jamwal & Sharma, 2021:** Using geospatial techniques, the author evaluated the risk of landslides in the Western Indian Himalayas' Upper Basin of the River Sutlej. The terrain, geology, land cover, slope, and rainfall were among the characteristics used to create themed maps using remote sensing and GIS techniques. The priority of each factor's weight in the susceptibility study was determined by the authors using the Analytical Hierarchy Process (AHP) approach. Using a weighted overlay approach, they then combined the several maps into one showing landslide risk. The research's findings revealed that while 51.8% of the studied region was only somewhat susceptible to landslides, 14.1% of it was. According to the authors, the use of geospatial techniques is a useful method for determining landslide susceptibility. These studies can help with efforts to reduce the risk of disasters by providing knowledge that decision-makers can use to make wise decisions. Particularly in India's hilly regions, the research findings may be helpful for planning land use, building infrastructure, and managing natural disasters.

**2.5 Singh et al., 2022:** The research provides a thorough framework for determining the danger of landslides in steep terrain. Geology, topography, rainfall, land use, and anthropogenic activities are just a few of the variables the writers explore as they relate to landslide risk. Additionally, they suggest using geographic information systems and data from remote sensing to assess the risk of landslides using a multi-criteria decision analysis approach. The suggested framework consists of a number of processes, including data preparation and collection, the production of maps for the landslide inventory, the identification of the causes and triggers of landslides, the evaluation of landslide susceptibility, and the risk assessment. To guarantee that the outcomes of the evaluation are pertinent and helpful for decision-making, the authors emphasize the significance of stakeholder participation in the process. In general, the chapter offers a helpful manual for academics and professionals concerned with assessing the danger of landslides, particularly in mountainous terrain. The suggested framework offers a systematic method for determining and reducing landslide risk by taking into consideration numerous elements that impact landslide risk. The suggested framework is a useful tool for landslide risk management because it makes use of GIS and remote sensing data to provide a more precise and effective evaluation.

**2.6 Rahman et al., 2022:** The study's analysis of social vulnerability to landslide catastrophes in Bangladesh's Chittagong metropolis is its main emphasis. In order to create a social vulnerability index and identify the social categories most at risk from landslides, the study was carried out. According to the report, those most at risk from landslides include low-income households, individuals who lack access to land, women, children, and the elderly. The researchers also found a number of elements that contribute to social vulnerability, such as poverty, a lack of knowledge, a lack of readiness, and substandard housing. The study's conclusion stresses the need for using social vulnerability assessment in landslide risk management techniques to lessen the impact of landslide catastrophes on vulnerable populations.

**2.7 Kaur et al., 2022:** The study explores the human population's susceptibility to landslide catastrophes in the Sikkim Himalayas. To locate susceptible people and gauge their exposure to landslide threats, the scientists combine remote sensing data analysis with GIS analysis and field surveys. According to the study's findings, a number of variables, including population density, slope steepness, land use, and land cover, affect how vulnerable human populations are to landslides in the Sikkim Himalayas. The authors contend that the creation of early warning systems, awareness campaigns, and the encouragement of land-use planning and sustainable development techniques may all lessen the susceptibility of human populations to landslide disasters. The study offers helpful insights into the elements that increase human population susceptibility to landslide disasters and can help practitioners and policymakers create efficient plans for disaster risk reduction and management in the Sikkim Himalayas.

**2.8 Hosenuzzaman et al., 2022:** The focus of this study is on how landslides affect agriculture and the community's efforts to reduce the dangers. In Bangladesh's mountainous, frequently prone-to-landslides region, the study was carried out. To gauge how vulnerable agriculture is to landslides, the scientists combined several techniques, including remote sensing, GIS, and field surveys. The findings showed that landslides had a substantial negative influence on the region's agriculture, including crop destruction, soil erosion, and loss of livelihoods. A community-based approach to resolving these problems, including the creation of early warning systems and the use of soil conservation techniques, is also explored in this chapter. The authors stress the value of community participation in disaster risk reduction and contend that community-based efforts can greatly lessen the susceptibility of agricultural regions to landslides. Overall, the study emphasizes the necessity of interdisciplinary strategies that take into account the socioeconomic and environmental aspects of landslide-prone regions to successfully handle the issues posed by landslides.

**2.9 Khan et al., 2022:** The paper looks at how communities in Pakistan's Swat Valley have been able to adapt to landslides while integrating socio-economic processes. To determine the elements that influence communities' susceptibility to landslides, the study used a mixed-methods approach that included interviews, focus group discussions, and field surveys. The authors contend that socioeconomic issues, such as poverty, a lack of resources, and inadequate infrastructure, have a substantial influence on a community's ability to withstand landslides. The study investigates the function of NGOs, government organizations, and community-based organizations in boosting the resilience of disadvantaged populations. The authors advise combining development programs with measures to reduce catastrophe risk to address the underlying reasons for vulnerability. The study concludes that to increase community resilience, it is vital to use a participatory strategy that incorporates communities in decision-making, develops their skills, and gives them the tools they need to be less vulnerable to landslides. In conclusion, the study offers important new insights into the intricate relationships between socioeconomic factors and community landslide resilience in the Swat Valley, which may guide practice and policy in other contexts.

**2.10 Kumar et al., 2022:** This research focuses on the socioeconomic effects of mountain risks in the Himalayas of Uttarakhand. The authors evaluated the local population's susceptibility to natural hazards such as landslides, floods, and earthquakes using remote sensing and GIS approaches. According to the report, the local population depends significantly on agriculture and related industries for their livelihoods, making them susceptible to natural disasters. The authors discovered that mountain dangers have a negative influence on the local economy, causing loss of revenue, infrastructure destruction, and population displacement. The chapter makes the case that a thorough risk assessment and mitigation strategy are necessary to address the socioeconomic vulnerability of the local community. To lessen the susceptibility of communities to mountain hazards, the study emphasizes the significance of creating a sustainable and resilient economic structure. In order to comprehend the socioeconomic effects of natural disasters in mountain regions and create practical risk-mitigation methods, policymakers and researchers can benefit from the information in this chapter.

1. **GAP ANALYSIS**

According to the ten research articles that were examined, there is a vacuum in the literature on the evaluation of socioeconomic development and vulnerability in India's landslide hotspots. There is no comprehensive method for doing so. While numerous studies have evaluated vulnerability and its effects on socioeconomic development using a variety of methods and models, there is a need for a standardized framework that can be applied in various contexts and geographical areas. The effectiveness of various mitigation strategies and policies in lowering landslide risks and advancing socioeconomic development in these locations is also not well understood, leaving a research void. By creating thorough frameworks and analyzing the efficacy of various interventions and policies in supporting sustainable development in landslide-prone regions, future research should attempt to close these gaps.

1. **CONCLUSION**

The ten studies that were evaluated shed light on various facets of landslide vulnerability assessment and socioeconomic growth in Asia, notably in India. The research emphasizes how crucial it is to use geospatial methods and machine learning algorithms for precise localization and mapping of landslide-prone locations. Emphasis is also placed on the role that awareness and education programs have in lowering the danger of landslides and encouraging resilience. The examined studies also highlight the need for laws that address the socioeconomic vulnerabilities of people living in landslide-prone regions. Despite the advancements made recently, more research is still required to close the knowledge gap between science and policy and to create long-lasting solutions for the management of landslide risk in disadvantaged areas.

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