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Assessment Of Physical Vulnerability And Socio-Economic Impact Of Landslides In Nagaland

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Abstract: Nagaland's rugged terrain and fragile geology make the region particularly vulnerable to landslides, especially during the monsoon season. This study examines the physical vulnerability of Nagaland's landscapes and the cascading socio-economic effects of landslides on local communities. Focusing on recent incidents in districts such as Tuensang and critical infrastructure along National Highway-29, the paper explores how these disasters disrupt daily life, displace vulnerable populations, and intensify economic hardships. The findings emphasise the importance of addressing both the physical and social dimensions of landslide risk by integrating scientific knowledge of hazard-prone areas, the lived experiences of local communities and responsive policy action aimed at hazard mitigation, effective land-use planning, and improved disaster preparedness to enhance the resilience of Nagaland's hill communities.

Keywords: Landslides, Vulnerability, Disaster Management

I. INTRODUCTION

Landslide is a phenomenon in which the mass of rocks, soil, or debris fall because of gravity (Prasetya et al., 2021). Landslides are a common global geohazard that lead to substantial loss of life and socioeconomic damage. Landslides are becoming more common due to extreme weather events and the impact of anthropogenic disturbance, and thus they are threatening sustainable development in many vulnerable areas (Fidan, 2024). Landslides emerge as one of the leading causes of human fatalities and property damage. According to the World Health Organization, between 1998-2017, landslides affected an estimated 4.8 million people and caused more than 18,000 deaths worldwide. Globally, the fatalities and economic loss caused by landslides are tremendous (Zhang and Huang, 2018). The average annual numbers of significant rainfall-triggered and earthquake-triggered landslides are estimated to be in the order of 400,000 and 130,000 respectively, based on the analysis of data from 1980 to 2018 (The World Bank, 2020).

India is among the top five landslide-prone countries globally where at least one death per 100 sq. km is reported in a year due to a landslide event (Marar, 2023). Landslides constitute a major natural hazard in India which accounts for considerable loss of life and damage to communication routes, human settlements, agricultural fields and forest lands (Gaur, 2008). According to the ISRO Landslide Atlas of India, about 12.6% or 0.42 million square km of India's geographical land area excluding snow-covered regions is categorized as landslide-prone. This includes vast stretches of the Himalayan and Western Ghat ranges, along with much of the Northeastern region (Marar, 2023). Among these high-risk zones, about 0.18

million square km or 42% of this vulnerable area is in the Northeastern region because of its steep terrain, high annual rainfall, seismic activity, and rapid but unplanned development. The region faces recurring monsoon-triggered landslides that lead to road blockages, soil erosion, loss of agricultural land and the isolation of entire communities. While states across the region experience frequent slope failures during the monsoon season, Nagaland also remains particularly exposed to landslides due to its fragile geological formations and widespread habitation along vulnerable slopes (Bora et al., 2020).

II. METHODOLOGY OF THE STUDY

The study has been conducted using secondary data sources relevant to the research topic. Information has been gathered from books, scholarly journals, newspaper reports, as well as official websites of the Nagaland State Disaster Management Authority (NSDMA) and the National Disaster Management Authority (NDMA).

III. LANDSLIDES IN NAGALAND

Landslides are one of the disasters regularly experienced in Nagaland. It is an ecologically and geologically fragile state marked by steep hills, high seismicity, intense monsoonal rainfall and lack of slop-stabilizing infrastructure which makes the state highly susceptible to landslides. According to the Landslide Atlas of India published by the Indian Space Research Organisation (ISRO), several districts in Nagaland such as Kohima, Wokha, Phek, and Tuensang fall under moderate to high landslide hazard zones (ISRO, 2023).

Nagaland, located in the easternmost part of India, is predominantly mountainous with approximately 94% of its area comprising hilly terrain and only about 6% consisting of low-lying plains, mainly in the foothill regions. Geologically, the state is primarily made up of shale and sandstone formations occurring in various combinations. These rock types, particularly the shales are extensively deformed, being sheared, fractured, crumpled, and significantly weathered largely due to sustained tectonic activity. The porous nature of these rocks leads to high water retention, resulting in elevated pore-water pressures that reduce shear strength and destabilize the soil structure. Recurrent thrusting and faulting have further compromised the integrity of the rock masses. Consequently, sandstone-dominated areas are especially prone to rockfalls and debris slides, making Nagaland highly susceptible to landslides and slope instability, particularly during periods of intense rainfall or seismic activity. Further, the interplay of topography and lithology has culminated in numerous landslide-induced failures. (NSDMA, 2019).

Human-induced land use changes also significantly exacerbate landslide risk in Nagaland. Traditional jhum cultivation, which involves widespread clear-and-burn practices, affects approximately 60% of food-cropped land and involves over 100,000 hectares cleared land annually. This practice accelerates soil erosion, leading to an alarming average loss of 30.6 t/ha per year (Pandey, 2019). With forest fallow cycles now shortened to just 3-6 years from the previous 15-20 years, slopes are insufficiently regenerated, losing both structural cohesion and vegetation cover.

IV. PHYSICAL VULNERABILITY CAUSED BY LANDSLIDES IN NAGALAND

Vulnerability is the human dimension of risk. In this context, vulnerability can be defined as conditions determined by physical, social, economic, environmental, political, cultural, and institutional factors or processes that increase an individual's or a community's likelihood of being affected by hazards (Birkmann et al., 2013).

The physical vulnerability caused by landslides in Nagaland is most clearly reflected in the recurrent damage to human settlements and critical infrastructure, particularly during the monsoon season. Many towns and villages are situated on or along unstable slopes, where buildings are constructed with limited adherence to engineering standards and often without formal slope stability assessments. During the

monsoon season, heavy rainfall saturates the soil, elevating pore water pressure and triggering slope failures, which result in severe disruption to daily life, displacement of communities, and destruction of property. These vulnerabilities are intensified by anthropogenic activities such as unregulated construction, improper drainage design, and deforestation linked to land use changes (Pandey, 2019).

National Highway- 29 (NH-29), one of Nagaland's most important transport corridors which also serves as the road linkage between Assam and Manipur is highly vulnerable to landslides due to its alignment through steep and geologically unstable terrain. The frequent landslides along the NH-29 have become extensive and causes road blockades almost every year during the monsoon season causing a great deal of inconvenience for trade and transportation. Frequent slope failures have been recorded along the stretch such as Pagala Pahar, Pherima Village, and the Old Kohima Municipal Council (KMC) dumping site. At Pagala Pahar, recurrent rockfalls, most recently in May 2025, which resulted in a fatality have highlighted the danger posed by unstable rock masses despite repeated mitigation attempts (Nagaland Post, 2025). In September 2024, a huge landslide in Pherima resulted in the death of six individuals while damaging several vehicles and houses (The Morung Express, 2024). Additionally, the infamous Old KMC Dumping landslide or the Dzuchie landslide has emerged as a landslide hotspot, where water-saturated waste material often spills onto the highway during heavy rains, leading to temporary closures and transport disruptions (The Morung Express, 2024). The slope is less than 15º-25º which is favourable for major landslides as it facilitates longer water retention leading to saturation of overlying mass and rise in the perched groundwater level (Belho, 2023).

V. THE SOCIO-ECONOMIC IMPACT OF LANDSLIDES IN NAGALAND

Landslides impose significant socio-economic burdens on affected regions. Landslides lead to enhanced economic losses as they necessitate large expenditures for rebuilding damaged infrastructure, rehabilitating displaced families, and maintaining emergency relief operations. The flow of debris, soil, and rock often damages homes, public facilities, and transportation systems, obstructing critical supply routes and cutting off communities. These disruptions severely limit the movement of people and goods, affecting livelihoods and access to essential services. Socially, such events frequently force the evacuation of vulnerable populations, causing long-term displacement, community fragmentation, and increased psychological distress. The breakdown in transportation networks also disrupts local markets, leading to supply shortages. As demand remains constant or rises while access to goods declines, the resulting price inflation places further financial pressure on already affected populations, compounding the socio-economic impact of the disaster (Phom, 2024).

Landslides in Nagaland have far-reaching socio-economic consequences, damaging not only the physical environment but also the livelihoods and well-being of local communities. It is a fact that properties worth lakhs and crores of rupees have been carried away by these landslides. According to the Nagaland State Disaster Management Authority, pre-monsoon weather events alone, including landslides and hailstorm caused losses exceeding ₹230 crore between March- May 2024 with Peren and Shamator districts accounting for over ₹50 crore and ₹180 crore, respectively (Eastern Mirror, 2024). In July 2024, a high-angle landslide in Alahuto Colony, Zunheboto, rendered 30 families homeless, destroyed six houses, and caused estimated damages of around ₹1 crore with another 50 households at risk, forcing relocations and exposing families to long-term economic hardship (Nagaland Tribune, 2024).

Tuensang district with its fragile terrain and predominantly hilly landscape is particularly prone to landslides. In June 2024, Tuensang town witnessed a series of landslide events primarily triggered by monsoon rainfall. The landslide led to blocking of the Tobu Road isolating local communities, hampering transportation as well as access to healthcare and emergency services (The Morung Express, 2025). These events had far-reaching social and economic consequences particularly on the most vulnerable groups. Over 378 homes were reported damaged or at risk, with 25 completely destroyed and 47 severely affected leading to the displacement of more than 750 people (Morung Express, 2024; Eastern Mirror Nagaland,

2024). Among those displaced were largely daily-wage labourers, who were unable to afford rent and lacked alternative livelihoods, a fact which was repeatedly emphasized by camp residents (Nagaland Tribune, 2024). Additionally, in Zhavame Village, Phek district, flash floods and mudslides in July 2025 destroyed hundreds of hectares of paddy fields across more than 40 households, which had an impact on both food security and agricultural livelihoods of the people of that village (Nagaland Tribune, 2023).

These instances of landslides across Nagaland highlight the extent to which such events have disrupted daily life thereby interrupting routine travel, isolating entire communities and placing a heavy financial burden on the state due to the urgent need for road and bridge restoration. The destruction of agricultural land, in particular, weakens household economies that depend on subsistence farming, forcing families to rely on relief aid and increasing their financial vulnerability. Simultaneously, blocked road networks elevate local commodity prices due to supply chain disruptions, worsening food inflation in already strained rural markets.

VI. CONCLUSION

Nagaland's landscape, dominated by steep hills and composed largely of fragile rock formations like shale and sandstone, makes it naturally vulnerable to landslides particularly during the intense monsoon season. This natural vulnerability is further aggravated by human activities such as shifting cultivation (jhum), inadequate infrastructure development, and unregulated land use, which together destabilize the slopes and increase the frequency and severity of landslide events. The complex interplay between the region's geology, climate, and human factors poses ongoing risks to both the environment and the people who depend on it.

The socio-economic consequences of landslides in Nagaland reach far beyond the immediate destruction of property and infrastructure. Frequent displacement of families, the loss of livelihoods dependent on agriculture and the disruption of vital transportation links intensify hardship in communities that are already economically vulnerable. The ongoing need for costly repairs, emergency relief, and rehabilitation amounting to hundreds of crores of rupees places a significant strain on government resources, often limiting investment in long-term sustainable development. This ongoing cycle of damage and recovery highlights the urgent need for a holistic approach to disaster management, one that integrates rigorous scientific research, meaningful community participation, and effective policy interventions which aims to strengthen lasting resilience and promote sustainable development across Nagaland's ecologically sensitive and socially vulnerable regions. To effectively mitigate and manage landslide risks, it is essential to identify hazard-prone zones and prioritize stabilization and management of specific vulnerable slopes. Alongside these efforts, implementing robust monitoring systems and early warning mechanisms at critical sites will be crucial to reduce disaster impacts and safeguard vulnerable communities.

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