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Pathing Village's Struggle against Landslides: A Socio-Economic Perspective

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Abstract

The Gaguney landslide in Pathing village, Namchi district, Sikkim, has had a profound impact on the local community, causing widespread destruction and displacement. This study examines the social and economic impacts of the landslide, highlighting the vulnerability of the local population to natural disasters. The landslide, which occurred on November 27, 2022, was triggered by heavy rainfall and has resulted in significant damage to infrastructure, including roads and agricultural land. The study reveals that the landslide has had a devastating impact on the livelihoods of the villagers, who are primarily dependent on agriculture and dairy farming. The blockage of the only road in the area has disrupted the supply chain, leading to losses for farmers and dairy producers. The study also highlights the social impacts of the landslide, including displacement, trauma, and stress among the local population. The villagers have been forced to seek shelter elsewhere, and many are struggling to access basic necessities like food, water, and healthcare. The study emphasizes the need for sustainable infrastructure development and disaster risk reduction measures to mitigate the impact of future disasters. It also highlights the importance of providing support to the affected community, including financial assistance, technical support, and infrastructure development. The findings of this study will contribute to a better understanding of the impacts of landslides on local communities and inform policy decisions aimed at reducing the risk of such disasters. The study's recommendations will be useful for policymakers, stakeholders, and researchers working in the field of disaster risk reduction and management. Overall, this study provides valuable insights into the social and economic impacts of the Gaguney landslide and highlights the need for a comprehensive approach to disaster risk reduction and management. By understanding the impacts of landslides on local communities, we can develop more effective strategies to mitigate the effects of future disasters and promote sustainable development in the region. The study's findings will be useful for developing policies and programs aimed at reducing the vulnerability of local communities to natural disasters and promoting sustainable development in the region.

Keywords: Landslides, Socio-economic impact, Livelihood vulnerability, Land-use planning, Pathing Village, Sikkim.

Introduction

India's diverse mountain chains are a result of its unique geographical location and geological history, primarily formed due to the collision between the Indian and Eurasian tectonic plates,

shaping the country's varied landscapes (Van Hinsbergen et al., 2012; Favre et al., 2015). The Indian plate's ongoing northward movement at 2cm/year causes continuous orogenic activity, rendering the Himalayas geologically active and structurally unstable due to the persistent tectonic forces shaping the region. (A. Goswami, et al., 2013). The Himalayan region's complex geological structure, characterized by folding, faulting, and thrusting, renders it prone to natural and human-induced hazards. Landslides, a significant threat, occur frequently due to gravitational forces, involving rock, earth, or debris. Triggered by natural or anthropogenic events, landslides pose a substantial danger to human life and infrastructure in the Himalayas (Oldrich Hungr, 2005). Although it plays a vital role in shaping landforms, it is of a major concern for the people inhabiting regions prone to landslides. Landslides are also known as mass wasting due to the downfall of mass. Hazards due to landslide vary naturally but majority of them are disastrous in nature. In the country landslide alone is a part of major catastrophes, it affects roughly 15% of the total geographical area of India, due to several different factors (NDMA). The country is therefore divided into different regions or zones for such. The north eastern region falls under the highest vulnerability zone and is severely affected by landslides every year. One can presumably predict future landslides but the ratio of chances is seemingly low. Since, landslides are of frequent occurrences in said regions, living along it have been in some way necessary for people.

Sikkim, situated in the young fold mountains of the Himalayas, is highly susceptible to landslides of varying severity, resulting in significant loss of life. Landslides are a frequent occurrence in the region's hilly terrain, triggered primarily by heavy rainfall and seismic activities. The instability of slopes is attributed to numerous factors, making the region vulnerable to these natural disasters. The unique geology of the area, combined with external triggers, contributes to the high incidence of landslides, posing a substantial threat to the local population and infrastructure. Landslide mitigation efforts are crucial in this region.

Study Area

Pathing Village, located in South Sikkim's Namchi district, is nestled between Yangang and Ravangla towns at N 27°18.235' latitude and E 88°23.797' longitude, with an elevation of 2208 meters. The village's geology features low-grade metamorphic rocks like quartzite and phyllite. The Gurung community dominates the population, relying mainly on agriculture and dairy farming for their livelihood. With limited government job opportunities, they depend on their farm products for daily needs. The village has a subsistence-based economy, leveraging traditional practices. The region boasts natural beauty, cultural heritage, and potential for eco-tourism. The climate is temperate, with cool winters and mild summers, supporting lush vegetation like rhododendron, oak, and pine forests. However, Pathing Village faces challenges like inadequate infrastructure, limited market access, and climate vulnerability, impacting residents' livelihoods.

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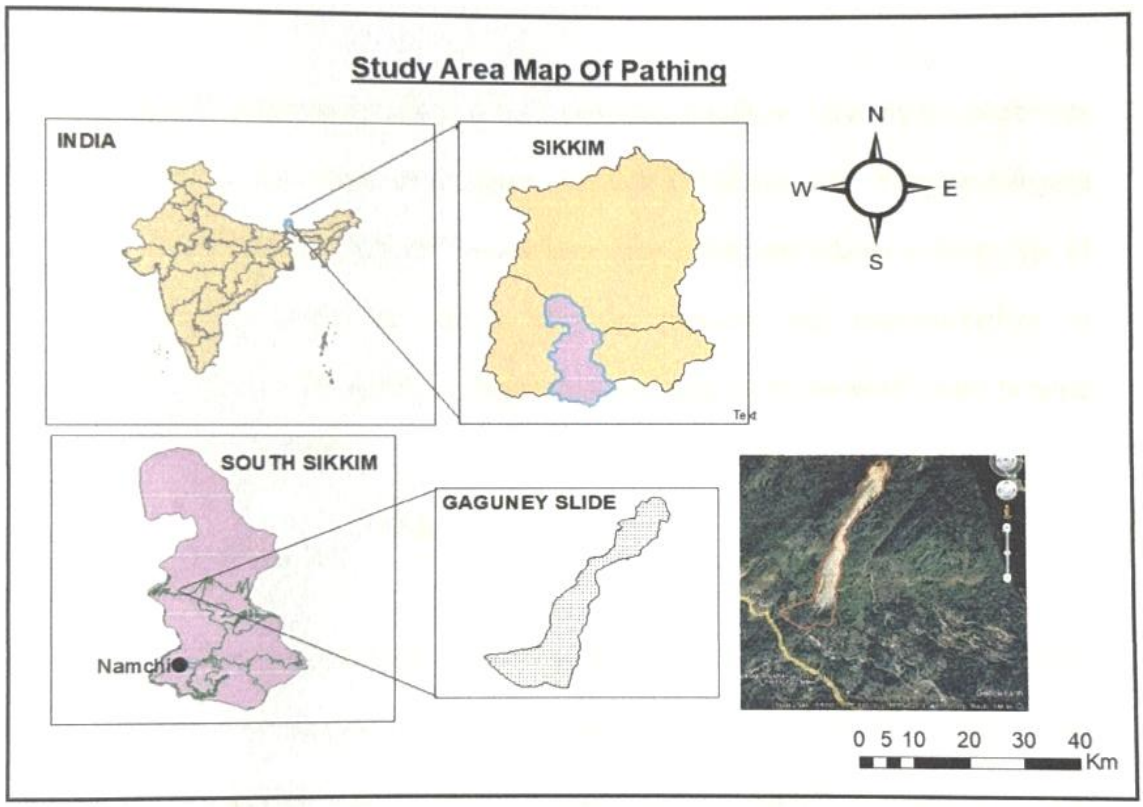
Map 1. Location Map of the Study Area



Source: *map created by researcher using ArcGIS 10.8*

Objectives

i. To analyse the impact of landslide in social and economic life of a community.

ii. To map landslide vulnerable zone for proper mitigation strategy.

Database and Methodology

This study employs a mixed-methods approach, combining qualitative and quantitative data collection and analysis methods. Primary data constitutes over 80% of the research, as there is limited existing literature on the topic. To gather primary data, multiple visits were made to Pathing Village to understand the socio-economic conditions of the study area. Structured and unstructured interviews were conducted with local residents, and data was also collected from the Village Panchayat Office and Mines and Geology Department in Gangtok, Sikkim. A total of 30 individual household interviews were conducted using random sampling, focusing on socio-economic conditions. Geographic Information System (GIS) tools, specifically (AreGIS) version 10.8 and Google Earth Pro, were utilized to create cartographic representations, including a location map. These tools enabled efficient data visualization and analysis. Secondary data sources, including articles, journals, reports from NGOs and government institutions, were also used to supplement primary data. The combination of primary and secondary data, along with GIS analysis, provides a comprehensive understanding of the socio-economic conditions and landslide vulnerability in Pathing Village.

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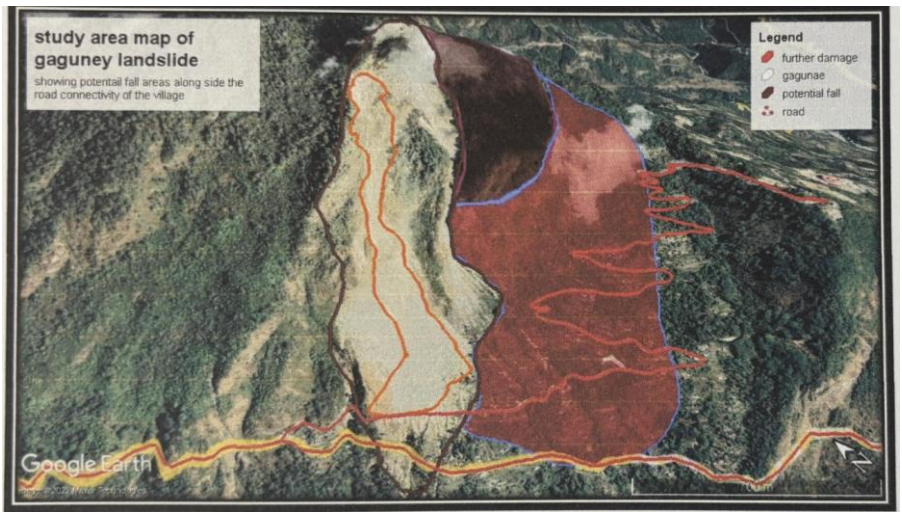
Results and Discussion

The Himalaya's rapid tectonic uplift leads to swift river incision, resulting in steep mountain slopes. These slope's extreme steepness indicates that many are near their stability limits, making the region prone to geological instability and landslides due to the ongoing tectonic activity and erosion processes. (J. Gerrared, 1990). The Himalayan region, including Sikkim, is prone to landslides due to its geomorphologic instability. During the monsoon season, thousands of landslides occur, triggered by intense rainfall. This natural phenomenon severely impacts the region, damaging roads and disrupting transportation networks annually. Forests and agricultural lands also suffer, as erosion destroys plantations and hinders growth. Areas with softer rocks, such as phyllites and schists of the Daling group, are particularly vulnerable to mass wasting. The region's fragile geology, combined with heavy rainfall, makes it susceptible to landslides, which have significant environmental and economic implications. Effective measures are needed to mitigate the impact of landslides and protect the region's infrastructure and natural resources. Landslide management strategies can help reduce the risk and promote sustainable development in Sikkim. (DMMG). Pathing Village in Namchi district's Yangang subdivision, South Sikkim, is highly susceptible to landslides due to its geology, comprising low-grade metamorphic rocks like quartzite and phyllite. A devastating landslide occurred on November 27, 2022, impacting the village's livelihood. The topography is characterized by an older landslide with a sparse village situated below it, making the region fragile and prone to landslides. The socio-economic condition of the region is fairly good, with 90% of the population engaged in primary activities like farming and dairy, and 10% in government sectors and tourism. The disaster prompted government intervention, with officials visiting the site and providing financial aid. The Geological Survey of India is conducting a detailed study to determine the best course of action. The villagers, reliant on agriculture and dairy farming, are struggling to meet their basic needs and are hopeful for government support to rebuild their lives. With its unique geology and vulnerability to landslides, Pathing Village requires sustainable development initiatives to mitigate the impact of such disasters and promote resilience among its residents.

Map 2. Areal Map showing affected zone of Landslide



Source: *Map created by researcher using Google Earth Pro*

Land use and land cover with soil

The study area's land use and land cover are primarily composed of forest, agriculture, and settlements. The region's geology, characterized by the Daling sequence of rock formation, makes the slopes highly susceptible to weathering, erosion, and landslides. According to the National Bureau of Soil Survey (1994), the area encompasses all five physiographic zones, each with distinct soil characteristics.

The soils in the study area vary according to the physiographic zones:

1. Summit and ridge tops: Steep slopes (>30% angle) have coarse-grained soils with rock fragments, while moderate slopes (15-30% angle) exhibit thick, well-drained fine loamy soils.

2. Side slopes of hills: Steep slopes (>50% angle) have extensively drained coarse to fine loamy soils with occasional surface stones.

3. Valleys: Excessively drained loamy skeletal soils with slight stoniness and moderate erosion.

4. Cliff and precipitous slopes: Extensively drained loamy skeletal soils with strong stoniness and severe erosion.

Overall, the soils in the study area are predominantly loamy, with varying degrees of drainage, stoniness, and erosion. The diverse physiographic zones and soil characteristics highlight the region's complex geology and susceptibility to landslides. Understanding these soil properties is crucial for land use planning, agriculture, and disaster mitigation in the study area. The unique combination of geology, soil, and land use makes the region prone to erosion and landslides, emphasizing the need for sustainable land management practices.

Table 1. Description of Gaguney Landslide

Sl. No.	Particulars	Remarks
1	Name of the Slide	Gaguney Landslide
2	District	Namchi
3	Sub-Division	Yangang
4	Geographical Coordinates	Latitude- 27°18.235’ N , Longitude-88° 23.797’E
5	Altitude	2208 amsl
6	Lithology	Quartzite and Phylites
7	Grade of Rock	Low grade Metamorphic Rock
8	Slide Type	Rotational cum debris slide

9	Slide material	Highly weathered fractured/ jointed quartzite phylites rock intermixed with silty soil
10	Triggering factor	High rainfall pattern leading to high weathering of rock
11	Dimensions of Slide	Length- approximately 930 m, Breadth- approximately 260 m
12	Water activity	Medium
13	Household affected	75 households
14	Infrastructure affected	Dozok-Yangang road

Source: *Department of mines and Geology, Gangtok Sikkim, 2023*

A Background of the Landslide

The Gaguney landslide in Pathing village, located in the Yangang-Rangang subdivision of Namchi district, Sikkim, is a catastrophic event that has left a lasting impact on the region. Geographically situated at N27°18.235' E 88°23.797', between the towns of Ravangla and Yangang, this infamous landslide has been a subject of concern for over 20 years, according to local inhabitants. The landslide, which is visibly dry and composed of loose sediments of weathered rock fragments and boulders, has been in motion since October 2021 and again in November 2022, catching the residents off guard and inducing widespread panic. The abrupt nature of the landslide has created an atmosphere of fear and anxiety among the villagers, who are struggling to cope with the disaster. The area's geology plays a significant role in the landslide's occurrence, as it falls under the Daling group of rock formations, known for their weaker geological structure. This natural predisposition, combined with the region's exposure to harsh weather conditions, including heavy downpours and prolonged heat waves, has exacerbated the landslide's impact. The rotational nature of the landslide, classified according to Verners classification, has led to a significant increase in size over time, with the surface area of rupture eroding and widening substantially. The steep slope of the land further contributes to the constant shooting of weaker jointed and fractured rock segments, posing a significant threat to the lives and livelihoods of those living in the vicinity. The Gaguney landslide has undergone numerous decades of varying intensity and types of weather conditions, which have cumulatively contributed to its downward movement. Not only has the landslide grown in size, but it has also exhibited substantial displacement of the crown and lengthening of the toe, with a new route downslope emerging adjacent to the previously existing one. This has created a sense of uncertainty and vulnerability among the local population, who are witnessing their homes, livelihoods, and environment being slowly destroyed by the debris. The impact of the landslide extends beyond the immediate victims, affecting the social and economic aspects of life for those in neighbouring areas as well.

The consequences of the Gaguney landslide are multifaceted, with far-reaching implications for the environment, society, and economy. The disaster has not only damaged the natural landscape but also disrupted the delicate balance of the ecosystem, leading to a loss of biodiversity and ecosystem services. Moreover, the landslide has created unrest among the

local population, who are struggling to cope with the trauma and stress caused by the disaster. The economic implications are also significant, with the landslide affecting agricultural productivity, infrastructure, and tourism, ultimately hampering the region's development prospects. In light of these findings, it is essential to develop strategies for mitigating the impact of landslides in the region. This can be achieved through a combination of measures, including land-use planning, infrastructure development, and community-based initiatives. By understanding the complex relationships between geological, meteorological, and socio-economic factors that contribute to landslides, policymakers and stakeholders can work together to reduce the risk of such disasters and promote sustainable development in the region. Ultimately, the Gaguney landslide serves as a reminder of the importance of disaster preparedness and mitigation, highlighting the need for proactive measures to protect the lives and livelihoods of those living in landslide-prone areas.

Impact of Gaguney Landslide on Pathing Village

Social and Humanitarian Impacts

The social impacts of the Gaguney landslide in Pathing village have been profound and far-reaching, affecting the daily lives of the inhabitants in numerous ways. The disaster has caused significant disruptions to the community, leading to a range of social issues that are similar to those experienced in other disaster-affected areas. The need for rebuilding, urgent access to healthcare, and basic necessities like food and water have become pressing concerns for the villagers. The traumatic nature of the event has also taken a heavy toll on the mental health of the residents, leaving many in a state of distress, dismay, and depression. The emergency situation created by the landslide has been extremely stressful and disruptive for the affected community, causing widespread trauma and upheaval. The entire village has been uprooted, with friends and families divided, and homes, livelihoods, and lives endangered or lost. The aftermath of the disaster has led to a significant level of post-traumatic stress among the community members, making recovery a challenging and arduous process. The villagers, who have survived and succumbed to the previous landslide that occurred decades ago, are now facing new challenges and greater threats to their community. The recent landslide, which began showing signs of rockfall after the monsoonal period in October 2021, has had a devastating impact on the villagers. As the landslide grew in momentum and widened its surface of rupture, the locals were met with unprecedented obligations, forcing them to acknowledge and seek help from the government. The destruction of houses and agricultural farmland, which was the primary source of income for the inhabitants, has further exacerbated the social impacts of the disaster. The massive landslide that occurred on November 27, 2022, adjacent to the previous one, was the final blow, leaving the inhabitants with no choice but to flee their homes and seek shelter elsewhere.

The narratives of the locals and victims of the landslide paint a vivid picture of the social impacts of the disaster. The fear and anxiety that grip the villagers every time the landslide shows signs of movement are palpable. The constant threat to their lives and livelihoods has created a sense of uncertainty and vulnerability, making it challenging for them to cope with the situation. The social fabric of the community has been severely strained, with many families struggling to access basic necessities and services. The impact of the landslide on the

social life of the villagers is multifaceted, affecting various aspects of their daily lives. The disaster has disrupted social networks and relationships, causing widespread trauma and stress. The loss of homes, livelihoods, and community infrastructure has further exacerbated the social impacts, making it challenging for the villagers to rebuild their lives. The need for external support and aid is evident, and the government and other stakeholders must work together to provide the necessary assistance to help the community recover from this devastating disaster. The social impacts of the Gaguney landslide in Pathing village are a stark reminder of the devastating consequences of natural disasters on human communities. The disaster has caused widespread trauma, disruption, and loss, affecting the daily lives of the inhabitants in numerous ways. It is essential to provide immediate support and aid to the affected community, while also working towards long-term recovery and rehabilitation efforts. By understanding the social impacts of the disaster, we can develop more effective strategies to mitigate the effects of future disasters and promote sustainable development in the region.

Economic Impact and Infrastructure Damage

The economic impacts of the Gaguney landslide in Pathing village have been substantial, with far-reaching consequences for the local community. The disaster has caused significant direct and indirect losses, affecting the livelihoods of the villagers and the overall economic stability of the region. The blockage of the only road in the area, which was a crucial transportation network for the villagers, has had a devastating impact on their daily lives. The villagers, who are primarily dependent on agricultural produce and dairy products for their income, have faced serious problems in accessing markets and selling their products. The economic impact of the landslide is multifaceted, with both short-term and long-term consequences. In the short term, the blockage of the road has disrupted the supply chain, leading to losses for farmers and dairy producers. The villagers have had to find alternative routes, which has increased transportation costs and reduced their profit margins. The damage to the road infrastructure has also affected the connectivity between Pathing village and neighbouring towns, such as Ravangla and Yangang, which has had a ripple effect on the local economy. The economic losses incurred by the villagers are significant, with many families struggling to make ends meet. The landslide has destroyed crops, damaged agricultural land, and affected the livestock, leading to a substantial decline in agricultural productivity. The dairy industry, which is a significant contributor to the local economy, has also been severely impacted, with many dairy farmers struggling to maintain their livestock due to the lack of access to markets and veterinary services. The vulnerability shadow cast by the landslide is extensive, with the economic impact felt beyond the immediate area. The neighbouring towns of Ravangla and Yangang have also been affected, with the damage to the road infrastructure causing disruptions to trade and commerce. The lack of access to markets and services has increased the vulnerability of the local population, making it challenging for them to recover from the disaster.

The economic impact of the landslide is not limited to the immediate effects of the disaster. The long-term consequences of the landslide will be significant, with potential damage to the local economy and infrastructure. The landslide has highlighted the need for sustainable

infrastructure development and disaster risk reduction measures to mitigate the impact of future disasters. The government and other stakeholders must work together to provide support to the affected community, including financial assistance, technical support, and infrastructure development. In addition to the direct economic losses, the landslide has also had indirect economic impacts, including the loss of tourism revenue and the decline of local businesses. The disaster has affected the overall development prospects of the region, making it challenging for the local economy to grow and develop. The landslide has also highlighted the need for disaster risk reduction and management measures to be integrated into development planning, to ensure that the local economy is resilient to future disasters. In conclusion, the economic impacts of the Gaguney landslide in Pathing village are significant, with far-reaching consequences for the local community. The disaster has caused substantial direct and indirect losses, affecting the livelihoods of the villagers and the overall economic stability of the region. It is essential to provide immediate support and aid to the affected community, while also working towards long-term recovery and rehabilitation efforts. By understanding the economic impacts of the disaster, we can develop more effective strategies to mitigate the effects of future disasters and promote sustainable development in the region.

Narrative Accounts of the Landslide Victims

The devastating landslide in Pathing village has left an indelible mark on its residents, causing widespread destruction and disrupting the lives of the villagers. For over two decades, the villagers had grown accustomed to occasional landslides, but nothing could have prepared them for the catastrophic event that ravaged their homes and livelihoods. The landslide's impact on agriculture has been particularly harsh, with many farmers losing their land and livelihoods. The villagers, who are primarily farmers, have seen their agricultural land and livestock, which were their primary sources of income, destroyed or severely affected. The landslide has also caused significant damage to roads and infrastructure, making it difficult for the villagers to access basic necessities like food, water, and medical care. Mr. Tika Ram, a 76-year-old farmer, recalled the early signs of the landslide, which initially caused minor damage to roads and infrastructure. However, over time, the landslide's intensity and frequency increased, rendering the once-peaceful village uninhabitable. The villagers were forced to abandon their homes and livelihoods, seeking shelter in safer areas. The landslide has had a significant economic impact on the villagers, with many losing their primary sources of income. The loss of businesses has not only affected the owners but also the employees who depended on these ventures for their livelihood. The villagers, who were once self-sufficient, are now struggling to make ends meet. Mr. M.L. Gurung, a 45-year-old business owner, saw his hotel business come to a standstill, resulting in a substantial loss of revenue. Similarly, Mr. D.B. Gurung's homestay business, which had been operational since 2006, was forced to shut down due to the landslide. The loss of businesses has caused significant economic distress, and many families are struggling to cope with the loss of income. The villagers were forced to relocate to safer grounds, leaving behind their homes, land, and livelihoods. The displacement has caused significant social and emotional distress, with many struggling to cope with the uncertainty of their future. The village's children, like Ms. Isha Gurung and Master Bishal Gurung, have been particularly affected, with their education and well-being compromised due to the disaster.

The villagers are facing significant challenges in adjusting to their new reality. Many are struggling to access basic necessities like food, water, and shelter. The displacement has also caused significant emotional distress, with many villagers feeling anxious and uncertain about their future. The landslide has also taken a toll on the physical and mental health of the villagers. The stress and uncertainty of their situation have affected not only the adults but also the children, who are struggling to come to terms with their new reality. Many villagers are experiencing anxiety, depression, and other mental health issues due to the trauma caused by the disaster. Mrs. Bishnu Gurung, a 38-year-old homeowner, spoke about the serious health and mental issues that have arisen due to the disaster. The villagers are in dire need of mental health support and counseling to help them cope with the trauma caused by the landslide. The villagers are now struggling to survive, with many facing difficulties in accessing basic necessities like food, water, and fodder for their livestock. The villagers are in dire need of support and assistance to rebuild their lives and restore their livelihoods. Mrs. Tara Devi, a 54-year-old farmer, spoke about the loss of her home and agricultural land, which has left her family without a steady income. The villagers are struggling to cope with the loss of their livelihoods and are in need of support to rebuild their lives.

Conclusion

The Gaguney landslide in Pathing Village, Sikkim, has brought to the forefront the complex and multifaceted nature of natural disasters in the Himalayan region. This study has demonstrated that the impact of landslides extends far beyond the immediate physical damage, affecting the social, economic, and environmental fabric of the community. The findings of this research underscore the need for a comprehensive approach to disaster risk reduction and management, one that takes into account the unique geological, meteorological, and socio-economic factors that contribute to landslides in the region. The study's results highlight the significance of understanding the local context and the importance of community-based initiatives in mitigating the impact of landslides. The villagers' narratives and experiences provide valuable insights into the social and economic impacts of the disaster, emphasizing the need for external support and aid to facilitate recovery and rehabilitation efforts. Furthermore, this research emphasizes the importance of integrating disaster risk reduction and management measures into development planning to ensure that the local economy is resilient to future disasters. The study's findings have significant implications for policymakers, stakeholders, and local communities, underscoring the need for proactive measures to protect the lives and livelihoods of those living in landslide-prone areas. Ultimately, this study contributes to the growing body of research on landslides in the Himalayan region, highlighting the need for continued investigation and analysis to better understand the complex dynamics of these natural disasters. By exploring the impact of landslides on communities and the environment, this research aims to inform and support the development of effective strategies for mitigating the effects of future disasters and promoting sustainable development in the region.

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