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Environmental Hazards and Management with Reference to Human-induced Disaster and its Impacts: A Case Study of Stone Quarry at Aizawl South, India

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ABSTRACT

The term "landslide" refers to a wide variety of motions of earth elements that occur downslope and cause soil, rock, and plant life to move perceptibly downward and outward as a result of the force of gravity. The magnitude and frequency of landslides in mountainous terrains can vary greatly, and each one can cause significant harm to both human life and property. Also, the interruption of the communication network is caused when there are frequent blockages. In addition, the region's geological environment has been negatively impacted, and it is in a state of permanent danger due to the fact that its many components are continuously deteriorating. An estimated eighty percent of all landslides that occur in other parts of the world are caused by human activity. This study is a case study that looks at the geological features that make the soil more likely to slide, as well as the effects of those features and what can be done to stop or lessen them. The study was done in relation to the slope instability of the South Hlimen landslide.

Key words: *Environmental hazards, Stone quarry, Aizawl*

Introduction

"Landslides" refer to all kinds of large-scale movements of hill slopes, including the falling, sliding, and flowing of slope-forming materials over surfaces of separation made of rocks, soils, artificial fills, or a combination of all these materials, fast or slowly. Although landslides frequently occur in hilly regions, they can also happen where surface excavations are being made for roads, buildings, or open pit mines.

In practically every region of the world, particularly in mountainous areas, landslides are regarded as one of the primary environmental risks. Every year, a great deal of priceless life and property are lost in many areas of the world due to the unexpected and unforeseen onset of this tragedy. Buildings fall, communication networks are down, roads are obstructed, construction projects are put on hold, and other buildings are left unusable.

Anthropogenic influences are thought to be the cause of 80% of all landslides in different places of the planet. When it comes to landslides, even the state of Mizoram is classified as an extremely high-risk zone. Since this phenomenon poses a serious threat to the environment, it is crucial to understand its causes, effects, and potential solutions.

The distance from Aizawl to the study location is

only 7 kilometres. It is the location of one of Mizoram's most well-known quarries. On August 9, 1992, a stone quarry 300 metres in length and 2050 metres in thickness collapsed in this location, causing widespread destruction. Almost sixty individuals, including villagers and workers, perished as a result of this tragedy. .

Study Area

The research area is in the village of South Hlimen, which is about 7 kilometres south of Mizoram's capital city of Aizawl. The location is between latitudes 23° 40' and 23° 40" 944" N and longitudes 92° 42' and 92° 42' 985" E. The research area measures 243.84 m in length and 396.34 m in width. It has a floor size of roughly 96643.54 square metres.

The terrain is steep, and the elevation in the area is between 1000 and 1100 metres. The site's highest point is 1065 metres above sea level and is mostly made up of Tertiary rocks from the Bhuban subgroup. An uneven layer of soil primarily made up of alternating thinly bedded shale covers the rocks. Because of the compactness and hardness of the stones, Hlimen, where the study area is located, is well-known for quarrying in the state. The study area is divided by a road that links to the nearby village of Lungleng.

Mizoram is located in a monsoon-influenced climatic zone. The region experiences a dry season from November to April and a wet season from May to October that receives an average annual rainfall of 250 cm. Winter temperatures at the location of the study can fluctuate between 17 °C and 27 °C.

Geology and Relief

Landslides are widespread in the hilly terrains of the northeastern areas, as they are elsewhere in the highlands. They occur in the region at varied magnitudes and frequencies, causing significant damage to human property and life. Furthermore, frequent obstructions impair the communication network. Furthermore, the region's geo-environment is being harmed and is in constant risk as its various aspects deteriorate.

The region is classified as part of the Upper Bhuban unit, which is part of the Bhuban Subgroup and dates back to the Tertiary. The types of rock that are exposed in this region include sandstones with densely alternating beds of shale that have thinly alternate beds. The sandstones in the quarry range in colour from grey to brown, have fine to medium-sized grains, are tightly packed, contain mica, and are moderately hard. The cementing material in the sandstones is of variable composition, including calcareous, arenaceous, ferruginous, and so on. In addition to having a colour ranging from grey to brown, the shales are micaceous, thinly laminated, and on occasion clayey.

Rock formations at the quarry site generally incline in a north-south direction, with a dip of 45 degrees due west, and are cut through by joint planes that tend to run east-west. Because both the bedding planes and the joint planes are devoid of surface aspirates, the resulting planes of structural discontinuities are comparatively smooth. Because of the flat, smooth structure of the rock in this area, the plants that grow there do not have roots that go very far below. After the vegetation covers have been removed, the soil composition is more likely to become quickly loosened by the direct rainfall, which then results in a rapid slide down the slope. There is a road that runs right down the middle of the hillside.

As Mizoram's physical landscape is primarily made up of mountainous terrain made of tertiary rocks, the relief condition is one of the key physical variables impacting landslides. The mountain ranges are parallel and oriented from north to south. River valleys that are deep and slender divide the ranges. The study location is situated on a mountain range's side slope that extends from Melthum's outskirts. This region's terrain is undeveloped and young. It displays relief characteristics with slopes that are not too steep. The physiographic division category for Mountainous Terrain Province includes the research area. The elevation is between 1000 and 1100 m above mean sea level, and the slopes are relatively steep. The study region has a slope degree of around 45°, which is sufficient for slope failures to develop.

Objective of the Study

1. To get an understanding of the factors that contributes to unstable slopes;
2. To investigate the impact of landslides and to make recommendations for their prevention.

Methodology

Since the purpose of the study is to gain an insight into the geological structure, causes of slope instability that result in frequent landslides, consequences

or effects, and mitigation strategies, it is primarily based on field observations. It was necessary to conduct interviews with the locals in order to obtain information on the historical backdrop, as there is no secondary source for the collection of data.

It is feasible to identify zones with comparable features, such as those susceptible to landslides, based on research of topographical conditions in areas affected by prior or ongoing landslides. A region is susceptible to such failures if its topographical characteristics are comparable to those of a location where a terrain failure has already occurred. Many indicators of instability allow us to investigate the landslip zone.

With the current trends in quarry operations, it is simple to comprehend the causes of slope instability in the research region. Human activities, such as the use of explosives, are the single most influential factor, along with tropics and heavy rains, in diminishing the cohesive strength of joint planes.

The use of GPS is beneficial for determining the real dimensions and location of the study area. The elevation above mean sea level is measured using this method. Photo interpretation provides valuable information on topography aspects such as slope, soil qualities, and land use patterns, among others.

Sources of Data

The data on the research area is acquired primarily from primary sources. The primary data consist of:

i) Fieldwork: To learn more about the process and instability components involved in terrain failures, the landslide location is first investigated and field observations are made there. The current study takes into account the regions where terrain collapses occur, or where landslides begin. It is possible to get important information about terrain characteristics, such as slope, soil properties, land usage, etc., with the help of photo-interpretation and field observation. With the aid of a measuring tape, the area is actually measured.

*ii) Application of Global Positioning System (GPS):*The precise location of and the acceleration in landslide movement are determined using The GPS is often utilised in this observation to identify the specific location of the study area and its height above mean sea level. The apparatus is highly automated, and its operation requires little labour.

Because there is insufficient secondary information regarding the research area, the material is derived primarily from primary data sources. However, the geological structure of the study region is based on a research paper named 'South Hlimen landslides in Mizoram (a pointer)'. The physical environment, climate, vegetation, soil, and landslides are also studied in books and periodicals.

Causes of Instability

Many factors, such as geology, gravity, the weather, groundwater, wave movement, and even human activity, can lead to the occurrence of a slide. Landslides are more common on steep slopes, but they can also occur on flatter terrain. Slope failures related to quarries and open-pit mines, ground failures of river bluffs, collapses of cur and fill that may follow highway and building excavations, and the collapse of mine-waste heaps are all potential causes of landslides. Underwater landslides in lakes, reservoirs, or offshore marine settings often occur in low relief areas with modest slope gradients. When these conditions are met, landslides are common.

Hlimen is widely considered to be the best and largest quarry in our state. Since the stones are dense and tough, they can be used in a variety of construction methods. Natural vegetation occupied the region before the quarry operation began, and gardens belonging to nearby residents took over portion of the space. The native population benefits greatly from these natural vegetations, as they are used to construct homes and other buildings.

The road cuts right into the midst of the hillside where people live.

Little landslides have been common for a very long time, and this continues to the present day. The land was not used as a quarry at first, but in 1974 the idea to turn it into one was conceived, and beginning in 1975 the land began to be used as a stone quarry. These quarry grounds are owned by the neighbourhood residents. In the beginning, the stones extracted from this quarry were only used for fulfilling the needs of the immediate community. A commercial expansion occurred after a few years of this endeavour. This quarry is one of the most important sources of construction materials for the city of Aizawl.

Stone-cutting at this quarry eroded its foundation, leading to a historic calamity on August 9, 1992. Sadly, many construction workers were killed, and numerous homes and businesses were wrecked, during the course of this disaster. Twenty-two houses, as well as eight stone crushers and air compressors, were destroyed. Seventy people were re-

ported dead and roughly Rs. 100 lakh worth of property was destroyed or stolen in this incident. State officials listened to locals' concerns about the safety of their hamlet and shut down the quarry for three years. It has just resumed normal operations. The eroded hillside is once again the site of small-scale mining, and boulders are being collected.

It is implied that reckless quarrying is to blame for the collapse of the slope. Slope instability, however, was further aided by the local geology and the area's geography. In its natural state, the area is covered in dense vegetation before quarrying operations begin. Although locals clean this vegetation, severe rain and gravity nonetheless quickly transport the materials.

The blocky composition of the sandstones also plays a role in this instability. The large north-south and east-west sandstone slabs are the result of the structural discontinuities' intersecting planes. As more and more toe material disappeared, the natural support for the uphill blocks weakened. The instability that resulted caused these objects to get dislodged and roll along the bedding plane.

The excavation process can be sped up with the help of explosives. Cracks, both little and large, formed as a result of the intense blasting. When the clay fillings in these joints became saturated with rainwater, they developed extremely brittle joint planes. Moreover, they have aided in the speedy descent of massive sandstone boulders. The tropical temperature and excessive rainfall further weakened the cohesiveness of the joint planes.

Findings

The Aibawk R.D. Block is the location of the current study, which takes place in South Hlimen. This block is situated approximately 7 kilometres south of Aizawl city. Due to the blocky nature of the rocks in this area, the possibility of a catastrophic landslip occurring here on August 9, 1992 was low. However, as a result of the persistent removal of toe material and in conjunction with rain water, the natural support for the uphill block was gradually losing strength, and the cohesive strength of the joint planes was further reduced; ultimately, these were subject to free fall along the bedding planes. In Mizoram the occurrence of landslides is primarily caused by human activity.

South Hlimen Quarry is recognised as being among the most productive quarries in Mizoram within the scope of the present research. Theoperates at a significant scale, providing significant quantities of stones for use as building materials for both residential and commercial construction projects. This quarry is now providing employment for a significant number of families, which helps them maintain their standard of living. Every day, a sizeable number of truckloads are extracted from the site. There are no large landslides occurring in this region any longer.

The current study sheds light on the factors that led to and were affected by landslides in the area under investigation. It is a region that was formerly home to one of the most successful quarries that has been discovered in our state. The geological structure, the topographic features, and human influence are the primary variables that contribute to the occurrence of landslides. Human actions are also one of these fundamental contributors. The most significant contributor to landslides in this region is the quarrying activity, which is carried out in a haphazard manner without first conducting a comprehensive survey of the terrain. In addition to this, it is situated along the sides of the highways, and the excavation of stones begins at the foot of the hill and works its way up, which is not the correct method for quarrying activities. The natural support provided by the uphill block is weakened when the toe materials are removed, which results in free fall along the bedding planes.

The area was formerly covered with nearly dense natural vegetation, and the roots of the trees used to bind the soils together. Because of this, the soils are resistant to erosion and do not slide readily. The felling of trees makes it possible for rainwater to penetrate the ground without going through any intermediary channels. As water completely permeates the soil, it transforms into a loose, mushy substance that is prone to slide. In addition to that, there is not an adequate drainage system in this region. In addition, explosives are utilised in this region in order to hasten the process of stone excavation. This results in the formation of major and minor cracks, which allow water to seep in. As a result, the cohesive strength of the stones is diminished, which ultimately causes the stones to tumble more quickly. As a direct consequence of this, the villagers are reluctant to build residential homes along the roadsides. In the event that this specific kind of quarry activity continues to be carried out, the incidence of accidents in the years to come is unavoidable.

In order to take care of themselves and their families, a significant number of people go to work each day. This quarry supplies between 13 and 15 truckloads of stones per day to meet the ever-increasing demand for construction materials brought on by the rapid pace of urbanisation and the expansion of developmental endeavours. The reason for this demand is to satisfy the ever-increasing demand for construction materials brought on by the rapid pace of urbanisation and the expansion of developmental endeavours.

Quarrying work is carried out in a haphazard manner without first conducting an accurate study of the area. As was pointed out earlier, in this quarry in 1992 there was a catastrophic landslip that resulted in the loss of life for a number of workers as well as a significant number of properties. In addition, a significant landslip took place in 1995; however, in comparison to the one that took place in 1992, this one was not deemed to be as catastrophic. In addition to this, there have been several landslides in the same region up till the present time.

In the event that quarrying operations continue to be conducted using the approach that is now in use, the risk of landslides occurring in the future will be unavoidable. The good news is that there hasn't been any big landslip, so the quarry work may continue as normal. In the same vein, it is strictly forbidden to make use of explosives anywhere other than in designated safety zones.

Suggestion for Mitigation Measures

The state's quarry operations are carried out in a fashion that is the furthest thing from scientific, and the excavation begins from the bottom of the hill and works its way up, which is not the correct method for quarrying. The following suggestions are recommended in order to ensure that quarrying is carried out without incident and to reduce the likelihood of landslides and the damage they cause:

1. Because the Quarry is thought to be the principal cause of the recent landslides, the best and most effective strategy to prevent more landslides is to close it down immediately.
2. There should be a significant increase in the amount of land that is forested in order to reduce the amount of land that is degraded by landslides and soil erosion.
3. To conduct extensive awareness campaigns not only among the local communities but also among the government officials and departments that are concerned regarding the causes of landslides, the negative impacts of landslides on socioeconomic, political, and environmental systems, and the mitigating measures.
4. The removal of stones should begin at the highest point and work its way downward, creating benches along the route as recommended for quarrying activities.
5. The use of explosives is restricted to the legal parameters set out.
6. Prior to the beginning of the quarrying activity, a comprehensive survey of the site is carried out.

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